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Petition for Determination of Non-regulated Status for Freeze Tolerant Hybrid *Eucalyptus* Lines

The undersigned submit this petition under 7 CFR Part 340.6 to request that the Administrator make a determination that the article should not be regulated under 7 CFR Part 340.

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Certification

The undersigned certify, that to the best knowledge and belief of the undersigned, this petition includes all information and views on which to base a determination, and that it includes all relevant data and information known to the petitioner which are unfavourable to the petition.

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Executive Summary

ArborGen Inc. is submitting this Petition to USDA-APHIS-BRS to request a determination of non-regulated status for Freeze Tolerant *Eucalyptus* (FTE) lines 427 and 435 and plants propagated from these lines under 7 CFR Part 340. The pulp and paper industry is a major economic sector in the southeastern United States, with annual global shipments of paper products valued at almost $60 billion. Hardwood trees in the Southeast are a critical feedstock component for this industry. A reliable, high quality and cost-effective hardwood supply is necessary to sustain the pulp and paper industry in the United States, both to meet domestic demands and retain a competitive position in global markets. Hardwood supplies in the United States are projected to experience increasing demands, both from the pulp and paper sector as well as emerging new bioenergy applications. Despite this, hardwoods are not extensively planted and managed in dedicated stands due in part to the cost of plantation establishment, and their relatively slow growth and corresponding long rotation time to harvest. The development of purpose-grown hardwood trees with fast growth rates and short harvest cycles is one of the effective solutions to address hardwood supply challenges anticipated in the southeastern United States.

Eucalyptus species are among the fastest growing woody plants in the world and represent about 8% of all planted forests (~18 million hectares) grown in 90 countries (FAO, 2007). While there are over 700 *Eucalyptus* species identified, only a limited number are grown commercially. *Eucalyptus* is a preferred fiber source for the global pulp and paper industry, both for its fiber qualities and productivity. It has been the focus of extensive breeding and tree improvement programs aimed at enhancing desirable wood properties such as basic density, cellulose content, fiber length and improved growth (Raymond, 2002). There is a range in freeze sensitivity among the *Eucalyptus* species, however the most productive *Eucalyptus* species favor tropical to sub-tropical conditions, and the preferred fast-growing pulp species show very limited tolerance to freezing temperatures. Attempts have been made to grow a wide variety of *Eucalyptus* species in several parts of the southeastern US but in many cases these species have been unable to withstand the dramatic and sudden drops in temperature that are typical of the region. Efforts to improve the freezing tolerance of fast growing species through controlled crossing with inherently freeze tolerant (but slower growing) temperate *Eucalyptus* species have in the past not been very successful. Currently, large scale plantings of *Eucalyptus* in the southeastern US are limited to regions of central and southern Florida. However, non-genetically engineered *Eucalyptus* is actively being developed by a number of research programs as an alternative fiber and biomass source for the U.S. south and can reasonably be expected to be established in forest plantations across the region in the near future.

Scientific advancements in understanding the cold acclimation process allowed the discovery of transcription factor genes common to the plant cold-response pathway (Jaglo-Ottsen et al., 1998; Stockinger et al.; 1997, Gilmour et al., 1998; Liu et al., 1998; Kasuga et al., 1999). The discovery of cold tolerant genes combined with the development of efficient *Argobacterium*-mediated gene transfer methods for *Eucalyptus* species has allowed the development of genetically engineered FTE lines as described in this Petition. FTE lines included in this Petition were developed by the introduction of the C-Repeat Binding Factor (*CBF2)* gene from *Arabidopsis* into a fast growing but freeze susceptible commercial hybrid genotype of *E. grandis x E. urophylla.* The potential for reduced growth by over-expression of *CBF* genes in the FTE lines has been significantly mitigated by the use of a cold-inducible promoter that limits the expression of the *CBF* gene under conditions where this would not be desirable. In addition to the *CBF2* gene, these FTE lines contain a selectable marker used extensively in plant transformation and a gene expression cassette that prevents pollen development. This pollen control cassette provides an additional level of confinement by restricting gene flow from the FTE lines. However, the inclusion of pollen control mechanism has only limited bearing on the consideration for deregulation of FTE lines because the existing biological limitations of *Eucalyptus* species, when grown in the southeastern US, would in themselves serve as an effective barrier to gene flow.

The FTE lines included in this Petition were subject to detailed molecular characterization of the inserted DNA. These analyses confirm the insertion of a single T-DNA insert with intact gene cassettes integrated at a single locus within the *Eucalyptus* genome. The results also indicate the absence of any notable backbone sequence from the plasmid used for transformation. Analyses performed on the translines using Western blots indicated that CBF2 protein expression is too low to detect which is consistent with the scientific literature. However, RNA analysis confirmed detectable levels of transcription in response to cold. The field data for the FTE lines under a freeze-stress environment provides convincing evidence that the freeze tolerant phenotype is correlated with the induced expression of the inserted *CBF2* gene.

Field performance of FTE lines 427 and 435 was assessed under authorized APHIS-BRS Notifications and Permits at multiple sites representing both freeze stress and freeze stress-free environments across the southeastern US. Performance of selected freeze tolerant lines 427 and 435 was assessed in 21 field trials established at 8 different locations representing USDA Hardiness Zones 8a (potential kill zone), 8b (target freeze stress zone) and 9a (freeze stress-free zone) across the southeastern US. The data collected from these trials over five winter/growing seasons clearly show that translines 427 and 435 are substantially equivalent to EH1 control trees for growth characteristics under freeze stress-free conditions and prior to a significant freeze event in freeze stress environments. The cumulative multi-season data obtained from these trials demonstrate conclusively that the freeze tolerant trait in line 427 and 435 provided protection against temperature fluctuations typical of those expected at this location in USDA Hardiness Zone 8b. In addition, the data collected from these trials also demonstrate that in mild winters, minimal damage occurred to both the translines and the EH1 control trees while in more severe winters there was clear differentiation between the control and transgenic trees. It is evident from these studies that translines 427 and 435 are able to withstand the winters that are likely to occur in the target freeze stress environment represented by the USDA Hardiness Zone 8b in the southeastern US. We can therefore conclude that the selected translines 427 and 435 would be preferably planted for commercial production in USDA Hardiness Zone 8b and in the regions south of this Zone where there is an occasional risk for occurrence of a significant freeze event. From data collected from trials established in USDA Hardiness Zone 8a, where temperatures routinely fell below 15°F, both translines showed severe or total dieback each winter together with an associated reduction in survival. It is therefore not expected that these translines will be planted for commercial production in the Hardiness Zone 8a.

The non-transformed control variety has been grown for over a decade in Brazil over many thousands of acres and has not demonstrated any plant pest characteristics. Since translines have been imported under strict quarantine measures these are not expected to be a source for introducing any new pests and diseases of *Eucalyptus* or other plants into the USA. Through extensive monitoring of field trials there is no evidence that FTE lines have increased susceptibility to pest or diseases compared to the non-genetically engineered controls. Introduction of FTE lines therefore would not result in significant biological impacts from pests or diseases associated with these trees. Compositional analyses of wood samples using standard industry analytical methods for several commonly assessed wood quality parameters indicated that the transgenic trees are comparable to the untransformed controls. Therefore, there is no evidence to suggest that these FTE lines express any phenotypes other than those expected based on the introduced genes. The detailed comparisons of FTE lines and the non-transformed control trees in these studies demonstrate that FTE lines are not likely to pose any greater plant pest risk compared to the control variety used for transformation or any other non-genetically engineered *Eucalyptus* planted in the region.

Deregulation of the FTE lines is unlikely to have any negative environmental consequences resulting from gene flow and outcrossing to other species. The absence of sexually compatible species in areas of the southeastern US where FTE is expected to be grown, differences in phenology and asynchronous flowering between species, and the efficacy of the pollen ablation trait all serve to make the potential for gene flow essentially zero. Furthermore, the weediness potential and risk of volunteers in FTE lines is negligible because of demonstrated noninvasive nature of this hybrid and other *Eucalyptus* species currently grown in the southeastern US, their limited seed dispersal potential, lack of seed dormancy, poor self fertility of the hybrid leading to production of a very low number of viable seeds, and no evidence for spreading via vegetative propagation. The controlled seed germination studies with seed capsules collected over three years from field trials allowed to flower have indicated that either no, or a very low number of viable seeds, are produced in FTE lines and control EH1 trees and that this is most likely as a result of limited self-fertilization by pollen from the fertile EH1 control trees. The results of the simulated seed germination studies under competitive conditions in greenhouse experiments indicate that in the absence of suitable conditions for seed germination in the field, the seedling establishment from translines is extremely unlikely. Regular volunteer monitoring of six different trials over 2-3 years have further confirmed the absence of any seeded volunteers in or around the field tests. Based on the very low amounts of viable seed production in the FTE lines and EH1 control trees compared to open pollinated *Eucalyptus* trees, combined with the poor seedling establishment under less than ideal *Eucalyptus* seed germination conditions present in a typical managed field planting, and lack of any seeded volunteers in the field trials allowed to flower in the southeastern US, it is highly unlikely that FTE lines would spread beyond a managed plantation. An Environmental Report prepared by a third party with expertise in NEPA analysis further addresses the potential impacts of a range of biological (biodiversity, threatened and endangered species, hydrology, soil nutrients) cultural and public health and safety (fire, noise, hazardous material and air quality) issues in detail. The report concludes that FTE does not present any unique or significant concerns over that which would be expected for non-genetically engineered *Eucalyptus*. The extensive experience from growing *Eucalyptus* in the temperate regions in Brazil is a good indicator that eucalypts including FTE may be grown and managed appropriately in the southeastern US with no significant negative environmental impacts. There is no evidence that suggest that FTE would be invasive or would negatively impact endangered species. Based on the scientific literature and data from our field trials we therefore do not believe that any new significant negative environmental impacts would result from the deregulation of FTE.

The data and literature presented in this Petition demonstrate that FTE lines are not likely to present any more plant pest risk than the non-transgenic control trees because: 1) the introduced genes themselves do not have any plant pest characteristics; 2) integration of a single intact insert of the gene cassettes was demonstrated; 3) other than the engineered freeze tolerant trait the phenotypic characteristics of transgenic lines are comparable to non-transgenic control trees; 4) compositional analysis of the transgenic lines and non-transgenic control trees are comparable; 5) there are no expected impacts from gene flow due to the natural biological limitation of *Eucalyptus* together with demonstrated ablation of pollen; 6) the noninvasive nature of this *Eucalyptus* hybrid, together with very low amount of viable seed production, lack of seeded volunteer production and no potential for vegetative spread, ensures negligible weediness potential; and 7) the translines are not expected to have any greater impact on threatened or endangered species or any other environmental factor than that which would be expected for non-genetically engineered *Eucalyptus* plantings in the region using common forestry management practices.

The commercialization of FTE lines will benefit private landowners and the pulp and paper industry, and will also contribute significantly to national strategies to achieve greater energy security. Therefore, ArborGen Inc. is requesting that FTE lines 427 and 435 and plants propagated from these lines be granted non-regulated status under 7 CFR Part 340.

This Petition is submitted for a determination of non-regulated status of hybrid *Eucalyptus* genetically modified for enhanced freeze tolerance as exemplified by lines 427 and 435 described herein. We anticipate that additional freeze tolerant *Eucalyptus* lines may be generated in the future using the same construct with this hybrid genotype or similar *Eucalyptus* hybrids, or other related species. Any such additional freeze tolerant *Eucalyptus* lines would be verified to exhibit comparable freeze tolerant characteristics, but they may differ in the inherent genetic improvements conferred by the parental genotype. While these improved genetic characteristics are not anticipated to materially affect the potential plant pest characteristics of these lines, they will provide growers with greater genetic diversity. Therefore, ArborGen Inc. may submit such additional freeze tolerant *Eucalyptus* lines, where the freeze tolerant trait is demonstrated to be comparable to that in lines 427 and 435, for consideration for deregulation.

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List of Abbreviations

ABA	Abscisic Acid
AF&PA	American Forest & Paper Association
AP2/EREBP	Apetala2/ethylene-responsive element binding proteins
APHIS	Animal and Plant Health Inspection Service
AR	Approach Report (study identifier)
ATP	Adenosine triphosphate
BAP	Benzylaminopurine
bp	Base pair
BMP	Best Management Practices
BRS	Biotechnology Regulatory Service
BTU	British thermal units
^{o}C	Degrees Celsius
4CL	4-Coumarate CoA ligase promoter
CaMV35S	35S Promoter from Cauliflower mosaic virus
CBF	C-Repeat Binding Factor
cDNA	Complementary DNA
CFR	Code of Federal Regulations
CO_2	Carbon dioxide
CRT	C-Repeat
Cor15a	Cold-regulated 15a gene
CTAB	Cetyl-trimethylammonium bromide
DBH	Diameter at breast height
DNA	Deoxyribonucleic acid
DOE	U.S. Department of Energy
DREB	Dehydration Responsive Element Binding Factor
EDTA	Ethylene diamine tetra acetic acid
EH1	*Eucalyptus* Hybrid variety
EREBP	Ethylene-responsive element binding proteins
EST	Expressed Sequence Tag
^{o}F	Degrees Fahrenheit
FAO	Food and Agriculture Organization
ft	Feet
FTE	Freeze Tolerant Eucalyptus
g	Gram
G_b	Basic specific gravity
GHG	Greenhouse gas
GUS	β-Glucuronidase
ha	Hectare
HCl	Hydrochloric acid
His	Histidine
HPAEC-PAD	High Performance Anion Exchange Chromatography with Pulsed Amphoteric Detection
IgG	Immunoglobulin G
IPST	Institute for Paper Science and Technology
IPTG	Isopropyl-beta-D-thiogalactopyranoside
JADS	JADS tissue culture medium
kb	Kilobase

kDa	Kilodalton
LB-medium	Luria -Bertani broth
LB	Left Border
MBp	Megabase pair
µg	Microgram
mg/L	Milligrams per liter
ml	Milliliter
MS	Murashige and Skoog medium
MWM	Molecular weight markers
N-P-K	Nitrogen-Phosphorus-Potassium (plant fertilizer)
NaCl	Sodium chloride
NaOAc	Sodium acetate
NCBI	National Center for Biotechnology Information
ng	Nanogram
nptII	Neomycin phosphotransferase gene (plant)
nptIII	Neomycin phosphotransferase gene (bacterial)
nos	Nopaline synthase gene
NREL	National Renewable Energy Laboratory
oriV	Origin of Replication
PCR	Polymerase Chain Reaction
pg	picogram
pH	Potential of hydrogen
py-MBMS	Pyrolysis molecular beam mass spectroscopy
PrMC2	Male cone-specific promoter from *Pinus radiata*
PVP	Polyvinylpyrrolidone
RB	Right Border
RbcS2	Ribulose-1, 5-bisphosphate carboxylase small subunit promoter
RBS	Robosomal binding site
RCBD	Randomized Complete Block Design
RISI	Resource Information Systems Inc.
rd29A	Responsive to Desiccation 29A promoter
RFS	Renewable Fuels Standard
RNA	Ribonucleic acid
RNS2	Ribonuclease 2 gene promoter
ROP	Repressor of primer
RPS	Renewable Portfolio Standards
rpm	Revolutions per minute
RT-PCR	Reverse transcriptase PCR
SDS	Sodium dodecyl sulfate
S/G ratio	Ratio of syringyl: guaiacyl lignin subunits
TA29	Tapetum-specific promoter
TAE	Tris-Acetic acid-EDTA buffer
T-DNA	Transferred DNA
TE	Tris-EDTA buffer
TEV	Tobacco etch virus
Ti	Ti plasmid from *Agrobacterium tumefaciens*
TN5	Transposon 5 (bacterial)
TOPO	Topoisomerase 1
TrfA	Replication initiation protein from plasmid RK2
TUA	*α-tubulin* gene

UBQ10	polyubiquitin promoter
µg	Microgram
USDA	United States Department of Agriculture
V	Volt
Xg	Relative centrifugal force
X^2	Chi-squared statistical analysis
YEP	Yeast extract-peptone medium

I. Rationale for Development of Freeze Tolerant *Eucalyptus*

I.A. Market for Hardwoods in the United States

Market overview

The pulp and paper industry is a key economic sector in the southeastern United States which includes Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Louisiana, Arkansas and Texas. Collectively these States account for over 2/3 of US timber production (RISI, 2006), meeting the paper and fiber demands of the US public as well as an important export industry. This industry employs over 170,000 people with a total annual payroll of $12.5 billion in this region with more than 1,500 paper manufacturing facilities and annual paper shipments exceeding $60 billion (AF&PA, 2008). There are 68 to 80 million tons of hardwood harvested each year in this region, representing 63% of the total US hardwood market (Figure I.A.). The pulp and paper industry represents the bulk of this market accounting for roughly 78% or approximately 57 million tons in recent years (RISI, 2006). Current consumption does not include potential demand increases associated with emerging bioenergy applications.

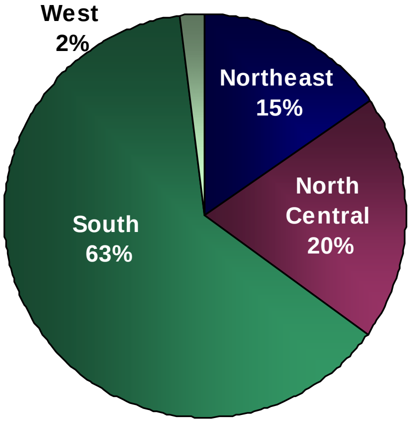


Figure I.A. Regional percentage of US hardwood harvest from private operable forests, 1997-2005 (RISI, 2006)

Hardwood supply concerns

Despite the high demand for hardwoods in the United States, hardwoods are not extensively planted and managed in dedicated stands, in contrast to softwoods such as pine. Nearly all the hardwoods consumed in the southeastern United States come from managed stands that have been naturally regenerated following their harvest. Stands managed in this way typically have very slow growth rates. One of the factors contributing to the hardwood supply problems being faced by the southeastern US is the long rotation times for a hardwood stand to regenerate and achieve a harvestable size after the previous harvest. Expected rotation time (the time to rotate through one cycle of harvest, regeneration and regrowth to the next harvest) for naturally regenerated hardwood stands is typically 30 to 50 years or more. This approach to hardwood production, combined with lost inventory from urbanization, conservation, and re-planting to other crops such as pine has led to a decline in operable hardwood inventory in recent years. RISI, an independent forest products data provider, estimates that current private "operable" hardwood inventory (94% of all hardwood harvested in the United States) is declining at a rate of 0.5 to 1.0% annually nationwide and 1.0 to 2.0% in the southeastern United States (Figure I.B. and Figure I.C.). This represents 30 to 43 million tons of operable inventory lost annually in the southeastern United States from 2000 to 2005. This effect of declining operable inventories is even more pronounced in areas closest to hardwood consumers, where harvesting has already occurred over many years as mills aim to minimize transportation costs by meeting their needs from supplies that are located within an economically reasonable distance. Declining inventories and slow re-growth create a situation where a mill must look further and further away to supply its hardwood, resulting in increasing transportation costs. In some cases existing hardwood sources are located on bottomland or lowland sites that are susceptible to seasonal weather conditions that limit access in wet periods during the year and hinder the viability of year round harvesting. These factors have contributed to a hardwood supply that is becoming increasingly expensive and less reliable. Continuation of these trends will likely exacerbate this situation even further in the future.

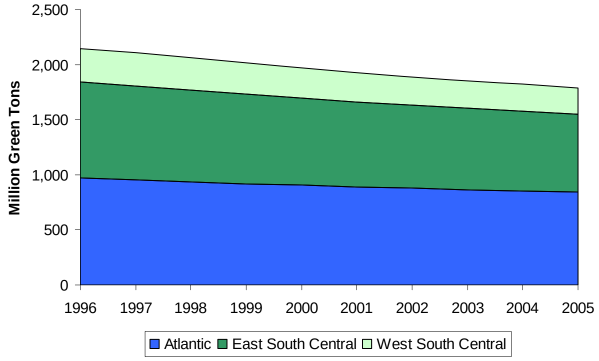


Figure I.B. Hardwood private operable inventory - US South, 1996-2005 (RISI, 2006)

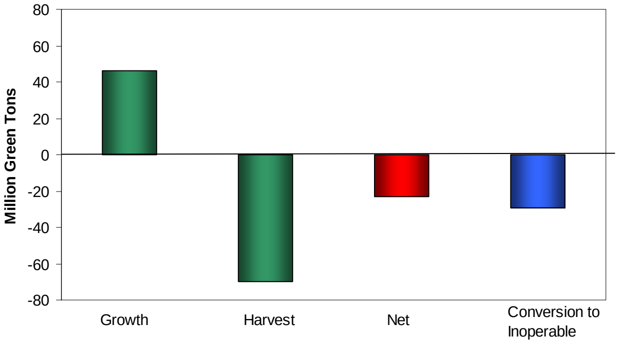


Figure I.C. Change in hardwood private operable inventory – US South, 2005 (RISI, 2006)

Hardwood fiber remains a critical component for the pulp and paper industry in the United States. Increased demand and strain on available hardwood resources is also likely to result from additional opportunities outside of the pulp and paper industry, particularly with respect to the potential use of hardwood fiber as a bioenergy feedstock. Purpose-grown hardwood trees with fast growth rates and short rotations can provide a reliable, high quality and cost effective solution to the hardwood supply challenge in the southeastern United States.

Limitations to purpose-grown hardwoods

There has been extensive research within the forest industry in the southeast on the development of cost effective purpose-grown hardwood supplies that alleviate the challenges from natural regeneration. However, success has been limited due to high production costs, intensive management requirements, and relatively long rotation lengths, in particular when compared to well established silvicultural practices for pine plantations. Historically, it has been more economically attractive to plant an acre of pine or even other land use alternatives rather than an acre of hardwood. As a result, many paper companies have planted company-owned lands with pine in search of higher investment returns (Gallagher, 2008). The economic forces of declining supply and steady demand for hardwoods in the United States are leading to higher overall prices, although this has not yet been sufficient to justify plantation hardwoods over other land use alternatives for landowners in the southeast. In addition to overall price increases, declining inventories have led to price spikes and less reliable sourcing for a mill. Even so, there are several areas that must be addressed in order to make plantation hardwood production on a large-scale economically viable:

- Fast growth rates and/or short rotation lengths
- Low establishment and management costs
- Ability to grow on available land within a reasonable proximity to a mill
- Desirable wood and fiber properties for the end-use

Fast growth rates and high yields are keys to the economic feasibility of purpose-grown hardwood plantations in the southeastern United States (Gallagher, 2008). Technology that allows development of short rotation and high wood quality hardwood species that can be established cost effectively within the desired proximity to a mill will address the major supply hurdles and will further make purpose-grown hardwoods an economically viable alternative.

I.B. *Eucalyptus* as a Preferred Fiber Source for the Global Pulp and Paper Industry

Eucalyptus is a preferred fiber source for the global pulp and paper industry and has been the focus of extensive breeding and tree improvement programs aimed at capturing desirable wood properties such as basic density, cellulose content and fiber length (Raymond, 2002). These programs have also focused on improving the productivity of *Eucalyptus* to generate more biomass at a shorter rotation providing higher returns to the landowner for a given acre of land. Today *Eucalyptus* pulp is preferred due to numerous highly desirable properties which include: bulk, opacity, formation, softness, porosity, smoothness, absorbency, and dimensional stability (Foelkel, 2007). It is a preferred raw material in the manufacture of tissue, printing and writing paper, cartonboards, industrial filters, and many other paper products and can be used either as the sole fiber in the pulp furnish or part of a blend (Foelkel, 2007). Demand for *Eucalyptus* pulp is growing rapidly in the global paper market. In 2003, global *Eucalyptus* pulp demand was 8 million tons and it represented 40% of the world's hardwood pulp market (Lehtonen, 2005). A large part of the global supply is concentrated in Brazil where *Eucalyptus* plantations are found on approximately 3.5 million hectares.

As a native of warm weather climates, the most productive *Eucalyptus* species favor tropical to sub-tropical conditions with limited tolerance for freezing weather. *Eucalyptus* in other parts of the world, outside the US, where freeze tolerance is not necessary is grown in 5 to 7 year rotations with yields exceeding 20 green tons/acre/year and is one of the fastest growing trees in the world. This growth rate is significantly faster than any other hardwood species currently available to forest landowners and the pulp and paper industry in the southeastern US.

Some *Eucalyptus* species are inherently freeze tolerant with several being grown as ornamental plants in the US. However, these are not suitable for forestry applications based on both growth form and yield. While other species are suitable from the perspective of tree form these are much less productive (8-12 green tons/acre/year) and have less desirable wood quality characteristics for the end use compared to the most desirable species grown in warmer climates.

Winter weather patterns restrict Eucalyptus plantations in the southeastern US

While a number of *Eucalyptus* species have been tested over many years in the southeastern US, there has been very little success outside of central Florida except for a few ornamental species. USDA Plant Hardiness Zone Maps provide a broad perspective of temperature based on 5 degree Fahrenheit ranges in average annual minimum temperatures, or the lowest temperatures that can be typically expected each year in the designated area. For example, Zones 9a and 9b cover a large part of central Florida and represent annual minimum temperature ranges of 20 to 25 °F and 25 to 30 °F respectively. Commercial plantings of *Eucalyptus grandis* are known to occur in south-central parts of Florida in and around zone 9b. Both academic and forest industry researchers have evaluated moderate to fast growing *Eucalyptus* species in colder zones such as zone 8b (15 to 20 °F average annual minimum temperature) where there is a high concentration of pulp and paper mills that would utilize this resource. In many cases these species may be able to grow at these northern sites for a few years, depending on normal fluctuations of weather patterns, but have been unable to withstand the dramatic and sudden drops in temperature that are typical of the southeastern US. A precipitous drop in temperature from the 70's °F to below freezing over a 24 – 48 hour period is not uncommon in many parts of the south. Such temperature fluctuations have been most challenging to the establishment of *Eucalyptus* plantations in the region.

There have been several attempts to improve the freeze tolerance of fast growing species through directed breeding but with no notable success (as evidenced by the lack of scientific literature in this area). Many traits observed in *Eucalyptus* species, such as growth and tolerance to freezing temperatures, are believed to be controlled by additive genes rather than dominant genes (Tibbits et al., 2006). Thus, conventional hybridization between a temperate species with inherent freeze tolerance and slower growth, and a tropical species with no freeze tolerance and fast growth results in progeny with intermediate characteristics with respect to both growth and freeze tolerance. This phenomenon was demonstrated most clearly in a similar attempt to improve the cold tolerance of loblolly pine in the US. Loblolly pine was hybridized with the more cold tolerant pitch pine in an attempt to produce a fast growing conifer for regions further north than where loblolly is able to survive. The hybrid progeny had better freeze tolerance than loblolly and faster growth than pitch, but poorer freeze tolerance than the pitch and slower growth than the loblolly (Genys, 1970).

Since the USDA Hardiness Zones provide average minimum temperatures, it is anticipated that in some years the absolute minimum temperature would be below this average range. Indeed, occasionally the absolute minimum has been substantially lower than these average values, for example in the freeze events of the early 1980's which caused significant damage to Florida's citrus crops. Based on an analysis of temperature data from a selection of sites (see Table I.A) across the south we estimated the probability that temperatures in any given year would fall within or below the range for zone 8b (Table I.A). Over the past 15 years only two of the sites evaluated for zone 8b fell below the 15 to 20 °F range (Amite, LA and Fair Hope AL at 13 °F and 14 °F respectively). It should be noted that the freeze tolerant *Eucalyptus* product concept is aimed at addressing typical weather patterns. Management practices and grower decisions should take into account the possibility for occasional extreme cold events, in much the same way that Florida's citrus growers recognize the potential for such events to impact their industry. (Note that when the rare freeze events of the 1980's are taken into account all sites analyzed, including those in zone 9b, experienced temperatures of less than 15 °F). A distinguishing feature of freeze tolerant *Eucalyptus* however is that while a grower's annual citrus crop might be lost completely, freeze damaged or even killed trees can still be harvested and utilized for a variety of applications.

Table I.A. Fifteen year minimum temperature data for select locations across the southeastern US (11/1990 through 4/2005)

Location	USDA Hardiness Zone	Mean # Freezes/ Year	Minimal Low Temps. in Last 15 years	Probability of Temps. ≤20 and >15°F	Probability of Temps. ≤15°F	Probability that Temps. Remain >20°F
Albany, GA	8a	35	12, 15, 17	63%	12%	25%
Bamberg, SC	8a	37	14, 14, 14	63%	25%	12%
Brewton, AL	8a	48	12, 13, 15	50%	38%	12%
DeFuniak Springs, FL	8a	23	12, 16, 18	25%	6%	69%
Thomasville, AL	8a	39	9, 11, 13	31%	44%	25%
Waycross, GA	8a	35	10, 13, 14	50%	31%	19%
Amite, LA	8b	30	13, 17, 17	31%	6%	63%
Fair Hope, AL	8b	18	14, 17, 19	25%	6%	69%
Jennings, LA	8b	13	18, 20, 20	19%	0%	81%
Lake City, FL	8b	14	16, 18, 18	25%	0%	75%
Liberty, TX	8b	11	19, 21, 21	6%	0%	94%
Ocalla, FL	8b	7	20, 21, 21	6%	0%	94%
Summerville, SC	8b	38	15, 15, 16	63%	6%	31%
Tallahassee, FL	8b	26	16, 17, 18	56%	0%	44%
Federal Point, FL	9a	3	23,26,27	0%	0%	100%
Lafayette, LA	9a	11	16, 20, 21	13%	0%	87%

Based on the USDA hardiness maps and the above analysis we concluded that improving freeze tolerance of a fast growing *Eucalyptus* species to confer tolerance to ~15 °F should be sufficient to allow for commercial plantings in and around zone 8b, and closer proximity to the existing pulp and paper industry in the majority of years.

I.C. Understanding of the Freeze Tolerance Pathway Leads to Opportunities for Enhancing this Trait in *Eucalyptus*

Plants from tropical regions have little to no capacity to withstand freezing temperatures, while plants from temperate regions can survive freezing temperatures ranging from -5 to -30 °C (~23 to -22 °F), depending on the species. The capacity of plant freeze tolerance is not constitutive, but is induced by exposure to low and non-freezing temperatures (generally below ~12 °C or ~54 °F), a phenomenon known as “cold acclimation”. A significant advance in understanding cold acclimation has been the discovery of the C-repeat/dehydration-responsive element binding factor (*CBF/DREB*) cold-response pathway in *Arabidopsis* (Jaglo-Ottsen et al., 1998; Stockinger et al., 1997; Gilmour et al., 1998; Liu et al., 1998; Kasuga et al., 1999). RNA analysis shows that *CBF* transcripts can be detected in *Arabidopsis* 1 hour after exposure to cold (4 °C, ~39 °F)) and peaking after 2 hour exposure (Liu et al., 1998) but disappearing after 6 hours, suggesting that their expression is transiently induced by low temperatures. In the majority of studies *CBF* gene expression appears to be specific to cold induction and does not respond to other stress signals such as ABA, drought or salt stress (Liu et al.1998; Medina et al., 1999).

The *CBF* genes are transcription factors that belong to the AP2/EREBP family of DNA-binding proteins (Riechmann and Meyerowitz, 1998) and like other transcription factors act as control switches for the coordinated expression of other genes in defined metabolic pathways. *CBF* protein recognizes and binds to a cold- and drought-responsive DNA regulatory sequence designated as the C-repeat (CRT)/dehydration-responsive element (DRE) (Baker et al., 1994; Yamaguchi-Shinozaki and Shinozaki, 1994) which is found in the promoter regions of many cold-inducible genes (Maruyama et al., 2004). Both cDNA and microarray experiments have identified a variety of genes that function downstream of and are regulated by *CBF* (Maruyama et al., 2004; Fowler and Thomashow, 2002; Seki et al., 2002; Vogel at al, 2005). All of these are involved in functions that mitigate environmental stresses. The *CBF* genes appear to have redundant functional activities since analysis of transcript levels of other genes revealed no difference between plants over-expressing *CBF1*, *CBF2*, or *CBF3* (Gilmour et al., 2004; Cook et al, 2004; Fowler and Thomashow, 2002). The changes in gene expression patterns in response to cold could be largely mimicked by ectopic expression of *CBF* genes at warm temperatures, demonstrating a prominent role of *CBF* genes in the regulation of cold-response pathways (Cook et al., 2004). *CBF* genes themselves are regulated by other transcription factors (Zhu et al., 2007; Chinnusamy et al., 2003; Agarwal et al., 2006; Zarka et al., 2003; Zhu et al., 2007). A comparison of *CBF*-like gene expression in plants that are able to acclimate and those that are unable to acclimate in response to low temperatures concluded that the components of the *CBF*-cold response pathway are highly conserved in flowering plants and are not limited to those that cold acclimate (Jaglo et al., 2001).

Recent studies have reported that *Eucalyptus CBF* homologues in species with known cold tolerance are responsive to cold. Transcription of two *CBF* homologues in *Eucalyptus gunnii* was detected 15 minutes after exposure to low temperature (4 °C) and reached maximum levels 2-5 hours after exposure (El Kayal et al., 2006). Similarly RT-PCR analysis of a *CBF* homologue from *E. globulus* revealed that expression was transiently induced in seedlings 15 minutes after exposure to cold (Gamboa et al., 2007). Two *CBF* homologues have been isolated from *E. dunnii* (ArborGen, unpublished results). Transcripts of the *E. dunnii CBF* homologues were detected in young plants 30 minutes after exposure to low temperature (4 °C), and the cold induction continued up to 4 hours. Over-expression of either of these genes conferred cold tolerance in transgenic *Arabidopsis* (ArborGen, unpublished results). These results strongly suggest that a functional cold tolerance pathway regulated by *CBF* exists in some *Eucalyptus* species. These results also suggest that the susceptibility of tropical *Eucalyptus* to freezing temperatures may be due to either a lack of and/or an inappropriate expression of specific transcription factors or their target stress tolerance effector genes. While it is expected that the genes for the cold tolerance pathway are present broadly in the *Eucalyptus* genus, since this pathway does not confer any selective advantage in tropical regions, its functionality has been lost in those *Eucalyptus* species that are native to tropical regions.

Over-expression of *CBF* genes have been shown to confer cold, drought and salt tolerance in *Arabidopsis* (Liu et al., 1998; Kasuga et al., 1999). Over-expression of the *Arabidopsis CBF* genes in *Brassica napus* and tobacco induced the expression of orthologs of *Arabidopsis CBF*-targeted genes and increased the freezing and drought tolerance of transgenic plants (Jaglo et al., 2001; Kasuga et al., 2004). Similar results have been observed from over-expression of *Arabidopsis CBF1* in other species including *Populus* (Benedict et al., 2006). Likewise, *CBF* homologues have been isolated from a wide variety of species including pepper (Yi et al., 2004), rice (Dubouzet et al., 2003; Ito et al., 2006), maize (Qin et al., 2004) and wheat (Jaglo et al., 2001;Vagujfalvi et al., 2005; Kobayashi et al., 2005), with several of these demonstrating enhanced cold tolerance when transferred into other species. In contrast, there are also some examples where introducing different *CBF* genes did not lead to increased cold tolerance, particularly in tomato and potato (Hsieh et al., 2002; Zhang et al., 2004, Benham et al., 2007; Pino et al., 2007).

A common observation across experiments in which *CBF* genes are overexpressed in transgenic plants is that constitutive expression of *CBF* negatively impacts a number of other traits (Hsieh et al., 2002). In potato for example constitutive expression of *Arabidopsis CBF* genes using the CaMV35S promoter was associated with smaller leaves, stunted plants, delayed flowering, and reduction or lack of tuber production (Pino et al., 2007). In contrast, *CBF* genes under the control of a cold-induced promoter, rd29A (Yamaguchi-Shinozaki and Shinozaki, 1993, Kasuga et al., 1999; Naruska et al., 2003), increased freezing tolerance to the same level as constitutive expression (about 2 °C, or ~36 °F) while restoring growth and tuber production to the levels similar to wild-type plants (Pino et al., 2007). In the rd29A controlled *CBF* plants the same level of freezing tolerance as the CaMV35S versions was observed after only a few hours of exposure to low but non-freezing temperatures. These results suggest that using a stress-inducible promoter to direct *CBF* transgene expression could significantly improve freeze tolerance without negatively impacting other agronomically important traits.

Based on the understanding of scientific advances in the freeze tolerance pathway, we hypothesized that the introduction of the *CBF* gene into a fast growing but freeze susceptible commercial genotype of *Eucalyptus* could enable these trees to withstand freezing events typically experienced in areas found in USDA Hardiness Zones 8 and 9 in the southeastern United States. Using an elite hybrid *Eucalyptus* variety that is widely grown in Brazil, we introduced the *CBF2* gene under the control of cold-inducible promoter. Field trials at multiple sites have identified lines of this hybrid with the *CBF2* gene that are able to survive freezing events typically experienced in the southeastern United States. The trials have not revealed any evidence of adverse effect on the environment or any plant pest potential of these lines. Commercialization of this fast growing *Eucalyptus* with engineered freeze tolerance could provide an economically viable option for hardwood production to help meet demand within the pulp and paper sectors of the southeastern US.

I.D. Applications of Mechanisms to Control Fertility

Control of plant fertility has been widely investigated and has a number of potential applications (see Strauss et al., 1995). In particular male sterile corn (USDA APHIS petitions for deregulation 95-288-01p, 97-342-01p and 98-349-01p), rapeseed (petitions 98-278-01p and 01-206-01p) and chicory (petition 97-148-01p), developed as a tool for reliable pollination control for hybrid seed production, have been reviewed and granted deregulated status by USDA APHIS. It has been postulated that in species where the seed is not the primary commercial product then reducing or preventing flowering could redirect energy and metabolites to other parts of the plant and result in increased yields (Strauss et al., 1995). The prevention of flowering has also been advocated as a mechanism to limit gene flow, for example in some pharmaceutical-producing plants (Mascia and Flavell, 2004). Under CFR 340.3(c) and 340.4(f) APHIS requires that measures be taken to prevent the unauthorized release or persistence of regulated articles in the environment. Flowering control mechanisms can be useful as a tool in meeting these requirements by mitigating gene flow from field trials. Finally, public perception was identified as a key obstacle in the application of genetic modification in trees (FAO, 2004) and mechanisms of gene containment could have value in reducing public concerns.

The application of flower control systems should be based on scientific principles and evaluated on a case-by-case basis, taking into consideration the species and the engineered trait. For plants with seed-based propagation systems flower control mechanisms must be balanced with the need and ability to propagate and produce suitable progeny through seed. For plants that are vegetatively propagated, including some tree species, the inclusion of flower control technology would not restrict their commercial production. ArborGen has developed a robust system for the prevention of pollen formation and has tested this in a number of tree species. This pollen control mechanism was included in vector pABCTE01 used in the development of freeze tolerant *Eucalyptus*. While pollen control may be seen as providing an extra level of confinement, historical observations that *Eucalyptus* does not spread naturally in Florida demonstrate that existing biological limitations provide effective confinement. Therefore we do not believe that the inclusion of a pollen control system has a significant bearing on a consideration for deregulation in this case.

I.E. Further Benefits of *Eucalyptus* in End Use Applications

In addition to the high value of *Eucalyptus* fiber for the pulp and paper industry, the development of freeze tolerant *Eucalyptus* offers additional benefits.

Uniformity of supply

A uniform, purpose-grown *Eucalyptus* source provides benefits to pulp manufacturers that extend beyond its desirable wood quality. The uniformity of the fiber source benefits the processor through decreased variability. Fast-growing, purpose-grown trees help to address supply challenges by improving logistics for the pulp manufacturer who is able harvest and transport all of its hardwood fiber within a smaller radius.

Bioenergy

The search for alternative, renewable sources of energy has become an extremely important issue in political, academic and industrial settings. Bioenergy and biofuels have received a great deal of attention as a solution for these pressing challenges and new national and regional targets are being set for the use of bioenergy in the future. The 2007 Renewable Fuels Standard (RFS) mandates the use of 36 billion gallons of renewable fuels by 2022. Of this total, 21 billion gallons must come from "Advanced Biofuels" such as cellulosic ethanol (Figure I.D.).

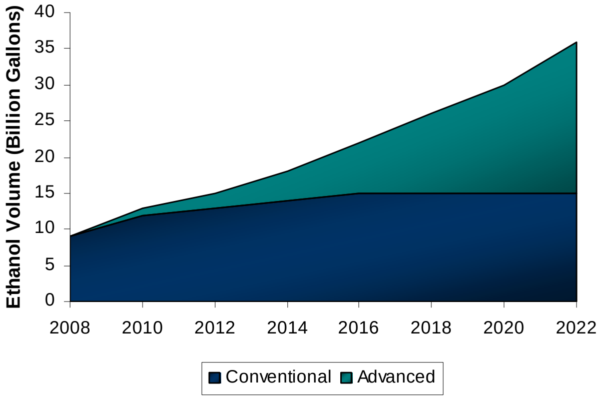


Figure I.D. Renewable fuels standard, 2007

Wood and purpose-grown trees as an energy crop have been identified as cornerstones of a comprehensive energy solution. Production of energy from lignocellulosic materials requires a reliable, large volume, supply of feedstock. Purpose grown short rotation hardwoods can help enable this new industry by improving the productivity and reducing the production costs of biomass as a bioenergy feedstock. *Eucalyptus* that enables the production of biomass for energy production from purpose-grown trees in 5 to 7 year rotations, with yields exceeding 10 dry tons/acre/yr, can provide economically competitive delivered feedstock costs.

Generating energy through biomass offers a number of environmental and security benefits:

- Greater energy independence as a nation
- Opportunities for rural development and economic growth
- Decreased dependency on non-renewable fossil fuels
- Environmental benefits through the reduction of greenhouse gases

- Reduced gasoline price volatility
- Renewable sources of energy that support a positive energy balance

The use of fast growing, short rotation trees as a feedstock offers several unique benefits:

- Trees are available year-round to meet year-round processing demands
- Trees can be harvested on-demand eliminating the need for costly storage
- Wood is more energy dense than grass crops (BTU or gallons of biofuel per unit volume)
- Wood has equivalent composition as grasses for production of specific bioenergy products

In addition, the southeastern US is uniquely positioned to be a leader in this new industry. This region has a well-developed existing infrastructure for the harvesting, handling, transporting, and processing of wood biomass. In addition, pulp and paper mills as they exist currently are already some of the largest existing biorefineries. Biorefining of wood pulp for energy products such as cellulosic ethanol would provide new employment and energy opportunities for the region.

High value products

In recent years, there has been increasing interest in using plantation *Eucalyptus* for the production of sawn timber, veneers, reconstituted wood and other high value products (Raymond, 2002). *Eucalyptus* hardwood products from South America are becoming more common in the market as specialty hardwood lumber products. These, along with other high value wood products, may create additional demand for *Eucalyptus* in the southeastern United States.

Global competitiveness

The sustainability of the United States' global competitive position in hardwood consuming markets relies upon a reliable and economical hardwood supply. Competition from other parts of the world with abundant wood resources or lower cost manufacturing/labor environments has resulted in an increasing supply of wood products that cost considerably less than those made in the United States (Hansen, 2005). Short-rotation, purpose-grown hardwoods such as Freeze Tolerant *Eucalyptus* address many of these problems and could help position the United States as a global leader in hardwood consuming industries.

II. The Biology of *Eucalyptus*

Eucalyptus species are among the most widely planted and developed hardwoods in the world, therefore the biology of eucalypts has been extensively discussed in many published books and review chapters. Williams and Woinarski (1997) provide one of the most comprehensive reviews of the genus *Eucalyptus*. An excellent review of the biology of *Eucalyptus grandis* has been published by the US Forest Service (Meskimen and Francis, 1990). Most recently, the biology and domestication of *Eucalyptus* has been summarized by Grattapaglia (2008). The key components of *Eucalyptus* biology as they relate to this petition are discussed below.

II.A. Origin of *Eucalyptus* Species and their Hybrids

Over 700 *Eucalyptus* species, commonly known as eucalypts, are native to Australia and the neighboring islands of Timor and Indonesia (Groves, 1994; Ladiges, 1997; Myburg et al., 2006). There are no wild relatives of eucalypts that occur naturally in the USA. Eucalypts grow across a wide range of soil types and climatic environments, ranging from lowland tropical forests to temperate high elevations that regularly experience freezing temperatures. Natural *Eucalyptus* forests cover over 40 million hectares

(Eldridge et al., 1994). Eucalypts are among the fastest growing woody plants in the world with mean annual increments up to 100 m^3/ha. Due to their superior growth, adaptability to specific environments, and desirable wood properties, *Eucalyptus* species have become the most valuable and widely planted hardwoods in the world with ~11.8 million hectares planted in 90 countries (FAO, 2007).

Eucalypts are widely grown as exotic plantation species in tropical and subtropical regions of Africa, South America, and Asia. Where local climatic conditions allow, eucalypts are also planted in some temperate regions of Europe, South America, North America, and Australia. Four Eucalypt species, *Eucalyptus grandis*, *E. urophylla, E. camaldulensis* and *E. globulus* together with various hybrids with these species, account for about 80% of the eucalypt plantations worldwide (Eldridge et al., 1993; Grattapaglia, 2008), selected mainly based on their good growth and form and adaptability in different regions. *E. globulus* is the premier species for temperate zone plantations in Portugal, Spain, Chile and Australia. *E. grandis* is the most widely used species in plantation forestry worldwide in tropical and subtropical areas. It is planted as a pure species, but also utilized as a parental species in hybrid breeding (Myburg et al., 2006). The largest total area of plantations of *E. grandis* and its hybrids has been established in Brazil, with several other Central and South American countries also having significant plantings (FAO, 2006). It has also been planted extensively in India, South Africa, Zambia, Zimbabwe, Tanzania, Uganda and Sri Lanka and is grown on a small scale in the United States in Florida and Hawaii. While *E. grandis* is native to Australia, *E. urophylla* is not found naturally in Australia. It occurs in Timor and nearby Indonesian islands. *E. urophylla* was introduced in Brazil in 1919 under the name *E. alba* and progeny from this introduction, commonly known as "Brazil alba", were used to establish large planting areas in Brazil and other countries (Hillis and Brown, 1984). Following its introduction in Brazil, *E. urophylla* has also been widely planted in other regions of the tropics (Turnbull and Brooker, 1978). Hybrids of E. *urophylla* x *E. grandis* (colloquially referred to as *E. urograndis* hybrids*)* were initially developed by a breeding program in the Congo aimed at combining the local adaptation, disease resistance of *E. urophylla* with the high growth potential of *E. grandis*. Elite varieties of *E. grandis*, *E. urophylla* and their hybrids are planted extensively in tropical and subtropical regions for pulp production and increasingly for solid wood production (Bertolucci et al., 1995; Potts, 2004).

II.B. Taxonomy of the Genus *Eucalyptus*

Eucalypts have been historically classified into two genera (*Angophora* Cav. and *Eucalyptus* L'Her.) that belong to the Myrtaceae family of angiosperms (Briggs and Johnson, 1979). The *Angophora* is a small genus with only 11-13 species confined to eastern Australia whereas *Eucalyptus* includes more than 700 species (Ladiges, 1997; Grattapaglia and Bradshaw, 1994). Over the years several classifications of the genus *Eucalyptus* have been proposed. Among these a comprehensive and informal classification proposed by Pryor and Johnson (1971) has been widely used by taxonomists and ecologists (Table II.A). This classification recognizes seven subgenera within *Eucalyptus* (*Corymbia, Blakella, Eudesmia, Gaubaea, Idiogenes, Monocalyptus* and *Symphyomyrtus*). An eighth subgenus, *Telocalyptus*, was subsequently added to this list by Johnson (1976). Other recent classifications have dropped these major groups, with primary emphasis on the species description and grouping of species into 92 series (Chippendale, 1988).

Table II.A. Major taxonomic groups of eucalypts. Adapted from Pryor and Johnson (1971); Johnson (1976); Brooker et al. (2002)

Family	Genus	Subgenus	Section	No. of Series/Section	No. of Species/Genus/ Subgenus
Myrtaceae	*Angophora*				11-13
	Eucalyptus				700 +
		Corymbia			102+
			Rufaria	4	
			Ochraria	3	
		Blakella			20
			Lemuria	1	
		Eudesmia			20
			Quadraria	2	
			Apicaria	2	
		Gaubaea			2
			Curtisaria	1	
		Idiogenes			1
			Gympiaria	1	
		Monocalyptus			140+
			Renantheria	9	
		Symphyomyrtus			450+
			Transversaria	2	
			Bisectaria	18	
			Dumaria	4	
			Exsertaria	3	
			Maidenaria	2	
			Adnataria	11	
		Telocalyptus			4

With the development of molecular biology tools, new data have been generated for supporting the phylogeny of the eucalypts. Chloroplast DNA restriction fragment length polymorphism (Sale et al., 1993) and sequencing of 5S ribosomal DNA repeats (Udovicic et al., 1995; Udovicic and Ladiges, 2000)) have shown two major evolutionary lineages (clades) for eucalypts. One clade includes the *Angophora*, *Corymbia* and *Blakella* whereas the other clade includes the remaining six subgenera of *Eucalyptus* as described by Johnson (1976). Based on the similarities observed in molecular analyses and re-examination of morphological characters, the recent taxonomic revisions recognize *Corymbia* and *Blakella* as separate genera instead of subgenra of the genus *Eucalyptus* (Hill and Johnson, 1995; Ladiges, 1997). While the debate on classification of *Corymbia* and *Blakella* as monophyletic groups continues, Brooker et al. (2002) have outlined a formal classification of the genus *Eucalyptus* that assigns all species to a system of subgenra, sections, subsections, series, subseries and supraseries. Among the *Eucalyptus* subgenera, *Symphyomyrtus* is the largest subgenus and is divided into six major sections (Transversaria, Bisectaria, Dumaria, Exsertaria, Maidenaria and Adnataria). *E. grandis* and *E. urophylla* belong to closely related series of section Transversaria whereas most other species grown in the southeastern US are members of other distantly related subgenera and sections with the exception of *E. robusta* (Table II.B).

Table II.B. Taxonomic classification of *Eucalyptus* species grown in Florida and southeastern USA.

Genus	Subgenus	Section	Series	Species Grown in Florida and SE USA
Eucalyptus	*Symphyomyrtus*	Transversaria	Salignae	*E. robusta*
				E. grandis
			Resiniferae	***E. urophylla****
		Maidenaria	Viminales	*E. viminalis*
				E. macarthurii
				E. rubida
				E. dalrympleana
			Ovatae	*E. camphora*
			Neglectae	*E. neglecta*
			Globulares	*E. nitens*
			Cordatae	*E. gunnii*
			Cinereae	*E. nova-anglica*
				E. cinerea
			Benthamianae	*E. benthamii*
				E. dorrigoensis
		Exsertaria	Exsertae	*E. camaldulensis*
				E. tereticornis
				E. amplifolia
	Monocalyptus	Renantheria	Pauciflorae	*E. pauciflora*
				E. niphophila
	Corymbia	Ochraria	Eximae	*E. torelliana*

** E. urophylla is currently not grown in Florida and southeastern US. This species is included in the table as one of the parental species used in the hybrid.*

II.C. Cytogenetics of *Eucalyptus*

All examined species of the genus *Eucalyptus* are diploid (2n=22) with haploid chromosome number of n=11 (Myburg et al., 2006). There are no confirmed reports of natural polyploidization in *Eucalyptus* (Grattapaglia and Bradshaw, 1994; Eldridge et al., 1994; Potts and Wiltshire, 1997). The chromosomes of *Eucalyptus* species are extremely small in size (2-6 µm) with diploid nuclear (2C) DNA content ranging from 0.77-1.47 pg (Grattapaglia and Bradshaw, 1994). The estimated haploid genome size of eucalypts range from 370 to 700 million base pairs (Mbp). Sub-genera *Symphyomyrtus* species had an average haploid genome size of 650 Mbp, and species within the same section had similar DNA contents, with *E. globulus* and *E. dunnii* at the lower end of the scale (530 Mbp) and *E. saligna* at the higher end (710 Mbp). *Corymbia* species have a haploid genome size of around 380 Mbp, much smaller than the other eucalypts (Grattapaglia and Bradshaw, 1994). Hybrids, where they exist, have an intermediate DNA content between the two parent species with no evidence of polyploidy. Pinto et al. (2004) recently estimated the DNA content of *E. globulus* at 644 Mbp, larger than that estimated by Grattapaglia and Bradshaw (1994).

The precise size of the eucalypt genome is expected to be determined accurately as a result of current efforts to sequence the complete genome. Being the hardwood genus of the greatest economic importance, *Eucalyptus* is the subject of significant research at the global level. *Eucalyptus* genome sequencing work has been initiated in several parts of the world. The *Eucalyptus* Genome Initiative (www.ieugc.up.ac.za) is an international association of academic and industry scientists interested in *Eucalyptus* DNA markers and gene sequences. A separate genome sequencing project for *Eucalyptus* is also under way in Japan (www.businesssupport-chiba.jp/cgi-bin/dire/backnumber.cgi?act=5). A large sequencing project for *Eucalyptus* expressed sequences, Genolyptus (genolyptus.ucb.br/genolyptus-english.jsp), was initiated several years ago in Brazil with funding from a combination of government and commercial sources. An EST project in *E. grandis* has accumulated more than 170,000 sequences from 20 libraries (Strabala, 2004). The NCBI lists approximately 2600 sequences for *E. grandis* and a further 1800 for other members of the genus. The knowledge from these genome sequencing efforts will lead to further understanding of the evolution, development and diversity of the genus *Eucalyptus*.

II.D. Reproductive Biology of *Eucalyptus*

All eucalypts, including *E. grandis* and their hybrids, bear hermaphrodite flowers (Meskimen and Francis, 1990) with stamens as the most conspicuous and attractive part of the flower. Although the basic structure of the flower is very similar, differences exist between species in inflorescence structure, flower size and arrangement, degree of self-incompatibility, seed size and number of viable seed produced (House, 1997). The inflorescences in eucalypts are produced laterally in leaf axils of the current season’s newly produced shoots in the outer crown (Beardsell et al., 1993). Flower buds form in axillary umbels usually in groups of 3, with 7 or more buds per flower cluster. Each flower bud is enclosed in either one or two protective caps (opercula) depending on species. Anthesis takes place when the inner operculum is shed. In an individual flower, the stigma is not receptive until 5-7 days after pollen shed, a condition known as protandry, preventing self-pollination within an individual flower. The pollen is generally viable for 3-4 days after anthesis. *Eucalyptus* trees generally bloom serially over a period of 5 to 10 weeks, with an average of only 12% of a tree's flowers in prime bloom during a given week. The development of flowers within and between inflorescences is sequential and gradual so that flowers with receptive male and female phase may be in close proximity. As a result mixed pollination can occur as a tree’s stigma may receive pollen from itself as well as from other trees, which can either be genetically identical (as in a clonal plantation) or genetically different, and seeds of both parental types may coexist inside a capsule (Griffin et al., 1987). Self-pollination leads to reduced capsule production, lower seed yield and poor seedling vigor in comparison to cross pollination (Hodgson, 1976; Eldridge and Griffin, 1983; Grattipaglia et al., 2004). Both pre- and post-zygotic control mechanisms have been implicated in the reduced and non-viable seed production in self-pollinated progeny (Hodgson, 1976; Ellis at el., 1991). In many cases, the potential for crossing among individuals of the same parental genotype is effectively zero which eliminates crossing within and between plantings of same parental genotype (Campinhos et al., 1998; Pound et al., 2002). Cross-pollination is therefore the preferred mating system in eucalypts. However, the blooming season in *Eucalyptus* varies among different species (Eldridge et al., 1994;House, 1997). This asynchronous flowering serves as a natural barrier for cross pollination between species.

Eucalyptus is adapted for insect pollination, with bees being the predominant pollinator (Pacheco et al., 1986; House, 1997). The potential for pollen dispersal in *Eucalyptus* is limited to a relatively short distance. Under ideal conditions of humidity and temperature, viable *Eucalyptus* pollen can only be found within approximately 100m from the edge of the nearest tree stand (Peters et al., 1990; Linacre and Ades, 2004). Pacheco et al. (1986) verified that bees (Apis spp.) are the most effective pollinators of *Eucalyptus*, with activity increasing up to 100m from the beehive, and decreasing after this distance. de Assis (1996) suggested that the minimum distance to prevent undesirable pollen contamination of seed producing areas is approximately 300 meters.

From 2 to 3 weeks after blooming, the stamens and style wither and fall away, leaving a woody, urn-shaped seed capsule closed by four to six valve covers. Most umbels carry three to seven capsules to maturity. Seed capsules mature 4-7 months after flowering. At maturity the valves of the capsules dry out and open to release seeds. Harvested capsules scattered loosely on a dry surface release seed after about 2 hours in full sun. Commercially seeds are extracted using chambers equipped with open-mesh shelves, controlled heating (30-35°C), forced-air circulation, and dehumidification. Individual trees bear from 3-25 sound seeds per capsule, with an average of 8 seeds per capsule (Hodgson, 1976) and a much greater mass of infertile ovules called "chaff." Fertile seeds are tiny, only about 1mm in diameter. Operational quantities of seed can be harvested from an orchard at age ~3.5 years, and production increases annually to about age 10 (Meskimen and Francis, 1990). Seeds may be stored refrigerated and have been successfully stored for 20 years by freezing at -8°C (Meskimen and Francis, 1990).

II.E. Hybridization within the Genus *Eucalyptus*

Natural hybridization among different subgenera and sections within the genus *Eucalyptus* is rare, and hybrid viability decreases with increasing taxonomic distance between parents (Griffin et al., 1988; Potts and Dungey, 2004). Even among closely related species, hybridization rates are generally very low (Volker, 1995). There are two major pre-zygotic barriers to interspecific hybridization: a structural barrier in which pollen tubes of small-flowered species are too short to reach the ovules of large flowered species; and a physiological barrier that result in pollen tube abnormalities and pollen tube arrest in the pistil (Gore et al., 1990; Ellis et al., 1991). Physiological barriers may also act after fertilization with the zygote failing to start cell division or developing slowly, or reduced cellularization of the endosperm (Sedgley and Granger, 1996; Ellis et al., 1991; Potts and Wiltshire, 1997). Despite these biological limitations, F_1 hybrids can be produced among closely related species of genus *Eucalyptus* through human intervention by controlled pollination. (Potts and Dungey, 2004). These generally exhibit poor vigor and reduced fitness compared to open pollinated intraspecific progeny (Lopez et al., 2000). Interspecific hybrids have been successfully developed through rapid development and testing of large populations and application of high selection intensities. Such hybrids, including *E. urograndis*, have been extensively used in *Eucalyptus* plantations worldwide (Bertolucci et al., 1995; Turnbull, 2003; MacRae, 2003). Another key factor in the operational success of these hybrids has been the development of methods that allow their vegetative propagation.

There are several species of *Eucalyptus* that can be grown in Florida and the southeastern USA (Table II.B). *Eucalyptus grandis* has been grown commercially in southern Florida since the 1960s for mulch and pulpwood production (Meskimen et al., 1987). Other than *E. grandis*, the main species present in southern Florida include *E. robusta*, *E. camaldulensis*, *E. tereticornis*, *E. torelliana,* and *E. amplifolia*. *E. grandis* and *E. amplifolia* can be grown in central Florida as short rotation energy crops and for mulch (Stricker et al., 2000; Rockwood et al., 2004). Other species of *Eucalyptus* that have been grown on a small scale or in species screening trials in northern Florida include *E. pauciflora* (for ornamental foliage production near Barberville, FL), *E. viminalis*, *E. nova-anglica*, *E. macarthurii*, *E. camphora, E. rubida*, *E. dalrympleana*, and *E. nitens* (Rockwood, Per. Com). In addition to these species there are several cold-hardy species that can be grown in parts of the southeastern US including *E. neglecta, E. niphophila, E. gunnii¸E. benthamii and E. dorrigoensis. E. cinerea,* which is also known as the silver dollar tree or Argyle Apple, is commonly grown in the southeast as an ornamental species.

The potential for crossing of an *E. urograndis* hybrid with other species is highly unlikely due to asynchronous flowering and cross-incompatibility (Potts and Dungey, 2004). For example, *E. grandis* and *E. urophylla*, for which hybrids have been generated in directed breeding programs, are in the Salignae and Resiniferae series, respectively, of section Transversaria (Table II.B). In contrast, *E.*

cinerea and other cold hardy species mentioned above are far removed from *E. grandis* and *E. urophylla* on the evolutionary scale and reside within the distant Sections of genus *Eucalyptus* (Table II.B). The phenology (season, time and duration of flowering, intensity of flowering) of *Eucalyptus* also plays an important role in limiting the success of interspecific hybridization (Gore and Potts, 1995; Potts et al., 2003; Barbour et al. 2006). A further barrier to potential crossing of the *E. urograndis* hybrid with ornamental *E. cinerea* and other species grown in southeastern US would be their expected differences in phenology. For example, the *E. urograndis* hybrid genotype produces mature flowers in the mid to late summer whereas *E. cinerea* flowers in the late spring.

II.F. Weediness of Planted *Eucalyptus*

The species belonging to genus *Eucalyptus* are generally characterized by production of large number of flowers, fruits and high numbers of seeds (House, 1997). Although *Eucalyptus* seed is light and very small, it is not adapted to wind dispersal and the dispersal of seed is very limited, generally being confined within a radius of twice the tree or canopy height (approximately 50m for a 25m tall tree at harvest age) (Cremer, 1977; Linacre and Ades, 2004). Another consequence of the very small size of *Eucalyptus* seed is that these have very limited reserves, and therefore are very intolerant of shade or weedy competition. *Eucalyptus* seeds do not have any dormancy barriers to prevent germination (Grose, 1960; Wellington, 1989; Gill, 1997) and seed viability and storage of *Eucalyptus* seeds in soil is less than one year (Gill, 1997). *Eucalyptus* plantations are typically established using rooted plantlets because of poor establishment using direct seeding methods. Even for rooted plants, competition control is recommended for several months after planting to ensure optimal survival (Meskimen and Francis, 1990).

The Global Invasive Species Database of the world's top 100 invasive species (Fondation d'Entreprise Total, 2000) does not list any *Eucalyptus* species. Among several *Eucalyptus* species introduced in California (Santos, 1997; King and Krugman, 1980; Merwin, 1983), only two, *E. globulus* and *E. camaldulensis* are categorized as invasive by the California Invasive Plant Council (CIPC, 2007). *E. globulus* in particular is well adapted to the Mediterranean climate of parts of coastal California where frequent summer fog is conducive to seed germination in that species (Santos, 2007). *E. grandis* has been tested in California but with limited success (Merwin, 1987). In the US, weed risk assessments pertinent to *E. grandis* have been conducted in Hawaii, California, and Florida. A risk assessment adapted from an Australia Weed Risk Assessment model for importing *E. grandis* into Hawaii and other Pacific islands suggested that this species posed some risk at those locations (Daehler et al., 2004; http://www.botany.hawaii.edu/faculty/daehler /wra/full_table.asp).. However, personal surveys conducted by N. Dudley, A. Yeh, N. Koch, and D. Rockwood of *E. grandis* plantations in Hawaii detected no escapes, suggesting that this species is unlikely to be invasive (Rockwood, Per.Com.).

E. grandis has been planted commercially in Florida since the 1960s and now constitutes ~8,000 ha of mulchwood plantations (Rockwood, Per.Com.). As recently as 2005, the absence of any eucalypts on the Florida Exotic Pest Plant Council's 2005 Invasive Plants lists (FLEPPC, 2005) shows that *Eucalyptus* species had not demonstrated invasiveness characteristics in Florida. Several commercially important *Eucalyptus* species grown in Florida were evaluated according to the IFAS (Institute of Food and Agricultural Sciences) Assessment of the Status of Non-Native plants in Florida's Natural Areas (Fox et al., 2005). These species had not been documented in the undisturbed natural areas of Florida as of February 2008, (http://plants.ifas.ufl.edu/assessment/conclusions.html). Based on recent assessments using the modified Australian Weed Risk Assessment model, *E. grandis*, one of the parents of the EH1 hybrid, was found to be 'predicted to be invasive' by this model (Gordon et al., 2008). As neither *E. urograndis* nor the *urophylla* parents have been widely grown in the U.S. there are limited data available for Florida. However, since its introduction in 1994, EH1 has been planted in Brazil on ~150,000 hectares with no notable indication of its spread beyond plantations. In addition, our own experience with

EH1 planted in Alabama and Florida where the trees have been allowed to flower and produce seeds over several growing seasons suggest that this genotype does not spread beyond planted areas. Therefore, there is no scientific evidence to suggest that this hybrid genotype is invasive or even has potential to be invasive.

In order to successfully germinate and establish, Eucalyptus seed need contact with bare mineral soil and little or no competition. Lack of competition can result from human intervention (weed control) or naturally following a fire event (Bell and Williams, 1997; Meskimen and Francis, 1990). D. Rockwood with the University of Florida (Per. Com.), after forty years of breeding, developing and growing Eucalyptus in Florida, noted only one instance in which conditions were suitable for germination and spread of *E. grandis* outside the boundaries of the plantation setting. In this situation a fire in an 8-year-old *E. grandis* seed orchard consumed all understory vegetation, exposed moist soil, and encouraged capsule opening and heavy seed release from the trees resulting in abundant seedlings throughout the orchard. However, no seedlings developed in the unburned pasture and plantation adjacent to the orchard. Importantly, incidental observations by Rockwood of 8,000 ha of *E. grandis* plantations (~1,500 trees/ha) over nearly 40 years of variable weather, understory conditions, fire events, harvesting and replanting activities have not detected a single established volunteer seedling. These observations confirm that this species has extremely low potential to seed propagate and to pose a weediness risk potential in Florida.

Under favorable conditions eucalypts can be regenerated by coppicing (sprouting) from the cut stumps (Reddy and Rockwood, 1989; Webley et al., 1986). Two or three coppice rotations are commonly harvested before replanting. Coppice shoots initially grow faster than seedlings, but that advantage is partially offset by stump mortality, which is typically about 5% per harvest (Stubbings and Schonau, 1979). There is no evidence for natural vegetative propagation of commercially grown *Eucalyptus* species and hybrids (Hartney, 1980). Coppicing can regenerate the tree from the cut stump but does not produce new or independent individuals. Although *Eucalyptus* is often propagated as vegetative cuttings, this process requires specific cultural treatments and controlled laboratory or greenhouse conditions (Watt et al., 1995; Yang et al., 1995; Fogaca and Fett-Neto, 2005). Cuttings from small seedlings root readily, but rooting capability ceases before seedlings are about one meter tall because of natural rooting inhibitors produced by mature leaves (Paton et al., 1970). However, even in adult trees, cuttings from epicormic shoots induced at the base of the tree by felling or girdling retain the ability to root. Rooting success varies substantially among varieties, and there are strong seasonal influences and precise cultural requirements for each geographic area. The technique is particularly important in multiplying outstanding hybrid individuals. Beginning in the mid-1970's commercial plantations were propagated by rooted cuttings in Brazil (Campinhos, 1980; Hartney, 1980), where the method is now routinely used to establish major clonal plantations (Campinhos and Ikemori, 1987).

In conclusion, there are several reasons to believe that variety EH1 or translines derived from this variety are highly unlikely to be invasive: 1) absence of any wild relatives of eucalypts that occur naturally in the southeastern US; 2) lack of cross-compatibility and hybridization between EH1 and other species grown in the southeastern US that belong to distantly related subgenera and sections; 3) negligible potential for crossing of EH1 with other species due to asynchronous flowering and cross-incompatibility; 4) high degree of self incompatibility in eucalypts leading to reduced capsule production, low seed yield and poor seedling germination and vigor; 5) requirement of direct contact of seed with bare mineral soil devoid of competition in order for successful germination; 6) lack of seed dormancy; 7) limited seed dispersal potential; and 8) no evidence for spread via vegetative propagation.

III. Description of the Transformation System

III.A. Plant Materials

The *Eucalyptus* variety EH1, which is the progenitor of the freeze tolerant lines developed for this petition, was obtained from International Paper Co. in Brazil. This variety was identified as a hybrid between *E. grandis* and *E. urophylla*. EH1 was selected for its improved growth, superior wood quality and adaptability to different soil types and environments. These characteristics have made EH1 a preferred genotype for deployment in operational *Eucalyptus* plantations in Brazil. EH1 was used as a recipient variety for insertion of T-DNA to obtain freeze tolerant lines.

The sterile tissue culture shoots of EH1 were transferred from Brazil to ArborGen's contract research laboratories (Trees and Technology/Horizon 2, TeTeko, NZ) in New Zealand. The shoot cultures were micropropagated and maintained on solid MS medium (Murashige and Skoog, 1962) supplemented with 1µM BAP and 20g/L sucrose. Shoot cultures were transferred to fresh medium every 3-4 weeks and grown in a growth chamber at 25±2ºC under a 16-hour photoperiod and low light intensity provided by cool white fluorescent tubes.

III.B. *Agrobacterium* Preparation

Agrobacterium tumefaciens strain EHA105 (Hood, 1993; McBride and Summerfelt, 1990) harboring construct pABCTE01 (see section IV) was used for transformation.

Agrobacterium tumefaciens cultures were initiated from frozen glycerol stocks (50µl) in 10 ml YEP broth (Lichtenstein and Draper, 1986) supplemented with 50mg /L kanamycin and 50mg /L rifampicin. The culture was grown overnight at 25°C on an orbital shaker (200 rpm), pelleted by centrifugation at 3000 × g for 10 minutes and resuspended in 20-30 ml liquid MS (2.0% w/v glucose, no plant growth regulators or antibiotics) for explant inoculation.

III.C. Inoculation and Co-cultivation

Leaf explants of EH1 were harvested from actively growing micropropagated shoot clumps, inoculated with the resuspended *Agrobacterium* cells and plated on MS-based co-cultivation medium as described by Cheah (2001). The explants were co-cultivated for 4 days under low light at approximately 22°C in a growth chamber.

III.D. Selection and Regeneration

Following co-cultivation, explants were transferred to regeneration medium (Cheah, 2001) containing 50 mg/L kanamycin to allow selection of transformed cells and 250 mg/L timentin to kill any remaining *Agrobacterium.* After two to three weeks, shoot primordia were produced at the base of leaf explants. The developing shoot primordia were transferred to the same basal regeneration medium containing 100 mg/L kanamycin. Four weeks later, the shoot primordia converted into adventitious shoots that were then maintained for 12 weeks on selection medium containing 150 mg/L kanamycin by subculturing at 4 week intervals. Individual kanamycin resistant shoots were recovered from each event (designated as a transgenic line) at 16 to 20 weeks after co-cultivation. From each actively growing putative transgenic shoot, two to three young leaves were harvested for molecular verification. DNA was extracted from leaf samples and analyzed by PCR using standard procedures for the presence of genes-of-interest, selectable marker gene and the absence of vector backbone, as well as for insert copy number.

III.E. Propagation and Rooting of Transgenic Lines for Field Testing

Shoot cultures were maintained and identity-preserved for each confirmed transgenic line on MS-based medium containing 50mg/L kanamycin and 250mg/L timentin by subculturing every 4 weeks. The antibiotics were eliminated from the medium at shoot elongation. For shoot elongation and root induction, the elongated shoots of the confirmed transgenic lines were harvested and placed on JADS medium (Vanderlei, 2002).

The sterile rooted tissue culture plants or shoot cultures of transgenic lines and non-transgenic control plants of the same parental genotype produced in New Zealand were imported into the US under approved BRS import permits (Appendix A). Upon arrival in the US, the individual rooted plants of transgenic lines were transferred to soil in suitable containers, labeled appropriately using a durable water insoluble label, and grown in our secure greenhouse facilities in South Carolina. The transgenic plants were then acclimatized outdoor and field tested under acknowledged BRS notifications and permits (Appendix A and C).

IV. Donor Genes and Regulatory Sequences

IV.A. Vector pABCTE01

The plasmid pABCTE01 used for transformation of hybrid variety EH1 is shown below in Figure IV.A. The vector is 11,078 base pairs and contains a *CBF2* expression cassette, a *barnase* expression cassette, and an *nptII* selectable marker cassette between the left and right T-DNA border regions. The size of the T-DNA, between the right border (RB) and left border (LB), that is predicted to be incorporated into the *Eucalyptus* genome of transgenic lines is approximately 7.0 kb, and the remaining (unincorporated) backbone region of the plasmid is approximately 4.0 kb.

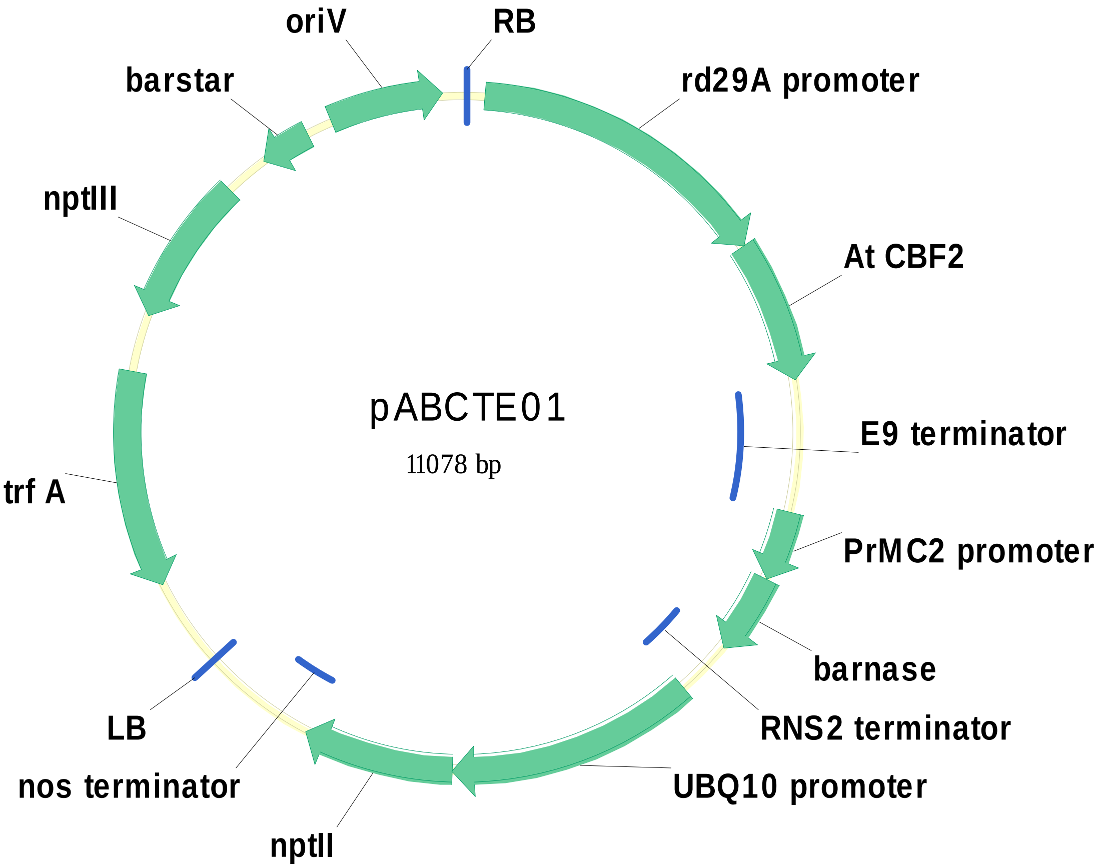


Figure IV.A. Map of pABCTE01

IV.B. The Proteins and Regulatory Sequences

The Table IV.A provides a summary of genetic elements used in the vector pABCTE01, their position in the vector and references for the source of these elements.

CBF2 cassette

The *CBF2* cassette is located within the T-DNA adjacent to the right border (RB) region. It consists of a cold-inducible promoter rd29A (Yamaguchi-Shinozaki and Shinozaki., 1993), the *CBF2* (C-Repeat Binding Factor) cDNA, both from *Arabidopsis thaliana*, and the 3' terminator region from the ribulose-1, 5-bisphosphate carboxylase subunit (*RbcS2*) from *Pisum sativum* (Coruzzi et al., 1984).

The *CBF2* gene is part of the C-repeat/dehydration-responsive element binding factor (*CBF/DREB*) cold-response pathway (Jaglo-Ottosen et al., 1998; Zhang et al., 2004). *Arabidopsis* encodes a small family of cold-responsive transcriptional factors known as *CBF1*, *CBF2*, and *CBF3* (also called *DREB1b*, *DREB1c* and *DREB1a,* respectively). The *CBF* transcriptional factors belong to the AP2/EREBP family of DNA-binding proteins (Riechmann and Meyerowitz, 1998) and recognize the cold- and drought-responsive DNA regulatory sequence designated as C-repeat (CRT)/dehydration-responsive element (DRE), which has a conserved core sequence (Baker et al., 1994; Yamaguchi-Shinozaki and Shinozaki, 1994). This CRT/DRE core sequence was found to be present in the promoter regions of many cold-inducible genes including *rd29A* and *cor15a* (Maruyama et al., 2004) and it is believed that binding of *CBFs* to these promoters leads to increased expression.

It is known from the literature that overexpression of *CBF* genes under control of a constitutive promoter can increase cold tolerance but can also promote dwarfing (Zhang et al., 2004). To overcome this problem, stress-inducible plant promoters with a low background expression level have been used in conjunction with the cold tolerance genes (Yamaguchi-Shinozaki and Shinozaki, 1993). In vector pABCTE01, we utilized the rd29A cold-inducible promoter isolated from *Arabidopsis thaliana* which confers induction of expression primarily under cold-stress conditions (Kasuga et al., 2004).

The terminator for the cassette is from the 3' untranslated region from the ribulose-1, 5-bisphosphate carboxylase subunit (*RbcS2*) isolated from *Pisum sativum* (Coruzzi et al., 1984). This terminator has been previously used in several deregulated crop plants including tomato (APHIS petition #95-053-01p) and canola (petition #01-324-01p).

Barnase cassette

This cassette consists of a modified *barnase* gene from *Bacillus amyloliquefaciens* (Mossakowska et al., 1989, Meiering et al., 1992) under control of an anther-specific promoter (PrMC2) isolated from *Pinus radiata* as described in U.S. Patent Application # 20030101487. The PrMC2 promoter was demonstrated to be active primarily in the tapetum of the pollen sac (Walden et al., 1999). Tissue specific expression of this promoter and efficacy in eliminating pollen production has been demonstrated in tobacco and other plant species (see Appendix D).

Barnase in combination with the tapetum-specific TA29 promoter has been used previously to accomplish male sterility (corn, petitions #95-228-01p, #98-349-01p and *Cichorium intybus,* petition #97-148-01p). Early experiments at ArborGen (unpublished results) suggested that even very low expression of *barnase* can be detrimental to the plant transformation and regeneration process. We therefore developed a modified form of the *barnase* gene with attenuated activity such that very low levels of expression would not impact overall plant development but would have sufficient activity to obtain ablation of developing pollen. The terminator for this cassette is the 3' region from the *RNS2* (Ribonuclease 2) gene from *Arabidopsis thaliana* (Taylor et al., 1993).

Selectable marker cassette

Neomycin phosphotransferase (*nptII*) from *Escherichia coli* transposon Tn5 was used as a selectable marker. The kanamycin resistance selectable marker gene used in this cassette is generally accepted as being safe (Fuchs et al., 1993) and has been previously used in several deregulated crop plants (e.g. corn, petition # 01-137-01p; rapeseed, petition #01-206-02p; cotton, petition #95-045-01p; and papaya, petition #96-051-01p).

This cassette utilizes the *Arabidopsis thaliana* polyubiquitin (UBQ10) gene promoter (Norris et al., 1993). This promoter shows strong expression in a wide range of tissues and was selected based on its efficacy when driving *nptII* gene in plant transformation (ArborGen unpublished results). The terminator used for the *nptII* gene is from the nopaline synthase (*nos*) gene of *Agrobacterium tumefaciens* (Bevan et al., 1983).

IV.C. T-DNA Borders

The right and left borders used in plasmid pABCTE01 were derived from the Ti plasmid of *Agrobacterium tumefaciens* strain C58. These sequences delineate the region of the plasmid to be transferred into the target plant genome and are required for efficient T-DNA transfer (Depicker et al., 1982; Barker et al., 1983).

IV.D. Genetic Elements Outside the T-DNA Borders

Four elements are located in the vector backbone outside of the T-DNA borders, and therefore are not expected to be transferred into the *Eucalyptus* genome. These elements are necessary for bacterial maintenance and replication of the plasmid. The first element, trfA, is a bacterial origin of replication for plasmid maintenance in *E. coli* (Frisch et al., 1995). The second, *nptIII,* encodes a neomycin phosphotransferase gene conferring kanamycin resistance used in selecting for the vector in *E.* c*oli* and *Agrobacterium* (Frisch et al., 1995*)*. The *barstar* gene from *Bacillus amyloliquefaciens* has been used previously for bacterial plasmid maintenance when the *barnase* gene is present (Hartley, 1988, 1989). Finally, the oriV element is an origin of replication from pRK2 for plasmid maintenance in *Agrobacterium (*Stalker et al., 1981).

Table IV.A. Summary of genetic elements in the plasmid pABCTE01

Genetic Element	Position in Plasmid	Function and Source (Reference)
T-DNA		
RB (right border)	1-25	DNA region from *A. tumefaciens* containing the right border sequence used for T-DNA transfer. Barker et al., 1983
intervening sequence	26-95	Sequences used in DNA cloning
rd29A promoter	96-1717	rd29A cold-inducible promoter from *Arabidopsis thaliana.* Yamaguchi-Shinozaki and Shinozaki., 1993
At CBF2	1718-2476	C-repeat binding factor 2 (*CBF2*) from *Arabidopsis thaliana*; Liu et al., 1998; Cook et al. 2004; Jaglo-Ottosen et al., 1998
intervening sequence	2477-2509	Sequences used in DNA cloning
E9 terminator	2510-3166	3' untranslated region from ribulose-1,5-bisphosphate carboxylase small subunit (*RbcS2*) *E9* gene from *Pisum sativum;* Coruzzi et al., 1984
intervening sequence	3167-3172	Sequences used in DNA cloning
PrMC2 promoter	3173-3544	PrMC2 male-specific promoter from *Pinus radiata;* Walden et al., 1999
Barnase	3545-3969	*barnase* from *Bacillus amyloliquefaciens;* Mossakowska et al., 1989; Meiering et al., 1992
intervening sequence	3970-3975	Sequences used in DNA cloning
RNS2 terminator	3976-4258	RNS2 (Ribonuclease 2) terminator from *Arabidopsis thaliana*; Taylor et al., 1993
intervening sequence	4259-4266	Sequences used in DNA cloning
UBQ10 promoter	4267-5590	Polyubiquitin (UBQ10) promoter from *Arabidopsis thaliana* ; Norris et al., 1993
nptII	5591-6395	Neomycin phosphotransferase from Tn5 of *E. coli.* Fuchs et a;. 1993; Rothstein et al. , 1981
intervening sequence	6396	Sequences used in DNA cloning
nos terminator	6397-6651	3' untranslated region of nopaline synthase (nos) from T-DNA of *Agrobacterium tumefaciens;* Depicker et al. 1982; Bevan et al., 1983
intervening sequence	6652-7006	Sequences used in DNA cloning
LB (left border)	7007-7031	DNA region from A. tumefaciens containing the left border sequence used for T-DNA transfer. Barker et al. 1983
Vector Backbone		
intervening sequence	7032-7485	Sequences used in DNA cloning
trfA	7486-8631	Replication origin from *E. coli;* Frisch et al., 1995
intervening sequence	8632-8932	Sequences used in DNA cloning
nptIII	8933-9724	Neomycin phosphotransferase gene from *Enterococcus faecalis;* Frisch et al., 1995
intervening sequence	9725-9956	Sequences used in DNA cloning
barstar	9957-10226	*Barstar*, a natural inhibitor of *barnase*, from *Bacillus amyloliquefaciens* Hartley, 1988, 1989
intervening sequence	10227-10367	Sequences used in DNA cloning
oriV	10368-10970	Origin of replication from plasmid pRK2 for maintenance of plasmids in *Agrobacterium.* Stalker et al., 1981
intervening sequence	10971-11078	Sequences used in DNA cloning

V. Molecular Characterization of Lines 427 and 435

V.A. Molecular Characterization Methods

Molecular analysis was performed on freeze tolerant *Eucalyptus* lines 427 and 435 to characterize the integrated T-DNA. Southern blot analysis was used to determine insert number, copy number, cassette intactness and to confirm the absence of vector backbone.

Materials and Methods

For lines 427 and 435, *in vitro* leaf tissue was harvested from replicated shoot cultures grown in a growth chamber. Control leaf samples were obtained from untransformed shoot cultures of the hybrid *Eucalyptus* variety used for transformation (EH1). Leaf tissue was harvested periodically from the *in vitro* shoot cultures throughout the study.

Plasmid pABCTE01, used in the production of lines 427 and 435 also served as a reference substance. For Southern blot analyses, standards and positive hybridization controls were created using specific quantities of plasmid pABCTE01 spiked into Calf Thymus (Sigma, Cat. No. D4764) carrier DNA which was then digested with designated restriction enzymes. The amount of spiked pABCTE01 plasmid (60 pg) representing a single copy per diploid genome was calculated based on the formula:

$\# \text{pg} = (M * 10^6 * P) / G$

where M = # micrograms of genomic DNA run in a lane, 10^6 = conversion from µg to pg, P = size of plasmid in bp, G = size of diploid genome in bp. The calculation used 11078 bp for pABCTE01, a diploid genome size of 1.33×10^9 base pairs (Grattapaglia and Bradshaw, 1994), and 7 micrograms of genomic DNA. A molecular size marker (New England Biolabs, Cat. No. N3232L, 10 kb-0.5 kb) was used for size estimations on Southern blots. In the following discussion, a single copy per diploid genome is referred to as the 0.5 copy standard to reflect the amount of spiked DNA on a haploid genome basis.

Purification of genomic DNA

DNA from both transgenic and untransformed samples was purified using a CTAB extraction protocol. Two grams of *in vitro* leaf material were added to a mortar and ground into a fine powder in the presence of liquid nitrogen. The powder was placed into a labeled 35 ml Oakridge style tube containing 14 ml of CTAB extraction buffer (0.1 M Tris pH 7.5, 0.7 M NaCl, 10 mM EDTA, 1% CTAB, 1% PVP), the tube was sealed and then incubated at 60°C for 15 min. with periodic agitation. Cellular debris was pelleted by centrifugation at ~10000 × g for 5 min. The supernatant was poured into a second labeled 35 ml Oakridge style tube containing 14 ml of phenol (Sigma, Cat. No. P4557, pH 10.5) and inverted several times to create a homogenous emulsion. The emulsion was separated into two phases by centrifugation at 14000 × g for 5 minutes. The upper aqueous layer was removed and added to a fresh tube containing 14 ml of chloroform/isoamyl alcohol (Sigma, Cat. No. C0549, 24:1). The tube was agitated for several minutes to form a uniform emulsion followed by centrifugation at 14000 x g for 5 min. The aqueous layer was removed and added to a fresh tube containing 14 ml of chloroform/isoamyl alcohol (24:1) with 10% CTAB (0.1 M Tris pH 7.5, 0.7 M NaCl, 10 mM EDTA, 10% CTAB, 1% PVP). The tube was inverted several times again followed by centrifugation at 14000 x g for 5 min. The aqueous layer was removed and placed into a newly labeled 35 ml Oakridge style tube and combined with 8 ml of 3 M NaOAc (pH 4.8) followed by 9 ml of isopropanol. The tube was then gently inverted several times. The DNA was pelleted by centrifugation at 14000 x g for 20 min., rinsed once with 70% ethanol and air dried for up to 1 hour. The DNA was then resuspended in TE buffer (10 mM Tris-Cl, pH 7.5, 1 mM EDTA).

DNA samples were quantitated using a SpectraMAX Gemini Fluorescence microplate reader (Molecular Devices, Inc.) using standards of known concentration (1kb DNA ladder, New England Biolabs) for calibration.

Restriction endonuclease digestion

Digest reactions for untransformed control samples contained 7μg of genomic DNA and were performed overnight at 37°C in a total volume of 400 μl using 50 – 100 units of the appropriate restriction enzyme. For the translines, samples were prepared for both a long run and a short run on the electrophoresis gels by digesting a total of 14 μg genomic DNA in 800 μl in the same reaction overnight at 37°C. This digest was then separated equally into two tubes (7μg each) and precipitated. Whole plasmid pABCTE01, used as a positive hybridization control, was spiked into 7 μg of calf thymus DNA prior to incubation. Following digestion, samples were precipitated by adding 40 μl of 3M NaOAc, pH 5.2 and 0.7 volumes of isopropanol. The DNA was pelleted by centrifugation at 14000 x g for 10 minutes, washed briefly with 70% ethanol, briefly air dried and resuspended in 60 μl of TE buffer. To facilitate gel loading, samples were loaded into a speedvac and spun for 40 minutes to reduce the overall volume and to remove residual ethanol.

DNA probe preparation for Southern blot analysis

Template DNA for hybridization probes was prepared by either restriction endonuclease digestion or PCR amplification of purified plasmid pABCTE01 (Figure V.A.). In both cases, following completion of the reaction, samples were run on an agarose gel and the appropriate band was purified using a commercially available kit (Qiagen, Cat. No. 28604). Approximately 25 ng of each probe template was labeled with α ^{32}P-dATP using a random priming reaction (Invitrogen Inc., Cat. No. 18187-013) as described by the manufacturer. Radiolabeled probes were purified using column chromatography (BioRad, Cat. No. 732-6231).

Southern blot methods

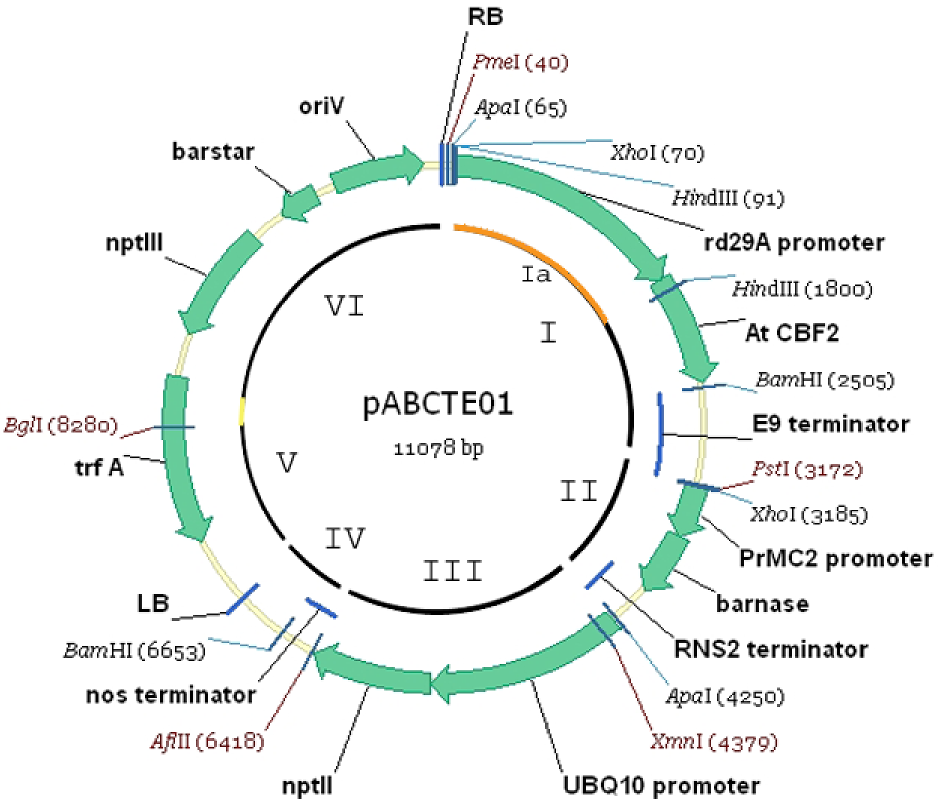
DNA samples were analyzed using standard Southern blot analysis (Southern, 1975) by digesting samples with restriction endonucleases and separating the resulting fragments by electrophoresis on 0.8% agarose gels that were run in 1 × TAE buffer (40 mM Tris-acetate pH 8.3, 1 mM EDTA). Two runs were performed for each sample on each gel. A long run enabled greater resolution of high molecular weight fragments while a short run allowed the observation of low molecular weight fragments. The long run samples were loaded onto the gel and run overnight at 20V. Short run samples were loaded the next day in lanes adjacent to the long run samples and run at 140V for 2 hours. A molecular size marker (New England Biolabs, Cat. No. N3232L, 10 kb-0.5 kb) was used for size estimations on each run. Following electrophoresis, gels were stained with ethidium bromide for 10 minutes, destained for 10 minutes and then photographed. The gels were placed into a depurination solution (0.125 N HCL) and gently rocked for 12 minutes followed by denaturing solution (0.5 M NaOH, 1.5 M NaCl) for 30 minutes and then a neutralizing solution (0.5 M Tris-HCL pH 7.0, 1.5 M NaCl) for 30 minutes. DNA was transferred to Zeta-Probe nylon membranes (BioRad, Cat. No.162-0165) overnight using 20 × SSC (3 M NaCl and 0.3 M sodium citrate, pH 7.0) using standard Southern blotting techniques (Southern, 1975). The following day, blots were covalently crosslinked to the membrane using the "autolink" setting on a UV Stratalinker (Stratagene) and then oven dried at 65°C for 20 minutes. Blots were prehybridized for 1-2 hours using a hybridization solution containing 0.25 M sodium phosphate pH 7.2 and 7% SDS. Probe was added directly to the prehybridization solution and allowed to hybridize for 16-20 hours at 65°C. Membranes were washed three times using 0.1% SDS and 0.1 × SSC for 20 minutes at 65°C. Multiple exposures were obtained using Kodak BioMax MS film with two intensifying screens at -80°C. Typical exposure times were 2-3 days.

Outline of Southern blot analysis

A map of pABCTE01 annotated with the probes used in the analysis is presented in Figure V.A. Figure V.B. shows the predicted restriction fragments generated within the T-DNA that were used in the analyses.

1) Insert Number Analysis

The number of inserts (number of insertion sites within the genome) was analyzed by digesting DNA from each transline with three restriction endonucleases (*Age* I, *ApaL* I and *Nhe* I) concurrently, none of which cut within plasmid pABCTE01. This restriction digest would release an intact T-DNA flanked on either side by a portion of plant genomic DNA. After hybridization with a T-DNA-specific probe, the number of observed bands would be indicative of the number of T-DNA inserts present within the genome: lines containing a single insert would be indicated by a single band. The size of the fragment is a function of the restriction sites in the flanking plant DNA, thus multiple inserts would be expected to yield different size fragments.



Probe	Enzymes or PCR Primers	Start Position	End Position	Length (bp)
Probe I (*CBF2* cassette and insert)	*Xho* I and *Pst* I	70	3172	3103
Probe Ia (copy number)	*Hind* III	91	1804	1714
Probe II (*barnase* cassette)	*Xho* I and *Xmn* I	3185	4379	1195
Probe III (*UBQ10* & *nptII*)	*Apa* I and *Afl* II	4246	6422	2177
Probe IV (*nos* & left border region)	TTAAGATTGAATCCTGTTGC, GTGGTGTAAACAAATTGACG	6418	7018	601
Probe V (backbone)	AAGATCGAGCGCGACAGCGT, CGGCAGCTCGGCACAAAATC	7056	8475	1420
Probe VI (backbone)	*Bgl* I and *Pme* I	8277	40	2838

Figure V.A. Map of pABCTE01 with probe and restriction enzyme locations
Restriction enzyme sites used in the Southern blot analysis are shown. Enzymes which cut only once in pABCTE01 are indicated in colored font. The table below the map details the size and location of the hybridization probes, labeled I through VI, used for the hybridization. Only the region from the RB, proceeding clockwise as shown in the map, to the LB is inserted into the plant genome.

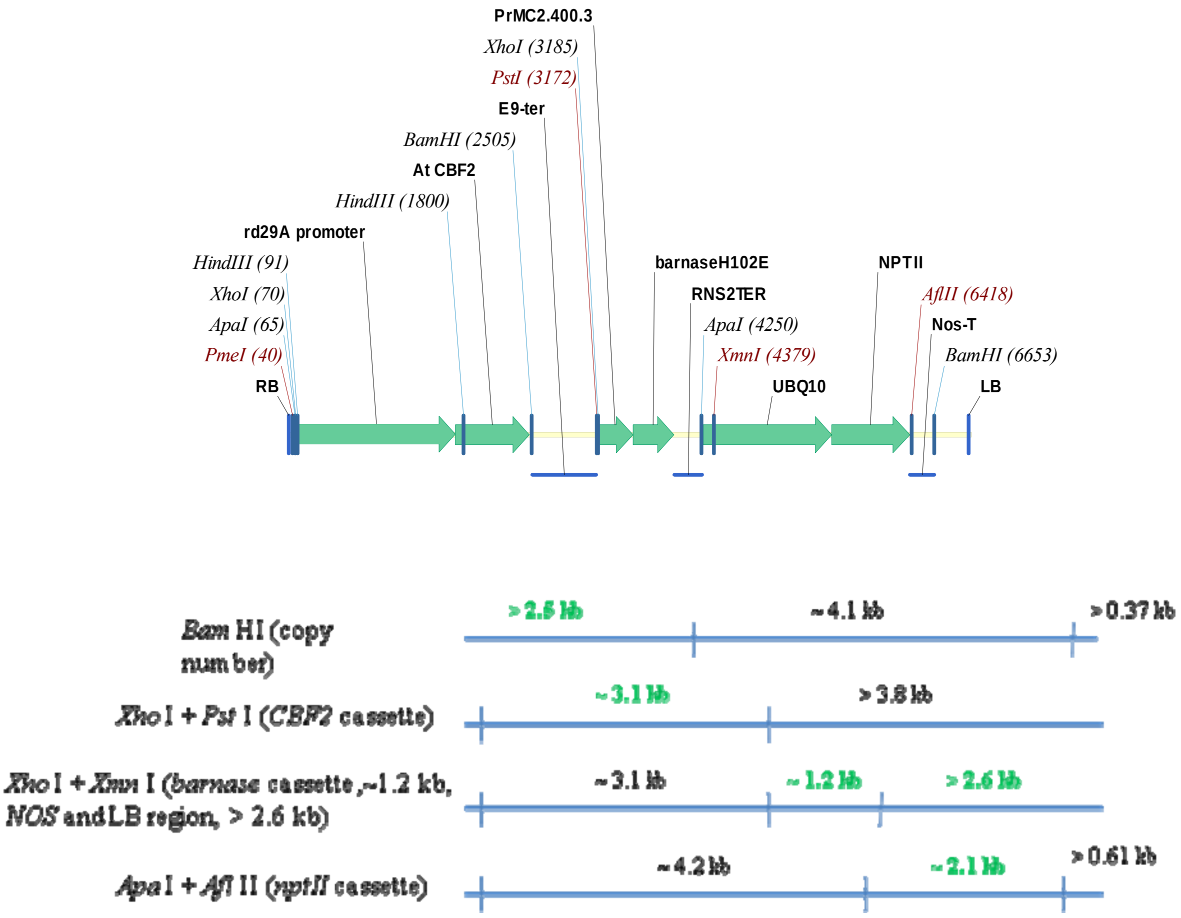


Figure V.B. Linear map of the T-DNA from the transformation vector pABCTE01
The predicted sizes of the restriction fragments in transgenic lines used in the analysis are depicted above. The highlighted (green font) fragments represent the bands used for the analysis. Fragment sizes were calculated based on the DNA sequence of the plasmid. For transgenic plants, the left and right borders that are depicted on the map are expected to be linked to adjacent *Eucalyptus* genomic DNA and the degree by which the fragments exceed the minimum predicted sizes will depend upon the specific insert locations in the transgenic lines.

2) Copy Number Analysis

A single T-DNA insert could have multiple copies of the transformation cassette within a single locus of integration. A copy number analysis was performed to ensure that the single locus insertion contained one copy of the transformation cassette. The number of copies was determined by digesting genomic DNA with the restriction enzyme *Bam*HI, which cleaves twice in the T-DNA (Figure V.B.), and probing blots with Probe Ia (Figure V.A.). A single copy of the T-DNA integrated at the insertion site would produce a single fragment of greater than 2.5 kb consisting of the portion flanking the right border of the T-DNA and extending into the *Eucalyptus* genomic DNA (Figure V.B.). For multiple copies of the T-DNA at a single insertion site, or for multiple insertion sites, this analysis would be expected to produce multiple fragments.

3) Cassette Intactness

Plasmid pABCTE01 is comprised of three gene cassettes: *CBF2*, *barnase* and *nptII* (Figure V.A.), each consisting of the promoter, gene and terminator sequences. The intactness of each cassette was determined by digesting genomic DNA with restriction endonucleases that release, in most cases, the complete gene cassette from the T-DNA. Due to the lack of suitable restriction endonuclease sites for analyzing the complete *nptII* cassette, the UBQ10 promoter and the *nptII* gene were excised and analyzed together while the *nos* terminator and left border region were analyzed separately (see below). To serve as positive hybridization controls, plasmid pABCTE01 was spiked into calf thymus DNA and digested with the corresponding enzyme(s) for each specific blot. The following results are predicted where the three gene cassettes are intact: 1) digesting transline genomic DNA with *Xho* I and *Pst* I and probing with the *CBF2* cassette probe (Probe I) would yield a ~3.1 kb hybridization fragment; 2) digesting transline genomic DNA with *Xho* I and *Xmn* I and probing with the *barnase* cassette probe (Probe II) would yield a ~1.2 kb hybridization band, and:, 3) digesting transline genomic DNA with *Apa* I and *Afl* II and probing with the *nptII* cassette probe (Probe III) would yield a ~2.2 kb hybridization band.

The left and right border sequences that define the T-DNA delineate the DNA that is typically transferred to the plant genome (Klee et al. 1987; Zambryski, 1992). Literature indicates that the transfer of T-DNA into a plant genome via *Agrobacterium*-mediated plant transformation begins at one border sequence and continues through the T-DNA to the next border sequence (Tinland, 1996). The analysis described above would indicate if the three gene cassettes contained within and representing the majority of the T-DNA are intact. The remaining portion of the T-DNA occurs near the left border and contains the nos terminator from the *nptII* cassette (255 bp) and an additional 381 bp of noncoding T-DNA adjacent to the left border. The presence of an intact *nptII* cassette including the *nos* terminator in both translines is supported by the growth of tissue and plants in the presence of antibiotics during and following the transformation process. However, there are no restriction enzyme sites in the pABCTE01 T-DNA that allow the excision of a fragment that represents this complete region. In order to demonstrate the presence of these sequences in the translines a probe which includes these sequences (Probe IV, Figure V.A.) was generated by PCR amplification using primers 545-NosToLB_probe_F and 546-NosToLB_probe_R (TTAAGATTGAATCCTGTTGC, and GTGGTGTAAACAAATTGACG, respectively) and used for Southern blot analysis. Southern blots with genomic DNA digested with *Xho* I and *Xmn* I were used in this analysis (blots used to demonstrate the presence of the *barnase* cassette that were stripped of probe). If the entire *nos* terminator and left border region is intact then a fragment of greater than 2.6 kb is predicted, which would be flanked on one side by the *Xmn* I site in the T-DNA and either a *Xho* I site or *Xmn* I site in the *Eucalyptus* genome. A fragment smaller than this size would be indicative that the region around the left border is truncated.

4) Analysis for Plasmid Backbone

Translines were analyzed for the presence of backbone sequences from plasmid pABCTE01. Overlapping (shown in yellow in Figure V.A.) Probes V and VI representing almost the entire plasmid backbone were used for the analysis. Probe V was created by PCR using primers 547_LB_to_mid_BB_probe_F and 551_Mid_BB (AAGATCGAGCGCGACAGCGT and CGGCAGCTCGGCACAAAATC) that amplifies a 1.4 kb product close to the left border. Probe VI was created by a restriction enzyme digest of pABCTE01 DNA using *Bgl* I and *Pme* I that produces a 2.8 kb fragment that overlaps with probe V. An equimolar amount of each fragment was combined and used as a probe for the analysis. Transline genomic DNA digested with restriction endonucleases *Age* I, *ApaL* I and *Nhe* I, which do not cut within the plasmid pABCTE01, were hybridized using the above probes. The lack of any detectable hybridization bands even after prolonged exposure indicates that the translines do not contain any notable backbone sequence from plasmid pABCTE01.

V.B. Molecular Characterization Results for Line 427

Genomic DNA from line 427 was digested with different restriction endonucleases (Figure V.A.) and used for Southern blot analyses. Line 427 was assessed for the number of inserts present within the *Eucalyptus* genome, the number of copies of the T-DNA present at the site of integration, the integrity of the gene cassettes within the T-DNA and the absence of vector backbone sequence.

Insert number analysis for line 427
The number of inserts was analyzed by digesting DNA from line 427 with three restriction endonucleases that do not cut within pABCTE01 (*Age* I, *ApaL* I and *Nhe* I). Calf thymus DNA was spiked with pABCTE01 (0.5 copy and 1 copy as described above) and digested with *Xho* I, which cuts twice in the T-DNA and served as a positive hybridization control. The blot was probed with Probe I which covers the *CBF2* cassette (see Figure V.A.). Results for the insert number analysis for line 427 are shown in Figure V.C. Lane 2 (untransformed control lane) showed no signal, as predicted. The positive hybridization controls (lanes 4 and 5) produced the predicted size bands of approximately 3.1 kb (Figure V.B.). Line 427 yielded a single hybridization signal of >10 kb in both long and short runs (Figure V.C., lanes 3 and 6). These results demonstrate that line 427 contains a single T-DNA insert.

Copy number analysis for line 427
As described above, an analysis of the insert number indicates that T-DNA has been inserted at a single site in the *Eucalyptus* genome but may not distinguish between a single copy or multiple copies inserted at that site. Therefore a separate copy number analysis was performed and these results are shown in Figure V.D. DNA from the untransformed line EH1 (Figure V.D., lane 2) yielded two fragments, of ~3.8 kb and ~ 6 kb using Probe Ia. These signals indicate hybridization of the probe with sequences present within the *Eucalyptus* genome. This result is consistent with all experiments using this probe (see Figure V.L. for transgenic line 435). Probe Ia consists of a purified *Hin*dIII fragment which corresponds to the complete rd29A stress-induced promoter from *Arabidopsis thaliana* together with a small portion (118 bp) of the *CBF2* gene. It is expected that *Eucalyptus* contains promoters with stress-inducible elements (El Kayal et al., 2006) and these results indicate that DNA sequences native to *Eucalyptus* share some homology to elements of the rd29A promoter.

The pABCTE01 plasmid positive controls digested with *Xho* I produced the predicted size band of approximately 3.1 kb. Long and short runs of line 427 yielded three fragments (Figure V.D., lanes 3 and 6). These include a 4.8kb fragment, which gives a strong hybridization signal comparable to that of the 0.5 copy standard, together with the ~3.8 kb and ~6 kb fragments observed in the untransformed EH1 control DNA sample. The weaker hybridization signal for the ~3.8 kb and ~6 kb fragments is consistent with conclusion that these fragments share some (but less than 100%) homology to Probe Ia sequence. We therefore conclude that the 4.8 kb fragment observed corresponds to the inserted T-DNA, including approximately 2.5 kb of the rd29A promoter and *CBF2* gene adjacent to the right border, extending into the *Eucalyptus* genomic DNA to a BamHI site approximately 2.3 kb from the right border. The single, transline-specific 4.8 kb fragment indicates that line 427 contains a single copy of the T-DNA at the integration site.

Cassette intactness for line 427

(i)CBF2 Cassette – Probe I.

Results for the *CBF2* cassette for line 427 are shown in Figure V.E. Untransformed control DNA (Figure V.E., lane 2) showed no hybridization signal. Positive control plasmid pABCTE01 digested with *Xho* I and *Pst* I gave the predicted ~3.1 kb fragment (Figure V.E., lanes 4 and 5). Line 427 genomic DNA digested with *Xho* I and *Pst* I (Figure V.E., lanes 3 and 6) also yielded a predicted ~3.1 kb fragment. These results confirm that the *CBF2* gene cassette is intact in line 427. No other fragments were detected, indicating that line 427 does not contain any additional *CBF2* cassette sequences other than that which is associated with the single T-DNA insert.

Note that Probe Ia described above, a subfragment of Probe I, gave two signals with the EH1 control sample which likely result from cross hybridization to native *Eucalyptus* sequences. Similar signals would be predicted using Probe I but were not observed with the *Xho* I – *Pst* I double digest, likely because fragments were too large to be transferred to the membrane used in Southern blot analysis. When Probe I was used to analyze *Bam* HI digested DNA then the predicted fragments as seen with Probe Ia were detected (data not shown).

(ii)Barnase cassette – Probe II.

Results for the *barnase* cassette for line 427 are shown in Figure V.F. Untransformed control DNA (lane 2) showed weak hybridization signals to two fragments (~2.9 kb and ~ 2.2 kb). These two fragments are likely the result of low homology between Probe II and native *Eucalyptus* sequences. The likely reason for this hybridization is homology with the *PrMC2* promoter from *Pinus radiata.* The *PrMC2* promoter used to drive *barnase* in plasmid pABCTE01 has been shown to have homologs in angiosperms (Walden et al., 1999). Positive control plasmid pABCTE01 digested with *Xho* I and *Xmn* I gave the predicted ~1.2 kb fragment (Figure V.F., lanes 4 and 5). Line 427 genomic DNA digested with *Xho* I and *Xmn* I also gave strong hybridization to the ~1.2 kb fragment (Figure V.F., lanes 3 and 6) that corresponds to the intact *barnase* cassette, together with weak hybridization to the ~2.2 kb and ~2.9 kb fragments observed in the untransformed control DNA. No other fragments were present, indicating that line 427 does not contain additional *barnase* sequences other than that associated with the single intact T-DNA insert.

(iii)UBQ10 promoter/nptII gene – Probe III.

Results for the *nptII* cassette for line 427 are shown in Figure V.G. As previously mentioned, Probe III was created by digesting plasmid pABCTE01 with *Apa* I and *Afl* II. This restriction fragment contains the *UBQ10* and *nptII* elements. Untransformed control DNA (Figure V.G., lane 2) showed weak hybridization signals to two fragments of ~0.6 kb and ~ 2.7 kb, likely the result of low homology between the *Arabidopsis*-derived *UBQ10* promoter in probe III and native *Eucalyptus* sequences. Positive control plasmid pABCTE01 digested with *Apa* I and *Afl* II yielded the predicted ~2.1 kb fragment (Figure V.G., lanes 4 and 5). Line 427 genomic DNA gave a strongly hybridizing fragment of the predicted ~2.1 kb size (Figure V.G., lanes 3 and 6) that corresponds to the intact *nptII* cassette, together with the weak hybridization signals at ~ 0.6 kb and ~2.7 kb as observed in the untransformed control DNA. No other fragments were present, indicating that line 427 does not contain additional *nptII* sequences.

(iv)Left border region and nos terminator - Probe IV.

Control DNA digested with *Xho* I and *Xmn* I produced no hybridization signals (Figure V.H., lane 2) as expected since neither the *nos* terminator nor the left border region are expected to share any significant homology to *Eucalyptus* DNA sequences. Positive control plasmid pABCTE01 DNA produced the predicted ~6.7 kb fragment (Figure V.H., lanes 4 and 5). This fragment consists of the *UBQ10* promoter, *nptII* gene, *nos* terminator and left border region together with the entire backbone of pABCTE01 and right border up to the *Xho* I site just inside the right border of the T-DNA. Long and short runs of line 427 (V.H., lanes 3 and 6) yielded a single fragment of approximately 2.9 kb. The single 2.9 kb fragment indicates that line 427 contains a single copy of the T-DNA, confirming the results obtained from the copy number analysis above (Figure V.D.). These results further indicate that line 427 contains at least a significant portion of Probe IV sequence, most likely ending at the left border of the T-DNA, and does not contain any additional left border region or *nos* sequences other than those within the intact T-DNA insert.

Analysis for plasmid backbone in line 427

Line 427 was analyzed for the presence of backbone sequences from plasmid pABCTE01. Results from the backbone analysis are shown in Figure V.I. Line 427 and control genomic DNA were digested with restriction endonucleases *Age* I, *ApaL* I and *Nhe* I which do not cut within the plasmid pABCTE01. Positive control plasmid pABCTE01 digested with *Xho* I produced the predicted ~7.9 kb fragment (Figure V.I., lanes 4 and 5). Control DNA gave no detectable band as expected. Line 427 (Figure V.I., lanes 3 and 6) showed no detectable hybridization bands after a 4 day exposure. This result indicates that line 427 does not contain any notable backbone sequence from plasmid pABCTE01.

Predicted insert map for line 427

Based on the above data we conclude that line 427 contains a single complete T-DNA insertion from pABCTE01 at a single site in the genome of EH1 with all gene cassettes intact. A map of the predicted T-DNA was generated based on the results from the Southern analysis on line 427 (FigureV.J.).

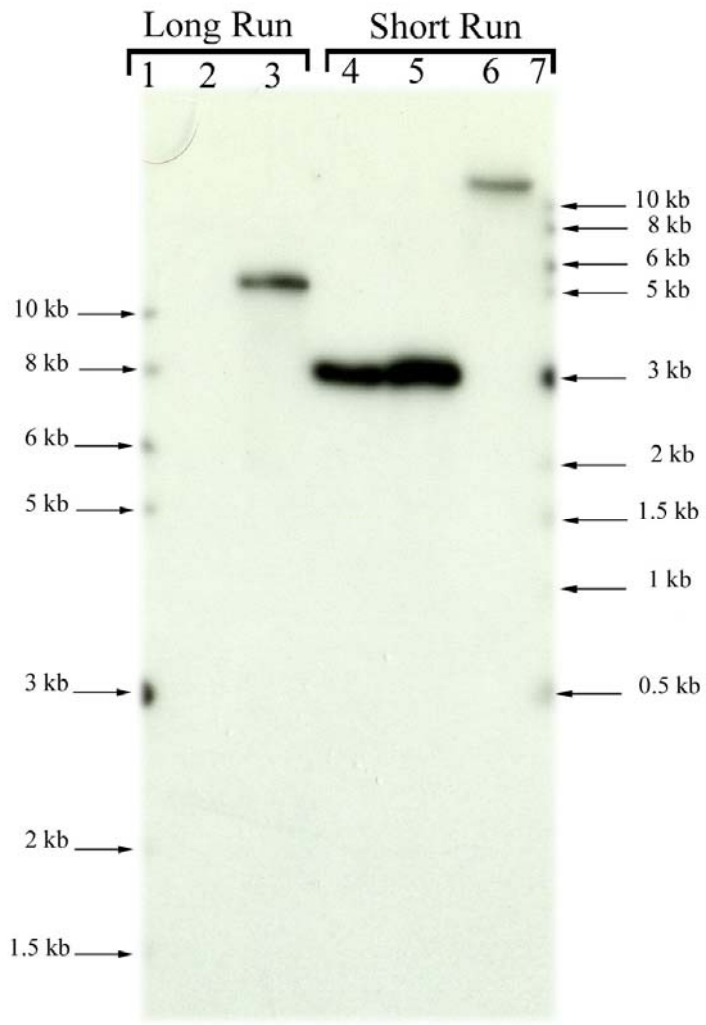


Figure V.C. Southern blot analysis of line 427: insert number

Seven micrograms of untransformed EH1 and line 427 genomic DNA were digested with restriction endonucleases *Age* I, *Apa* LI and *Nhe* I. The blot was probed with the *CBF2* cassette probe (Probe I). Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 427
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

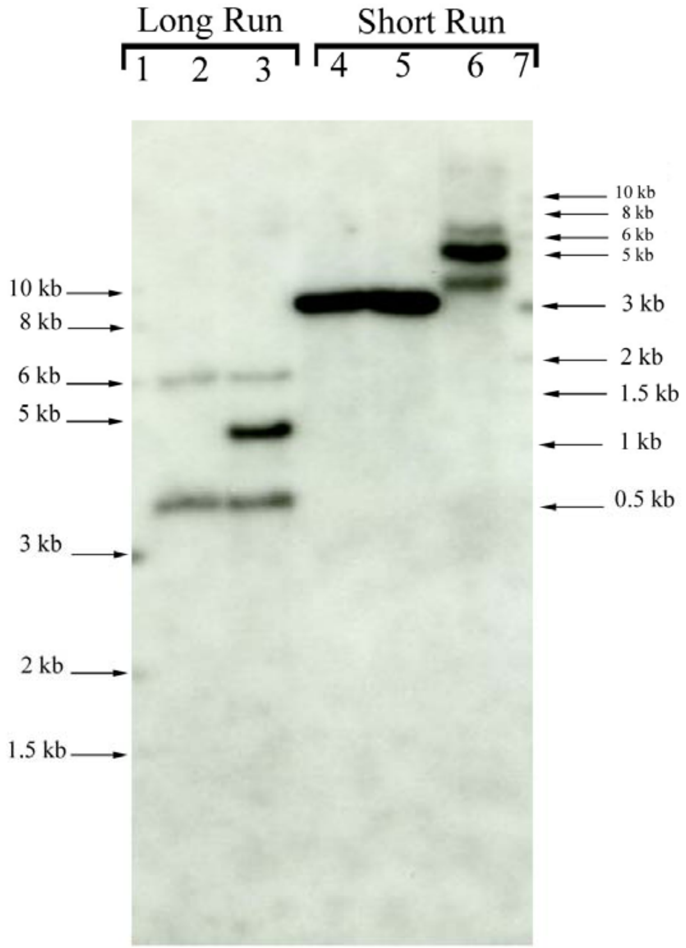


Figure V.D. Southern blot analysis of line 427: copy number
EH1 and line 427 genomic DNA were digested with restriction endonuclease *BamH* I. The blot was probed with the Probe Ia (*rd29A* promoter).
Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 427
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

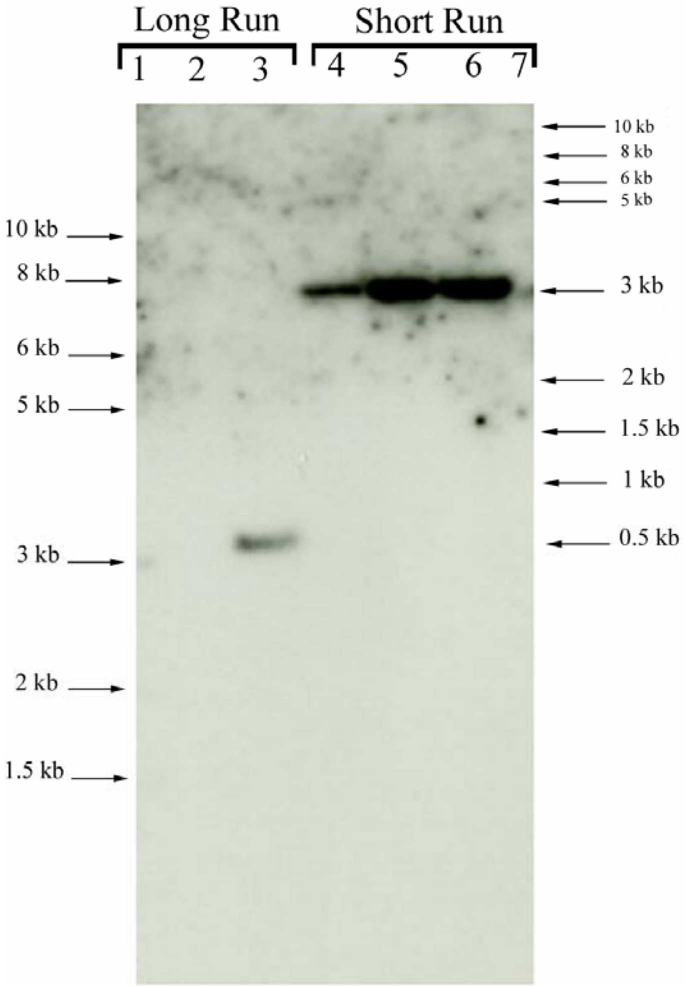


Figure V.E. Southern blot analysis of line 427: *CBF2* cassette

EH1 control and line 427 genomic DNA were digested with restriction endonucleases *Xho* I *and Pst* I. The blot was probed with the *CBF2* cassette (Probe I).

Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 427
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

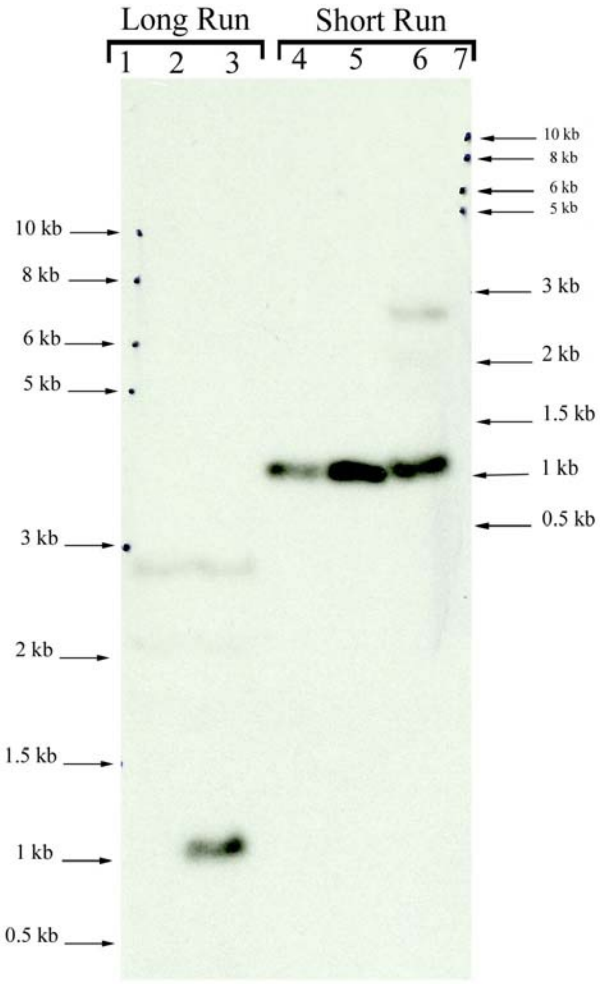


Figure V.F. Southern blot analysis of line 427: *barnase* cassette

EH1 control and line 427 genomic DNA were digested with restriction endonucleases *Xho* I *and Xmn* I. The blot was probed with the *barnase* cassette promoter (Probe II).

Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)

Lane 2: EH1 untransformed control DNA

Lanes 3 and 6: Digested DNA from line 427

Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)

Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

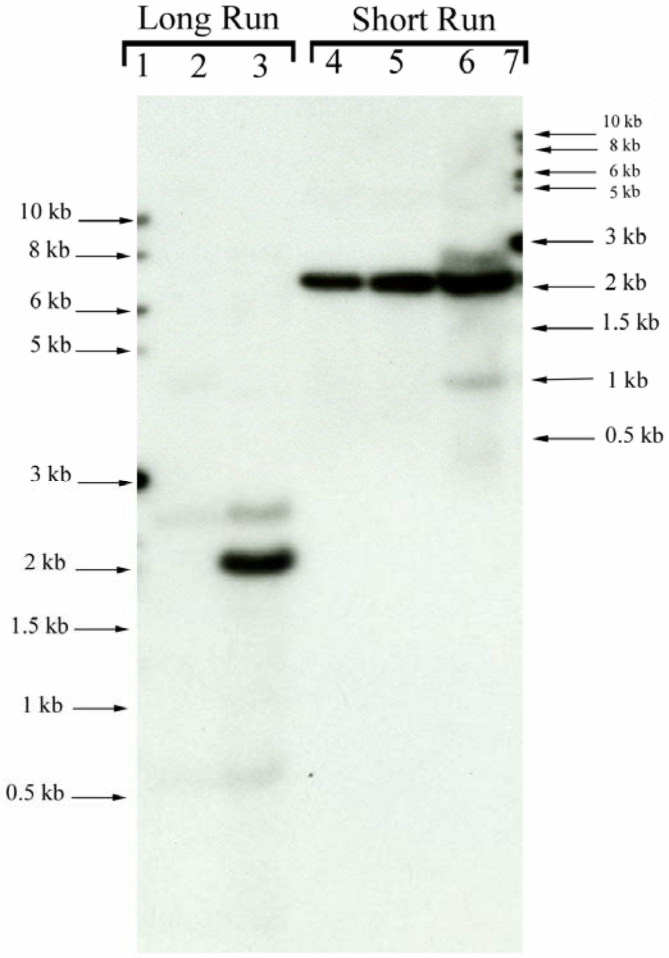


Figure V.G. Southern blot analysis of line 427: *nptII* cassette

EH1 control and line 427 genomic DNA were digested with restriction endonucleases *Apa* I *and Afl* II. The blot was probed with the *nptII* cassette (Probe III).

Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)

Lane 2: EH1 untransformed control DNA

Lanes 3 and 6: Digested DNA from line 427

Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Apa* I (0.5 copy)

Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Afl* II (1 copy)

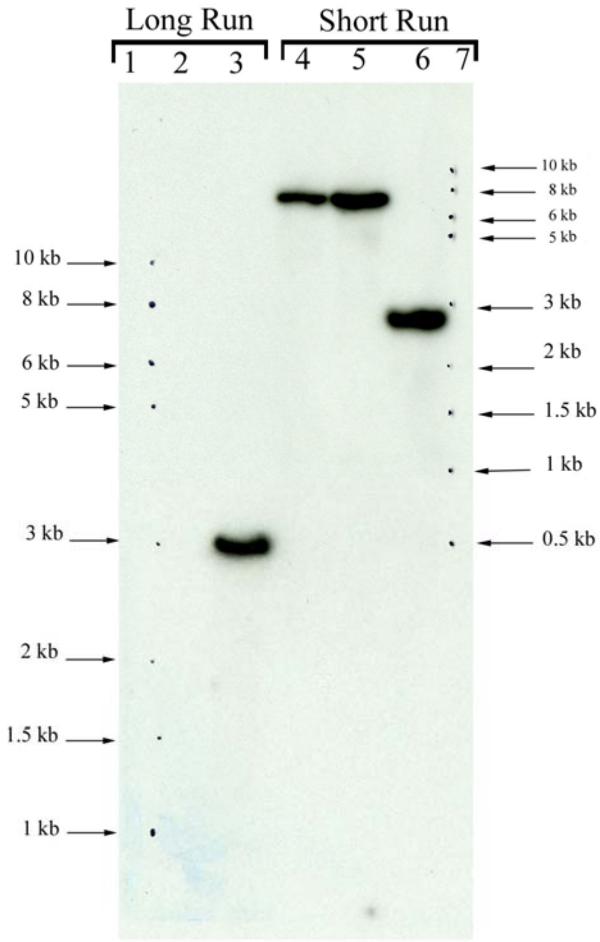


Figure V.H. Southern blot analysis of line 427: left border region and *nos* terminator

EH1 control and line 427 genomic DNA were digested with restriction endonucleases *Xho* I *and Xmn* I. The blot was probed with a PCR product that contained the left border region and *nos* terminator (Probe IV).

Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 427
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

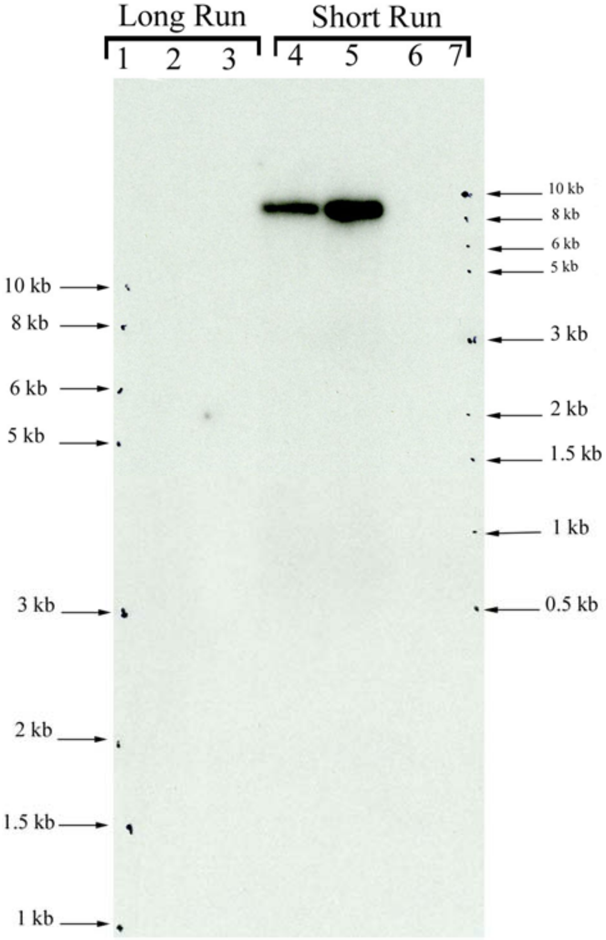


Figure V.I. Southern blot analysis of line 427: backbone

EH1 control and line 427 genomic DNA were digested with restriction endonucleases *Age* I, *ApaL* I *and Nhe* I. The blot was probed with the backbone of plasmid pABCTE01 (Probes V and VI).
Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 427
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

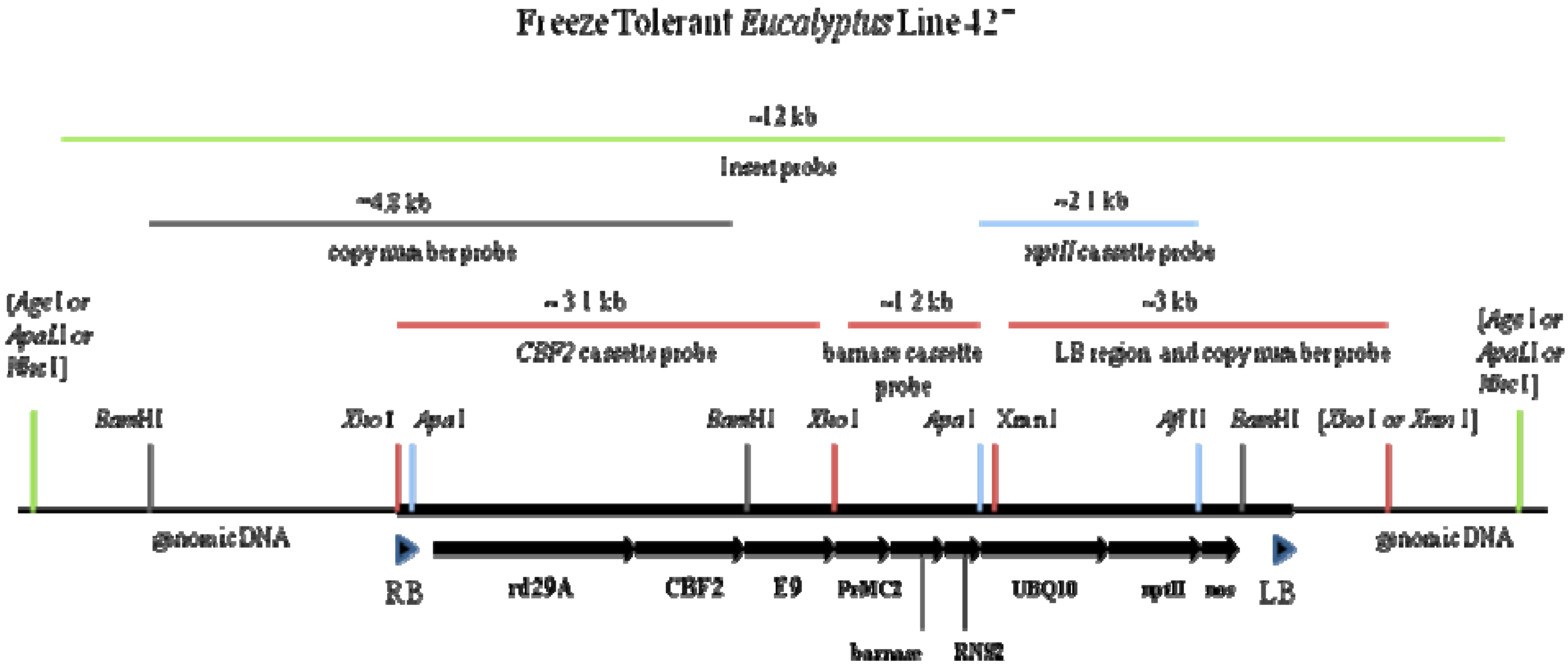


Figure V.J. Schematic of the T-DNA insertion contained within line 427
The heavy, black line represents the T-DNA of construct pABCTE01 inserted into the *Eucalyptus* genome. The thin, black lines on either side of the T-DNA represent genomic DNA. The genetic elements within the T-DNA are identified by black arrows. Depicted above the T-DNA are restriction fragments generated by the insert characterization analysis. Colors match between the restriction enzymes and the fragments they created. In cases where fragments contained adjacent genomic DNA (such as for copy number, insert and LB region), data from Southern blots was used to locate the restriction site within the genomic DNA. Had vector backbone been present within line 427, a ~ 12 kb band, identical to the ~12 kb insert band would have been detected as depicted.

V.C. Molecular Characterization Results for Line 435

Genomic DNA from line 435 was digested with different restriction endonucleases (Figure V.A.) and used for Southern blot analyses. Line 435 was assessed for the number of inserts present within the *Eucalyptus* genome, the number of copies of the T-DNA present at the site of integration, the integrity of the gene cassettes within the T-DNA and the absence of vector backbone sequence. .

Insert number analysis for line 435
The number of inserts was analyzed by digesting genomic DNA from line 435 with restriction endonucleases *Age* I, *ApaL* I and *Nhe* I and probing with the *CBF2* cassette probe (Probe I, Figure V.A.). Results for the insert number analysis for line 435 are shown in Figure V.K. Lane 2 (untransformed control lane) showed no signal, as predicted. The positive hybridization controls (lanes 4 and 5) produced the predicted size bands of approximately 3.1 kb (Figure V.B.). Line 435 yielded a single hybridization signal estimated at about 15-20 kb in both long and short runs (Figure V.K., lanes 3 and 6). These results establish that line 435 contains a single T-DNA insert.

Copy number analysis for line 435
The number of copies within the single insertion was determined for line 435 by digesting genomic DNA with the restriction enzyme *Bam*HI and the blot probed with Probe Ia (Figure V.A.). As noted above for line 427, a single copy of the T-DNA integrated at the insertion site would produce a single fragment, consisting of the portion flanking the right border of the T-DNA and extending into the *Eucalyptus* genomic DNA (Figure V.B.). Results of the copy number analysis are shown in Figure V.L. As observed previously for experiments using line 427, control DNA from the untransformed line EH1 exhibited two weakly hybridizing fragments, of ~3.8 kb and ~ 6 kb (Figure V.L., lane 2). We conclude that these signals are the result of hybridization to elements of the rd29A stress-inducible promoter to homologous regions in the native *Eucalyptus* genome. The pABCTE01 plasmid positive controls digested with *Xho* I produced the predicted size band of approximately 3.1 kb. Long and short runs of line 435 yielded two fragments (Figure V.L., lanes 3 and 6): a strong signal of ~6 kb and a weaker signal at ~3.8 kb as observed in the EH1 control DNA sample. Based on results from the control EH1 DNA and previous results in line 427 we conclude that the ~ 6 kb fragment consists of two overlapping fragments of similar size, the weak hybridizing ~6 kb fragment observed in untransformed EH1 DNA together with a fragment of similar size from the inserted T-DNA. This conclusion is substantiated by comparing the intensity of the ~3.8 kb and ~6 kb fragments in the untransformed control line EH1 (Lane 2, Figure V.L.). In EH1 the signal from the ~3.8 kb fragment is of greater intensity than the ~ 6 kb fragment. Conversely, in line 435 the ~6 kb fragment is more intense than the ~3.8 kb band (Figure V.L., lanes 3 and 6) indicating the presence of a second, T-DNA derived fragment in the ~6 kb size range. These results indicate that line 435 contains a single copy of the T-DNA at the integration site.

Cassette intactness for line 435
The intactness of each cassette in line 435 was determined by Southern blot analysis using probes representing each cassette, as described above for line 427.

(i)CBF2 cassette – Probe I
Results for the *CBF2* cassette for line 435 are shown in Figure V.M. Untransformed control DNA (Figure V.M., lane 2) showed no hybridization signal while the positive control plasmid pABCTE01 digested with *Xho* I and *Pst* I gave the predicted ~3.1 kb fragment (Figure V.M., lanes 4 and 5). Genomic DNA from line 435 digested with *Xho* I and *Pst* I (Figure V.M., lanes 3 and 6) gave a hybridization signal at the predicted size of ~3.1 kb. These data, indicate that this gene cassette is intact in line 435. No other

fragments were detected, indicating that line 435 does not contain any additional *CBF2* cassette sequences other than that which is associated with the single T-DNA insert.

(ii)Barnase cassette – Probe II
Results for the *barnase* cassette for line 435 are shown in Figure V.N. As observed previously in experiments with line 427, untransformed control DNA (Figure V.N. lane 2) showed weak hybridization signals to two fragments (~2.9 kb and ~ 2.2 kb)that likely are the result of hybridization of regions of low homology between Probe II and native *Eucalyptus* sequences. As noted above, the *PrMC2* promoter has been shown to have homologs in angiosperms (Walden et al., 1999). Positive control plasmid pABCTE01 digested with *Xho* I and *Xmn* I gave the predicted ~1.2 kb fragment (Figure V.N., lanes 4 and 5). Line 435 genomic DNA digested with *Xho* I and *Xmn* I, gave strong hybridization to the ~1.2 kb fragment (Figure V.N., lanes 3 and 6) that corresponds to the intact *barnase* cassette, together with the weak hybridization to the ~2 kb and ~2.9 kb fragments observed in untransformed control EH1 DNA. No other fragments were present, indicating that line 435 does not contain additional *barnase* sequences other than that associated with the single intact T-DNA insert.

(iii)UBQ10 promoter/nptII gene – Probe III
Results for the *nptII* cassette for line 435 are shown in Figure V.O. The *Apa* I and *Afl* II restriction fragment from pABCTE01 that is Probe III contains only the *UBQ10* and *nptII* elements. Untransformed control DNA (Figure V.O., lane 2) showed weak hybridization signals to two fragments of ~0.6 kb and ~ 2.7 kb as observed previously using this probe. Positive control plasmid pABCTE01 DNA digested with *Apa* I and *Afl* II yielded the predicted ~2.1 kb fragment (Figure V.O., lanes 4 and 5) that corresponds to the intact *nptII* cassette. Line 435 genomic DNA also gave a strongly hybridizing fragment of the predicted ~2.1 kb size (Figure V.O., lanes 3 and 6) of the intact *nptII* cassette, together with the weak hybridization signals at ~ 0.6 kb and ~2.7 kb that are present in untransformed EH1 control DNA. No other fragments were present, indicating that line 435 does not contain additional *nptII* sequences.

(iv)Left Border Region and nos Terminator - Probe IV
Southern blots with line 435 and control genomic DNA digested with *Xho* I and *Xmn* I were hybridized using Probe IV, a PCR fragment representing the *nos* terminator and left border region of pABCTE01 T-DNA.. Using this probe a fragment of greater than 2.6 kb is indicative of the presence of the complete *nos* terminator and left border region in the *Eucalyptus* genome. Control EH1 DNA digested with *Xho* I and *Xmn* I produced no hybridization signals (Figure V.P., lane 2) as expected. Positive control plasmid pABCTE01 DNA produced the predicted ~6.7 kb fragment (Figure V.P., lanes 4 and 5). Long and short runs of line 435 (Figure V.P., lanes 3 and 6) yielded a single fragment of approximately 5.3 kb indicating that line 435 likely contains the complete *nos* terminator and left border region. The single 5.3 kb fragment also confirms that line 435 contains a single copy of the T-DNA(see copy number analysis above, Figure V.L.). These results indicate that line 435 contains a single inserted copy of the T-DNA , and does not contain any additional left border region or *nos* sequences other than those within the intact T-DNA insert.

Analysis for plasmid backbone in line 435
Probes V and VI (Figure V.A.) representing almost the entire plasmid backbone were to test for the presence of backbone sequences in line 435. Line 435 and control genomic DNA were digested with restriction endonucleases *Age* I, *ApaL* I and *Nhe* I. Positive control plasmid pABCTE01 DNA digested with *Xho* I produced the predicted ~7.9 kb fragment (Figure V.Q., lanes 4 and 5). Control DNA gave no detectable band as expected. Line 435 (lanes 3 and 6) showed no detectable hybridization bands after a 4 day exposure. This result indicates that line 435 does not contain any notable backbone sequence from plasmid pABCTE01.

Predicted insert map for line 435

Based on the above data we conclude that line 435 contains a single complete T-DNA insertion from pABCTE01 at a single site in the genome of EH1 with all gene cassettes intact. A map of the predicted T-DNA was generated based on the results from the Southern analysis of line 435 (Figure V.R.).

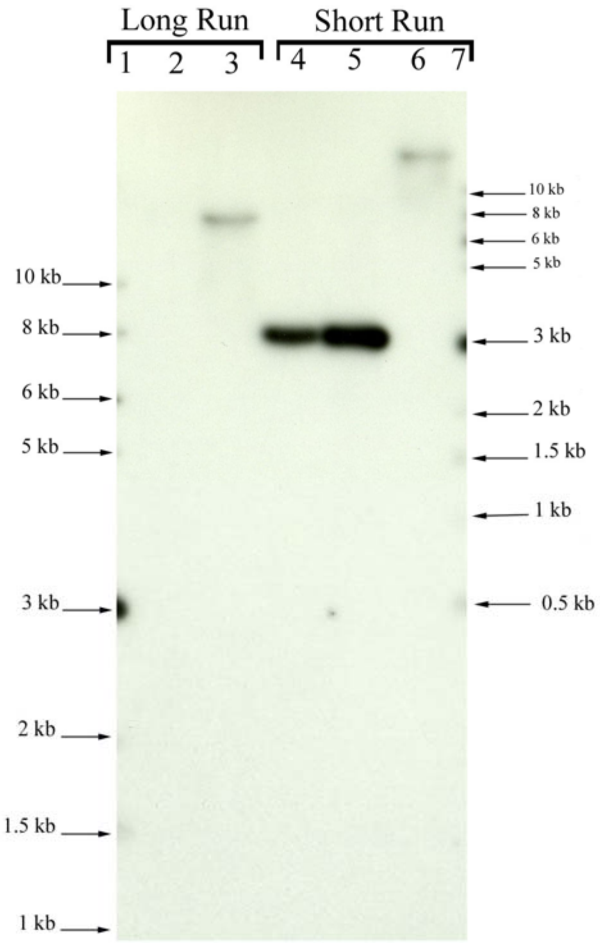


Figure V.K. Southern blot analysis of line 435: insert number

Seven micrograms of untransformed EH1 control and line 435 genomic DNA were digested with restriction endonucleases *Age* I, *Apa* LI and *Nhe* I. The blot was probed with the *CBF2* cassette probe (Probe I).

Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)

Lane 2: EH1 untransformed control DNA

Lanes 3 and 6: Digested DNA from line 435

Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)

Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

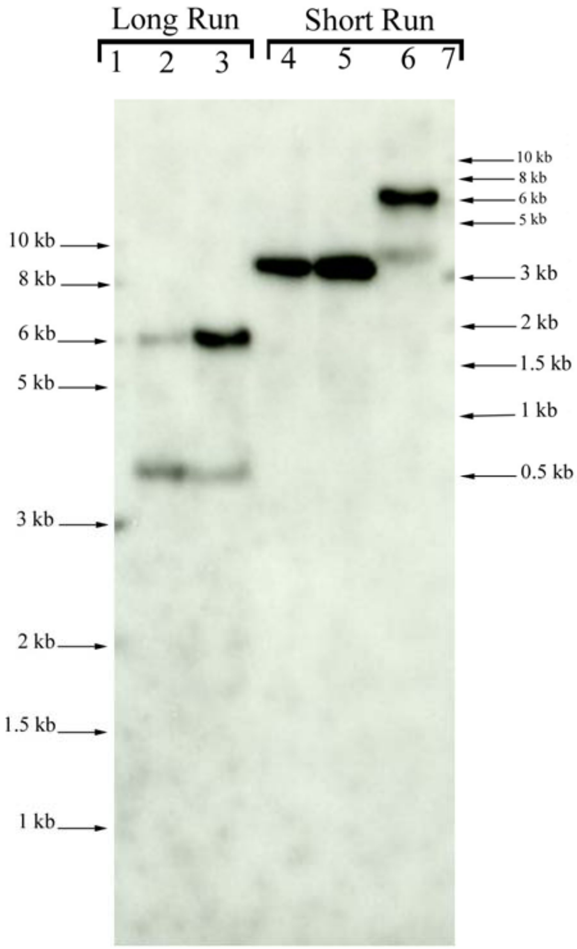


Figure V.L. Southern blot analysis of line 435: copy number

EH1 control and line 435 genomic DNA were digested with restriction endonuclease *BamH* I. The blot was probed with the Probe Ia.

Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 435
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

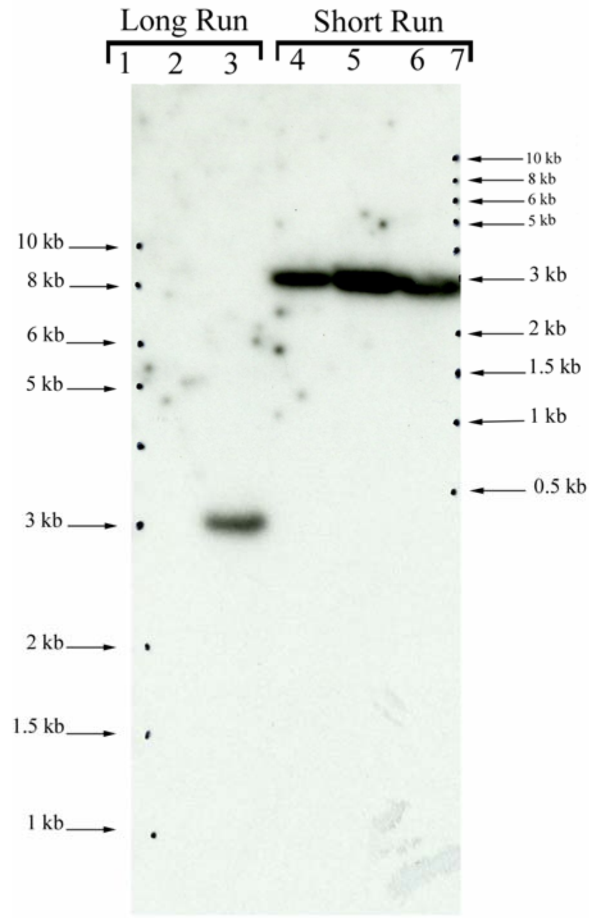


Figure V.M. Southern blot analysis of line 435: *CBF2* cassette

EH1 control and line 435 genomic DNA were digested with restriction endonucleases *Xho* I *and Pst* I. The blot was probed with the *CBF2* cassette probe (Probe I).

Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 435
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

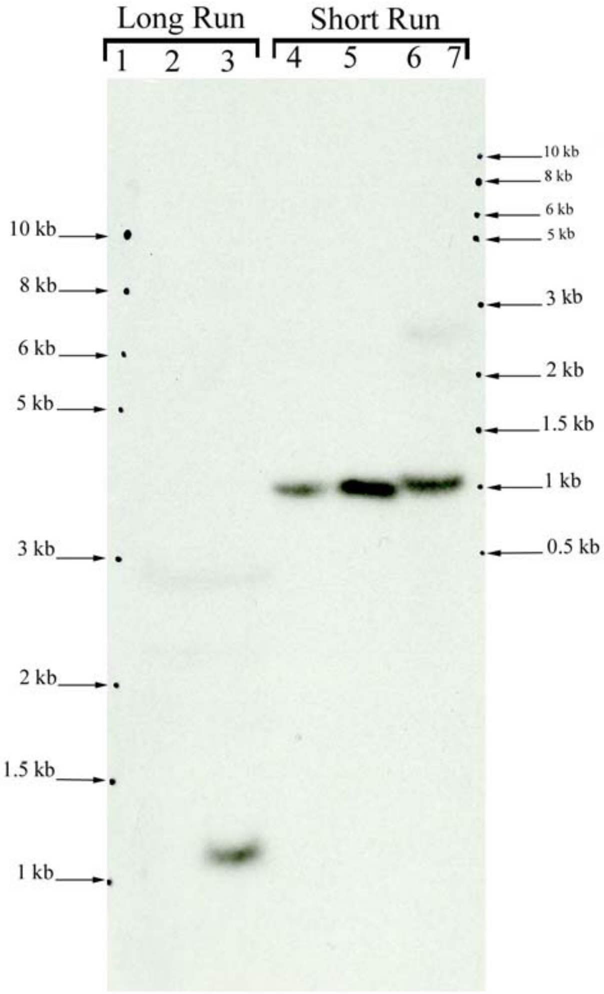


Figure V.N. Southern blot analysis of line 435: *barnase* cassette

EH1 control and line 435 genomic DNA were digested with restriction endonucleases *Xho* I *and Xmn* I. The blot was probed with the *barnase* cassette promoter (Probe II).

Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)

Lane 2: EH1 untransformed control DNA

Lanes 3 and 6: Digested DNA from line 435

Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)

Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

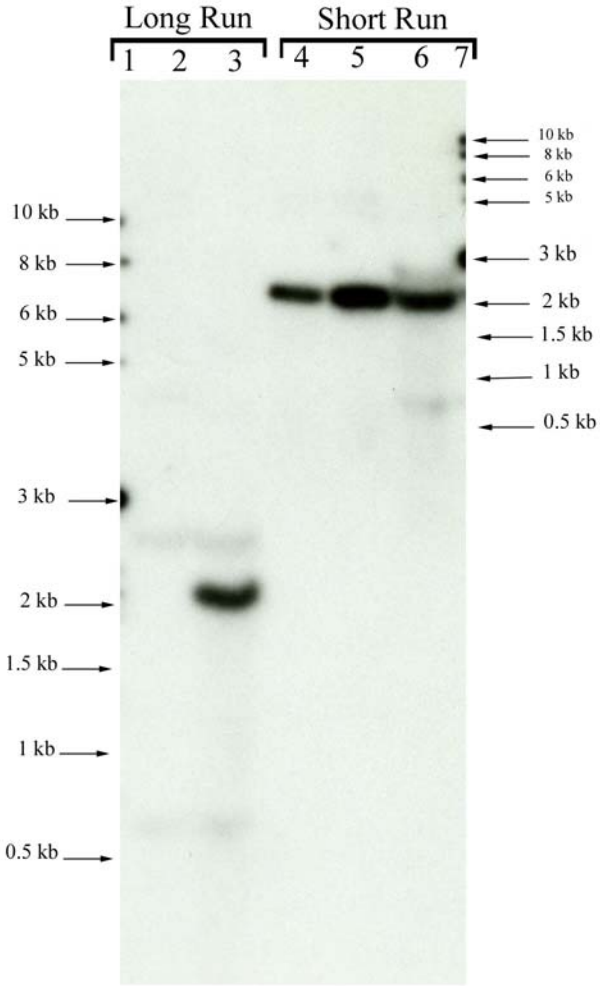


Figure V.O. Southern blot analysis of line 435: *nptII* cassette

EH1 control and line 435 genomic DNA were digested with restriction endonucleases *Apa* I *and Afl* II. The blot was probed with the *nptII* cassette (Probe III).

Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 435
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with Apa I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Afl* II (1 copy)

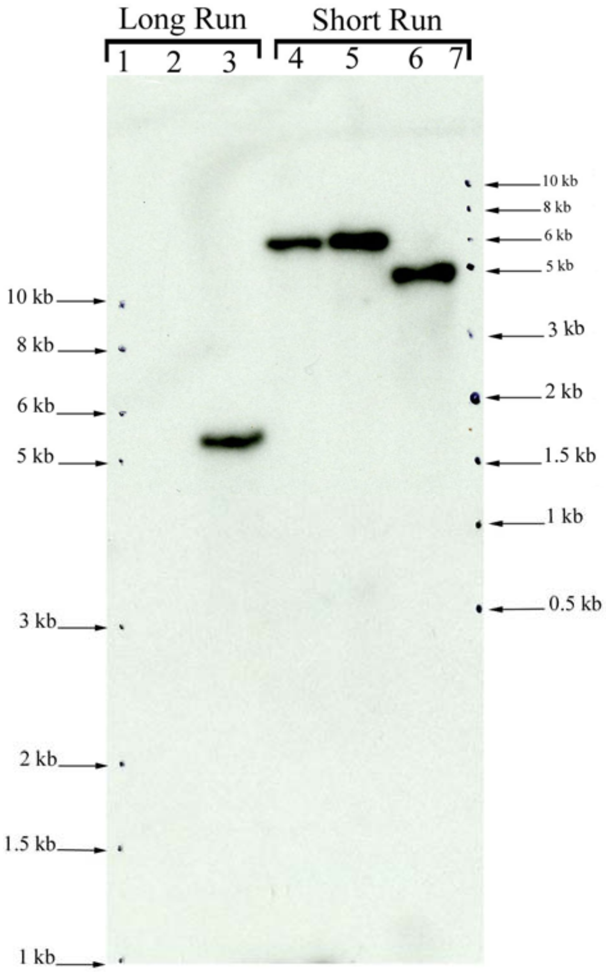


Figure V.P. Southern blot analysis of line 435: left border region and *nos* terminator

EH1 control and line 435 genomic DNA were digested with restriction endonucleases *Xho* I *and Xmn* I. The blot was probed with a PCR product that contained the left border region and *nos* terminator (Probe IV).

Lane information:
Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)
Lane 2: EH1 untransformed control DNA
Lanes 3 and 6: Digested DNA from line 435
Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)
Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

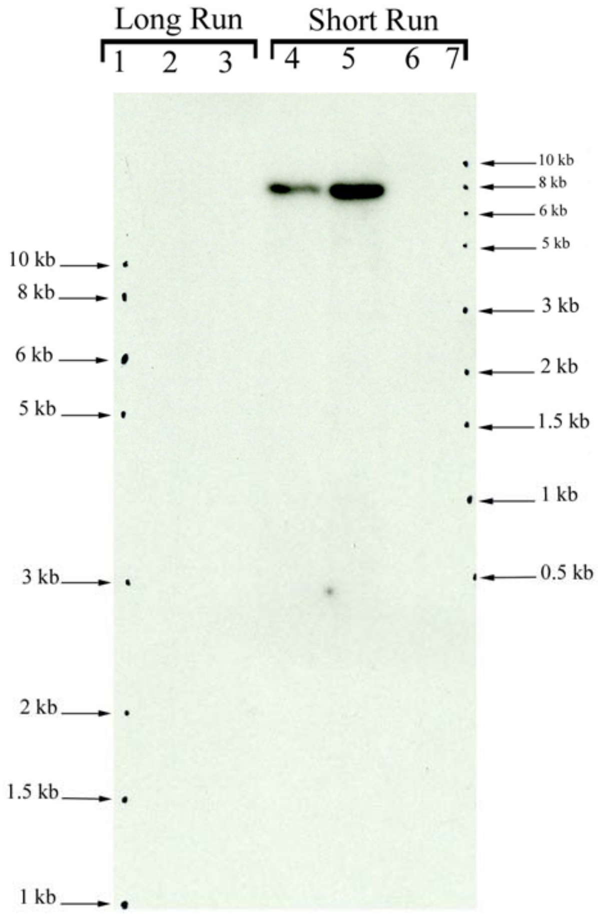


Figure V.Q. Southern blot analysis of line 435: backbone

EH1 control and line 435 genomic DNA were digested with restriction endonucleases *Age* I, *ApaL* I *and Nhe* I. The blot was probed with the backbone of plasmid pABCTE01 (Probe V and VI).

Lane information:

Lanes 1 and 7: 1 kb Molecular Weight DNA Ladder (NEB) (partially shown only)

Lane 2: EH1 untransformed control DNA

Lanes 3 and 6: Digested DNA from line 435

Lane 4: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (0.5 copy)

Lane 5: Calf Thymus DNA spiked with plasmid pABCTE01 digested with *Xho* I (1 copy)

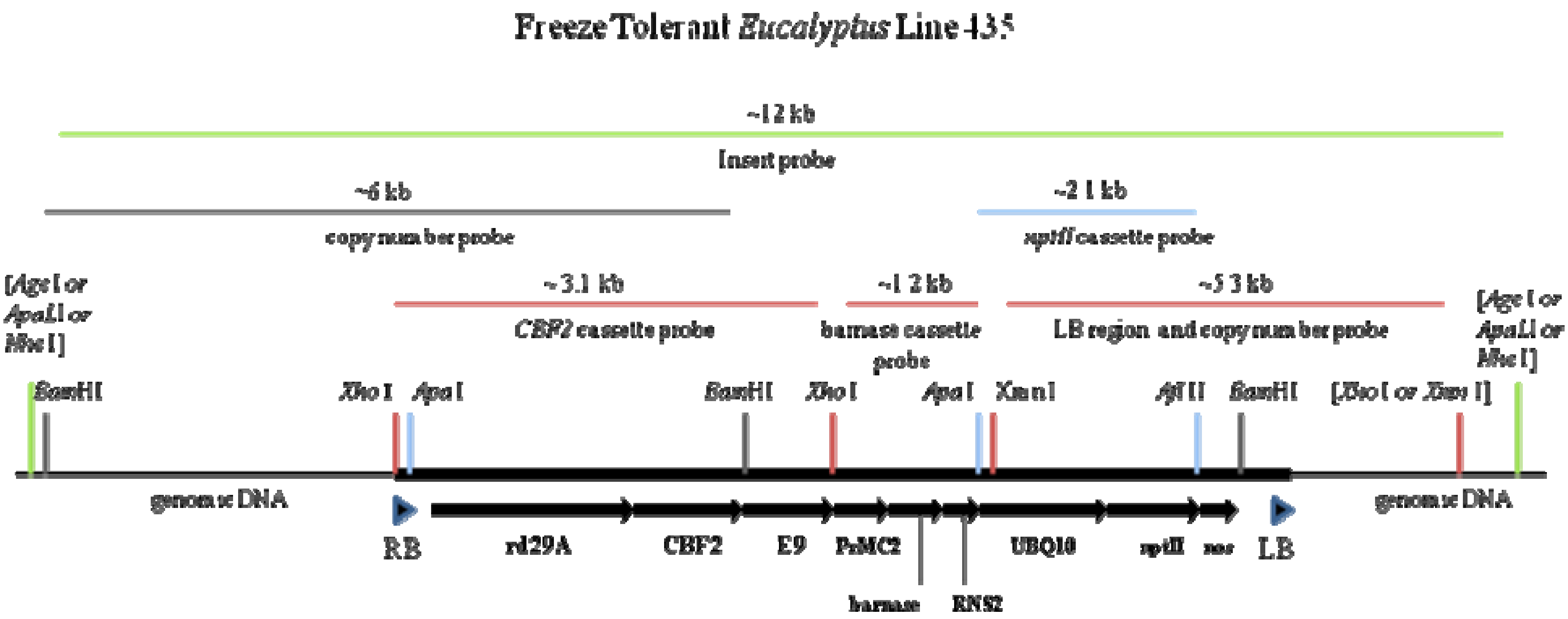


Figure V.R. Schematic of the T-DNA insertion contained within line 435
The heavy, black line represents the T-DNA of construct pABCTE01 inserted into the *Eucalyptus* genome. The thin, black lines on either side of the T-DNA represent genomic DNA. The genetic elements within the T-DNA are identified by black arrows. Depicted above the T-DNA are restriction fragments generated by the insert characterization analysis. Colors match between the restriction enzymes and the fragments they created. In cases where fragments contained adjacent genomic DNA (such as for copy number, insert and LB region), data from Southern blots was used to locate the restriction site within the genomic DNA. Had vector backbone been present within line 435, a ~ 12 kb band, identical to the ~12 kb insert band would have been detected as depicted.

VI. Characterization of Gene Expression in Lines 427 and 435

VI.A. CBF2 Western Blot Analysis

To evaluate the expression of the CBF2 gene we tested if the CBF2 protein could be detected in cold-induced lines 427 and 435 using Western blot analysis. The purpose of the analysis was to compare, if possible, the CBF2 protein produced by cold induced lines and that of CBF2 protein standard produced in *E. coli*.

Materials and methods

i) Preparation of E. coli derived CBF2 *protein*

The Champion™ pET151 Directional TOPO® Expression Kit (Invitrogen, Cat. No. K151-01) was used to produce the *E. coli* derived CBF2 fusion protein standard used in this analysis. The expression vector, pET151/D-TOPO, contains an N-terminal 6xHis signal which was used for purification of the recombinant CBF2 protein. Also included in the vector is a TEV cleavage site for the removal of the 6xHis tag from the recombinant CBF2 protein. pABCTE01 was used as a PCR template to amplify the complete coding sequence of the *CBF2* gene using gene specific primers (5'-CACCATGGACTCATTTCTGCC-3' and 5'-TTAATAGCTCCATAAGGACAC-3'). The forward primer contained a four base overhang (CACC) that was used to produce a PCR product that could be directionally cloned in-frame. The expression vector, pET151-CBF2 (Figure VI.A.) was then created by cloning the CBF2 PCR product into pET151/D-TOPO as described by the manufacturer. The vector was transformed into a chemically competent *E. coli* maintenance line (One Shot® TOP10) provided with the kit and plated onto LB media (50 µg/ml carbenicillin). From this plate, a single colony was selected, grown in liquid LB media under selection and the vector DNA extracted using the Plasmid Mini Kit (Qiagen Cat. No.27106). Vector DNA was digested with restriction endonuclease *Eco*RV to confirm the presence of the *CBF2* insert. To verify that the *CBF2* coding sequence was cloned in-frame and in the correct orientation, pET151-*CBF2* sequence was analyzed using the T7 forward promoter primer (5'-TAATACGACTCACTATAGGG-3') and T7 terminator reverse primer (5'-TAGTTATTGCTCAGCGGTGG-3'). After confirming that the CBF2 sequence was properly inserted into pET151/D-TOPO and contained no discrepancies, pET151-CBF2 plasmid DNA was transformed into an *E. coli* expression line (BL21 Star™, DE3, One Shot®) provided with the kit and an induction culture (50 ml) was initiated. The culture was induced with IPTG (0.7 mM) for three hours at 37°C with shaking. The cells were harvested by centrifugation (3000 × g) and the CBF2 fusion protein was purified under denaturing conditions using nitrilotriacetic acid (Ni-NTA) metal-affinity chromatography (Qiagen, Ni-NTA Fast Start Kit, Cat. No.30600). Prior to using the CBF2 fusion protein in Western blot analysis, the 6xHis tag was removed from the CBF2 protein by incubating the fusion protein in the presence of TEV protease which specifically cleaves at the TEV recognition site separating the 6xHis tag from the recombinant protein.

ii) Preparation of antibodies

*Anti-*CBF2 *Antibodies.* Polyclonal antibodies specific to the CBF2 protein were prepared by Anaspec Inc. (San Jose, CA) using the *E. coli* produced CBF2 fusion protein as antigen. Antibodies specific to the 6xHis tag were first removed by passing rabbit anti-sera (twice) through an affinity column coupled with a peptide containing the 6xHis sequence (GSSHHHHHHSSGLVPRGSC). Total rabbit IgG was then purified using Protein-A Sepharose affinity chromatography.

Anti-NPTII Antibodies. Polyclonal antibodies specific to the NPTII protein were purchased from Sigma-Aldrich (Cat. No. N6537).

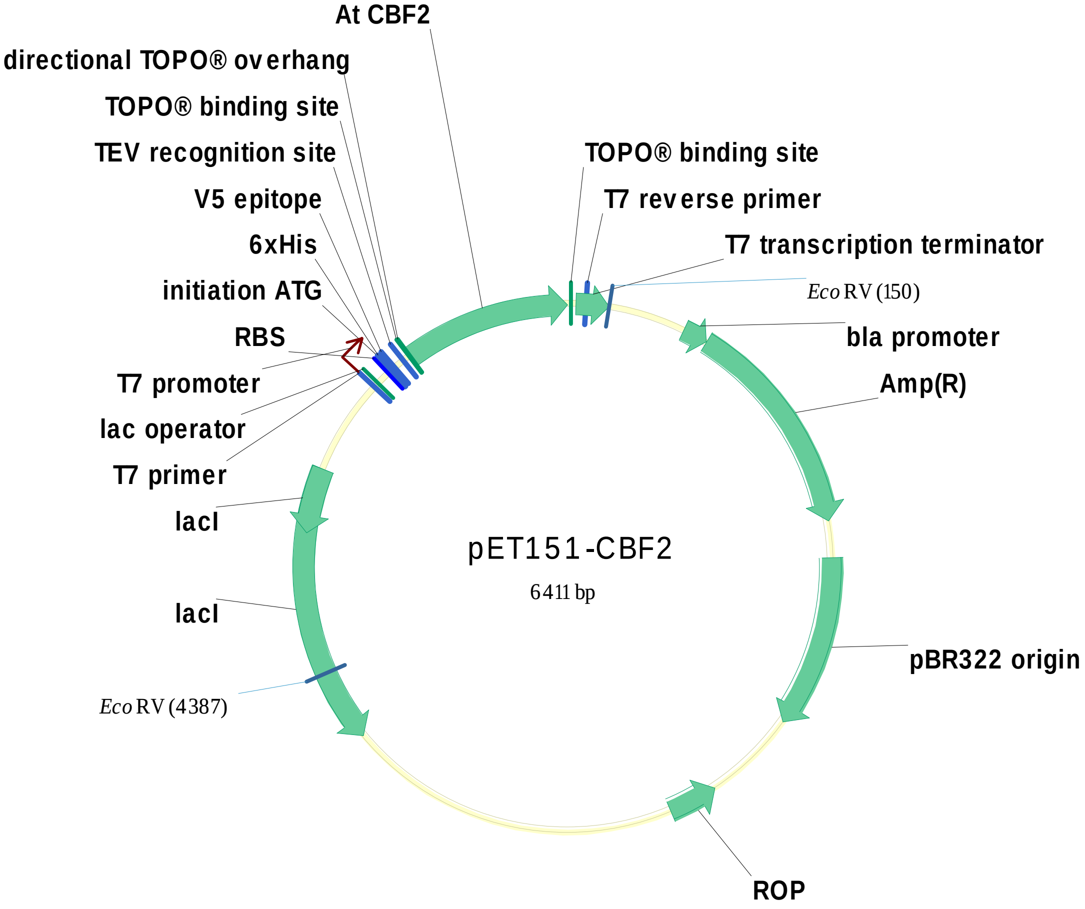


Figure VI.A. Map of *CBF* expression vector pET151-CBF2

iii) Protein gels and Western blots
Leaf tissue was collected from lines 427, 435 and an EH1 untransformed control in a 1 year old field trial during November, 2007. Samples were collected following a cold event that consisted of two successive nights with temperatures below 4° C (~6 hr and ~5 hrs at or below 4° C respectively), conditions that are expected to induce expression from the rd29A promoter (Yamaguchi-Shinozaki and Shinozaki, 1993). Total protein was extracted under denaturing conditions from 10 mg of leaf tissue using the P-PER Plant Protein Extraction Kit (ThermoFisher Scientific, Cat. No. 89803) per the manufacturer's instructions and quantified using a BCA protein assay kit (ThermoFisher Scientific, Cat. No.23250). For each of the lines the extracted protein was run on three separate 4-12% gradient (Invitrogen, Cat. No. NP0321BOX) SDS-PAGE protein gels. Gel 1 was stained using SimplyBlue Safe Stain (Invitrogen, Cat. No. LC6060) to visualize the amount of total protein contained on the gel (data not shown). Gels 2 and 3 were transferred to separate nitrocellulose membranes (Invitrogen, Cat. No. LC2000) and used for Western blot analyses. Each set of Western blots contained the following: a protein ladder (Invitrogen, Cat. No. LC5602), two control samples of untransformed EH1 total protein (100 µg) spiked with *E. coli* derived CBF2 protein (6 ng and 12 ng), a Line sample (25 µg and 100 µg) and an untransformed EH1 total protein control sample (100µg).

Blots were probed with either the polyclonal primary antibody (Anaspec Inc.) raised against the *E. coli* produced CBF2 fusion protein or a commercially available primary NPTII antibody (Sigma-Aldrich, Cat.

No. N6537). For both sets of blots, a polyclonal secondary detection antibody was used (Zymed, Cat. No. 65-6122) in conjunction with a chemiluminescent substrate (CDP-Star, Invitrogen). Membranes were then exposed to X-ray film (Kodak X-OMAT AR) for between 2 and 60 minutes.

Results – NPTII protein expression

As expected, the 30 kDa NPTII protein could be clearly detected in both the 25 µg and 100 µg samples within lines 427 and 435 after a 10 second and was not present in the untransformed EH1 sample exposure (data for line 427 is presented in Figure VI.B.). These results provide evidence that the total protein from the cold induced lines is not degraded and that the Western blot and detection system is working correctly. NPTII protein was not quantified but is estimated at ~10 µg/g fresh weight comparable to that observed in other products.

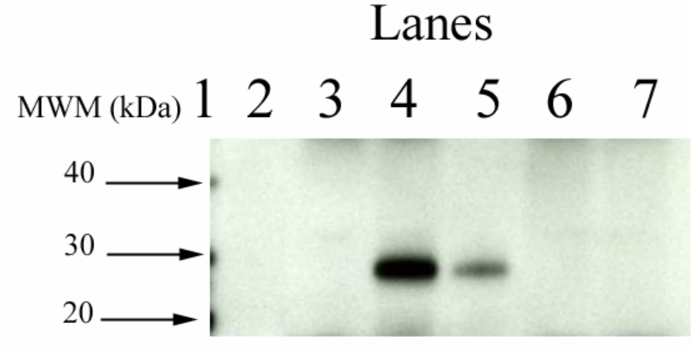


Figure VI.B. NPTII protein analysis of line 427

Samples were separated by SDS-PAGE (4-12%) and electrotransferred to nitrocellulose membrane. The blot was probed with a polyclonal NPTII antibody and detected with an alkaline phosphatase conjugated secondary antibody and detected by chemiluminescence using X-ray film (20 seconds). Lane 1 – molecular weight marker; lane 2 – blank; lane 3 – total protein from untransformed EH1 control (100 µg); lane 4 – total protein from line 427 (100 µg); lane 5 – total protein from line 427 (25 µg); lane 6 – total protein from untransformed EH1 control spiked with 12 ng of *E. coli* CBF2; lane 7 – total protein from untransformed EH1 control spiked with 6 ng of *E. coli* CBF2.

Results – CBF2 *expression*

As expected, for all blots probed with the CBF2 antibody (Figures VI.C. and D.), visible signal was detected for the positive controls in lanes 4 and 5 containing 12 and 6 nanograms respectively of *E. coli* derived CBF2 protein (~30 kDa) spiked into untransformed EH1 total protein following a 2-5 minute exposure . The calculated molecular weight of the CBF2 protein is 24.3 kDa. No signal was detected in the untransformed control (lane 3) as expected. The plant produced CBF2 protein could not be detected by Western blot in cold induced lines 427 or 435 (lanes 2 and 3) even after a maximum exposure time of one hour.

As noted above the calculated molecular weight of the CBF2 protein is 24.3 kDa however the observed molecular weight of the *E. coli* produced CBF2 protein from Western blots is ~30 kDa. The reason for the difference between the calculated and the observed molecular weights is not known. Strong evidence exists to support the conclusion that the *E. coli* produced protein standard is indeed CBF2. 1) DNA sequencing analysis of the *CBF2* coding sequence inserted in the pET151-CBF2 expression vector confirmed that the insert was in-frame and in the correct orientation, and did not contain any insertions, deletions or changes. 2) A time-course experiment of induction of expression of the pET151-CBF2 vector showed that that a ~34 kDa band (30 kDa CBF2 protein plus 4 kDa 6xHis tag) was not present in the uninduced samples but was seen increasing in intensity over the three hour induction period (data not shown). 3) The ~30 kDa protein bound strongly to the Ni-NTA column and was eluted in a pure (>90%), high concentration (4.2 mg/ml) which would indicate that the 6xHis tag was fused to the protein as expected. 4) Incubating the eluted protein with TEV protease which cleaves the 6xHis tag resulted in a 3-4 kDa reduction in the molecular weight of the protein corresponding to the size of the fusion tag. To further confirm the identity of the ~30 kDa CBF2 reference protein two additional affinity purified polyclonal antibodies were produced using synthesized peptides (CBF-pep1 and CBF-pep2: cpkkpagrkkfretrhpiy: amino acids 33-51, and yrgvrqrnsgkwvcelrepnkktri: amino acids 51-75 respectively) from the CBF2 amino acid sequence as antigen. Both antibodies bound to the ~30 kDa *E. coli* derived CBF2 protein standard. We concluded therefore that the ~30 kDa protein produced from pET151-CBF2 is CBF2. The size discrepancy relative to the calculated molecular weight likely reflects anomalies inherent with SDS-PAGE. Such discrepancies are well known in the literature (see for example Lehtovvara, 1978) and in some cases have been seen as a greater than 50% increase in size estimate for SDS-PAGE compared to calculated size (Klenova et al., 1997).

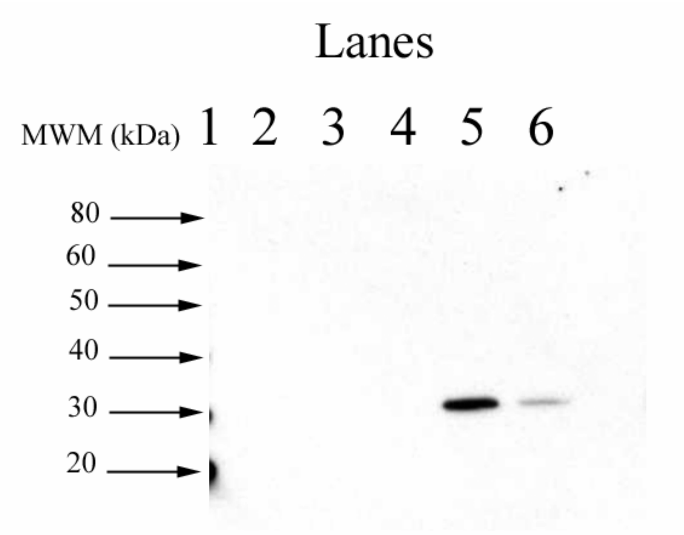


Figure VI.C. CBF2 protein analysis of line 427
Samples separated by SDS-PAGE and transferred to nitrocellulose membrane were probed with a polyclonal CBF2 antibody and detected by chemiluminescence (5 minutes). Lane 1 – molecular weight marker; lane 2 – total protein from EH1 cold induced untransformed control (100 µg); lane 3 – total protein from cold induced line 427 (100 µg); lane 4 – total protein from cold induced line 427 (25 µg); lane 5 – total protein from EH1 cold induced untransformed control spiked with 12 ng of *E. coli* CBF2; lane 6 – total protein from EH1 cold induced untransformed control spiked with 6 ng of *E. coli* CBF2

VI.B. *CBF2* Transcript Analysis

Based on the results above we concluded that the CBF2 protein was at levels that were too low to detect. We therefore confirmed the expression of the *CBF2* gene by transcription analysis in RNA samples from cold induced lines 427 and 435.

Materials and methods
Leaf tissue from cold induced lines collected for the CBF2 Western blot analysis (above) was also used for *CBF2* transcript analysis. Total RNA was extracted from cold induced lines 427, 435 and the EH1 untransformed *Eucalyptus* control using a method developed by Brunner (2004). Extracted total RNA was then incubated in the presence of DNase I (Ambion, Turbo DNA-free, Cat. No. AM1907) to remove any potential contaminating genomic DNA. A single tube RT-PCR (reverse transcriptase-PCR) reaction was conducted (Qiagen, OneStep RT-PCR Kit, Cat. No. 210210) that contained 300 nanograms of total RNA and *CBF2* specific oligonucleotide PCR primers. The *CBF2* specific PCR primers (5'-GGACTCATTTTCTGCCTTTTC-3', 5'- CGTATAAATAGCCTCCACCAA-3') amplify a 461 bp fragment of the *CBF2* coding region.

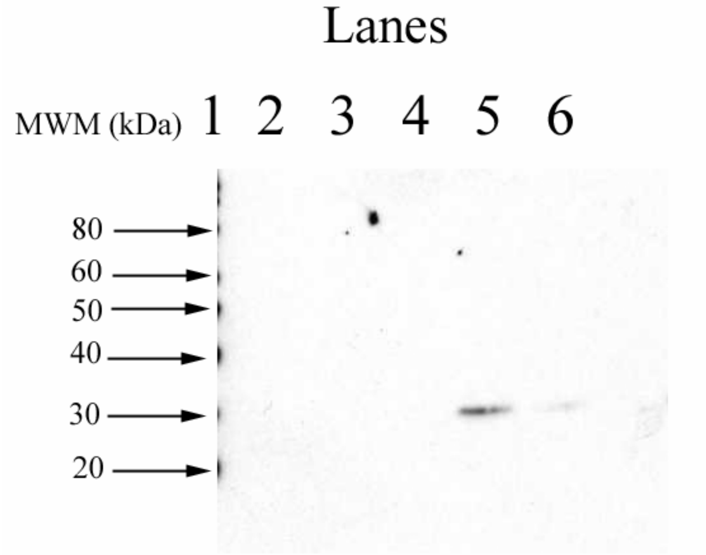


Figure VI.D. CBF2 protein analysis of line 435
Samples were separated by SDS-PAGE (4-12%) and electrotransferred to nitrocellulose membrane. Blot was probed with a polyclonal CBF2 antibody and detected with an alkaline phosphatase conjugated antibody. Signal was detected by chemiluminescence and exposed to X-ray film (5 minutes). Lane descriptions are as in Figure V1.C. except that lanes 3 and 4 contain protein from cold induced line 435 µg at 100 and 25 µg respectively.

Samples were reversed transcribed at 50°C for 30 minutes followed by a 25 cycle PCR. In addition to running the RT-PCR samples, several controls were added to the analysis. A control reaction without the reverse transcription (no-RT reaction) step but including the subsequent 25 cycle PCR was used for each sample as a control for contaminating genomic DNA. RNA from untransformed EH1 was used as a control for any endogenous expression of *CBF* in cold-induced EH1. A no template control (no RNA) was run as a control for contamination within the RT-PCR reagents.

Results
The presence of a band just below 500 bp indicates that the *CBF2* transcript is present within cold-induced lines 427 and 435 as predicted (Figures VI.E. and F. lane 2). No signal was present in the no-RT control lanes (lane 3 and 5) as expected. Similarly, no signal was detected in the no-template control lane as expected (lane 6).

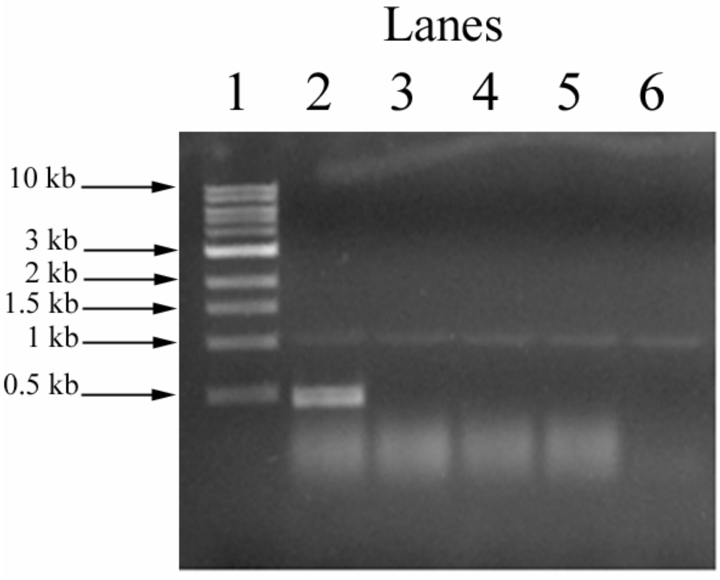


Figure VI.E. *CBF2* transcript analysis of line 427
RNA samples were reverse transcribed and then PCR amplified using *CBF2*-specific primers. Lane 1 – molecular weight marker; lane 2 - RT-PCR sample from line 427; lane 3 – No-RT sample from line 427; lane 4 – RT-PCR sample from nontransgenic EH1 control; lane 5 – No-RT sample from nontransgenic control; lane 6 – RT-PCR control with no RNA template.

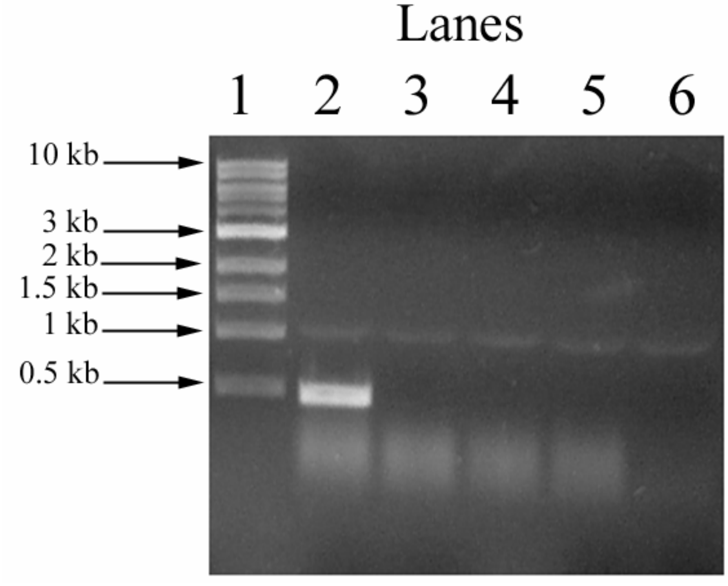


Figure VI.F. *CBF2* transcript analysis of line 435
RNA samples were reverse transcribed and then PCR amplified using *CBF2*-specific primers. Lanes are as described for Figure VI.E. except that lanes 2 and 3 RT-PCR sample from line 435 and No-RT sample from line 435 respectively.

In spring 2008, we also analyzed expression of the *CBF* transcript in non-cold induced samples. Leaf tissue was collected from the translines as well as re-sprouted EH1 controls during May 2008 from the same trial analyzed earlier. These were then compared with RNA extracted previously from induced samples described above. In these experiments we also included PCR primers for the α-*TUBULIN* (*TUA*) gene as a positive control. *Tubulin* is involved with cell wall formation (Oakley et al., 2007) and is known to express throughout the growing season in *Populus* (Brunner et al., 2004). The *TUA* specific PCR primers (5'

-GGCAACCATCAAGACCAAGCG -3', 5'-GCACCGACCTCCTCATAATCCTTC-3') amplify a 315 bp fragment of the *TUA* coding region. A single tube RT-PCR (reverse transcriptase-PCR) reaction was conducted for both induced and uninduced samples for each of the lines and the untransformed EH1 control. The cycling conditions were as follows: 50°C for 30 min., 95°C for 15 min., 34 cycles of 94°C for 30 sec., 55°C for 30 sec., 72°C for 1 min., final extension of 72°C for 7 minutes.

As expected the *CBF2* transcript was detected in cold induced samples from lines 427 and 435 (Figure VI.G., panels A and C, lane 2) but was not detected in EH1 untransformed control or in the uninduced sample for line 427 (Figure VI.G., panel A, lane 4). *CBF2* transcript was detected in the uninduced sample for line 435 (Figure VI.G. panel C, lane 4) but at a level much lower than in the induced sample. The *TUA* signal could be detected for both the induced and uninduced samples as predicted, indicating that both sets of RNA templates used for the analysis were intact, as well as the EH1 samples (Figure VI.G. panel F, lanes 2 and 4). The absence of signal in the No-RT lanes (lanes 3 and 5) indicate that the RNA template did not contain contaminating genomic DNA and that the signal (if present) is being generated from expressed RNA transcript. Positive controls that contained RNA template spiked with genomic DNA gave signals in all samples as expected (Figure VI.G., lane 6 all panels).

In order to verify the very low level of expression observed in the non-cold induced sample of line 435 we extracted RNA from additional ramets in this trial, again in May 2008. Figure VI.H. shows that there is some variation in this low level expression of the *CBF2* transcript from ramet to ramet under the non-cold induced conditions at the time of sampling, but consistently lower to much lower when compared to the cold-induced sample. Over expression of *CBF* has been linked with significantly reduced growth in several species. Based on our data on growth in line 435 across multiple sites and years, we conclude that even if this very low level expression can occur under non-cold induced conditions (the predominant condition for most of the year) it does not have a significant negative impact on growth.

VI.C. Conclusions for Gene Expression Analysis

Analyses were conducted to correlate the freeze tolerant phenotype with expression of the inserted *CBF* gene. Evaluation of CBF protein expression in cold-induced samples using Western blots could not detect any CBF protein in any of the transgenic lines. This result is consistent with other research regarding CBF proteins (Gilmour et al., 2004) and is likely due to the protein being very rapidly degraded or at a concentration below the level of detection, as may be typical for transcription factors generally. The CBF2 protein was detected in control samples with 6 ng of protein. This suggests that when CBF2 protein is expressed in cold-induced translines (as evidenced by the phenotypic data), it is present at levels much lower than those detectable in control samples. Induced expression of the *CBF2* cassette in leaf samples from trees exposed to cold temperatures was confirmed by RNA analysis. Data for line 435 suggests that very low levels of expression can occur in the absence of cold induction in some ramets. Field data for the translines, based on both growth and freeze damage, provides strong evidence that the cold-tolerant phenotype is correlated with induced expression of the inserted *CBF2* gene.

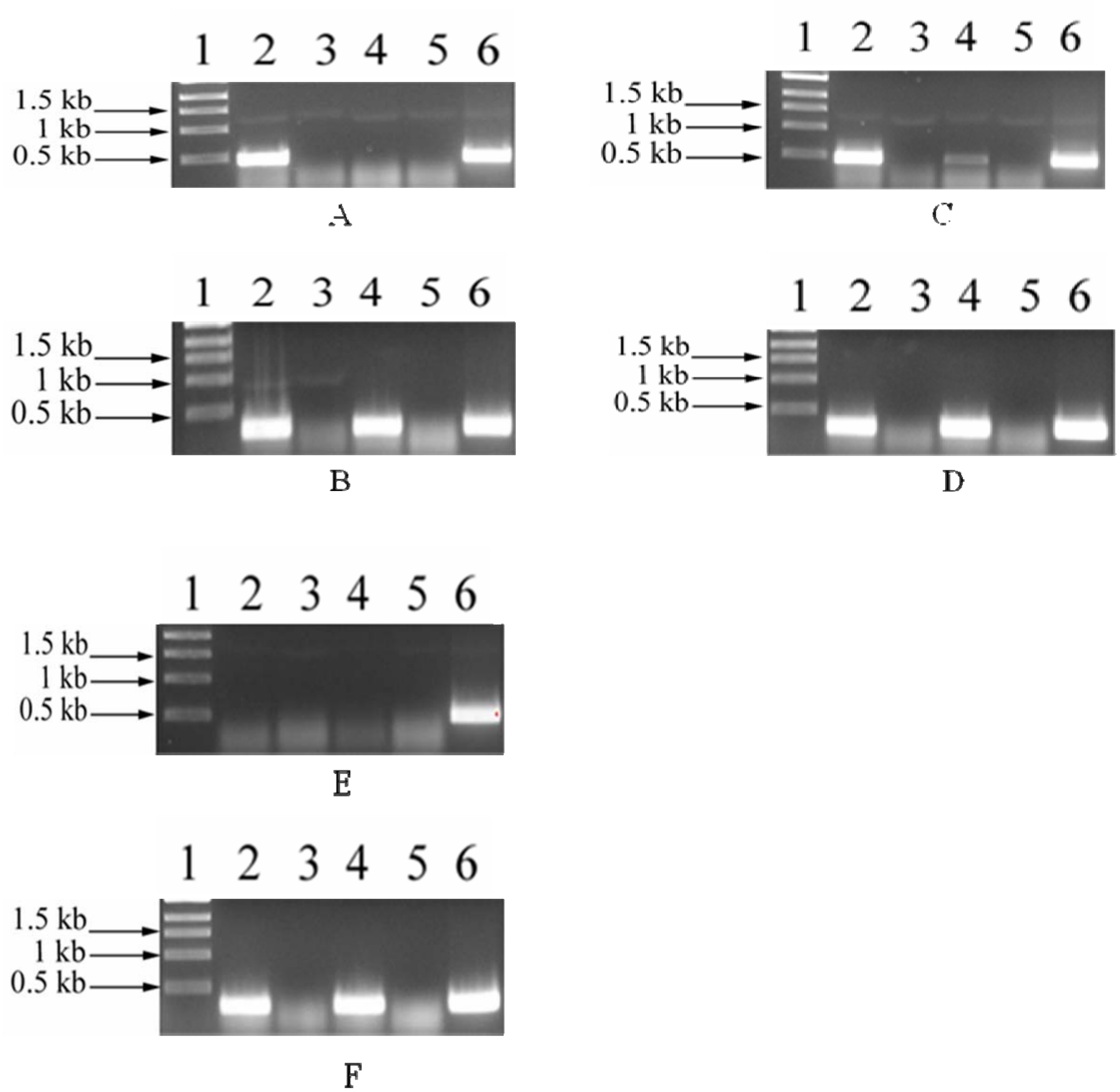


Figure VI.G. Transcript analysis for lines 427, 435 and the EH1 untransformed control

Panels represent paired analyses using either *CBF* primers (A, C, E) or TUA (B, D, F) primers for reverse transcription. Panel A and B: samples from line 427; panels C and D samples from line 435; panels E and F samples from EH1 control. Lane 1 molecular weight marker (New England Biolabs, Cat. No. N3232L). Lanes 2 & 3 – RNA template from cold induced samples from the transgenic lines.. The RNA template in lane 2 was reverse transcribed using gene specific primers prior to PCR while the RNA template in lane 3 was not reverse transcribed (No-RT control). Lanes 4 & 5 – RNA template from uninduced samples from the translines. Lane 4 is with reverse transcription while lane 5 is the No-RT control. Lane 6 – positive control containing RNA template spiked with 200 ng of transline genomic DNA.

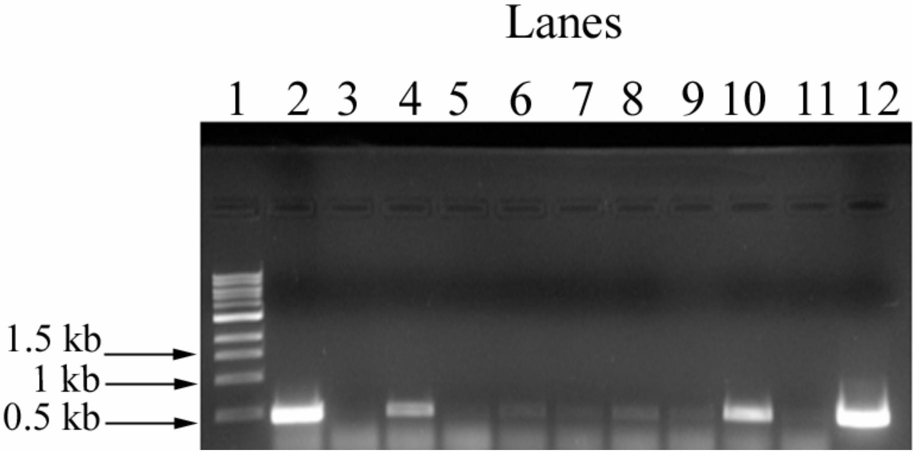


Figure VI.H. Transcript analysis for multiple ramets of line 435
Four ramets of line 435 were sampled during spring 2008, that is with no cold induction. Lane 1: molecular weight marker (New England Biolabs, Cat. No. N3232L). Lanes 2 to 12 represent paired samples with reverse transcription (even lanes) or No-RT controls (odd lanes) for different samples. Lanes 2 and 3: RNA from cold induced line 435; lanes 4 and 5: uninduced RNA from line 435 (same samples as in Figure VI.G.); lanes 6 and 7, 8 and 9, 10 and 11: uninduced RNA from three additional ramets of line 435; lane 12: positive control containing RNA template spiked with 200 ng of transline genomic DNA. No-RT controls indicate low levels of DNA contamination in some samples which contributes to the signal observed, notably in lanes 6 and 8.

VII. Phenotypic Characterization of Lines 427 and 435

Field trials were established at multiple locations in the southeastern US where the control and transgenic trees would be subjected to different levels of freeze stress based on historic weather patterns. Field trials were also established at some locations in freeze stress-free environment for comparative growth and phenotypic assessment of control trees relative to selected translines. For each location, detailed site descriptions and trial establishment methods are provided in Appendix B. The statistical analysis procedures used for all phenotypic data are also described in Appendix B.

A simple temperature recorder (HOBO Outdoor 4 Channel, Onset Computer Corporation) was used to obtain data on freeze events, with temperatures recorded at 15 minute intervals. At sites where there was no on-site recorder or a mechanical failure of the recording device occurred, the temperature data were obtained from the nearest available public source(s). Temperature data were used to determine the absolute minimum temperature and, when available, for calculating cumulative hours at or below defined temperature thresholds. A summary of the temperature data for each site is presented in Table VII.A.

Table VII.A. Summary of temperature data for field trial sites

State	Location/County	USDA Hardiness Zone	Winter Season	Minimum Temp. (°F)	Number of Freeze Periods Prior to Min. Temp.	Cumulative Freeze Hours Prior to Min. Temp.	Cumulative Freeze Hours			
							≤ 32 °F	≤ 25 °F	≤ 20 °F	≤ 15 °F
Alabama	Baldwin	8b	2005/2006	21.6	18	91	114	10	n/a	n/a
			2006/2007	20.6	28	152	189	28	n/a	n/a
			2007/2008	19.7	4	14	113	10	0.8	n/a
			2008/2009	22.8	6	37	110	11	n/a	n/a
			2009/2010	16.8	15	122	287	50	7	n/a
	Escambia	8a	2007/2008	17.9[a]	8	39	n/a	n/a	n/a	n/a
			2008/2009	14.6	22	144	222	66	14	0.3
			2009/2010	12.1	18	170	416	104	26	3
South Carolina	Charleston	8a	2005/2006	18.8[a]	n/a	n/a	n/a	n/a	n/a	n/a
			2006/2007	12	10	65	235	45	18	6
			2007/2008	10.9[a]	17	122	n/a	n/a	n/a	n/a
			2008/2009	8.4	25	241	464	213	103	37
	Bamberg	8a	2006/2007	14	13	83	327	94	27	4
			2007/2008	12[a]	16	103	n/a	n/a	n/a	n/a
			2008/2009	10.5	31	249	407	163	50	9
	Berkeley	8a/8b	2006/2007	17.9[a]	6	29	n/a	n/a	n/a	n/a
			2007/2008	15	15	108	251	64	16	2
			2008/2009	19.4[b]	23	165	266	50	1	n/a
Louisiana	St. Landry Parish	8b	2006/2007	19	9	46	106	19	2	n/a
			2007/2008	23	7	28	68	6	n/a	n/a
			2008/2009	26[b]	n/a	n/a	n/a	n/a	n/a	n/a
Texas	Hardin	8b	2009/2010	15	n/a	n/a	n/a	n/a	n/a	n/a
Florida	Highlands	9a	2006/2007	33.2	n/a	n/a	n/a	n/a	n/a	n/a
			2007/2008	32	n/a	n/a	n/a	n/a	n/a	n/a
			2008/2009	27.3	1	2	17	n/a	n/a	n/a

[a] Cumulative data is incomplete. Minimum temperatures are accurate based on data from nearest off-site source

[b] Temperature data obtained from nearest off-site source

n/a = not available

Initially, multiple transgenic lines were tested in field experiments established in freeze-stress environments as a first assessment of gene performance. These lines were evaluated for a number of different phenotypes manifested after freeze stress that were considered to be indicative of improved freeze tolerance. These phenotypic observations included tip and leaf damage following specific freeze events. A waiting period of several weeks was required for such a phenotype to manifest itself following the freeze event. In many cases, this was confounded by subsequent freeze events and it was difficult to assign a given observation to a defined time point and temperature. Nevertheless, the data from these initial observations were important in allowing the selection of a few potential candidate lines that merited further testing based on their level of apparent freeze tolerance, including lines 427 and 435 for which detailed phenotypic observations are reported in this petition.

Following these initial observations, it was concluded that a simple comparison of pre-winter (late fall, noted in the data as year-end measurement) and post-winter (spring) live height (top of the main stem where new growth emerged) measurements, used to calculate a percent dieback of the main stem, together with a post-winter qualitative assessment of green leaf retention (crown score), diameter at breast height (DBH) and volume measurements provided appropriate assessment of freeze tolerance and growth performance under field conditions. Dieback was calculated as the percent difference in live height between the pre-winter and post-winter height measurements. The crown score was based on visual observation and estimation of green leaf retention in the canopy at the end of the winter, using a scale of 0 to 100 (0 = complete brown leaf canopy followed by defoliation; 100 = complete green leaf canopy). Spring measurements allowed for the assessment of the cumulative effect of multiple freeze events and also avoided the challenge with mid-winter assessments that could be confounded by overlapping and incremental freeze events. Post-winter tree survival was also assessed. For trees that were killed by freeze events to or near ground level, survival was assessed based on the capability of the tree to produce new shoots that were of measurable height at the end of the growing season. Trees which did not produce measurable shoots were considered nonviable.

VII.A. Field Performance in a Target Freeze Stress Environment

VII.A.1.Performance of field trials established in Baldwin County, Alabama

This location in Baldwin County, Alabama is typical of USDA Hardiness Zone 8b where the freeze tolerant *Eucalyptus* lines 427 and 435 are expected to be grown. Based on the historic weather patterns observed at this location, it was anticipated that in mild winters there would likely be minimal damage to both the translines and the EH1 control trees while in more severe winters there would be a clear differentiation in freeze damage between the translines and the controls.

VII.A.1.a. Results of field trial AR162a planted under BRS Permit # 06-325-111r (renewed as 10-112-101r)

This field trial consisted of a randomized complete block design (RCBD) with eight replicated single-tree plots for each transline. Multiple EH1 control trees were planted in each block. A total of 48 translines, including line 427 and 435, along with the EH1 control were planted in this trial. The trial was planted on 11/08/2005 (MM/DD/YYYY) and the area covered by this trial was ~1.1 acres. Trees were irrigated immediately after planting and then periodically over the next several weeks to ensure good establishment. After establishment, all trees planted in this trial were assessed annually for freeze tolerance and growth performance. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for this trial from 2005 to 2010 are summarized in Table VII.A.1.a.

Table VII.A.1.a. Phenotypic measurements of field trial AR162a at Baldwin County, Alabama (planted 11/08/2005)

	2006			2007			2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Height (ft) at end of 2005	1.4	1.2**	1.3**												
Live Height (ft) in Spring	1.1	1.1	1.2	17.9	16.8	15.0**	3.9	33.8**	33.3**	12.4	41.2**	38.9**	0.3	52.4**	48.0**
Stem Dieback (%) in Spring	21	0.9**	0.5**	9	12	13	90	9**	7**	19	10	10	99	7**	12**
Crown Score in Spring	86	80	88	78	79	73	0	56**	54**	52	53	49			
Height (ft) at end of year	19.8	19.1	17.2**	38.2	37.1	35.7	14.9	45.9**	43.4**	25.9	56.2**	54.6**			
DBH (in) at end of year	2.07	2.01	2.01	4.14	4.02	3.6**	1.33	5.37**	4.89**	1.61	6.36**	5.91**			
Volume (ft^3) at end of year	n/a	n/a	n/a	1.64	1.49	1.18**	0.15	3.26**	2.58**	0.23	5.56**	4.71**			
Net Annual Height Growth (ft)	18.4	17.9	16.0**	18.4	18.0	18.4	-23.3	8.8**	7.7**	11.0	10.3	11.2			
Net Annual DBH Growth (in)	n/a	n/a	n/a	2.10	2.00	1.6**	-2.80	1.4**	1.3**	0.30	1.00	1.00			
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	-1.50	1.8**	1.4**	0.10	2.3**	2.1**			
Survival (%) at end of year	97	100	100	97	100	100	97	100	100	97	100	100			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

The initial height of the trees planted in this field trial was measured soon after planting in November 2005. These height measurements indicated that EH1 was significantly taller than both translines (Table VII.A.1.a); however, this difference is a reflection of variation in the size of the planted material rather than any differences in growth performance or freeze damage. Several mild freeze events occurred at this site during the 2005/2006 winter season with 21.6 °F recorded as the lowest temperature (Table VII.A). Although the live height of EH1 control trees and translines measured in spring of 2006 were not significantly different, the young EH1 control trees showed a significantly higher stem dieback compared to translines. This observation combined with our cold chamber studies (data not shown) provided early indications that translines 427 and 435 showed the desired improved freeze tolerance compared to the EH1 control. These two translines along with a few other potential freeze tolerant candidate translines were, therefore, selected for expanded field testing at multiple locations. The results from these additional field trials are discussed in later sections of this petition.

Since 2005/2006 was a mild winter at this location (Table VII.A), no significant differences were observed between the EH1 control and transline 427 for crown score, year-end height, DBH or net annual growth during the 2006 growing season (Table VII.A.1.a). Although transline 435 showed a similar level of freeze tolerance to line 427, this line was significantly shorter than the EH1 control at the end of 2006. There was no significant difference between the EH1 control and translines for year-end survival of trees. The slightly lower tree survival (97%) recorded for the EH1 control in this trial was not caused by freeze damage but was attributed to the loss of a few control trees due to transplanting shock or mechanical damage.

The 2006/2007 winter at this location was also mild with the lowest recorded temperature being 20.6 °F (Table VII.A). As a result, in the 2007 growing season there were no significant differences between either of the translines and control trees for stem dieback, crown score or year-end height measurements (Table VII.A.1.a). Transline 427 was comparable to EH1 control for all characteristics measured in 2007. Transline 435 showed significantly lower DBH and volume measurements but the net annual height growth for this line was comparable to the EH1 control. These observations suggest that growth performance of both translines is essentially comparable to control trees in the absence of a significant freeze event.

The lowest recorded temperature at this location during the 2007/2008 winter was 19.7 °F (Table VII.A). Although the temperature at this location during 2007/2008 winter was less than one degree lower compared to the previous winter, a dramatic difference was observed in the freeze tolerance and growth performance between translines and control trees. In spring 2008, the average live height of EH1 control trees was ~4 feet compared to over 33 feet for both translines (Table VII.A.1.a). The EH1 control trees showed severe dieback with an average 90% dieback as opposed to only 9% and 7 % dieback observed for lines 427 and 435, respectively. Similarly, the crown score for the EH1 control was 0% indicating that all leaves in the canopy turned brown whereas for both translines more than 50% the canopy retained green leaves. These highly significant differences in live height, dieback and crown score between translines and EH1control trees were also reflected in other traits measured in the 2008 growing season, except for year-end tree survival which was not affected by this freeze event.

At this location, the winter of 2008/2009 was milder compared to all three previous winter seasons with the minimum temperature recorded for this winter being 22.8 °F (Table VII.A). As a result, no difference was observed in freeze tolerance between the EH1 control and the translines as indicated by stem dieback and crown score measurements (Table VII.A.1.a). Predictably, for the 2009 growing season all measured growth traits were significantly lower for the EH1 control compared to both translines due to the severe dieback experienced by control trees in the preceding winter season. However, the net annual height growth of EH1 was comparable to both translines. This observation indicates that after recovering from freeze damage the growth rate of three-year-old control and transgenic trees was not affected.

Among the five winter seasons experienced by trees at this location, the winter of 2009/2010 was recorded as the most severe winter with a minimum temperature of 16.8 °F (Table VII.A). Data for spring height measurement and stem dieback were recorded following the winter (Table VII.A.1.a). As expected after such a severe winter, the average live height of EH1 control trees was just ~0.3 feet compared to 52.4 and 48 feet for translines 427 and 435, respectively The EH1 control trees showed 99% dieback compared to only 7% – 12% dieback observed for the translines. These results are similar to those observed after the relatively severe winter of 2007/2008.

The dramatic differences observed in freeze tolerance between EH1 control trees and translines during the 2007/2008 winter compared to previous winter seasons which were just 1-2 degrees warmer may have resulted from a difference in the number of freezing periods and cumulative freeze hours experienced at this location *prior* to the lowest recorded temperature (Table VII. A). During the 2007/2008 winter, there were only four mild freeze periods with a total of 14.25 cumulative freeze hours prior to the lowest recorded temperature of 19.7 °F. In contrast, the lowest temperature (20.6 °F) recorded in the 2006/2007 winter season was preceded by 28 separate mild freeze periods with a total of 152 cumulative freeze hours. A similar weather pattern was observed in the winter of 2005/2006. It is known in the literature that the freeze tolerance response in plants is induced at low but non-damaging temperatures. We therefore speculate that a repeated induction of freeze tolerance responses at low but non-damaging temperatures as occurred in the two previous winters may have induced a moderate level of freeze protection in the EH1 control trees when the temperature dropped to the lowest point. This observation also indicates that EH1 trees have an intrinsic freeze tolerance pathway that operates to a limited extent only. In the winter of 2007/2008, there were fewer freeze periods for the induction of any native freezing tolerance response. Under these abrupt temperature fluctuations, the control EH1 trees were not able to tolerate a temperature drop to 19.7 °F whereas the translines were able to withstand this temperature. In the winter of 2009/2010, the temperature drop to 16.8 °F proved too severe for EH1 control trees despite 15 separate freeze periods with 122 cumulative freeze hours recorded prior the lowest temperature drop whereas the translines sustained only minor injury at this temperature.

The data collected from this trial over five winter/growing seasons clearly show that both selected translines are substantially equivalent to the control trees for growth characteristics prior to a significant freeze event and after recovering from freeze damage. The data also clearly demonstrate that the desired freeze tolerance phenotype was achieved in both translines 427 and 435 after experiencing freeze events that are likely to occur in the southeastern US. These observations also suggest that the freeze tolerance phenotype expressed in these translines is capable of providing protection to transgenic hybrid trees under variable and often dramatic temperature fluctuations commonly experienced during winter months in the southeastern US.

VII.A.1.b. Results of field trial AR162b planted under BRS Permit # 06-325-111r (renewed as 10-112-101r)

The field trials in this test series were planted at multiple locations and consisted of a set of select candidate lines which included lines 427 and 435. At this site, both single-tree and twenty-five-tree block plot trials were planted in a randomized complete block design (RCBD). The single-tree plots were established with 5 selected freeze tolerant lines and consisted of 10 replicated plots for each line. Block plots were established with the 5 selected translines and consisted of 4 replicated 25-tree block plots (5x5 square plots) for each line. Both single-tree plots and block plots also included replicated plots of EH1 control trees. Single-tree plots are widely used in forest tree improvement programs to generate statistically robust data for clonal evaluation and progeny testing (Osorio et al, 2003; Gezan et al., 2006). Block plots were established at this and other locations for evaluation of growth and freeze tolerance phenotypes of selected translines under conditions that would simulate commercial plantings. Block plots also provided an expanded footprint for observation of potential insect pests or diseases on individual translines and control trees. These trials were planted on 07/11/2006 and the total area covered by the single-tree and block plots was ~1.4 acres. Annual measurements were taken on all trees planted in single-tree plots and 9 internal trees planted in block plots. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for both single-tree and block plot trials from 2006 to 2010 are summarized in Table VII.A.1.b and Figures VII.A.1.b (i to iv).

Table VII.A.1.b. Phenotypic measurements of field trial AR162b at Baldwin County, Alabama (planted 07/11/2006)

SINGLE TREE PLOT TRIAL

	2006			2007			2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				7.7	8.3*	7.7	2.3	25.4**	24.5**	16.6	37.1**	36.1**	0.4	47.2**	44.1**
Stem Dieback (%) in Spring				12	2**	10	92	11**	12**	3	8*	9**	99	13**	15**
Crown Score in Spring				77.3	69.0	67.5	0.0	44.5**	58.0**	51.4	60.6	65.5**			
Height (ft) at end of year	8.8	8.5	8.5	29.9	28.4	27.8*	17.0	40.5**	39.6**	35.1	54.1**	52.2**			
DBH (in) at end of year	0.65	0.59	0.62	3.48	2.86**	2.82**	1.13	4.62**	4.47**	2.34	5.79**	5.41**			
Volume (ft^3) at end of year	n/a	n/a	n/a	0.90	0.59**	0.56**	0.07	2.13**	1.95**	0.58	4.49**	3.78**			
Net Annual Height Growth (ft)	n/a	n/a	n/a	21.1	19.9	19.3*	-12.9	12.1**	11.8**	18.1	13.9**	12.5**			
Net Annual DBH Growth (in)	n/a	n/a	n/a	2.83	2.26**	2.21**	-2.35	1.74**	1.65**	1.20	1.20	0.95			
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	-0.83	1.53**	1.39**	0.51	2.40**	1.83**			
Survival (%) at end of year	100	100	100	100	100	100	100	100	100	100	90	100			

BLOCK PLOT TRIAL

	2006			2007			2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				6.7	7.5**	6.3	2.6	24.9**	22.1**	n/a	n/a	n/a	0.1	48.5**	41.2**
Stem Dieback (%) in Spring				18	4**	16	91	11**	11**	n/a	n/a	n/a	100	9**	19**
Crown Score in Spring				44.4	44.2	44.6	0.0	50.8**	53.2**	n/a	n/a	n/a			
Height (ft) at end of year	8.2	7.8*	7.6**	29.1	28.0	25.0**	18.5	42.1**	38.0**	37.0	53.2**	50.6**			
DBH (in) at end of year	0.55	0.50*	0.48**	3.21	2.88**	2.67**	1.32	4.23**	4.08**	2.66	5.13**	4.87**			
Volume (ft^3) at end of year	n/a	n/a	n/a	0.78	0.59**	0.45**	0.09	1.88**	1.60**	0.83	3.52**	3.08**			
Net Annual Height Growth (ft)	n/a	n/a	n/a	21.0	20.2	17.4**	-10.6	14.2**	13.2**	19.5	11.1**	12.6**			
Net Annual DBH Growth (in)	n/a	n/a	n/a	2.66	2.37**	2.19**	-1.88	1.35**	1.41**	1.44	0.91**	0.78**			
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	-0.69	1.29	1.15	0.78	1.64**	1.48**			
Survival (%) at end of year	100	100	100	100	100	100	100	100	94	97	100	94			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Figure VII.A.1.b.i. Images of trees in trial AR162b at Baldwin County, Alabama prior to 2006/2007 winter EH1 control (left), line 427 (middle) and line 435 (right).

The 2006 year-end measurements of single-tree plots showed that all trees in this test were well established and were on average ~8.5 feet tall (Table VII.A.1.b). The leaf morphology and tree form of EH1 control and translines were also comparable (Figure VII.A.1.b.i). There was no significant difference between EH1 control and translines for height, DBH and survival of trees prior to the onset of winter. The freeze tolerance and growth performance of EH1 and transgenic lines 427 and 435 in this test during 2007, 2008 and 2009 winter/growing seasons (Table VII.A.1.b) was essentially similar to that observed in the older test (AR162a, Table VII.A.1.a) as described above. One exception was that, in this test, line 427 but not line 435 showed significantly lower stem dieback in 2007 compared to the EH1 control whereas the stem dieback in the older test for the control and translines was comparable (Table VII.A.1.a). This may have resulted due to slightly higher level of freeze tolerance exhibited in growing tips of relatively younger trees of line 427. As expected after the severe winter season in 2007/2008, the EH1 control trees in this test were killed back close to ground level whereas both translines sustained only minor dieback (Table VII.A.1.b). As a result of significant dieback in the preceding winter, the control EH1 trees were significantly shorter than translines at the end of the 2009 growing season. However, in this growing season, the net annual growth of EH1 control trees was significantly higher than the translines, possibly resulting from rapid growth of rejuvenated sprouts supported by an established root system. This is consistent with our observation that, in general, younger trees grow at a faster rate compared to older trees. The performance of trees planted in this test after the severe winter of 2009/2010 was similar to that observed after the winter of 2007/2008. The year-end survival of trees was not affected in this test except for loss of a single tree for line 427 during the 2009 growing season possibly due to mechanical damage.

All EH1 control and transgenic trees planted in block plot test at this site were visually observed on a regular basis. Annual measurements for freeze-tolerance and growth performance were taken on 9 internal trees planted in each block from 2006 to 2010. The block plot data for the EH1 control and transline 427 and 435 are summarized in Table VII.A.1.b. At the end of 2006, the EH1 control trees were slightly taller than both translines. The differences observed in height and DBH of young trees at this stage likely reflect variation in the height of initial planting stock. Similar to the observation in single-tree plots, the line 427 in block plots showed significantly lower stem dieback compared to the EH1 control in 2007 whereas line 435 was comparable to the EH1 control. However, the crown score for both translines was comparable to control trees. There were no significant differences in height of line 427 and EH1 control at the end of the 2007 growing season but line 435 remained significantly shorter (Table VII.A.1.b). In 2007, all trees planted in single-tree and block plots were in good health and the height of these trees averaged between 25-30 feet (Figure VII.A.1.b.ii). As observed in all other tests at this location, the EH1 control trees planted in block plots tests suffered severe stem dieback (91 to 99%) during the 2007/2008 and 2009/2010 winter seasons whereas both translines had minimal (11 to 20%) dieback of the main stem. The dramatic differences observed in dieback and crown score between the EH1 control and both translines are clearly demonstrated in images of block plots taken in spring 2008 (Figure VII.A.1.b.iii and Figure VII.A.1.b.iv). Except for small experimental variation in values of measured characteristics, the performance of the EH1 control and both translines in block plots was similar to that observed in single-tree plots. The non-significant difference in year-end survival of trees for EH1 control and line 435 observed in block plots in 2008 and 2009 does not appear to be related to freeze damage.

Figure VII.A.1.b.ii. Image of trees in trial AR162b at Baldwin County, Alabama prior to 2007/2008 winter. Trees averaged between 25 to 30 feet in height for control and translines in both single tree and block plots.

Figure VII.A.1.b.iii. Image of trees in block plot trial AR162b at Baldwin County, Alabama in February 2008. Block plot of transline 435 showing ~60% canopy with green leaves (right) and block of EH1 control with complete browning and desiccation of leaves (left).

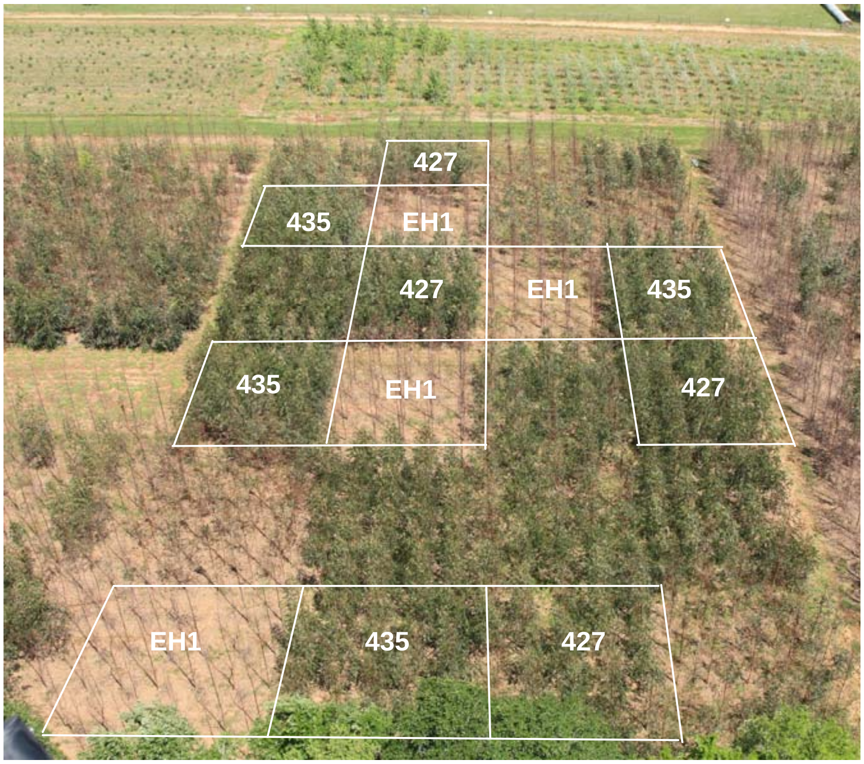


Figure VII.A.1.b.iv. Aerial image of block plot trial AR162b at Baldwin County, Alabama in April 2008. Blocks plots of EH1 and translines 427 and 435 are indicated on the image.

The results obtained from single-tree and block plot tests in this trial (AR162b) are consistent with our observations from the older single-tree plot trial (AR162a). The cumulative data from these trials clearly demonstrate that growth and phenotypic characteristics of both translines were comparable to the EH1 control prior to any winter damage and a desired freeze tolerance phenotype was expressed in both translines 427 and 435 after a significant freeze event. The data from trial AR162b also suggest that single-tree plots are comparable to block plots in providing accurate assessment of growth and freeze tolerance phenotypes of translines when compared to control trees of this same genotype. However, block plots are valuable for the assessment of area based metrics such as volume growth per acre and disease and pest observations.

VII.A.1.c. Results of field trial AR162d planted under BRS Permit # 06-325-111r (renewed as 10-112-101r)

Single-tree and block plot trials, that included transline 427 and 435, were planted in this test series at multiple locations. At this site, the single-tree plot trials were established in a RCBD with 12 selected freeze tolerant lines and consisted of 10 replicated plots for each line. Block plot trials were established in a completely randomized design (CRD) with 9 selected translines and consisted of 3 replicated 25-tree block plots (5x5 square plots) for each line. Both single-tree plots and block plots also included replicated plots of EH1 control trees. These trials were planted on 07/31/2007 and the total area covered by the single-tree and block plots was ~2 acres. Annual measurements were taken on all trees planted in single-tree plots and 9 internal trees planted in block plots. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for both single-tree and block plot trials from 2007 to 20010 are summarized in Table VII.A.1.c.

Table VII.A.1.c. Phenotypic measurements of field trial AR162d at Baldwin County, Alabama (planted 07/31/2007)

SINGLE TREE PLOT TRIAL

	2007			2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	3.8**	3.7**	7.9	17.6**	12.9*	0.1	23.8**	18.4**
Stem Dieback (%) in Spring				97	1**	3**	37	4**	8*	99	21**	25**
Crown Score in Spring				0.0	33.3**	32.2**	32.8	61.1**	69.4**			
Height (ft) at end of year	4.1	3.8	3.9	11.7	18.3**	13.9	22.2	30.0*	24.2			
DBH (in) at end of year	n/a	n/a	n/a	0.92	1.75**	1.49*	1.59	3.28**	2.51*			
Volume (ft^3) at end of year	n/a	n/a	n/a	0.03	0.15**	0.11*	0.23	0.81**	0.48			
Net Annual Height Growth (ft)	n/a	n/a	n/a	7.6	14.4**	10.2	10.4	11.7	10.3			
Net Annual DBH Growth (in)	n/a	n/a	n/a	n/a	n/a	n/a	0.64	1.53**	1.03			
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	0.20	0.66**	0.37			
Survival (%) at end of year	90	90	100	80	90	80	75	90	80			

BLOCK PLOT TRIAL

	2007			2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	4.9**	4.8**	13.0	23.3**	15.2**	0.1	35.0**	19.5**
Stem Dieback (%) in Spring				98	4**	4**	14	0.5**	3**	100	12**	27**
Crown Score in Spring				0.0	46.9**	42.6**	58.3	73.3**	70.5**			
Height (ft) at end of year	5.5	5.1	5.0*	15.2	23.4**	15.7	30.6	39.9**	27.3*			
DBH (in) at end of year	n/a	n/a	n/a	1.46	2.33**	1.80**	2.54	3.64**	2.51			
Volume (ft^3) at end of year	n/a	n/a	n/a	0.08	0.32**	0.13*	0.53	1.35**	0.50			
Net Annual Height Growth (ft)	n/a	n/a	n/a	9.4	18.3**	10.9*	15.4	16.5	12.8*			
Net Annual DBH Growth (in)	n/a	n/a	n/a	n/a	n/a	n/a	1.06	1.31*	0.96			
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	0.45	1.02**	0.44			
Survival (%) at end of year	100	100	100	74	100**	74	74	100**	93			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

At the end of the 2007 growing season, lines planted in single-tree plots were on average ~4 feet tall (Table VII.A.1.c). There was no significant difference between the EH1 control and translines for height measurement prior to the onset of winter. However, at the end of 2008 and 2009 growing seasons, line 427 was significantly taller than the EH1 control while line 435 was measurably taller than EH1 but not significantly different. After severe winter seasons in 2007/2008 and 2009/2010 the comparative freeze tolerance of EH1 and transgenic lines 427 and 435 was essentially similar to that observed in the two previous tests at this site (AR162a and AR162b). The EH1 control trees showed severe dieback (97-99%) whereas both translines had only minor winter injury (1-27 % dieback). As expected after the severe winter season, line 427 was significantly taller than EH1 control at the end of 2008 and 2009 growing seasons. However, there was no significant difference in tree height between line 435 and the EH1 control (Table VII.A.1.c). These height differences were also reflected in other characteristics measured for line 435 and EH1 control trees at the end of 2008 and 2009. Except for slight variability observed in height and year-end survival of trees, the performance of EH1 control and translines in block plots was essentially similar to that observed in single-tree plots (Table VII.A.1.c).

VII.A.1.d. Summary of field trials at Baldwin County, Alabama

Preliminary field observation made during the first winter season on trees planted in trial AR162a at this location provided some indications of improved freeze tolerance in translines compared to control EH1 trees. These observations combined with our controlled growth chamber studies allowed us to select a few candidate translines, including lines 427 and 435, for improved freeze tolerance. These two translines along with other potential freeze tolerant translines were, therefore, planted in expanded single-tree and block plot trials under test series AR162b and AR162d at this site as well as other locations in southeastern US.

The data collected from trial AR162a over five winter/growing seasons at this location clearly show that translines 427 and 435 are substantially equivalent to EH1 control trees for growth characteristics until they are subjected to a significant freeze event. The data from trial AR162a also demonstrate that the desired freeze tolerance phenotype was achieved in both translines 427 and 435 after experiencing significant freeze events and abrupt temperature fluctuations. The results obtained from a subsequent single-tree and block plot trial (AR162b) over four winters/growing seasons are consistent with our observations from the older single-tree plot trial (AR162a). Except for some variation observed in tree height and year-end survival of trees, the freeze tolerance and growth performance data collected from a younger trial (AR162d) over three winters/growing seasons is essentially similar to that observed in previous trials (AR162a and AR162b). The cumulative data from these trials demonstrate that growth and phenotypic characteristics of translines 427 and 435 were generally comparable to the EH1 control prior to a severe winter season (with 435 showing a slight reduction in growth relative to EH1 in some cases) and the desired freeze tolerance phenotype was expressed in both translines in response to a significant freeze event. The data from trial AR162b and AR162d also suggest that single-tree plots are comparable to block plots for assessment of growth and freeze tolerance phenotypes of translines.

The data obtained from these trials highlights the usefulness of obtaining observations from multiple winter/growing seasons in order to effectively evaluate the growth and freeze tolerant phenotypes in translines. The multi-season data addresses the subtle differences observed in weather patterns from year to year that are often modulated by other factors such as wind speed and soil moisture level as well as rate and frequency of temperature change prior to a significant freeze event. The data from these field trials demonstrate that minimum temperature is a meaningful metric against which to assess freeze tolerance. However, these data also point to the difficulties of making predictive calls in freeze damage based on temperature alone since, for any given temperature, a multitude of other dynamic environmental factors could impact freeze tolerance. The multi-season data obtained from these trials demonstrate conclusively that the freeze tolerant trait in line 427 and 435 provided good protection against temperature fluctuations typical of those expected at this location.

VII.B. Field Performance in a Freeze Stress-Free Environment

Field trials were established in a freeze stress-free environment to assess comparative phenotypic performance of EH1 and translines 427 and 435. For trials established in regions where the trees experienced freezing temperatures, growth of the EH1control trees was expected to be compromised after a significant freeze event. However, in freeze stress-free environments, the growth performance of translines is expected to be comparable to EH1 control trees. In the absence of any significant freeze damage, the percent dieback of trees was not applicable in these trials. Phenotypic observations typically included pre- and post-winter height measurements, diameter at breast height (DBH), tree volume, and year end survival of the trees.

VII.B.1.Performance of field trials established in Highlands County, Florida

This site is located in USDA Hardiness Zone 9a where most winters would not be expected to have any significant freezing temperatures. A summary of the winter temperatures recorded at this site is presented in Table VII.A.

VII.B.1.a. Results of field trial AR162b planted under BRS Permit # 08-151-101r

Field trials planted at this site were companion trials of the test series AR162b that were planted at multiple locations. These trials consisted of a set of select candidate lines which included lines 427 and 435. At this site, both single-tree and twenty-five-tree block plot trials were planted in a randomized complete block design (RCBD). The single-tree plots were established with 5 selected freeze tolerant lines and consisted of 10 replicated plots for each line. Multiple EH1 control trees were planted in each block. Block plots were established with the 5 selected translines and consisted of 4 replicated 25-tree block plots (5x5 square plots) for each line. Block plots also included 4 replicated 25-tree block plots (5x5 square plots) of EH1 control trees. These trials were planted on 07/18/2006 and the total area covered by the single-tree and block plots was ~1.4 acres. Trees were irrigated immediately after planting and then periodically over the next several weeks to ensure good establishment. Annual measurements were taken on all trees planted in single-tree plots and 9 internal trees planted in block plots. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for both single-tree and block plot trials from 2006 to 2009 are summarized in Table VII.B.1.a and Figure VII.B.1.a.i.

Table VII.B.1.a. Phenotypic measurements of field trial AR162b at Highlands County, Florida (planted 07/18/2006)

SINGLE TREE PLOT TRIAL

	2006			2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				10.1	8.4**	8.9*	35.6	33.7	32.8**	52.4	49.4*	47.0**
Stem Dieback (%) in Spring				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Height (ft) at end of year	6.3	5.0**	5.6	29.9	28.8	28.1	52.9	48.2*	47.3**	66.7	62.8**	61.6**
DBH (in) at end of year	n/a	n/a	n/a	3.35	2.90**	2.93*	5.31	4.47**	4.52**	6.70	5.50**	5.50**
Volume (ft^3) at end of year	n/a	n/a	n/a	0.84	0.62*	0.63*	3.75	2.46**	2.48**	7.50	4.84**	4.85**
Net Annual Height Growth (ft)	n/a	n/a	n/a	23.6	23.8	22.5	23.0	19.4*	19.2*	13.8	14.6	14.3
Net Annual DBH Growth (in)	n/a	n/a	n/a	n/a	n/a	n/a	1.97	1.57**	1.59**	1.39	1.03**	0.98**
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	2.91	1.84**	1.86**	3.76	2.38**	2.37**
Survival (%) at end of year	100	100	100	100	100	100	100	100	100	100	100	100

BLOCK PLOT TRIAL

	2006			2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				n/a	n/a	n/a	32.7	32.9	32.4	52.2	52.6	49.8
Stem Dieback (%) in Spring				n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Height (ft) at end of year	5.6	5.2	4.7**	27.5	28.5	27.8	48.7	48.1	46.5	64.9	62.5	62.7
DBH (in) at end of year	n/a	n/a	n/a	3.03	3.08	2.99	4.83	4.94	4.80	6.15	6.18	5.92
Volume (ft^3) at end of year	n/a	n/a	n/a	0.68	0.69	0.65	2.98	2.99	2.73	6.46	6.03	5.68
Net Annual Height Growth (ft)	n/a	n/a	n/a	22.0	23.3	23.1	21.3	19.6	18.7*	16.1	14.4	16.2
Net Annual DBH Growth (in)	n/a	n/a	n/a	n/a	n/a	n/a	1.80	1.86	1.80	1.32	1.23	1.12*
Net Annual Volume Growth (ft^3)	n/a	n/a	n/a	n/a	n/a	n/a	2.30	2.31	2.08	3.48	3.03	2.94
Survival (%) at end of year	100	100	100	100	100	100	100	100	100	100	100	100

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.

A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*

Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

The 2006 year-end measurements of single-tree plots showed that all trees in this trial were well established with 100% tree survival (Table VII.B.1.a). Approximately 5 months after planting the EH1 control trees were on average significantly taller than transline 427. There was no significant difference in average height between the EH1 control and transline 435. As expected, during the 2006/2007 winter, the temperatures at this site stayed above freezing (Table VII.A). Therefore, there was no dieback observed in either control trees or translines and in fact the trees continued to grow during the winter at this site. The spring 2007 measurements showed that on average EH1 control trees were significantly taller than both translines. Significant differences between control trees and the translines were also observed in DBH and tree volume. However, there was no significant difference in height and net annual height growth at the end of the 2007 growing season. Again, the temperatures at this site stayed at or above freezing during the 2007/2008 winter (Table VII.A). In the spring of 2008, there was no significant difference in height between the control EH1 and transline 427 but line 435 was significantly shorter than the control. The 2008 year-end measurements showed that EH1 control trees were significantly taller compared to both translines. Significant differences were also observed between the control and translines for all other variables measured during the 2008 growing season. Although the temperature dropped below freezing (27.3 °F) for few hours at this site during winter 2008/2009 (Table VII.A), there was no visible freeze damage to either control trees or translines and comparison of year-end height in 2008 to live height in spring of 2009 showed almost no differences. Measurements at the end of 2009 again showed that the EH1 control was significantly taller and had higher DBH and volume compared to both translines. However, there was no significant difference in net annual height growth of the control and translines. Overall, these data indicate that, in single-tree plots under freeze stress-free conditions at this site, the translines showed a slight reduction in growth compared to non-transgenic control trees. The detection of these difference likely resulted from the greater statistical power of single-tree plot trials (e.g. when compared to block plots – see below) especially considering that a higher number of control trees (30 ramets) were measured compared to translines (10 ramets).

All EH1 control and transgenic trees planted in block plot trial at this site were visually observed on a regular basis. All trees planted in the block plot trial were well established with 100% survival (Table VII.B.1.a). Annual measurements for growth performance were taken on the nine internal trees planted in each block from 2006 to 2009. The block plot data for the EH1 control and translines 427 and 435 are summarized in Table VII.B.1.a. At the end of 2006, there was no significant difference in average height between the EH1 control trees and transline 427. However, the trees of transline 435 were on average significantly shorter than control trees. From 2007 to 2009 all growth variables measured in block plot trial for EH1 control trees and translines 427 and 435 were comparable except for significantly lower net annual height growth and net annual DBH growth for transline 435 in 2008 and 2009, respectively (Table VII.B.1.a). The phenotypic measurements obtained from the block plot trial demonstrate that the growth performance of both translines was substantially comparable to EH1 control trees under freeze stress-free conditions at this site. Data from the block plot trial also supports the view that a slight reduction in growth of translines in the single tree plots may have been more readily detected as a result of both the greater number of ramets of EH1 control trees compared to translines as well as more replicates overall in the single tree plot trial.

Figure VII.B.1.a.i. Image of trees in block plot trial AR162b at Highlands County, Florida in November 2010. EH1 control (left), line 427 (middle) and line 435 (right).

VII.B.1.b. Summary of field trials in Highlands County, Florida

Over three winter seasons, the Highlands county site in central Florida did not experience freezing temperatures that were sufficient to produce observable damage to the non-transgenic control trees. We therefore consider that this site is generally representative of the performance of these trees in a freeze stress-free environment. The data from the test series AR162b trials established at this site demonstrate that the growth performance of both translines is generally comparable to EH1 control trees throughout the growing season under freeze stress-free conditions. Data collected from this trial over three winter/growing seasons also show that the performance of both translines compared to EH1 control trees was consistent in single-tree and block plot trials, respectively. The results obtained from the single-tree plots at this site showed a slight reduction in growth of translines compared to non-transgenic control trees. However, the results obtained from the block plot trial established at this site showed that both translines were not different from EH1 control trees for growth performance under freeze stress-free conditions. These results suggest that the slight reduction in the growth of translines in the single-tree plot test at this site may have been observed as a result of the test design (single-tree-plot vs. block plot). Data collected from multiple trials with single tree plots established in the freeze stress environments also indicated that growth and phenotypic characteristics of translines 427 and 435 in other tests were generally comparable to the EH1 control until the trees were subjected to a severe freeze event.

VII.C. Field Performance in Range of Freeze Stress Environments

In addition to establishing field trials in the target freeze stress (Baldwin County , AL) and freeze stress-free (Highlands County, FL) environments, trials were established at multiple locations in the southeastern US under a range of temperature and climatic conditions. A major objective of these trials was to assess the geographic limits in the southeastern US where translines 427 and 435 could be successfully deployed for commercial production. It was expected that in field trials established under severe freeze stress environments such as those experienced in USDA Hardiness Zone 8a where average annual minimal temperatures typically range from 10–15 °F, both the EH1 control trees as well as translines could be severely damaged or killed to ground level. Based on historic weather patterns for locations near the border of USDA Hardiness Zone 8a and 8b, it was anticipated that the growth and survival of EH1 control trees at these locations may be severely compromised after most winters compared to translines. At locations further south within USDA Hardiness Zone 8b, in mild winters there would likely be minimal damage to both the translines and the EH1 control trees while in more severe winters there would be a clear differentiation between the control and transgenic trees.

VII.C.1. Performance of field trials established in Charleston and Bamberg Counties in South Carolina and Escambia County in Alabama

The selected sites in Charleston and Bamberg Counties in South Carolina and Escambia County in Alabama are located in the USDA Hardiness Zone 8a where average minimal temperatures in most winters are expected to be between 10 and 15 °F. A summary of the winter temperatures recorded at these sites is presented in Table VII.A. Field trials in test series AR162a, AR162b, AR162d and AR162f were planted at these sites under different Notifications and Permits (Appendix A and C). All trials included trees of EH1 as controls and translines 427 and 435 planted in single-tree plots with 8 to 10 replications.

The trial under test series AR162a was planted on 11/04/2005 on ~0.8 acres in Charleston County, South Carolina. Seven days after planting a hard freeze (22.4 F) was experienced at this site. As a result, all trees were killed (100 % dieback) to ground level (data not shown). In the spring of 2006, there was no survival/re-sprouting of EH1 control trees whereas 12.5% (1of 8 ramets) and 25% (2 of 8 ramets) survival was observed for line 427 and 435, respectively. Since the trial was severely compromised by such high mortality it was subsequently terminated. Test AR162b was planted at this site on 7/06/2006 on ~0.3 acres. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trial AR162b, planted in Charleston County, from 2006 to 2009 are summarized in Table VII.C.1.a. and Figure VII.C.1.i.

Table VII.C.1.a. Phenotypic measurements of field trial AR162b at Charleston County, South Carolina (planted 07/06/2006)

	2006			2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	0.1	0.1	0.1	4.0**	4.4**	0.1	0.1	0.1
Stem Dieback (%) in Spring				99	99	99	99	77.4**	74.4**	99	99	99.4*
Crown Score in Spring				0	0	0	0	0	0	0	0	0
Height (ft) at end of year	6.5	5.7*	6.4	16.2	17.1	17.0	13.9	16.8*	17.9**	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a	1.39	1.42	1.55*	0.95	1.51**	1.66**			
Net Annual Height Growth (ft)	n/a	n/a	n/a	9.7	11.4**	10.5	-2.4	-0.3	0.9**			
Survival (%) at end of year	100	100	100	97	100	90	90	100	90			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.

A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control at 95% and 99% confidence levels, respectively.*

Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Figure VII.C.1.i. Images of trees in trial AR162b at Charleston County, South Carolina in the 2006/2007 winter. Images taken early January 2007. A) Representative trees for the different lines. From left to right: EH1, lines 427 and line 435. B) Image showing a border row of EH1 trees (right side) and a row of transgenic trees (mixture of lines, left side).

The 2006 year-end measurements of this trial showed that all trees in this test were well established and on average ~6 to 6.5 feet tall (Table VII.C.1.a). The lowest recorded temperature during the 2006/2007 winter at this location was 12 °F (Table VII.A). As expected after such a severe winter, all EH1 control and transgenic trees were killed to the ground level (99% dieback) with complete leaf browning (Figure VII.C.1.i) and eventual defoliation (0 crown score). There were no significant differences between the translines and control trees for the stem height of re-sprouts measured at the end of 2007. Although, the lowest temperature recorded in the 2007/2008 winter was 10.9 °F (Table VII.A), significantly lower dieback was observed in spring 2008 on the re-sprouted trees of the translines compared to control trees, with new growth occurring at an average height of about 4 feet in the translines. These differences were also reflected in the year-end height and DBH measurements with the translines significantly different from the EH1 controls for both traits (Table VII.C.1.a). However, complete dieback (99%) and defoliation were observed again in the spring of 2009 following the 2008/2009 winter where the lowest recorded temperature was 8.4 °F. The post winter tree survival over the course of the trial, although not statistically significant, was higher for transline 427 compared to control. This trial was terminated following spring observations in 2009. Similar results with respect to pre-winter growth and post winter dieback were obtained from the AR162d trial planted at this site (Table VII.C.1.b).

Table VII.C.1.b. Phenotypic measurements of field trial AR162d at Charleston County, South Carolina (planted 07/19/2007)

	2007			2008		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0	0	0
Stem Dieback (%) in Spring				100	100	100
Crown Score in Spring				0	0	0
Height (ft) at end of year	4.2	4.0	4.2	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a			
Survival (%) at end of year	97	100	100			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.

A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trials AR162b, AR162d and AR162f at Bamberg County in South Carolina, from 2006 to 2009 are summarized in Tables VII.C.1.c., VII.C.1.d. and VII.C.1.e. In general, there was no significant difference between control and transgenic trees prior to winter but after the severe winter all trees were killed to ground level. In this respect, the results from these trials were similar to those obtained from Charleston County, South Carolina for trials AR162b and AR162d as described above.

Table VII.C.1.c. Phenotypic measurements of field trial AR162b at Bamberg County, South Carolina (planted 07/05/2006)

	2006			2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	0.1	0.1	0.1	2.3**	1.1	0.1	0.1	0.1
Stem Dieback (%) in Spring				98	98	98	99	76**	91	99	99	99
Crown Score in Spring				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Height (ft) at end of year	3.5	3.3	3.5	8.6	8.2	7.6	12.5	14.3	13.4	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a	0.63	0.62	0.55	1.08	1.33	1.28			
Net Annual Height Growth (ft)	n/a	n/a	n/a	4.7	4.4	3.8	3.4	6.2	4.1			
Survival (%) at end of year	100	100	100	63	60	60	57	60	40			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.

A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control at 95% and 99% confidence levels, respectively.*

Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Table VII.C.1.d. Phenotypic measurements of field trial AR162d at Bamberg County, South Carolina planted (07/18/2007)

	2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	0.1	0.1	-	0.1	-
Stem Dieback (%) in Spring				97	97	97	-	99	-
Crown Score in Spring				0.0	0.0	0.0	-	0.0	-
Height (ft) at end of year	3.1	3.5	3.2	0.0	6.5	0.0	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a	n/a	n/a	n/a			
Net Annual Height Growth (ft)	n/a	n/a	n/a	n/a	n/a	n/a			
Survival (%) at end of year	100	100	100	0	60**	0			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control at 95% and 99% confidence levels, respectively.*

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Table VII.C.1.e. Phenotypic measurements of field trial AR162f at Bamberg County, South Carolina (planted 08/08/2008)

	2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	0.1	0.1
Stem Dieback (%) in Spring				95	95	95
Crown Score in Spring				0	0	0
Height (ft) at end of year	2.3	1.7**	1.8			
DBH (in) at end of year	n/a	n/a	n/a			
Net Annual Height Growth (ft)	n/a	n/a	n/a			
Survival (%) at end of year	95	100	100			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.

A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*

Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trials AR162d and AR162f at Escambia County in Alabama, from 2007 to 2009 are summarized in Tables VII.C.1.f. and VII.C.1.g. There was no significant difference between control and transgenic trees prior to winter but after the severe winter all trees were killed to ground level. In this respect, the results from these trials were essentially similar to those obtained from Charleston and Bamberg Counties in South Carolina as described above.

Table VII.C.1.f. Phenotypic measurements of field trial AR162d at Escambia County, Alabama (planted 07/31/2007)

	2007			2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	0.1	0.1	0.1	0.6	0.1	0.1	2.8*	0.0
Stem Dieback (%) in Spring				97	97	97	96	83	96	96	67	100
Crown Score in Spring				0.0	0.0	0.0	0.0	1.7	0.0			
Height (ft) at end of year	3.2	3.1	3.0	2.3	3.0	2.2	4.0	7.2	1.9			
DBH (in) at end of year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
Net Annual Height Growth (ft)	n/a	n/a	n/a	0.9	-0.1	-0.8	1.7	4.2	-0.3			
Survival (%) at end of year	100	100	90	65	100*	80	30	60	10			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Table VII.C.1.g. Phenotypic measurements of field trial AR162f at Escambia County, Alabama (planted 07/15/2008)

	2008			2009			2010		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	0.8	1.6	0.1	1.8	0.1
Stem Dieback (%) in Spring				94	69	49	95	72	99
Crown Score in Spring				0.0	5.0	8.8	n/a	n/a	n/a
Height (ft) at end of year	1.9	1.8	2.3	2.2	6.6	12.4*			
DBH (in) at end of year	n/a	n/a	n/a	n/a	0.80	1.30			
Net Annual Height Growth (ft)	n/a	n/a	n/a	0.0	3.7	9.2*			
Survival (%) at end of year	70	80	80	20	30	20			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

The data collected from these eight trials, established at three different sites in USDA Hardiness Zone 8a, over two to three winter/growing seasons show that both selected translines are comparable to the control trees for growth characteristics prior to a severe freeze event. The data also clearly demonstrate that translines 427 and 435 are not able to withstand the severe winters (with temperatures falling below 15°F) that are typical in the southeastern US region represented by the USDA Hardiness Zone 8a. In this region, the translines would be expected to show severe or total dieback each winter together with an associated reduction in survival.

VII.C.2. Performance of field trials established in Berkeley County in South Carolina

The Berkeley County, South Carolina site is located approximately on the border of USDA Hardiness Zones 8a and 8b and as such represents a possible northern limit to where lines 427 and 435 might be considered for planting. A summary of the winter temperatures recorded at this site is presented in Table VII.A. Field trials in the test series AR162b and AR162d were planted at this site under Notifications and/or Permits (Appendix A and C). Both trials included trees of the EH1 control and translines 427 and 435 planted in single-tree plots with 8 to 10 replications.

The trial AR162b was planted at this site on 07/05/2006 on ~0.3 acres. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trial AR162b from 2006 to 2008 are summarized in Table VII.C.2.a. and Figures VII.C.2.i. and ii.

Table VII.C.2.a. Phenotypic measurements of field trial AR162b at Berkeley County, South Carolina (planted 07/05/2006)

	2006			2007			2008		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.10	3.8**	3.7**	0.1	11.6**	13.5**
Stem Dieback (%) in Spring				98	5**	7**	99	40**	24**
Crown Score in Spring				0.0	61.0**	50.0**	0.0	38.5**	42.0**
Height (ft) at end of year	4.2	4.0	4.0	13.1	19.0**	17.7**	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a	0.92	1.86**	1.73**			
Net Annual Height Growth (ft)	n/a	n/a	n/a	13.0	15.1	14.0			
Net Annual DBH Growth (in)	n/a	n/a	n/a	0.88	1.85**	1.73**			
Survival (%) at end of year	100	100	100	70	100*	100*			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

The 2006 year-end measurements, approximately 4 months after planting, of this trial showed that all trees in the test were well established and on an average ~4 feet tall (Table VII.C.2.a). In the 2006/2007 winter, the lowest recorded temperature at this site was 17.9 °F (Table VII. A) and resulted in notable observed differences in the freeze tolerance and growth performance between translines and control trees. In spring 2007, the average live height of EH1 control trees was ~0.1 feet compared to ~4 feet for both translines (Table VII.C.2.a). The EH1 control trees showed an average of 98% dieback as opposed to only 5% and 7 % dieback observed for lines 427 and 435, respectively. Similarly, the crown score for the EH1 control was 0% indicating that all leaves in the canopy turned brown whereas for both translines more than 50% of the canopy retained green leaves (Figure VII.C.2.i.) These highly significant differences in live height, dieback and crown score between translines and EH1control trees were also reflected in other traits measured in the 2007 growing season except the net annual height growth. The year-end tree survival for both translines was also significantly higher compared to control trees. Although all control trees were killed to the ground level during winter, about 70 % of the EH1 control trees re-sprouted from the stem just above soil level.

A)

B)

Figure VII.C.2.i. Images of trees in trial AR162b after the 2006/2007 winter at Berkeley County, South Carolina. A) Images taken in early January 2007. B) Image taken in late March 2007 (different trees than panel A). From left to right: EH1, line 427, and line 435). All leaves on the EH1 control tree were brown and desiccated in January followed by complete defoliation in March.

Figure VII.C.2.ii. Image of trees in trial AR162b after winter of 2007/2008 at Berkeley County, South Carolina. Border row of EH1 control trees (right) and a row of translines (left). As in the winter of 2006/2007 all EH1 trees were killed to ground level.

In the winter of 2007/2008, a low temperature of 15 °F was recorded at this site. As a result, the re-sprouts of EH1 control trees were again killed to the ground level (99.2% dieback) whereas both translines showed significantly lower dieback (24% to 40%) of the main stem compared to control trees (Table VII.C.2.a. and Figure VII.C.2.ii). Both translines showed greater dieback in spring 2008 due to the lower absolute minimum temperature recorded at this site in the 2007/2008 winter. Statistically significant differences in dieback of the control and translines were also reflected in the crown score observation. The dramatic differences observed in dieback and crown score between EH1 control and both translines are clearly demonstrated in images taken in spring of 2008 (Figure VII.C.2.ii). The trial was terminated in 2008 to mitigate the risk of flowering which was not allowed under the permits issued for this trial.

Field trial AR162d was planted at this site on 7/20/2007 on ~0.2 acres. The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trial AR162d from 2007 to 2009 are summarized in Table VII.C.2.b. and Figure VII.C.2.iii. In this trial, the results for performance of transline 427 compared to control trees was remarkably consistent with trial AR162b at the same site. The performance of transline 435 while being better overall than the EH1 control was very variable in this test. The trial was terminated in the spring of 2009 to mitigate the risk of flowering.

Table VII.C.2.b. Phenotypic measurements of field trial AR162d at Berkeley County, South Carolina (planted 07/20/2007)

	2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.1	3.8**	2.8**	0.1	9.7**	1.5
Stem Dieback (%) in Spring				97	-0.2**	24**	98	20**	87
Crown Score in Spring				0.0	41.5**	33.3**	0.0	15.5**	1.0
Height (ft) at end of year	3.8	3.8	3.9	7.5	11.7*	8.7	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a	0.36	1.02**	0.64			
Net Annual Height Growth (ft)	n/a	n/a	n/a	3.6	7.9**	4.8			
Survival (%) at end of year	100	100	100	75	100*	100*			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Figure VII.C.2.iii. Image of trees in trial AR162d after 2007/2008 winter at Berkeley County, South Carolina. From left to right: EH1, line 427, line 435. Image taken in late spring 2008.

The data collected from the two trials established at this location over two winter/growing seasons again showed that both selected translines were comparable to the control trees for growth characteristics prior to a severe freeze event. The data also clearly demonstrate that translines 427 and 435 show some level of protection from freeze damage even down to 15°F. An important consideration for the Berkeley County site is that based on historical weather patterns, we considered this location to be outside the likely deployment zone for the freeze tolerant *Eucalyptus*. While the degree of dieback observed at this site in the 2007/2008 winter may not be acceptable from a commercial perspective for pulp and paper manufacturing it is possible that this level could be acceptable for other applications such as biomass for biofuels.

VII.C.3. Performance of field trials established in St. Landry Parish in Louisiana.

Saint Landry Parish in Louisiana is located within USDA Hardiness Zone 8b. After initial testing of select translines in Baldwin County in Alabama, additional tests were established at this site to further evaluate the potential zone of deployment for translines 427 and 435. A summary of the winter temperatures recorded at this site is presented in Table VII.A. Field trials in the test series AR162b, AR162d and AR162f were planted at this site under different Notifications and Permits (Appendix A and C). These field trials included trees of EH1 control and translines 427 and 435 planted in single-tree plots with 8 to 10 replications.

The field trial in the test series AR162b was planted at this site on 07/13/2006 on ~0.3 acres The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trial AR162b from 2006 to 2009 are summarized in Table VII.C.3.a.

Table VII.C.3.a. Phenotypic measurements of field trial AR162b at St. Landry Parish, Louisiana (planted 07/13/2006)

	2006			2007			2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				0.10	3.3**	3.8**	8.6	15.5**	15.7**	6.8	7.9	8.1*
Stem Dieback (%) in Spring				98	10**	7**	24	4**	5**	-4	0.4**	2**
Crown Score in Spring				1.3	63.5**	51.5**	45.5	89.0**	87.5**	91.4	91.0	89.0
Height (ft) at end of year	4.1	3.6**	4.1	11.6	16.2**	16.5**	n/a	n/a	n/a	Trial terminated		
Coppice height (ft) at end of year[1]							6.5	8.0**	8.2**			
DBH (in) at end of year	n/a	n/a	n/a	1.13	1.82**	1.84**	n/a	n/a	n/a			
Coppice DBH (in) at end of year							0.37	0.47	0.49			
Net Annual Height Growth (ft)	n/a	n/a	n/a	11.4	12.9	12.7	n/a	n/a	n/a			
Survival (%) at end of year	100	100	100	37	100**	100**	37	100**	100**			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.
A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*
Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

[1] *Trial was coppiced (cut and allowed to resprout) in summer of 2008*

The 2006 year-end measurements of this trial showed that all trees in this test were well established and on average ~4 feet tall (Table VII.C.3.a). However, the young trees of transline 427 were statistically shorter than EH1 control trees. The 2006/2007 winter at this location was severe with the lowest recorded temperature of 19 °F (Table VII.A). As expected after the severe winter, almost all EH1 control trees were killed (98% dieback) to the ground level whereas significantly lower dieback (7 to 10%) was observed for both translines. Similarly, the crown score for the EH1 control was 1.3% indicating that almost all leaves in the canopy turned brown whereas both translines retained more than 50% green leaves in the canopy. These highly significant differences in live height, dieback and crown score between translines and EH1control trees were also reflected in other traits measured in the 2007 growing season, except for the net annual height growth. The year-end tree survival for the EH1 control was significantly lower (37%) than both translines (100%). The winter of 2007/2008 at this site was milder compared to the previous winter with the minimum recorded temperature of 23 °F (Table VII.A). As a result, overall there was less winter damage in the control and both translines. Nonetheless, the dieback and crown score observations were significantly different in the EH1 control compared to both translines (Table VII.C.3.a). The trial was coppiced in summer 2008 to mitigate flowering which was not allowed under the permit for this test site. The 2008 year-end height measurements thus reflect coppiced re-sprouts of the trees. The height of the re-sprouted EH1 control trees was significantly lower compared to the translines. Year-end survival of trees in 2008 remained unchanged from 2007. At this location, the winter of 2008/2009 was even milder compared to the two previous winter seasons, with the minimum recorded temperature of just 26 °F (Table VII.A). As a result, no appreciable differences were observed in freeze tolerance between the EH1 control and the translines as indicated by the non-significant differences in crown score measurements and heights similar to the pre-winter measurements (Table VII.C.3.a). This trial was terminated in summer 2009 to mitigate the risk of flowering.

Table VII.C.3.b.Phenotypic measurements of field trial AR162d at St. Landry's Parish, Louisiana (planted 08/01/2007)

	2007			**2008**			**2009**		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				2.5	4.0**	3.7**			
Stem Dieback (%) in Spring				29	-11**	-1.0**			
Crown Score in Spring				40.8	76.0**	81.0**			
Height (ft) at end of year	3.3	3.6	3.7	9.8	15.4**	12.5	Trial terminated		
DBH (in) at end of year	n/a	n/a	n/a	1.02	2.07**	1.54			
Net Annual Height Growth (ft)	n/a	n/a	n/a	6.4	11.8**	8.9			
Survival (%) at end of year	95	100	100	75	90	70			

Dunnett's means comparison test was used to compare each transline mean with the EH1 control for all traits except survival.

A Chi-square test was used to compare frequencies of dead and alive trees for each transline and the EH1 control. Survival is shown as a percent in the table.

** and ** indicate significant difference between the transline and the EH1 control means at 95% and 99% confidence levels, respectively.*

Net Annual Growth (Height, DBH, and Volume) were each calculated as the mean of differences between successive year end values.

DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable

Table VII.C.3.c. Phenotypic measurements of field trial AR162f at St. Landry's Parish, Louisiana (planted 07/30/2008)

	2008			2009		
Characteristic	**EH1**	**427**	**435**	**EH1**	**427**	**435**
Live Height (ft) in Spring				2.8	3.2	2.7
Stem Dieback (%) in Spring				-6	-5	-5
Crown Score in Spring				81.8	87.0	88.5
Height (ft) at end of year	2.6	3.1	2.6			
Coppice height (ft) at end of year[1]				3.5	4.1	2.5
DBH (in) at end of year	n/a	n/a	n/a	n/a	n/a	n/a
Survival (%) at end of year	85	100	100	30	50	20

For all traits except survival, Dunnett's means comparison test was used to compare each transline mean with the EH1 control.
Survival data was analyzed using a Chi-square test to compare frequencies of dead and alive trees for each transline and the EH1 control.
Survival is shown as a percent in the table.
** and ** indicate significant difference between the transline and the EH1 control at 95% and 99% confidence levels, respectively.*
DBH = Diameter at Breast Height (4.5 feet); n/a - not applicable
[1] *Trial was coppiced (cut and allowed to resprout) in summer of 2009*

The comparative phenotypic characteristics of EH1 control trees and translines 427 and 435 measured for trials AR162d and AR162f from 2007 to 2009 are summarized in Tables VII.C.3.b. and VII.C.3.c. The results from these trials were essentially similar to those obtained from trial AR162b as described above except for slight variation in the year-end survival of trees.

The data collected from these three trials established at this location in USDA Hardiness Zone 8b over up to three winters and 2+ growing seasons clearly show that both selected translines are substantially equivalent to the control trees for growth characteristics prior to a severe freeze event. As expected, the data also clearly demonstrate that in mild winters minimal damage occurred to both the translines and the EH1 control trees while in more severe winters there was clear differentiation between the control and transgenic trees. Based on the data obtained from the Baldwin County site in Alabama and this location we can conclude that translines 427 and 435 are able to withstand the winters conditions that are likely to occur in the target freeze stress environment represented by the USDA Hardiness Zone 8b in the southeastern US.

VII.C.4. Performance of a field trial established in Hardin County, Texas.

Hardin County in Texas is also located within USDA Hardiness Zone 8b. After testing the performance of translines 427 and 435 in experimental tests at Baldwin County in Alabama and Saint Landry Parish in Louisiana, a demonstration field test (AR162i) was established at this site on ~20 acres. This field test was planted on 03/18/2009 and consisted of ~ 10 acres each of translines 427 and 489 (line not included in this petition). This test was designed as a demonstration plot for the performance of translines. Based on our observations at Saint Landry Parish, Louisiana and Baldwin County, Alabama where EH1 control trees were completely killed to ground level in some winters, EH1 was not planted in the test and therefore comparative phenotypic data with controls was not recorded. However, the trees were routinely observed and measured for survival and growth performance. As expected, the trees of both translines grew normally (average late fall height ~7 ft) prior to winter. During the winter of 2009/2010, a low temperature of 15°F(Table VII.A) was recorded at this site. Trees of both translines showed minor dieback of growing tips (average dieback~ 30 %) with associated leaf browning and defoliation (Figure VII.C.4.i.). All trees in the test recovered well and continued to grow normally in the summer of 2010 (Figure VII.C.4.i.) and attained an average height of ~18 ft in late fall of 2010). These observations together with data collected from the Baldwin County site in Alabama and Saint Landry Parish in Louisiana conclusively demonstrate that the selected translines are able to withstand the winters that are likely to occur in the target freeze stress environments.

Figure VII.C.4.i. Image of trees in trial AR162i after 2009/2010 winter at Hardin County, Texas. Trees of line 427 in April 2010 (left) and in August 2010 (right).

VII.C.5. Summary of field trials in a range of freeze stress environments

In addition to establishing field trials in the target freeze-stress (Baldwin County , AL) and freeze stress-free (Highlands County, FL) environments, trials were established at multiple locations in the southeastern US under a range of temperature and climatic conditions. A major objective of these trials was to assess the geographic limits in the southeastern US where translines 427 and 435 could be successfully deployed for commercial production.

Eight trials were established at three different sites (Charleston and Bamberg counties in South Carolina and Escambia County in Alabama) in USDA Hardiness Zone 8a. The data collected from these trials over two to three winter/growing seasons show that both selected translines are comparable to the control trees for growth characteristics prior to a severe freeze event. The data also clearly demonstrate that translines 427 and 435 are not able to withstand the severe winters (with temperatures falling below 15°F) that are typical in the southeastern US region represented by the USDA Hardiness Zone 8a. In this region, the translines would be expected to show severe or total dieback each winter together with an associated reduction in survival.

Two trials were established in Berkeley County South Carolina located approximately on the border of USDA Hardiness Zones 8a and 8b that represents a possible northern limit to where lines 427 and 435 might be considered for planting. The data collected from these trials over two winter/growing seasons showed that both selected translines were comparable to the control trees for growth characteristics prior to a severe freeze event. The data also clearly demonstrate that translines 427 and 435 show some level of protection from freeze damage even down to 15°F. Based on historical weather patterns, we considered this location to be outside the likely deployment zone for the freeze tolerant *Eucalyptus*. While the degree of dieback observed at this site, when the temperatures dropped down to 15°F, may not be acceptable from a commercial perspective for pulp and paper manufacturing, it is possible that this level could be acceptable for other applications such as biomass for biofuels.

Three trials were established in Saint Landry Parish, Louisiana that is located within the target stress zone represented by the USDA Hardiness Zone 8b. The data collected from these trials over up to three winters and 2+ growing seasons clearly show that both selected translines are substantially equivalent to the control trees for growth characteristics prior to a severe freeze event. As expected, the data also demonstrate that in mild winters minimal damage occurred to both the translines and the EH1 control trees while in more severe winters there was clear differentiation between the control and transgenic trees. A demonstration test established at a site in Hardin County, Texas (Hardiness Zone 8b) on ~20 acres also showed commercially acceptable performance of selected translines in the target freeze stress environment. Based on the data obtained from the tests at Baldwin County site in Alabama and Saint Landry Parish in Louisiana together with the observations from the demonstration test at Hardin County in Texas, we can conclude that translines 427 and 435 are able to withstand the winters that are likely to occur in the target freeze stress environment represented by the USDA Hardiness Zone 8b in the southeastern US.

VII.D. Summary and Conclusions from Field Performance Trials

Observation made during the first winter season on multiple translines planted in 2005 in a field trial at Baldwin County in Alabama (a target freeze-stress environment in Hardiness Zone 8b) combined with our controlled growth chamber studies allowed us to select a few candidate translines, including lines 427 and 435, for improved freeze tolerance. Performance of selected freeze tolerant lines 427 and 435 was then assessed in 21 field trials established at 8 different locations representing USDA Hardiness Zones 8a (potential kill zone), 8b (target freeze-stress zone) and 9a (freeze stress-free zone) across the southeastern US.

The data collected from the oldest trial established at Baldwin County in Alabama over five winter/growing seasons clearly show that translines 427 and 435 are generally equivalent to EH1 control trees for growth characteristics prior to a significant freeze event. The desired freeze tolerance phenotype was achieved in these translines after experiencing significant freeze events and abrupt temperature fluctuations. The results obtained from four subsequent single-tree and block plot field trials at this location over three to four winters/growing seasons are consistent with observations from the oldest trial. The cumulative multi-season data obtained from these five trials demonstrate conclusively that the freeze tolerant trait in line 427 and 435 provided good protection against temperature fluctuations typical of those expected at this location in USDA Hardiness Zone 8b.

In 2006, single-tree and block plot field trials were established at Highlands County in Florida (a representative freeze stress-free environment in USDA Hardiness Zone 9a) to assess comparative phenotypic performance of EH1 and translines 427 and 435 in a freeze stress-free environment. Data collected from the single tree and block plot trials at this site over three winter/growing seasons show that the growth performance of both translines was substantially equivalent to EH1 control trees. The results obtained from the single-tree plots at this site showed a slight reduction in growth of translines compared to non-transgenic control trees. However, the results obtained from the block plot trial showed that growth performance of both translines was not significantly different from EH1 control trees under freeze stress-free conditions.

Parallel to testing the performance of line 427 and 435 in the target freeze stress and freeze stress-free environments, field trials were established between 2006 and 2009 at multiple locations in the southeastern US under a range of temperature and climatic conditions. A major objective of these trials was to assess the geographic limits in the southeastern US where translines 427 and 435 could be successfully deployed for commercial production. Eight trials were established at three different sites (Charleston and Bamberg counties in South Carolina and Escambia County in Alabama) in USDA Hardiness Zone 8a. The data collected from these trials over two to three winter/growing seasons showed that both selected translines are comparable to the control trees for growth characteristics prior to a severe freeze event. In this region, where temperatures routinely fell below 15°F, both translines showed severe or total dieback each winter together with an associated reduction in survival. It is therefore not expected that these translines will be planted for commercial production in the Hardiness Zone 8a. Two trials were established in Berkeley County South Carolina located approximately on the border of USDA Hardiness Zones 8a and 8b that represents a possible northern limit to where lines 427 and 435 might be considered for planting. The data collected from these trials over two winter/growing seasons showed that both selected translines were comparable to the control trees for growth characteristics prior to a severe freeze event. The data also clearly demonstrate that translines 427 and 435 show some level of protection from freeze damage even down to 15°F. While the degree of dieback observed at this site in association with a minimum temperature of 15°F may not be acceptable from a commercial perspective for pulp and paper manufacturing, it is possible that this level of dieback could be acceptable for other applications such as biomass for biofuels.

Three trials were established in Saint Landry Parish, Louisiana that is located within the target freeze-stress environment represented by the USDA Hardiness Zone 8b. The data collected from these trials over up to three winters and 2+ growing seasons clearly show that both selected translines are substantially equivalent to the control trees for growth characteristics prior to a severe freeze event. As expected, the data also demonstrate that in mild winters minimal damage occurred to both the translines and the EH1 control trees while in more severe winters there was clear differentiation between the control and transgenic trees. A demonstration test established at the Hardin County site in Texas (Hardiness Zone 8b) on ~20 acres also showed commercially acceptable performance of selected translines in the target freeze-stress environment. Based on the data obtained from the tests at the Baldwin County site in Alabama and Saint Landry Parish in Louisiana together with the observations from the demonstration test at Hardin County in Texas, it is evident that translines 427 and 435 are able to withstand the winters that are likely to occur in the target freeze-stress environment represented by the USDA Hardiness Zone 8b in the southeastern US. We can therefore conclude that the selected translines 427 and 435 would be preferably planted for commercial production in USDA Hardiness Zone 8b and in the regions south of this Zone where there is an occasional risk for occurrence of a significant freeze event.

VII.E. Pest and Disease Analyses

VII.E.1. Lines 427 and 435 are unlikely to be a source of new pests or diseases

Eucalypts, in their natural environments, are known to be affected by several insect pests and diseases (Keane et. al., 2000). However, when *Eucalyptus* species and varieties are established outside of their natural habitats in managed plantations, they are relatively free of insect pests and diseases for the early part of their introduction. With the expansion of managed planted areas in a new environment, a few insect pests and diseases have spread to the area of their introduction (Gadgil et. al., 2000). In the process of introducing plant material from one region to another, it is possible that some insect pests and diseases associated with the introduced species and varieties may be transferred to the new area of its introduction. The Plant Protection and Quarantine (PPQ) measures designed to reduce and prevent the introduction of foreign pests and diseases are, therefore, considered to be the first and most important line of defense. Importation of *Eucalyptus* plants into the US is subject to post-entry quarantine as a precaution against the introduction of *Pestalotia disseminata* (also known as *Pestalotiopsis disseminata*) and Leaf Chlorosis Virus (USDA, 2007). All importations and handling of imported *Eucalyptus* plant material was in accordance with APHIS-PPQ requirements.

The plant material for control variety EH1 and the Freeze Tolerant Eucalyptus (FTE) lines 427 and 435, included in this petition, was imported into the USA as sterile tissue culture shoots or rooted plants under Import permits issued by APHIS-BRS and APHIS-PPQ. (Appendix A). The plants were inspected by the USDA at the port of entry for potential insect pests and diseases. The rooted tissue culture plants, or plants subsequently propagated from the stock material through rooted cuttings, were field tested under authorized APHIS-BRS and APHIS-PPQ permits (Appendix A and C). Field tests containing these plants have been subject to inspection by APHIS-PPQ for at least two years and these trees showed no indication of any symptoms for *Pestalotia disseminata* or Leaf Chlorosis Virus, or any other pests and diseases of significant concern. The plant material that will be used to propagate trees for commercial plantings has been verified to be free of diseases or pests and has been released from any post-entry quarantine restrictions. Since the sterile tissue culture material imported under these authorized permits was determined to be free of any insect pests and diseases at the time of arrival and has not shown any pests and diseases of significant concern during the post-entry monitoring period, it is highly unlikely that the stock material or plants propagated from this material for lines 427 and 435 would be a source for introducing any new pests and diseases of *Eucalyptus* in the United States.

After establishment of field tests of EH1 and freeze tolerant lines 427 and 435 across southeastern US, the trees were extensively monitored at regular intervals for the occurrence of insect pests and diseases. The observations for plant pest and diseases were made by trained field test personnel walking through each field trial and comparing transgenic lines with the non-transgenic EH1 control trees. A listing of the field trials conducted under APHIS-BRS acknowledged notifications and permits, together with a summary of diseases and pest observations collected from these field trials is given in Appendix C. Nearly 800 such observations were made in our transgenic field trials. These observations were made on tests where trees were planted as single tree plot or block plots on 36 different test sites and included a total of more than fourteen thousand trees of translines and non-transgenic control variety EH1. The results from these observations consistently showed that there were no differences in the occurrence of disease or insect pest susceptibility between freeze tolerant translines and non-transformed control trees of the EH1 hybrid genotype. As expected for a non-native species, for most of the observation dates, no incidence of diseases or insect pests was observed on any of the *Eucalyptus* trees. In very few instances, when observations noted symptoms of disease (such as rust) or evidence of insect damage (such as psyllids) these were not severe, were transient, and did not cause any significant injury to the trees. In all cases no differences were noted in the occurrence of these symptoms between translines and control trees. The observational data summarized in Appendix C indicate that there were no notable differences between the transgenic lines and control trees in plant morphology and susceptibility to diseases or insects. These observational data support the conclusion that the freeze tolerant lines 427 and 435 show no unexpected phenotypes with respect to disease or pest susceptibility and as such are not expected to exhibit any increased plant pest risk.

VII.E.2. Consideration of Eucalyptus pests and diseases already present in Florida

Although EH1 control and translines 427 and 435 are not likely to be a source for introduction of new insect pests and diseases of *Eucalyptus*, plantations established with these trees may serve as additional hosts for the pests and diseases that exist on *Eucalyptus* trees already currently grown in the southeastern US. A few instances of insect pests and diseases have been reported for *E. grandis* and other *Eucalyptus* species grown in Florida (Barnard et. al., 1987; Halbert et. al., 2003). Among these, the fungal pathogens *Cryphonectria cubensis, Cryphonectria gyrosa*, and *Botryosphaeria dothidea*, causing canker diseases on non-native *Eucalyptus* plantations are of some concern in the southeastern US (Brown, 2000; Old and Davison, 2000; FABI, 2002a; Wingfield et. al., 2001; FAO, 2007). These fungal pathogens have been found associated with *E. grandis* in Florida resulting in adverse effects on growth and coppice regeneration (Barnard, 1988). In addition, *Cylindrocladium scoparium* that is known to causes a range of symptoms including damping off, root rot, stem-girdling canker and leaf blight (Park et al., 2000) has been found to infect *E. grandis* seedlings grown in Florida nurseries. However, this can be effectively controlled with fungicides (Barnard, 1984).

Some other potential pests have been reported to infect *Eucalyptus* in Florida but have not caused significant economically relevant damage. These pests include guava rust (*Puccinia psidii*), redgum lerp psyllid (*Glycaspis brimblecombei*), *Eucalyptus* psyllid (*Blastopsylla occidentalis)* and bluegum chalcid (*Leptocybe invasa*). *Puccinia psidii* is believed to have originated on native Myrtaceae in South America, and is considered a significant concern for introduced *Eucalyptus* planted in that region (Burgess and Wingfield, 2002). It has also been observed in Australia as a new pathogen of concern for *Eucalyptus* (Coutinho et al., 1998). This pathogen has many hosts, all of which are within family Myrtaceae (Coutinho et al., 1998).

Puccinia psidii is a fungus that primarily attacks trees two years of age or younger, including coppice trees. It targets young leaves and shoots, and infected leaves become deformed and then shrivel. Susceptibility of *E. grandis* varies in different varieties, and *E. urophylla* is reported to be susceptible (Rayachhetry et al., 2001). To date, this pathogen has not been a major threat to *Eucalpytus* in the southeastern United States, though it has been a concern for guava plantations in these areas. Host specialization by *P. psidii* is known to occur, where isolates from one host do not infect other hosts that are known to be susceptible (Coutinho et al., 1998, Leahy, 2004). It is therefore possible that different strains of *P. psidii* are present on the guava and *Eucalyptus* in the southeastern United States. A strain of this pathogen has also been investigated as a possible biological control agent for Melaleuca, an invasive species found in Florida that belongs to the Myrtaceae family (Rayachhetry et al., 2001). Guava rust can be effectively controlled by planting resistant genotypes and the use of fungicides in nursery operations.

There are over 100 native species of psyllids in North America, most of which do not cause any notable damage to plants (Paine and Dreistadt, 2007). *Glycaspis brimblecombei*, the redgum lerp psyllid, is native to Australia. The nymphs make conical white coverings known as lerps. It has become well established in California, and was found for the first time in Florida in 2001 (Halbert et al., 2003). These psyllids feed on phloem sap, secrete honeydew, and cause premature leaf drop. This defoliation can cause increased susceptibility to insect damage. Healthy trees are less likely to show damage. In one study, only 3 of 21 species tested were found to be susceptible to *G. brimblecombei* (Brennan et al., 2001). *E. grandis* was found to be resistant in this study, though it was reported to be of intermediate resistance in a later study (Paine et al, 2006). For control, either systemic insecticides such as Imicide or Merit or biological control with an introduced wasp species are recommended (Paine et al, 2006). Topical treatments are less effective because the lerp protects the psyllids. Although psyllids were observed in 2007 (Appendix C) on some of the trees at the field site in Highlands County, FL, it is unlikely that these were the redgum lerp psyllid because there were no signs of lerp formation. At the observation date and site that the psyllids were observed, no damage was seen on the trees on this or subsequent observations and the psyllids did not return after treatment with an insecticide.

Blastopsylla occidentalis, the *Eucalyptus* psyllid, is also native to Australia and was found for the first time in Florida at a tourist park in 2001 (Halbert et al., 2003). This pest has been reported on *E. grandis* and *E. grandis x urophylla* in South America. The nymphs of this psyllid do not make lerps but they do secrete wax (Halbert et al., 2003). There are no reports of any significant damage to *Eucalyptus* in Florida by *B. occidentalis*. An exotic psyllid species (*Boreioglycaspis melaleucae*) was deliberately introduced by USDA in Florida in 2002 as a biological control agent for Melaleuca, an invasive tree species in the Myrtaceae family (same family as *Eucalyptus*). This psyllid has been reported to be very specific to Melaleuca, and does not damage related species including *E. grandis* (Wineriter et al., 2003). The insects have established in large populations at the release sites, with estimated numbers of multiple millions per acre (Buckingham, 2006) Over 1 million individuals have been redistributed to nearly 100 locations in South Florida since 2002, and they have also been discovered as far south as Puerto Rico (Pratt et al., 2006). It is possible that some of these psyllids might be present at low levels on the FTE trees, but research indicates that they would not cause damage.

Leptocybe invasa, the blue gum chalcid native to Australia, was first found in Florida in 2008, and to date has been documented in Broward, Dade, Hendry, Glades, Lee, and Palm Beach counties (Wiley and Skelley, 2008; Halbert, 2009a,b). Damage from this small wasp occurs through formation of galls on petioles, leaf midribs, and stems of new foliage. Galling causes leaves to curl and may stunt growth and weaken trees. The exact species of *Eucalyptus* that is infected in Florida has not been determined yet (Wiley and Skelley, 2008). *L. invasa* was tested on seedlings of 36 *Eucalyptus* species, 10 of which were found to be suitable hosts, including *E. grandis* (Mendel et al., 2004). *L. invasa* in its native Australia is kept in check by natural enemies that keep levels below detection. The adult wasps of this species are very small and likely are unable to fly for long distances, so it is believed that *L. invasa* spreads through distribution of contaminated nursery stock (FABI, 2007). There is no known chemical control for this pest but two insect parasitoids (*Quadrastichus mendeli* and *Selitrichodes kryceri*) are being evaluated as potential biological control agents (Kim et al., 2008). In cooperation with APHIS-PPQ and Florida Sate Pest control representatives, we are currently conducting surveys for detection and mitigation of this pest in our field trials.

As expected for any managed tree plantations, the plantations established with lines 427 and 435 will be monitored by the owners on a regular basis for occurrence of any pests and diseases. Regular inspections and application of best silvicultural practices as described in Appendix G for management of *Eucalyptus* plantations established with freeze tolerant lines 427 and 435 will play a role in minimizing spread of existing pests and diseases in Florida.

VII.E.3. Consideration of Eucalyptus pests and diseases in southeastern US outside of Florida

Other species within the family Myrtaceae are present in the southeastern United States and could act as a source or sink of *Eucalyptus* pests and diseases. Crapemyrtle is in the same order (Myrtales) as *Eucalyptus* but would not be expected to share common pests with *Eucalyptus* species. The most significant members of the Myrtaceae family that may be present in the southeastern US outside Florida are bottlebrush (*Callistemon* spp.), wax jambu (*Syzygium samarangense*), and Melaleuca. It is possible that pests present on these species could, under certain circumstances, also affect *Eucalyptus*. Conversely, pests affecting *Eucalyptus* could become pests of other nearby members of Myrtaceae under certain circumstances. Although these species related to *Eucalyptus* may be found in the region, they are not grown as commercial crops. As far as we are aware, there are no particular insect pests and diseases that are described as significant threat to these species. It is therefore highly unlikely that scattered or ornamental plantings of these species would serve as a source of insect pests and diseases for *Eucalyptus* plantations in the southeast or vice-versa.

Two closely related species of longhorned borer beetles (*Phoracantha semipunctata* and *Phoracantha recurva)*, which are native to Australia, have been found to attack *Eucalyptus* trees in California (Paine et al, 1995). *Eucalyptus grandis* is reported to be a susceptible host but these pests have not been reported outside of California (Lawson, 2006; Paine et al 2009). The borers mostly attack drought stressed trees and vigorously growing and well-managed trees are rarely the target for these pests. The tree damage occurs due to larvae feeding at the bark-cambium-xylem interface, which can functionally girdle the tree. Pesticides are reported to be ineffective but biological control combined with management of trees in vigorous active growth and planting of resistant varieties or species are proposed as effective control measures (Paine et al., 1995, 2009).

An additional pest of *Eucalyptus* in some regions of the United States is *Atta texana*, the Texas leafcutting ant. These ants harvest leaves and buds from many plant species, including ornamentals, fruit and nut trees, and commercially planted pine. The harvested plant material is taken to the colonies where it is used to raise a fungus that the ants eat (Drees and Jackman, 1999). This pest is present only on well-drained sites in southeastern Texas and western Louisiana. To date, they have been observed in the vicinity of one freeze tolerant *Eucalyptus* test planted in Texas, however they were not present within the test area, and no damage was observed on the test trees. Where they are present, control of these ants is a standard element of all forestry programs, including pine and *Eucalyptus*, and involves application of Amdro® or similar pesticides.

It is difficult to assess the potential risk of pests and diseases that are either not present in the region or are present but do not cause significant damage. It is expected that routine management of *Eucalyptus* plantations would identify any changes in pest or disease prevalence should this occur. There is no evidence based on the extensive experience of introducing *Eucalyptus* into other countries (including examples where millions of acres of *Eucalyptus* have been grown over many decades) that diseases and pests of *Eucalyptus* have resulted in any concerns of damage to native species or crops other than the *Eucalyptus* themselves.

VII.E.4. Dieback and potential impacts on occurrence of pests and diseases

Dieback and death of trees in *Eucalyptus* forests and managed plantations can be a consequence of a variety of environmental events including fire, temperature extremes, drought, severe storms, unsuitable soil conditions and other abiotic factors (Keane et al., 2000). The dieback or decay of trees may also result from attack by an insect pest or disease. Most often, the dieback caused by factors other than diseases or pests is not found associated with increased incidence of insect pests and diseases unless the dead and decaying wood is exposed over a long enough time to attract secondary infections. Our field observations of both young and older trees across a large number of sites, where minor or severe dieback occurred as a result of freeze damage, confirm that there has been no incidence of increased risk of pests and diseases. Where freezing temperatures caused complete dieback of control EH1 trees within the test but only minor damage to the translines, the dead trees might hypothetically act as a substrate for pests and diseases that then attack the otherwise healthy translines. However, no evidence for increased pests on healthy trees due to the close proximity of multiple dead trees was observed. Standing dead trees (snags), fallen trees and broken branches, often referred to as coarse woody debris, are all normal features of natural forests and can provide important habitat for wildlife. In a managed forest plantation setting where trees are harvested well before the age at which natural senescence occurs, levels of coarse woody debris are typically less than that of native forests but are not absent. In contrast, harvesting operations can leave large amounts of woody debris (cut tree tops and limbs) on site post-harvest. Therefore, there can be significant amounts of dead or decaying wood as part of the existing cycle of tree planting and harvesting. Notably, there is growing interest in using this woody residue material in bioenergy applications.

We expect no or minor dieback on trees of both translines when exposed to typical winter conditions in the deployment zone. However, it is reasonably foreseeable that occasional extreme winter weather events could result in significant damage to freeze tolerant *Eucalyptus* lines. Given the expectation that freeze tolerant *Eucalyptus* will be grown in highly managed plantations, it is likely that one or more of the following actions will be undertaken in the event of an occasional severe winter kill. For small trees less than a few years old, if overall survival is less than acceptable to the landowner the trees would likely be plowed under and the site replanted with *Eucalyptus*, other tree species, or another crop. If overall survival and resprouting from the base occurs at an acceptable frequency the landowner may elect to maintain the planting or destroy the resprouts and replant. In each of these cases on-site debris is expected to be limited in amount and transient. Older trees are likely to be cut and the harvested wood utilized, thereby removing much of the woody material from the site. Depending on the size of the tees these may be used in pulp and paper manufacture or for bioenergy applications. Based on results from our field trials, it is expected that there would be a high frequency of resprouting from the base of such trees. As such, it is highly likely that the landowner would elect to allow the trees to re-grow as coppiced sprouts. Should the landowner choose to switch to another crop, resprouts can be effectively controlled using herbicides. Such management decisions are already well founded in existing forestry operations in the US. For example hurricane damaged trees are handled in much the same way: sites with young trees being likely to be replanted and older trees harvested wherever possible for use in commercial applications.

Therefore, dieback in freeze tolerant *Eucalyptus* following occasional extreme winters will be transient and is not expected to have any significant impact on the prevalence of pests or diseases over what typically occurs in managed forests or native forestlands in the southeastern US.

VII.E.5. Pest and disease considerations in relation to planting of non-transgenic Eucalyptus

There is a long history of programs that have sought to introduce *Eucalyptus* as a forest tree species in the US south, but freeze tolerance has remained the dominant limiting factor. Recent successes with more freeze tolerant germplasm and species, together with potential new management options and applications in bioenergy, have lead to renewed interest in planting *Eucalyptus* (see for example http://www.istf-bethesda.org/Meetings-Courses/FNC_Eucalyptus_Oct_8_2009.pdf and http://www.treepower.org/papers/strickerny.doc). If programs to develop *Eucalyptus* for the Southeast are successful, significant expansion of where eucalypts may be grown across the southeastern US is likely, with plantings over and above the estimated 8000 hectares currently grown in central and southern Florida. The above discussion of potential pests and diseases of *Eucalyptus* is also relevant to the introduction of non-transgenic varieties. Similarly, it is expected that these plantings would be subject to the same occasional periodic severe winter kill that could occur in the transgenic freeze tolerant *Eucalyptus* lines. As described above, in these instances, management practices would likely be implemented which would limit the occurrence of dead wood on site and so this would represent an insignificant incremental change from the natural dynamics of tree growth and death in surrounding native forests and existing plantations. Therefore, pest and diseases associated with freeze tolerant *Eucalyptus* lines 427 and 435 are not expected to have any negative impacts relative to other plantings of *Eucalyptus* that currently exist or are reasonably foreseeable in the future.

VII.E.6. Summary and conclusions for pest and disease analyses

Eucalyptus species and varieties, established outside of their natural habitats in managed plantations, are typically free of insect pests and diseases during the early part of their introduction. With the expansion of managed planted areas in a new geography, there is increased potential for some insect pests and diseases to become established in the area of introduction. In this respect, the Plant Protection and Quarantine (PPQ) measures are a critical component in preventing or reducing the introduction of foreign pests and diseases. The plant material for control variety EH1 and the freeze tolerant lines 427 and 435 included in this petition, was imported into the USA as sterile tissue culture shoots or rooted plants under import permits issued by APHIS-BRS and was free of any insect pests and diseases at the time of arrival. Plants were established in field testing under authorized APHIS-BRS and APHIS-PPQ permits and have been monitored for the occurrence of pests and diseases for at least two years at all locations and have not shown any pests and diseases of significant concern during this time. Therefore, it is highly unlikely that the stock material and plants propagated from this material for lines 427 and 435 could be a source for introducing any new pests and diseases of *Eucalyptus*. Field tests of EH1 and freeze tolerant lines 427 and 435 established at multiple sites across the US south were monitored at regular intervals for the occurrence of insect pests and diseases. These observational data support the conclusion that the freeze tolerant lines 427 and 435 show no unexpected changes in respect to susceptibility to pests or disease. A detailed review of potential insect pests and diseases that may infect managed plantations of *Eucalyptus* in the southeastern US was performed. Since the translines will be established in intensively managed plantations, regular inspections and application of best silvicultural practices for management of *Eucalyptus* plantations can effectively minimize the prevalence and spread of pests and diseases, should these occur. As such, freeze tolerant *Eucalyptus* lines 427 and 435 are not expected to exhibit increased plant pest risk. Pests and diseases that can occur on *Eucalyptus* are not known to cause economic losses to other important crops in the Southeastern United States.

VII.F. Pollen Ablation Analyses

Plasmid pABCTE01, used in the development of freeze tolerant *Eucalyptus* lines 427 and 435, contains the modified pollen ablation cassette found in plasmid pAGF243. pAGF243 and another plasmid, pWVR220, have similar pollen control expression cassettes, however, pAGF243 carries a modified PrMC2 promoter (mPrMC2) which is 36 nucleotides shorter than the promoter in pWVR220. These two related pollen ablation cassettes were extensively evaluated in tobacco, two species of *Eucalyptus* (*E. occidentalis* and the hybrid *E. grandis* x *urophylla*), pitch x loblolly hybrid pine and loblolly pine (see Appendix D). Both cassettes were shown to effectively ablate pollen in these plant species. These pollen ablation cassettes do not appear to be influenced by other flanking genes and were functionally stable in transgenic plants over multiple years, different flowering seasons, different sites, and different physiological ages of plants (Appendix D).

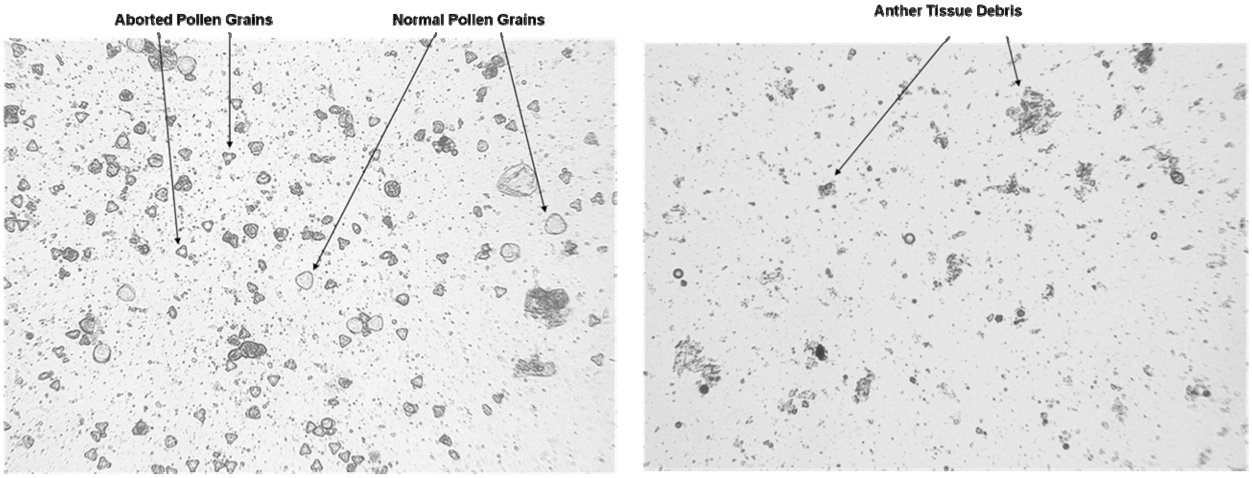
A field trial (AR162a) of freeze tolerant *Eucalyptus* containing pABCTE01 located in Baldwin County, Alabama was allowed to flower in 2007 under BRS permit 06-325-111r. Mature but unopened flowers were collected in September of 2007 from ~ 2year-old trees in this test. Only mature unopened flowers were analyzed in order to eliminate any ambiguity in pollen observations that could result from pollen transfer from other nearby opened flowers. Twelve transgenic lines, including lines 427 and 435, and untransformed controls trees were sampled from eight blocks in this trial (8 trees per line). The sampling scheme was designed to get a good representation of flowers from different parts of the tree. Each tree was divided into four quadrants (East, South, West, and North) and for each quadrant 5 selected floral inflorescences (flower clusters) were removed and placed into a 50 ml Falcon tube. In many cases the floral inflorescences, which contain 5-7 individual flowers, had some flowers that were already open, suggesting that the other unopened flowers on the same inflorescence were also very close to maturity. The floral samples were transported on ice back to our laboratories in Berkeley County, South Carolina.

In the laboratory eight samples were analyzed for each tree: 4 pooled samples and 4 individual flower samples. For a pooled sample, a total of 10 unopened floral buds were selected from the 4 quadrants (2 or 3 buds from each quadrant). Flowers were dissected and stamens were collected from the 10 buds then crushed in 500 µl of water in a microcentrifuge tube with a plastic pestle. One drop (~ 5 µl) of the liquid from each microcentrifuge tube was placed on a glass slide and the entire slide was examined under a compound microscope. For individual flower samples, the stamens were collected and crushed in ~80 µl of water in a microcentrifuge tube with a plastic pestle and examined under the microscope. For each transline therefore, a total of 64 separate samples were analyzed (8 individual trees with 8 samples per tree).

A similar procedure was used to collect and analyze flower samples from ~ 4 year-old transgenic and control trees in September 2010 from a field trial (AR162b) in Highlands County, Florida. The trial was allowed to flower under BRS permit 08-151-101r. A smaller, but representative, number of trees were sampled from this trial because of limited availability of flowers from these 60-70 feet tall trees.

Table VII.F.1. Results of microscopic pollen ablation analyses of flowers collected from translines and untransformed control trees from two different field trials.

Location (County/State)	**Trial ID**	**Planting date**	**Flower collection period**	**Tree age at flower collection**	**Transline ID**	**Number of trees sampled**	**Pollen production**
Baldwin/Alabama	AR162a	11/8/2005	September 2007	~2 years	**EH1**	**8**	**Yes**
					427	**8**	**No**
					435	**8**	**No**
					447	8	No
					456	8	No
					470	8	No
					489	8	No
					490	8	No
					493	8	No
					494	8	No
					495	8	No
					517	8	No
					434	8	No
Highlands/Florida	AR162b	7/18/2006	September 2010	~4 years	**EH1**	**3**	**Yes**
					427	**4**	**No**
					435	**2**	**No**



EH1 Control

Transline 427

Figure VII.F.1. Microscopic images of dissected flowers from a transline and an untransformed control tree (X200). Pollen was found in the flowers from untransformed EH1control (left) while no pollen was found in flowers from transgenic line 427 (right).

The results of pollen ablation analyses from these two field trials are presented in Table VII.F.1 and Figure VII.F.1. In flowers from untransformed control trees, a large amount of normal triangular-shaped pollen grains were observed in both pooled samples and individual flower samples. The observed pollen grains could be divided into two groups based on their size, large pollen and small pollen (Figure VII.F.1). Microscopic observation did not find pollen in any of the 4092 flowers examined from the 12 transgenic lines in the field trial AR162a (Table VII.F.1 Figure VII.F.1). In this trial, for each of the two selected freeze tolerant lines (427 and 435) ~350 flowers from 8 different ramets of ~2 year-old trees were analyzed. Microscopic observations of individual flowers and pooled samples confirmed that no pollen was produced in either transline. Similar results were obtained from translines and control trees analyzed from ~4 year-old trees in trial AR162b (Table VII.F.1). These results confirm that the pollen ablation cassette used in translines 427 and 435 is functionally stable in both lines over multiple years, different flowering seasons, different sites, and different physiological ages of plants.

VII.G. Seed Germination Analyses

VII.G.1. 2008 seed germination studies

In genus *Eucalyptus,* cross-pollination is the preferred method of mating although self-pollination is known to occur in some species. However, self-pollination generally results in reduced seed production, lower seed yield, decreased seed germination and poor seedling vigor in comparison to cross-pollination (see section II). In controlled self-pollination experiments, hybrid *Eucalyptus grandis* x *urophylla* variety EH1 flowers pollinated with EH1 pollen failed to produce any viable seed (ArborGen, unpublished results). The objective of this study described below was to assess the production of any viable seed in translines and EH1 control trees in the absence of any other suitable pollen donor under field conditions in the southeastern US.

Material and Methods
A field trial (AR162a) with multiple translines, including line 427 and 435, and EH1 control trees was established in Baldwin County, Alabama in November 2005. The trial was allowed to flower in 2007 under BRS Permit # 06-325-111r. Flower initiation was observed in this trial early in June 2007, approximately twenty months after planting. Large numbers of developing flowers were observed with

no discernable difference between translines or EH1 in quantity of flowers. In September 2007, numerous mature open flowers were present on all trees. It was anticipated that normal levels of pollen would be produced and released in the trial from the fully fertile flowers on the EH1 controls. Soon thereafter the formation of seed capsules was observed. As is typical of *Eucalyptus,* the seed capsules developed over several months turning from green to brown in late December/early January. At this time prominent radial splits in the cap of the capsules was observed indicating capsule maturity.

Seed capsules were collected in January 2008 from the upper canopies (~25 - 30 feet above ground level) of a select translines together with the EH1 non-transformed control. Duplicate samples were taken consisting of individual capsules from at least two positions within each tree. For each transline and EH1 control, two replicate blocks were sampled. Samples were placed in a pre-labeled sealed plastic bag and transported to our laboratories in Berkeley County, South Carolina under an acknowledged BRS interstate movement Notification. Upon receipt, the contents of each bag were transferred into pre-labeled paper bags for drying. Samples were then placed into a drying oven at 100 °F and dried for 48 hours.

Approximately 100 to 185 seed capsules were processed for each sample. Opened seed capsules were shaken to release their contents and the material obtained was passed through a series of sieves to separate large debris from any possible seed. The sieved sample of roughly 0.8 to 1.25 ml was then placed in a pre-labeled envelope for storage at 4°C. A subsample of ~0.1 ml was then taken of each sample, dispersed into a sterile Petri dish and observed under a dissecting microscope to count any viable and non-viable seeds. Non-viable seed can be generally distinguished from viable seeds based on their smaller size and irregular shape. A second ~0.1 ml sample was also taken and used in a controlled germination test to confirm if any viable seed was present. Samples were distributed onto moist filter paper in pre-labeled Petri dishes and incubated in a controlled environment chamber under light at 20°C. Open pollinated EH1 seed (0.1 ml) obtained from Brazil was also used as a control for these studies. The seed germination test was performed to verify the visual observation under the microscope for presence of any viable seeds. Seven days after incubation, the Petri plates were examined and the number of germinating seedlings was counted.

Results and conclusions

The results of 2008 seed germination studies (Table VII.G.1.1) show that a large number of viable seeds and germinating seedlings were observed in the open pollinated seeds of EH1 control samples obtained from Brazil. However, no viable seed or germinating seedlings were detected in any of the capsule samples for EH1 control and translines obtained from the field trial. The lack of viable seed production in both EH1 control trees and translines in this study was consistent with the earlier experiment where EH1 flowers were control pollinated with EH1 pollen and failed to produce any seed. This suggests that the lack of viable seed in these field samples resulted from ineffective self-pollination from the fertile EH1 control trees in the absence of any other suitable pollen donor. Alternatively, developing immature seeds may have been destroyed by the severe winter temperatures experienced at this site. Nonetheless, the lack of viable seed production or very low amount, if any, of seed production in translines resulting from possible self-pollination in this trial indicated that any potential for dispersal or spread of the translines via seed in the regions where these are expected to be grown will be effectively minimized.

Table VII.G.1.1. Results of 2008 seed germination studies for samples obtained from the field trial AR162a in Baldwin County, Alabama

Line ID	Block	Number of seed capsules processed /block	Sample size tested for germination (ml)	Viable seeds observed under the microscope	Germinating seeds observed
EH1	1	158	0.1	0	No
	5	115	0.1	0	No
427	1	121	0.1	0	No
	5	96	0.1	0	No
435	1	121	0.1	0	No
	5	96	0.1	0	No
EH1 control seeds from Brazil	Sample 1	NA	0.1	99	Yes
	Sample 2	NA	0.1	178	Yes
	Sample 3	NA	0.1	91	Yes

VII.G.2. 2009 seed germination studies

Material and Methods

Mature seed capsules were collected prior to opening in early March 2009. Capsules were collected from 49 select trees in three trials in Baldwin County, Alabama, (AR162a, AR162b, and AR202) and 12 trees from trial AR162b in Highlands County, Florida. Typically, up to four replicate samples were collected representing four separate ramets for each select line (see Table VII.G.2.1 for details). Twelve to 15 flower clusters or approximately 70 to 100 capsules were collected from different positions in the crown where possible (e.g. where more than one branch produced capsules). EH1 controls were extensively damaged by cold at the Alabama site and capsules from control trees were only available from trial AR202 at that site. EH1 controls showed no damage at the Florida site and had numerous capsules available for sampling. The capsules were placed in plastic bags which were sealed and transported back to our facilities in Berkeley County, South Carolina under an acknowledged BRS interstate movement Notification. The capsules were placed in closed paper bags in an empty greenhouse for drying. After ~1 week the contents of the capsules were extracted and placed back in plastic bags that were then sealed. The contents were then stored at 4°C.

Table VII.G.2.1 Results of 2009 seed germination studies for samples obtained from the field trials in Alabama and Florida.

BRS Permit Number	County, State	Trial ID	Line ID	Number of Samples Analyzed	Number of Sample with Germinants	Estimated Total Number of Capsules Analyzed	Estimated Germinants /g of Sample	Total Sample Weight per line (g)	Total Number of Estimated Germinants/ line	Estimated Germinants/ Capsule
06-325-111r	Baldwin, Alabama	AR162a	427	4	0	400	0.0	3.41	0	0.00
			435	4	0	400	0.0	4.30	0	0.00
			489	4	0	400	0.0	3.10	0	0.00
		AR162b	427	4	0	400	0.0	3.90	0	0.00
			435	4	0	400	0.0	3.50	0	0.00
		AR202	EH1	2	0	200	0.0	4.50	0	0.00
			427	4	0	400	0.0	2.70	0	0.00
			434	4	0	400	0.0	3.90	0	0.00
			489	1	0	100	0.0	0.20	0	0.00
			682	3	0	300	0.0	0.80	0	0.00
			755	3	1	300	10.0	3.20	32	0.11
			780	4	1	400	12.5	3.80	47	0.12
			810	4	0	400	0.0	4.20	0	0.00
			846	4	0	400	0.0	3.80	0	0.00
08-151-101r	Highlands, Florida	AR162b	EH1	4	4	400	45.0	7.80	351	0.88
			427	4	4	400	50.0	4.10	205	0.51
			435	4	2	400	10.0	5.80	58	0.15
			EH1 (OP)							25[a]

[a] Estimate obtained from experienced Eucalyptus breeders in Brazil.

A controlled germination test was initiated on June 9, 2009. One-eighth of a teaspoon or approximately 0.1 g of the extracted contents of each sample was spread on moist filter paper in a labeled standard Petri dish. The dishes were placed in an incubator at 28°C with no light. After three days, initial germinants were observed. Open pollinated seed of EH1 obtained from Brazil were germinated as control for comparison.

Results and conclusions

At the Baldwin County, Alabama location, only two samples (~4%) of two different translines collected from field trail AR202 showed any germinants in controlled germination tests (Table VII.G.2.1) out of 49 samples collected and analyzed. However, samples from other ramets of these same two lines showed no germinants. Samples from EH1 controls and other translines, including line 427 and 435, collected from all three trials (AR162a, AR162b, and AR202) at this site did not produce any germinants. As described above, in 2008, we did not observe any germinants in samples collected from field trial AR162a at this site which is consistent with the 2009 results. In Highlands County, Florida, ten samples of the 12 samples collected (83%) showed the presence of germinants, including all four ramets of EH1 control tested (Table VII.G.2.1).

In order to obtain an estimate of the number of germinants per capsule, we first estimated the total number of germinants in the whole sample for each line. This was obtained by multiplying the number of germinants estimated for 1.0 g of sample by the overall sample weight, which varied among lines (see Table VII.G.2.1). As noted above, the number of capsules was estimated to be ~ 70 to 100 for each sample. We therefore estimated the number of germinants per capsule by dividing the total number of germinants obtained for each line by total number of estimated capsules analyzed. These estimates ranged from a low of ~0.1 germinant per capsule to a high of ~0.9 germinants per capsule. Interestingly, the EH1 samples from Florida gave the highest (0.9) estimated number of germinants per capsule whereas all translines were estimated to produce from 0.1 to 0.5 germinants/capsule.

Based on the results of a controlled self-pollination study of EH1 performed by our collaborators in Brazil, together with the germination tests we conducted on samples collected from our field trial (AR162a) in Baldwin County, Alabama in spring/summer 2008, we anticipated that very low or no viable seed would be produced in these field trials as a result of self-pollination. Results we obtained for repeat samples from AR162a at the Baldwin County, Alabama site in the current germination tests are consistent with our earlier observations from this same test. Information obtained from our collaborators in Brazil suggests that open pollinated capsules from EH1 and other varieties of hybrid *Eucalyptus* can be expected to produce up to 25 viable seed per capsule. Therefore, even the highest (0.9) estimated germinants per capsule for the EH1 controls in Florida, at ~3.6% of the expected yield of open-pollinated capsules, is considerably less than what might be expected for open pollinated trees. The very low number of seeds produced per capsule in translines and EH1 control trees is consistent with the hypothesis that these germinants likely resulted from self-fertilization with pollen from the fully fertile EH1 control trees.

The controlled germination tests represent almost ideal conditions (controlled temperature, high moisture, lack of competing vegetation) for germination. Data collected from these controlled germination studies indicate that a low level of self-pollination in EH1 can occur and produce seed that are able to germinate. However, the number of germinants produced in translines and EH1 control trees is considerably less than what would be expected for an open-pollinating mixed stand of *Eucalyptus*. It is therefore highly likely that such a very low level of seed production combined with the expected very poor survival of seedlings in the absence of ideal germination conditions would severely minimize or eliminate the occurrence of any seeded volunteer plants from the translines under field conditions.

VII.G.3. 2010 seed germination studies

The seed germination studies were continued in 2010. The plan was to collect samples from both sites, Baldwin and Highlands Counties, again but a severe cold event in January 2010 caused all the seed capsules on the trees at the Baldwin County site to abort. Therefore, capsules were collected from the Highlands County site only.

Material and Methods

Capsule collection procedures were similar to those used in 2009, except samples were collected from the 25-tree block plots as well as the single-tree plots for both translines (427 and 435) and the control EH1trees. For each line and EH1 control trees a total of eight samples, four each from block plot and single tree plot trials, were collected. For block plots, one sample was collected from the center ramet in each of the four 25-tree block plot replicates and for single-tree plots four individual ramets were sampled. A total of 24 samples were collected for the study (Table VII.3.1). The capsules were collected in late February and the germination test was initiated on March 10, 2010. The extraction and germination procedures were the same as those used in 2009.

Table VII.G.3.1 Results of 2010 seed germination studies for samples obtained from the field trial in Florida.

BRS Permit Number	County, State	Trial ID	Test Design	Line ID	Number of Samples Analyzed	Number of Sample with Germinants	Estimated Total Number of Capsules Analyzed	Estimated Germinants /g of Sample	Total Sample Weight per line (g)	Total Number of Estimated Germinants/ line	Estimated Germinants/ Capsule
08-151-101r	Highlands, Florida	AR162b	Single Tree Plot	EH1	4	3	1,000	17.5	21.90	383	0.38
				427	4	0	488	0.0	8.50	0	0.00
				435	4	2	725	15.0	13.70	206	0.28
		AR162b	Block Plot	EH1	4	3	827	7.5	17.60	132	0.16
				427	4	2	704	5.0	13.30	67	0.10
				435	4	0	671	0.0	13.70	0	0.00
				EH1(OP)							25[a]

[a] Estimate obtained from experienced Eucalyptus breeders in Brazil.

Results and conclusions

Of 24 samples collected in 2010 from trees in the field trial in Highlands County, Florida, ten samples (42%) showed the presence of germinants (Table VII.G.3.1) which is much lower than what we observed (83%) in 2009. It was anticipated that the translines intermingled with the control trees in the single-tree plots would result in a higher frequency of seed set than in the block plots. In both single-tree plot and block plot trials, for the EH1 control 3 out of 4 ramets produced germinants. No viable germinants were observed for line 427 in samples collected from the single tree plot whereas 2 out of 4 samples produced germinants for line 435. The opposite was observed for these lines in samples collected for from block plots (Table VII.G.3.1). Despite the variability observed for the germinants in translines, the average estimated seed set per capsule was higher for control and translines in single tree plot samples (0.38 and 0.28 for EH1 and line 435, respectively) compared to block plot samples (0.10 and 0.16) suggesting that close proximity to the pollen source may results in higher rate of viable seed production. Overall, for those lines where germinants were produced, the estimates ranged from a low of ~0.1 germinant per capsule to a high of ~0.4 germinants per capsule. As in 2009, the EH1 samples again gave the highest (~0.4) estimated number of germinants per capsule whereas for both translines the number ranged from

0.1 to 0.3 germinants/capsule. The estimated total number of viable seed in the 24 samples collected from this study was 788 which is a small fraction (0.7%) of ~110,000 viable seeds expected from a similar sample collected from an open pollinated mixed stand of EH1 control. The production of very low number of seeds (less than one seed) per capsule in translines and EH1 control trees in 2010 is consistent with our 2009 results from this site and further confirms that these germinants likely resulted from self-fertilization with pollen from the fully fertile EH1 control trees.

VII.G.4. Seed germination under competitive conditions

The successful establishment of seedlings from a given seed source depends on multiple factors including seed production, maturation, dormancy, dispersal, and deposition. Germination and seedling establishment is heavily influenced by water availability, soil physical and chemical properties, and temperature during this sensitive process. For seeds with no dormancy requirements, immediate site specific factors will restrain or promote the level of success for each seed to establish and develop into a plant. On site competition from other plants, either as other emerging seedlings or from existing plant populations can similarly affect the establishment and subsequent survival of newly germinating seed.

It is well recognized that *Eucalyptus* species are generally adapted to fire-based ecosystems (see section VIII). Seedling germination and survival following local fire events are enhanced due to an increase in soil fertility, ash or mineral soil seedbeds, and the lack of other plant competition. This phenomenon is supported by observations of *Eucalyptus* grown in Florida, where over many decades the only notable examples of establishment of plants from seed have occurred following a fire or comparable conditions (Rockwood, Per. Com.; also see section III). Given the very low amount of viable seed produced in field trials of transgenic lines derived from EH1, it was not practical to test seed of these translines directly. Therefore, the greenhouse germination studies under different simulated environmental stress and competitive conditions were conducted using the open pollinated EH1 seed obtained from Brazil. The objective of this study was to understand the effect of environmental stress factors such as soil conditions, water availability and pre-existing vegetation cover that are likely to limit successful seedling establishment outside of a managed plantation.

Material and Methods

An open pollinated seed lot of *Eucalyptus* hybrid EH1 was obtained from our collaborator in Brazil. The germination has been shown to be high with this seed lot in controlled germination tests using Petri plates with moist filter paper (TableVII.G.1.1).

A supply of fine sandy loam soil was steam sterilized and used in this study. Plastic flats (2 1/4"deep x 7"long x 5" wide") were filled to ~80% of their capacity with the sterilized soil.

Two factors, water availability and competing vegetation, were manipulated to impart different types and levels of stress (Table VII.G.4.1). These were designed to mimic possible natural circumstances to which seed could be exposed: bare soil; existing actively growing competing vegetation (at two densities); or existing but not actively growing (herbicide killed) vegetation, all combined with either ample or minimal water availability.

Plant competition and ground cover challenges were established by sowing EH1 seeds into flats with a pre-existing, pre-established and actively growing stand of grasses and broadleaf plants (*Poa pratensis, Poa annua*, soy, maize, and Morning Glory). An additional treatment included introducing seed into flats containing soil supporting the debris of a grass and broadleaf stand sprayed 10 days previously with glyphosate. At the initiation of the study (sowing of EH1 seed), symptoms of glyphosate damage to the previous vegetation were pronounced with complete plant mortality and above ground plant desiccation.

Prior to the introduction of the EH1 seed, half of the flats with the competition canopy (both living and dead) were hand-thinned to ~50% of the original density to investigate whether the density of standing vegetation could be a factor in precluding seed /soil contact thereby limiting seedling establishment.

To understand how critical available water is to germination and seedling establishment of EH1, two watering regimes were established with one set receiving ample water (every other day) during the course of the study and a second set with limited watering thereby imposing periods of time with limited water availability. In this second set, following the initial application of seed, water was withheld until living plants (in the competing vegetation treatment) showed visible signs of wilting.

One tenth of a milliliter (0.1 ml) of seed was measured and dispensed to each treatment. For the bare soil treatments seed were either simply dropped onto the surface mimicking natural seed fall, or planted, by dropping and then covered with a thin layer of soil, representing idealized optimal conditions. For all other treatments seed were dropped onto the surface of the existing vegetation. All flats were generously watered directly after introduction of seed. The study design was a completely random design with three replicate flats used for each regime. The entire study was repeated about 1 month later. As a control treatment for germination 0.1 ml of seed were dropped onto moist filter paper in Petri dishes (three replicates) which were then sealed to prevent moisture loss. Dishes were incubated in a controlled environmental chamber under light and constant temperature (20-21 °C).

After study initiation, observations on seedling emergence were made 10, 14, 21, and 26 days after planting. Seedling counts were recorded on each observations date after which emerged seedlings were removed by cutting the stems at the soil line and discarded.

Table VII.G.4.1. Effect of environmental stress factors and competitive vegetation cover on germination of open pollinated seed of EH1 control.

Description of Treatment	Experiment 1			Experiment 2		
	Average Number of Germinating Seedlings	Tukey's HSD*	% of Planted Control	Average Number of Germinating Seedlings	Tukey's HSD*	% of Planted Control
Petri dish, moist filter paper	216	A	n.a	175	A	n.a
Bare ground planted, plentiful water	190	A	100	192	A	100
Bare ground planted, limited water	136	AB	72	159	A	83
Bare ground, seed drop, plentiful water	100	BC	53	103	B	53
Bare ground, seed drop, limited water	23	CD	12	27	C	14
50% ground cover (dead), seed drop, plentiful water	25	CD	13	26	C	13
50% ground cover (dead), seed drop, limited water	9	D	5	10	C	5
50% ground cover(live), seed drop, plentiful water	5	D	2	6	C	3
50% ground cover (live), seed drop, limited water	0	D	0	3	C	1
100% ground cover (dead), seed drop, plentiful water	29	CD	15	30	C	15
100%ground cover(dead), seed drop, limited water	20	CD	10	15	C	8
100% ground cover (live), seed drop, plentiful water	5	D	2	6	C	3
100% ground cover, (live), seed drop, limited water	4	D	2	5	C	2

* Tukey's HSD (P = .05) was used for means comparison. Values with the same letter are not significantly different

Results and conclusions

Seedling counts for all stressor regimes are provided in Table VII.G.4.1. Each regime was represented by three replicated flats and the seedling counts reflect the average associated with each regime. For seed that were planted, that is covered with a thin layer of soil, the seedling counts in the irrigated bare ground regimes were comparable with the numbers observed in the Petri dish controls, both in total numbers and rate of emergence. The planted treatments with limited irrigation showed a statistically non-significant reduction in germination compared to the watered controls. Since at the onset of the experiment, all regimes received ample above ground watering immediately after sowing, it is likely that the small pore spaces of the fine textured soil together with the more intimate seed/soil contact in the planted treatments allowed sufficient uninterrupted moisture to allow initial germination. In contrast, when seed were dropped onto the surface of the soil, germination was dramatically reduced in both the plentiful and limited irrigation treatments. For the dropped seed but irrigated treatments, initial germination was low with higher rates at later time points. This suggests that regular watering encouraged a more intimate contact with the soil resulting in improved conditions over the course of the experiment. Total germination numbers in this treatment were still significantly less than the ideal conditions, being about half that of the planted/irrigated and Petri dish controls. Limiting the application of water further reduced germination.

Ground cover, whether alive or dead, caused dramatic reduction in germination relative to the controls. Living ground cover, regardless of ample supply of water gave no more that 3.0% germination relative to the planted/irrigated ideal control treatment. In the treatments where the groundcover had been killed with glyphosate germination was higher but still less than ~15% of the control even with ample watering, and was further reduced with limited watering. Given that the competing vegetation was dead there is no direct competition for the available water, rather, despite the small size of the seed the physical presence of dead vegetation most likely simply functioned as a physical barrier, blocking direct contact to the soil.

Although we were not able to compare the germination of open pollinated EH1 seed with that from freeze tolerant *Eucalyptus* lines because either no or a very low amount of viable seed was produced in our field trials, this study allowed us to assess the effect of key environmental factors on the successful establishment of a *Eucalyptus* plant from seeds. The study clearly shows that living or dead competing vegetation ground cover acts as a physical barrier is therefore a key factor in dramatically reducing the germination of EH1 control seed. The greatest reduction in seedling emergence was observed when seed was dispersed into a growing, pre-established population of grasses and broadleaves. In addition to physically preventing direct contact with the soil surface, the existing living vegetation also provides competition for resources that further reduces the chances of germination and establishment of seedlings. While the supply of plentiful water in the dead vegetation treatments resulted in increased germination of EH1 seed, this was not the case for treatments with living groundcover. Consistent with information from the scientific literature, the results from these greenhouse experiments with open-pollinated EH1 seed clearly indicate that the absence of a suitable seed bed, lack of moisture and presence of competing dead or living vegetation cover, which are likely scenarios expected under most field situations, would result in extremely poor germination rates of hybrid *Eucalyptus* seeds.

VII.G.5. Seeded Volunteer Monitoring

Five field trials consisting of a variety of translines, including lines 427 and 435, and EH1 control trees established in Baldwin County, Alabama were allowed to flower beginning in 2007 (trial AR162a allowed in 2007 and the remaining trials allowed to flower in 2008) under BRS permit # 06-325-111r (Table VII.G.5.1). An additional field trial (AR162b) established in Highlands County, Florida was allowed to flower beginning in 2008 under BRS Permit # 08-151-101r. Mature flowers and seed capsules have been observed in all these tests since they were allowed to flower. All six trials have been regularly monitored for the presence of seeded volunteers in the test and within 100m perimeter surrounding the tests. The oldest trial (AR162a) planted in November of 2005 began flowering in 2007 and produced mature seed capsules in 2008. This trial has been monitored 25 times over three year period for seeded volunteers. Due to the fast growth rate of *Eucalyptus*, any surviving germinated seedlings would be readily identified and observed during this period. No seeded volunteers have been observed in or around this trial. Each of the remaining five trials at both locations has been monitored 14 to 16 times over a two year period following initial flowering and no seeded volunteers have been found in or around these trials (Table VII.G.5.1).

Table VII.G.5.1. Summary of seeded volunteer monitoring observations for field tests under flowering permits.

				2008		2009		2010	
APHIS-BRS Permit#	County, State	Trial ID	Planting Date	Number of Inspections	Seeded Volunteers Present	Number of Inspections	Seeded Volunteers Present	Number of Inspections	Seeded Volunteers Present
06-325-111r	Baldwin, Alabama	AR162a	11/8/2005	9	No	10	No	6	No
		AR162b	7/11/2006	9	NA	10	No	6	No
		AR162d	7/31/2007	9	NA	9	No	6	No
		AR202	8/8/2006	9	NA	10	No	6	No
		AR202a	6/27/2007	7	NA	8	No	6	No
08-151-101r	Highlands, Florida	AR162b	7/18/2006	11	NA	9	No	7	No

VII.G.6. Summary and conclusions of seed germination analyses

The controlled seed germination studies with seed capsules collected over three years (2008 to 2010) from field trials allowed to flower have indicated that either no, or a very low number of viable seeds are produced in translines and control EH1 trees, most likely as a result of self-fertilization by pollen from the fertile EH1 control trees. The results of seed germination studies under competitive conditions in greenhouse experiments with open-pollinated EH1 seed were consistent with expectations based on published literature. In the absence of a suitable seed bed, lack of moisture and presence of competing dead or living vegetation cover, the seedling establishment, if any, from a very limited amount of seed produced from translines is extremely unlikely. Regular volunteer monitoring of six different trials over 2-3 years have further confirmed the absence of any seeded volunteers in or around the field tests. Based on the very low amounts of viable seed production in the translines and EH1 control trees compared to open pollinated *Eucalyptus* trees, combined with the poor seedling establishment under less than ideal *Eucalyptus* seed germination conditions present in a typical managed field planting, and lack of any seeded volunteers in the field trials allowed to flower in the southeastern US, we conclude that FTE translines are highly unlikely to spread beyond a managed plantation.

VII.H. Compositional Analyses

Forest tree improvement programs typically have targeted both productivity and product quality traits. In terms of product quality there have developed over the years several standard measures and protocols aimed at understanding the biochemical and structural components of wood. Desirable traits include high density or specific gravity that produce greater yields of cellulose fiber from a given volume of harvested wood, together with basic measures of cellulose and other sugars as well as lignin and its constituent components. A key consideration in any tree improvement program is that improvements in one area should not lead to loss of quality in other areas. *Eucalyptus* hybrid variety EH1 has been extensively studied in Brazil where it was developed, and has desirable pulp yield and quality characteristics. In order to determine whether the freeze tolerant lines maintained these desirable characteristics we subjected samples to a series of standard industry analytical methods and compared these to samples of EH1.

Material and Methods

It is well known that wood composition and quality can vary with growing environment, therefore, samples were collected and compared from two field test sites: Highlands County in Florida, and Baldwin County in Alabama. Eight trees per line were harvested at age 17 months with four trees from each of the two field test sites. Average tree heights ranged in from approximately 25 to 30 feet (~7.5 to 9.0 m). Wood characteristics are also known to vary within a single tree, so subsamples were taken at different heights from each tree. The trees were first cut approximately two feet above ground level. A 4-ft segment of the main stem was then cut, the top cut corresponding to a height of approximately six feet above the ground. The average diameter of the cut stems was approximately 3 inches. Subsamples were taken from the bottom (2-ft height), midpoint (4-ft height) and top (6-ft (height) of the cut bole. To avoid branches (knots) and reaction wood which lead to localized changes in wood composition, in some cases the actual sample may have been taken from a section as much as 4" above or below the target height. In this way a total of 24 samples were prepared for each line (3 heights x four replicates x two sites). Samples were debarked, dried, and stored at room temperature until further processing.

To determine basic specific gravity (G_b), 1" thick disks (generally 20 – 40 g, broken in up to 4 pieces for larger disks) of wood were prepared from each subsample. The pieces were weighed after oven drying, and then were saturated by vacuum infiltration in water for 1-3 days. The volume of the saturated samples was then determined by water displacement. G_b was calculated as dry weight divided by the weight of water displaced by saturated volume (Simpson, 1993; ASTM, 2002).

Samples were prepared for chemical analysis by grinding ~40 g of wood in a Wiley mill and separating through a 20-mesh wire screen. The wood powder samples were divided into aliquots and submitted to the Institute for Paper Science and Technology (IPST, Georgia Institute of Technology, Atlanta, GA) and the National Renewable Energy Laboratory (NREL, Golden, CO) for chemical analysis. For IPST, samples of approximately 10 grams were provided and chemical analyses were performed twice for each sample. Following acid hydrolysis of the wood material wood sugars (arabinans, galactans, glucans, mannans and xylans) were determined using High Performance Anion Exchange Chromatography with Pulsed Amperometric Detection (HPAEC-PAD). Cellulose % was a calculated value determined by subtracting one-third of the mannan % value from the glucan % value determined by HPAEC-PAD as described by Easty and Malcolm (1982). Klason lignin analysis was performed by standard methods, which included the acid insoluble lignin determined gravimetrically from the acid hydrolysis solution. Soluble lignin was determined by UV absorbance at 205nm (Easty and Malcolm 1982).

Analysis at NREL was performed by pyrolysis molecular beam mass spectroscopy (py-MBMS) as described by Tuskan et al.(1999). The method requires only small amounts of material and is most well-suited for lignin composition. Approximately a gram of material was provided for each sample and analyses were performed five times. As the Lignin % values obtained at NREL and IPST were comparable, only the IPST values are shown in Tables VII.H.2 – 4 below. The ratio of syringyl:guaiacyl lignin subunits (S/G Ratio) values provided in Tables VII-H2 – 4 are from NREL data as these are not differentiated in the analysis performed at IPST.

Results and discussion

Table VII.H.1 shows that the specific gravity of samples from line 435 is comparable to that of the untransformed control. Samples from line 427 have slightly higher (~5%) specific gravity than the control, a difference that is statistically significant. However, this value is well within the range of values seen for the control. These data are consistent with those of Chen (2006) who reported a variety of *Eucalyptus urophylla* × *E. grandis* with an average specific gravity of 0.453 ± 0.015, with samples ranging from 0.422 to 0.482. There was no significant variation in specific gravity related to the field test site or position on stem.

For both transgenic lines, the mean values of the major sugars (cellulose and xylan) and lignin percentage of the wood are within one standard deviation of the control values (Table VII.H.2). The same is true for the minor sugar components (galactan, mannan and arabinan) and the ratio of syringyl and guaiacyl components of lignin (S/G Ratio).

Tables VII.H.3 and 4 provide details of the biochemical analysis broken down into subsets based on site and position on the tree respectively. Wood chemical content was seen to vary between Site 1 and Site 2, both in the controls and the transformed lines (Table VII.H.3). It can be seen in that for both lines, cellulose is higher and lignin is lower at Site 1 relative to Site 2, following the same trends as the untransformed control.

Table VII.H.1. Specific gravity of *Eucalyptus* wood from freeze tolerant lines and untransformed controls

Sample Set	Basic Specific Gravity (g/cm^3)
All Untransformed. (n = 20)	0.430 ± 0.016
Untransformed Range	0.403 – 0.474
All Line 427 (n = 24)	0.449 ± 0.015
All Line 435 (n = 24)	0.429 ± 0.012
All Samples - Site 1	0.431 ± 0.018
All Samples - Site 2	0.436 ± 0.015
All Samples - 2-ft	0.438 ± 0.016
All Samples - 4-ft	0.428 ± 0.015
All Samples - 6-ft	0.429 ± 0.016

Galactan and mannan varied with position on the tree while other components showed some variability but no real trends (Table VII.H.4). The samples showed a statistically significant difference between the galactan values for the 2-ft and 6-ft samples, with the 6-ft sample having a higher percentage galactan and the 4-ft samples being intermediate. Mannan showed the opposite trend, with values for the 6-ft samples lower than that of the 2-ft samples. Both sugars represent a very small fraction of the overall wood composition, but in both cases these trends were the same in the translines as for the controls.

These standard analyses do not indicate any significant or unexpected changes in the translines compared to the non-transgenic controls with respect to these important wood traits. These data support the conclusion that other than differences associated with the engineered freeze tolerance and pollen ablation traits, the translines are not substantially different from the EH1 progenitor.

Table VII.H.2. Chemical composition of *Eucalyptus* wood from freeze tolerant lines and untransformed controls. Values are provided for the samples grouped by line, field site, or location on bole. Numbers provided are the means for each set ± standard deviation. The Untransformed Range values seen in the second row of data are the lowest and highest values obtained across the 24 samples from the untransformed control in this set of analyses.

Sample Set	Cellulose %	Galactan %	Mannan %	Xylan %	Arabinan %	Lignin %	Lignin S/G
All Untrans. (n=24)	42.2 ± 2.3	1.04 ± 0.27	1.17 ± 0.20	14.2 ± 1.3	0.28 ± 0.04	30.1 ± 1.6	2.5 ± 0.2
Untrans. Range	38.2 - 48.1	0.71 - 1.68	0.86 - 1.55	10.9 - 16.7	0.22 - 0.38	27.5 - 33.7	2.2 - 2.8
All Line 427 (n=24)	42.2 ± 3.8	1.07 ± 0.22	1.11 ± 0.21	14.3 ± 1.2	0.31 ± 0.04	29.5 ± 1.2	2.4 ± 0.1
All Line 435 (n=24)	41.6 ± 4.1	1.09 ± 0.26	1.14 ± 0.26	13.8 ± 1.5	0.29 ± 0.04	30.2 ± 2.1	2.5 ± 0.1

Table VII.H.3. Variation by field site in chemical composition of *Eucalyptus* wood from freeze tolerant lines and untransformed controls. Values are provided for the samples of each line segregated by field site. Numbers provided are the means for each set ± standard deviation.

Sample Set	Cellulose %	Galactan %	Mannan %	Xylan %	Arabinan %	Lignin %	Lignin S/G
All Site 1 (n=47)	43.4 ± 2.6	1.18 ± 0.32	1.06 ± 0.20	13.7 ± 1.5	0.27 ± 0.03	28.6 ± 1.0	2.6 ± 0.2
Site 1 Untrans. (n=12)	42.8 ± 2.0	1.05 ± 0.27	1.09 ± 0.22	13.6 ± 1.5	0.25 ± 0.02	28.8 ± 0.9	2.6 ± 0.1
Site 1 Line 427 (n=12)	44.2 ± 3.2	1.18 ± 0.26	0.99 ± 0.17	14.2 ± 1.3	0.30 ± 0.03	29.0 ± 0.8	2.4 ± 0.1
Site 1 Line 435 (n=12)	43.9 ± 2.8	1.14 ± 0.30	1.12 ± 0.26	14.1 ± 1.4	0.27 ± 0.03	28.9 ± 0.7	2.5 ± 0.1
All Site 2 (n=48)	40.4 ± 3.3	1.02 ± 0.22	1.21 ± 0.22	14.1 ± 1.4	0.31 ± 0.04	30.9 ± 1.7	2.4 ± 0.1
Site 2 Untrans. (n=12)	41.6 ± 2.5	1.03 ± 0.28	1.24 ± 0.16	14.8 ± 0.7	0.30 ± 0.04	31.3 ± 1.2	2.4 ± 0.1
Site 2 Line 427 (n=12)	40.2 ± 3.3	0.96 ± 0.10	1.24 ± 0.18	14.5 ± 1.1	0.32 ± 0.04	30.0 ± 1.2	2.3 ± 0.1
Site 2 Line 435 (n=12)	39.4 ± 4.0	1.05 ± 0.22	1.16 ± 0.28	13.5 ± 1.7	0.31 ± 0.03	31.5 ± 2.3	2.4 ± 0.1

Table VII.H.4. Variation by position on stem in chemical composition of *Eucalyptus* wood from freeze tolerant lines and untransformed controls. Values are provided for the samples of each line segregated by position on the stem (height above ground). Numbers provided are the means for each set ± standard deviation.

Sample Set	Cellulose %	Galactan %	Mannan %	Xylan %	Arabinan %	Lignin %	Lignin S/G
All 2-ft (n=31)	41.3 ± 2.8	0.88 ± 0.14	1.29 ± 0.23	14.5 ± 1.1	0.29 ± 0.04	29.7 ± 1.7	2.4 ± 0.1
2-ft Untrans. (n=8)	41.6 ± 1.2	0.87 ± 0.19	1.25 ± 0.22	14.5 ± 0.6	0.26 ± 0.02	29.8 ± 1.7	2.6 ± 0.2
2-ft Line 427 (n=8)	41.8 ± 3.5	0.93 ± 0.1	1.23 ± 0.23	14.9 ± 1.0	0.32 ± 0.05	29.7 ± 1.6	2.5 ± 0.1
2-ft Line 435 (n=8)	40.9 ± 3.6	0.87 ± 0.13	1.31 ± 0.29	14.2 ± 1.5	0.28 ± 0.03	29.3 ± 1.6	2.6 ± 0.1
All 4-ft (n=32)	42.0 ± 2.7	1.07 ± 0.22	1.13 ± 0.17	14.0 ± 1.1	0.29 ± 0.04	29.9 ± 2.0	2.4 ± 0.2
4-ft Untrans. (n=8)	42.6 ± 2.3	0.96 ± 0.13	1.18 ± 0.16	14.4 ± 1.1	0.28 ± 0.04	30.0 ± 1.6	2.5 ± 0.1
4-ft Line 427 (n=8)	41.6 ± 2.8	1.04 ± 0.18	1.08 ± 0.19	13.9 ± 1.1	0.29 ± 0.03	29.5 ± 0.9	2.3 ± 0.2
4-ft Line 435 (n=8)	41.8 ± 2.1	1.06 ± 0.10	1.15 ± 0.14	14.0 ± 0.9	0.29 ± 0.04	30.8 ± 2.4	2.4 ± 0.2
All 6-ft (n=32)	42.3 ± 4.3	1.34 ± 0.28	1.00 ± 0.18	13.3 ± 1.8	0.29 ± 0.05	29.0 ± 2.5	2.6 ± 0.1
6-ft Untrans. (n=8)	42.3 ± 3.1	1.29 ± 0.27	1.07 ± 0.21	13.7 ± 1.9	0.28 ± 0.06	30.5 ± 1.7	2.6 ± 0.2
6-ft Line 427 (n=8)	43.1 ± 5.1	1.23 ± 0.24	1.03 ± 0.18	14.1 ± 1.3	0.31 ± 0.02	29.3 ± 0.8	2.5 ± 0.1
6-ft Line 435 (n=8)	42.2 ± 6.1	1.35 ± 0.26	0.95 ± 0.22	13.2 ± 2.0	0.29 ± 0.04	30.5 ± 2.1	2.6 ± 0.1

VIII. Environmental Consequences of the Introduction

Phenotypic evaluations of FTE lines were performed in field studies conducted under a broad range of environmental conditions that would be encountered in the target commercial plantation area in the southeastern US. The non-transformed control variety has been grown for over a decade in Brazil over many thousands of acres and has not demonstrated any plant pest characteristics. The detailed comparisons of FTE and the non transformed control trees in the studies described in this Petition demonstrate that these lines are not significantly different from the control trees except for freeze tolerance in cold challenged environments. Therefore, consistent with its progenitor variety, FTE is not likely to pose a plant pest risk.

As part of their review of permits for field trials of FTE BRS previously prepared Environmental Assessments and sought public comment. Several thousand comments were received, providing a comprehensive assessment of issues of concern to the public. Many of the concerns raised were in relation to planted *Eucalyptus* species generally, and not specific to the genetically engineered freeze tolerant lines. These included potential invasiveness, allelopathy, hydrology, biodiversity, fire, and soil nutrient use. These same concerns have been historically raised in other countries where large-scale plantations of *Eucalyptus* species have been established and in response there have been numerous scientific studies, reports and reviews published addressing these issues. Given the very large volume of these scientific publications it is impractical in this document to summarize all of the available literature on these issues. However, it is important to note that through this accumulated scientific understanding of *Eucalyptus* these concerns have been addressed and many countries continue to grow and harvest *Eucalyptus* or even expand on existing plantations (as is the case in Brazil for example). Indeed, this knowledge has fostered a better understanding of management practices that allow for highly productive *Eucalyptus* plantations to be grown in an environmentally sustained manner.

In order to fully address the potential for environmental consequences from introducing FTE we engaged environmental consultants from AECOM to perform an assessment and prepare an Environmental Report (ER; Appendix E). Recognizing that there are a number programs developing *Eucalyptus* species as a faster growing and superior fiber source for the US south, and the increasing interest in renewable fuels and bioenergy applications, the ER anticipates that some conversion of existing forestry operations to (non-genetically engineered) *Eucalyptus* will occur in the near future. The ER evaluates the issues raised in the earlier public comments as well as other areas including threatened and endangered species. The report concludes that FTE does not present any unique or significant concerns over that which would be expected for non-genetically engineered *Eucalyptus*. A summary of the ER is provided below.

VIII.A. Areas Addressed in the Environmental Report

VIII.A.1. Forestry and Agriculture:

VIII.A.1.a. Commercial Forestry

If FTE is deregulated, forestry commodities produced in the potential planting range would not differ significantly from the anticipated alternative whereby non-genetically engineered *Eucalyptus* is developed and deployed across the south. Introduction of FTE in place of other tree species (including non-genetically engineered *Eucalyptus* species) would not result in any significant change in the areas or total acreage under production. Any such changes in acreages of forests would continue to respond to other factors such as supply and demand for wood fiber and competing land use decisions. Introduction of FTE lines in place of non-genetically engineered *Eucalyptus* species would not involve substantial changes in harvesting practices or rotation times in comparison to non-genetically engineered *Eucalyptus*. The faster growth characteristics of both the non-genetically engineered *Eucalyptus* and FTE would be similar, allowing for overall shorter rotation/harvest cycles relative to existing hardwoods or pines. Similarly, the faster growth rate of both the non-genetically engineered *Eucalyptus* species and FTE could enable higher production rates in closer proximity to processing facilities and end-use locations, together with a related reduction in transportation-related impacts. The introduction of FTE is not expected to involve any change in the types, amounts, or application procedures associated with the use herbicides or pesticides relative to non-genetically engineered *Eucalyptus* species. As hardwoods, including *Eucalyptus* are typically more sensitive to herbicides than pines, it is likely that herbicide treatment regimes would differ from existing pine prescriptions, possibly even resulting in reduced herbicide use relative to pines. Introduction of FTE would not result in any adverse impacts associated with prescribed fire practices.

VIII.A.1.b. Agriculture.

The faster growth rates of both FTE and non-genetically engineered *Eucalyptus* species relative to other hardwoods may enable a reduction in acreage used for commercial forestry, and therefore could beneficially impact agricultural resources. The impact of FTE lines on agriculture as a result of water use would also be comparable to that associated with non-genetically engineered *Eucalyptus* species. Overall, the potential impact of the deregulation of FTE on agricultural resources would be either the same, or less than, those associated with the alternative of growing non-genetically engineered *Eucalyptus* species across the south.

VIII.A.1.c. Bioenergy

The faster growth rate of *Eucalyptus*, whether FTE or non- genetically engineered *Eucalyptus*, would provide a greater resource base to support the development of a bioenergy industry. High growth rates would allow efficient production of biomass in close proximity to bioenergy processing facilities thereby reducing transportation costs. Such bioenergy applications are also expected to facilitate economic development in rural areas.

VIII.A.2. Biological Resources

VIII.A.2.a. Biodiversity

As with any current forestry operation using a single species the diversity of tree species is more limited than natural or unmanaged forest. In this respect, planting FTE would be similar to installing plantations of other species. In converting an existing plantation to *Eucalyptus*, these would provide similar habitat structure and resources whether this was FTE or non-genetically engineered *Eucalyptus*. There is no evidence from our field trials that there are any allelopathic impacts from FTE. There is however, a distinct difference between FTE and non-genetically engineered *Eucalyptus* with respect to spread beyond the plantation area. While neither type of *Eucalyptus* is expected to spread or become a weed concern, because of the introduction of the pollen control trait in FTE it carries a further limitation over and above non-genetically engineered *Eucalyptus*.

VIII.A.2.b. Threatened and Endangered Species

The ER considers the potential impacts on threatened and endangered species that could occur as a result of planting *Eucalyptus*, particularly in respect to replacing current pine plantations. A number of species were identified that use managed pine plantations as at least one of their habitats. In planting non-genetically engineered *Eucalyptus* any potential impact on Threatened and Endangered Species must be taken into consideration and addressed. Potential impacts would not be affected by the use of FTE instead of non-genetically engineered *Eucalyptus* and thus the introduction of FTE would not result in significantly greater impacts on threatened and endangered species than would occur in the absence of this introduction.

VIII.A.2.c. Gene flow

There is little if any significant risk of outcrossing to or from other *Eucalyptus* species because they are unlikely to be compatible with FTE, have different flowering times, and should any hybrids form, these would be expected to be of very low vigor. The potential for gene flow from FTE is further mitigated by the inclusion of a pollen control mechanism in these trees.

VIII.A.2.d. Invasiveness/weediness potential

Where FTE has been allowed to produce flowers in field trials over several growing seasons the absence of any volunteer seedlings suggests that these do not spread beyond the areas planted. There is no scientific evidence from other studies or observation of the base variety, grown for many years on very large acreage, to suggest that this variety is invasive or has the potential to be invasive. The engineered traits in FTE are not expected to alter, nor have they been seen to alter this characteristic in our field trials. Therefore, introduction of FTE would not result in significant biological impacts from invasiveness.

VIII.A.2.e. Plant Pests and Diseases

Since FTE has been imported under strict quarantine measures these are not expected to be a source for introducing any new pests and diseases of *Eucalyptus* or other plants into the U.S. Through extensive monitoring of field trials there is no evidence that FTE has increased susceptibility to pest or diseases compared to the non-genetically engineered controls. Introduction of FTE therefore would not result in significant biological impacts from pests or diseases associated with these trees.

VIII.A.2.f. Soil biology/nutrients

Cultivation of FTE lines would be likely to have effects on soil nutrients similar to those of non-genetically engineered *Eucalyptus* that would be planted in the south. Based on the efficiency of *Eucalyptus* in its use of nutrients and its ability to maintain or improve soil fertility the incrementally greater rate of nutrient use by FTE compared to non-genetically engineered *Eucalyptus* would not be biologically significant.

VIII.A.3 Hydrology

There have been extensive research and analysis of the hydrological impacts of *Eucalyptus* plantations from several countries. There are well documented cases where *Eucalyptus* has been shown to have negative impacts on hydrology as well as numerous examples in which hydrologic impacts did not occur. Where negative impacts on hydrology have been seen, this has been associated mostly with afforestation in areas where trees are normally absent, typically areas of low rainfall that are dominated by grass species. However, in regions where rainfall is above 1,200 mm per year (as is the case for the southeastern US) this is not expected to be a problem. Other factors, including poor management have also been raised in connection with hydrological impacts of *Eucalyptus*. Local and site specific conditions should be considered for any large scale planting of trees or other vegetation type, and there likely are some areas within the potential planting range where *Eucalyptus* plantations could have hydrologic impacts and would not be an appropriate land use. However, there also are many areas where *Eucalyptus* would not have noticeable hydrological impacts and would be suitable for growth in plantations. In this respect, FTE is not expected to differ significantly from non-genetically engineered *Eucalyptus* that could be grown in the southeastern US. Conversely, physiological studies have concluded that *Eucalyptus* actually has lower water use per unit of biomass produced than many other types of vegetation (for example, about half that of conifers). As such, on a regional basis, if some of the annual wood demands from pine or slow-growing hardwoods were to be replaced by *Eucalyptus*, overall water use associated with wood production in the region would be lower. Similarly, other factors that could have adverse impacts such as the land area required to meet wood or biomass demand, and transportation distances, would also be reduced. Although slower-growing trees may use less water per unit land area planted, these cannot be managed effectively to maximize production without requiring increases in land use. Faster growing species such as *Eucalyptus* can fill the demand for wood products while using a lesser amount of land area, thus reducing other impacts associated with plantations. Finally, it is well understood that where necessary, management practices can be employed to mitigate the potential for hydrological impacts.

Water use and growth characteristics associated FTE are expected to be similar to non-genetically engineered *Eucalyptus* species. Therefore, the introduction of FTE would not be expected to have any greater impact on local hydrology than the planting of non-genetically engineered *Eucalyptus* or other fast-growing trees species.

VIII.A.4 Cultural Resources

Cultural resources potentially affected by the introduction of FTE, such as archeological deposits, historic buildings, and visual aesthetics are not expected to have any greater impact than the planting of non-genetically engineered *Eucalyptus* species.

VIII.A.5 Public Health and Safety

VIII.A.5.a. Fire

The scientific literature supports the conclusion that *Eucalyptus* is not inherently more flammable than many other tree species including pines. With the implementation of Federal, state and county programs to address fire safety and control the spread of wildfires, as well as appropriate management of *Eucalyptus* plantations, the introduction of either FTE or non-genetically engineered *Eucalyptus* would not contribute to any increased impacts associated with fire safety.

VIII.A.5.b. Hazardous materials and waste management

The introduction of FTE in place of other tree species (including non-genetically engineered *Eucalyptus* species) would not involve any change in the use of hazardous materials or the generation of wood wastes and therefore would not have an impact from these factors.

VIII.A.5.c. Noise

Due to their faster growth non-genetically engineered *Eucalyptus* would be grown under more frequent harvest cycles. The incidence of noise in the area immediately surrounding the plantation would therefore increase but not the noise levels, which would be comparable to existing forestry harvest operations. FTE is not expected to result in any change to noise levels.

VIII.A.5.d. Air Quality and Climate Change

Greenhouse gas emissions associated with the increase in the use of *Eucalyptus* species, including FTE, and their associated forestry management practices are not expected to be substantially different from emissions associated with current forestry species and practices. While the harvest frequency, and thus the use of heavy equipment will increase with fast growing trees, this is likely to be offset with the reduced transportation impacts that result from growing the wood/biomass feedstock closer to the processing facility. *Eucalyptus* is known to be relatively high in emissions of volatile organic compounds (VOCs), however, these are not expected to create adverse impacts in the rural areas in which *Eucalyptus* is expected to be planted.

VIII.B. Areas Not Addressed in the Environmental Report

The ER did not analyze concerns raised about the potential effects of *Cryptococcus* fungus on human health. This issue has been adequately addressed in previous analyses by APHIS-BRS with regard to issued permits for field trials of FTE. There is no scientific basis to suggest that planting of FTE or other non-genetically engineered *Eucalyptus* would result in any increased of exposure to *Cryptococcus*.

Further, the ER does not address the possibility of substitution of FTE for EH1 in more central or southern parts of Florida. EH1 can be grown in central and southern Florida today with no regulatory oversight or restrictions from APHIS-BRS. In the future, some growers of EH1 may elect instead to grow FTE as an approach to mitigating the effects of the infrequent but well documented severe freezes that can occur in this region. As the data from our field trials clearly show, the two FTE lines are equivalent to the parental EH1 line expect for the engineered freeze tolerance and pollen control traits. Substituting EH1 with FTE in this region would not result in any new or significant environmental consequences.

VIII.C. Conclusions of Environmental Report

While there have been numerous press reports about negative public attitudes and the perceived dangers of planting *Eucalyptus*, in many cases, when subject to scientific investigation these can not be substantiated. The environment into which freeze tolerant *Eucalyptus* will be planted in the southeastern US is very different from those specific climates where eucalypts have had well documented hydrological impacts. The extensive experience from growing *Eucalyptus* in the temperate regions in Brazil is a good indicator that eucalypts including FTE may be grown and managed appropriately in southeastern US with no significant negative environmental impacts. There is no evidence that suggest freeze tolerant *Eucalyptus* would be invasive or would negatively impact endangered species. Non-genetically engineered *Eucalyptus* is actively being developed as an alternative fiber and biomass source for the southeastern US and can reasonably be expected to be established in forest plantations across the region in the near future. Based on the scientific literature and data from our field trials we therefore do not believe that any new significant negative environmental impacts would result from the deregulation of freeze tolerant *Eucalyptus*.

IX. Socioeconomic Considerations for the Introduction

An analysis of socioeconomic factors, including population, demographics, housing, and income and local economy, is provided in the Environmental Report (ER; Appendix E). Introduction of FTE or non-genetically engineered *Eucalyptus* species would not be expected to significantly impact population levels, demographics, or housing in the potential planting range. The conversion slower growing pine plantations to *Eucalyptus* could have beneficial impacts on income and employment through increases in local job opportunities or through economic growth for those individuals or businesses involved in the planting, harvesting, and processing of the plantation trees.

In addition, the ER presents an environmental justice analysis which assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations. Environmental justice communities of concern were identified based on the percentage of individuals in each group present within each county compared to the overall average for the region where FTE is expected to be planted. The majority of the counties that constitute environmental justice communities of concern with respect to income are rural in nature. Introduction of FTE lines in rural areas could have localized impacts on income and the economy, as well as land use. With regard to environmental justice, these impacts could have the potential of being beneficial if they result in additional jobs or improvements in the local economy. If the growth of the bioenergy industry were to result in additional bioenergy activities in environmental justice communities of concern, it could constitute a localized beneficial impact.

Further discussion of the socioeconomic considerations with respect to applications in the pulp and paper industry, the bioenergy industry and carbon sequestration is provided below.

Based on an analysis of future fiber supply and demand, fast-growing freeze tolerant *Eucalyptus* has the potential to provide a reliable and economical source of hardwood fiber for the southeastern United States. While this is expected to help maintain and strengthen the global competitiveness of the US pulp and paper industry and associated socioeconomic benefits, there are significant additional potential benefits associated with future applications in bioenergy.

Bioenergy has become an issue of tremendous importance due to the expected wide range of environmental and energy security benefits arising from increasing its utilization. Aggressive goals are being set to increase the proportion of the US energy needs supplied by renewable sources. Among these sources lignocellulosic materials have been identified as part of the solution and are amenable to a variety of conversion pathways. Such applications would require a reliable, large volume supply of feedstock which could be met using fast-growing woody energy crops. The inherent logistical benefits of trees together with the high productivity of freeze tolerant *Eucalyptus* make it an ideal candidate for use as a bioenergy feedstock.

IX.A. Pulp and Paper Industry Applications

The pulp and paper industry is a vital and significant employer and economic producer in the rural infrastructure of the southeastern United States. This industry employs over 170,000 people with a total annual payroll of $12.5 billion in this region with more than 1,500 paper manufacturing facilities and annual paper shipments exceeding $60 billion (AF&PA, 2008). Over many years there has been a reduction in the availability of hardwood fiber due to harvest rates that exceed growth rates, seasonal accessibility issues and conversion of forestland to other uses. This, along with a variety of other factors, has lead to an increase in fiber costs (Figure IX.A.). Demand increases associated with emerging bioenergy markets are expected to lead to further increases in hardwood fiber costs. As a result, the pulp and paper industry has faced a decline in profit margins over the past seven years from around 17% to less than 11%, even though end product demand has been relatively steady and product pricing favorable (McNutt and Cenatempo, 2008). Fiber costs have also contributed to weakening of the international competitive position of the US pulp and paper industry and prevented it from enjoying a significant share of the growth in global pulp production in the face of expanding production capacity in Asian and Latin American countries (Figure IX.B.). Freeze tolerant *Eucalyptus* can help mitigate the negative effects of rising fiber costs by providing a reliable and economical source of hardwood fiber for the southeastern United States pulp and paper industry.

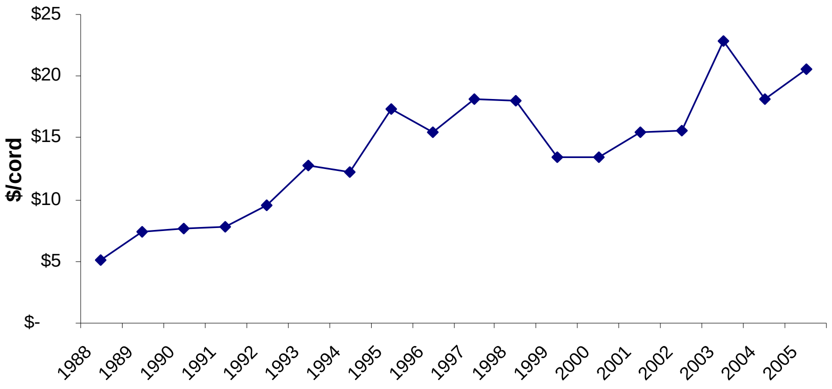


Figure IX.A. Southern hardwood pulpwood stumpage prices, 1988-2005. Adapted from RISI, 2007).

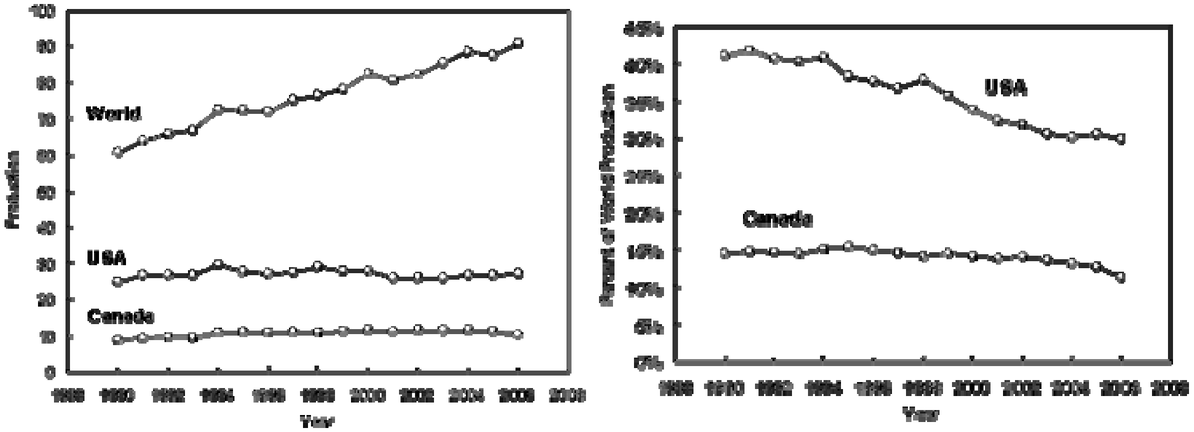


Figure IX.B. Bleached kraft pulp production (millions of metric tons), 1988-2006. (CPBIS).

IX.B. Bioenergy Applications

Although derived from ancient biomass, fossil fuels are replaced over very long time scales and can essentially be considered as a non-renewable resource. In contrast, the use of woody biomass in energy applications represents a renewable resource that can be replaced in real time using appropriate management (Malmsheimer et al., 2008). The need for renewable sources of energy is becoming more widely recognized as the US and other countries seek to reduce their dependence on non-renewable energy sources and provide for a sustainable energy future. In addition to the energy security benefits of reducing oil and gas imports, bioenergy offers opportunities for rural development and economic growth, together with a shift in use of non-renewable fossil fuels associated with high greenhouse gas emissions to renewable fuels with more desirable energy balance and greenhouse gas profile (Wang, 2005). Woody biomass provides a great deal of flexibility with multiple potential applications in the energy sector including: thermal energy for steam and heat; electricity generation and cogeneration; and transportation fuels (i.e., cellulosic ethanol). Bioenergy also offers a number of environmental benefits, discussed in further detail below.

The emerging bioenergy market is expected to have a tremendous impact on rural development. It has been estimated that an individual 100 million gallon/year ethanol biorefinery will generate more than 1,500 permanent new jobs across the economy (LECG, 2006), and in 2007 the US corn ethanol industry supported the creation of almost 240,000 jobs (LECG, 2008). That same year, the industry generated $4.6 billion in tax revenue to the federal government (an estimated $1.2 billion surplus over the value of Federal tax incentives) and $3.6 billion to state and local governments (LECG, 2008). Rural development will likely expand even further as research provides the technological developments that allow broader use of other feedstocks such as wood. Bioenergy is already becoming a substantial market outlet for wood in the southeastern US. According to RISI, in the past year, new bioenergy projects that would consume 22 million tons of wood annually have been announced and nearly 11 million tons of this new capacity would be in the US South as of March, 2008 (RISI, 2008). Timber Mart South estimated bioenergy projects that would consume 16 million green tons in the US South as of October, 2008 (Timber Mart South, 2008). In addition to job creation in biofuels conversion, the development of a bioenergy sector in the southeastern US holds great economic promise for the region through the establishment of a new industry producing up to 120 million green tons of biomass annually as a feedstock for advanced biofuels. At an estimated price of $20-30 per green ton, this represents $2 to $4 billion in new opportunities for landowners and logistics providers in biomass production alone.

Biomass for Transportation Fuels

The use of biomass for the production of transportation fuels has received increasing attention in recent years in response to rising gasoline prices, concerns over energy independence and security, and the need for environmentally sustainable sources of energy. Annual gasoline consumption in the United States is 140 billion gallons, and US diesel fuel consumption is 56 billion gallons (Malmsheimer et al., 2008). Each year the US uses 6.5 billion barrels of oil but produces only 2.5 billion barrels from domestic sources, requiring the importation of 4 billion barrels of oil to meet annual needs (Malmsheimer et al., 2008).

Today, ethanol is the primary renewable fuel in the US and is produced almost exclusively from corn or sugar. Recent global food supply concerns have lead to an increasing interest in the production of ethanol from non-food sources, including cellulose. The Advanced Energy Initiative announced by President Bush in 2006 has the objective of making cellulosic ethanol cost competitive with corn by 2012 and included two significant goals: “20 in 10” (replace 20 percent of today’s gasoline usage with biofuels by 2010) and “30 in 30” (replace 30 percent of today’s gasoline usage with biofuels by 2030) (Malmsheimer et al., 2008). In 2007 the Renewable Fuels Standard (RFS) mandated the use of 36 billion gallons of renewable fuels by 2022 with 21 billion gallons of this total coming from “advanced biofuels” derived from feedstocks other than corn and sugarcane (Figure IX.C) (Energy Independence and Security Act of 2007). In support of these aggressive targets, an increasing amounts of federal funding and venture capital are being channeled into the production of cellulosic ethanol (DOE, 2007; EESI, 2008).

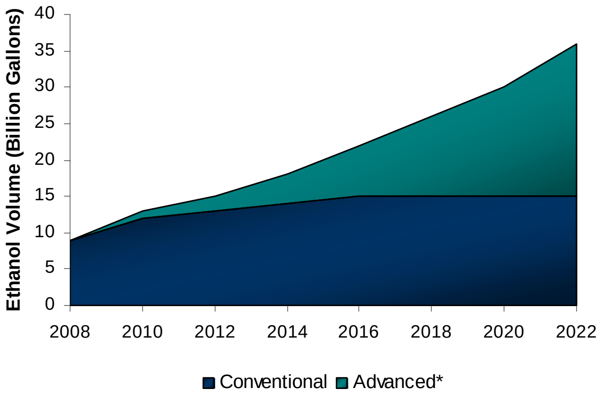


Figure IX.C. 2007 Renewable fuels standard. From the 'Energy Independence and Security Act of 2007'.

Table IX.A shows the quantity of biomass that would be needed to meet the "advanced biofuels" target in the 2007 Renewable Fuels Standard for the southeastern United States alone. Approximately 120 million green tons of biomass would be needed to generate ~6 billion gallons, the Southeast's share of the 21 billion gallon target for 2022. A total of fifty-nine 100 million gallon facilities would be needed in the Southeast to meet this demand creating an estimated 93,000 permanent new jobs (LECG, 2006) for the region. It is likely that this total is conservative as many outside observers are suggesting that the southeastern US may be a preferred region for production of advanced biofuels due to its climate, biomass productivity potential, and less concentrated agricultural presence.

Table IX.A. Wood harvest to meet the renewable fuels standard for the southeast

Renewable Fuels Standard 'Advanced Biofuels' Target[a]	21 billion gallons
Southeast percentage of US gasoline consumption[b]	28%
Southeast share of 'Advanced Biofuels'	5.9 billion gallons
Ethanol yield[c]	100 gallons EtOH/dry ton of biomass
Biomass needed	59 million dry tons of biomass
Harvested wood equivalent[d]	118 million green tons of biomass

[a] Energy Independence and Security Act of 2007
[b] Energy Information Administration (2008).
[c] Iogen Corporation (2006)
[d] Based on ~50% moisture content

Biomass for Electricity

Electricity generating plants are the largest stationary source of greenhouse gas (GHG) emissions from fossil fuels and it is estimated that the United States will need to build 1,200 new 300-megawatt power plants during the next 25 years in order to keep pace with projected increases in electricity demand (Malmsheimer et al., 2008). Coal will continue to be a major source of energy for electricity production but woody biomass, used as a feedstock to be burned or mixed with coal, presents a viable short and mid-term solution that has the potential to reduce GHG emissions (Malmsheimer et al., 2008).

The utilization of woody biomass for the production of electric power is already common but has substantial potential to be increased. The Energy Information Administration estimates consumption of 184 trillion BTUs (British Thermal Units) of renewable energy generated from wood and derived fuels in the US in 2007, with approximately 50% of these sources coming from the south (Energy Information Administration, 2008). The vast majority of this can be attributed to the pulp and paper industries where residues from production processes are routinely combusted to produce steam and electricity. Further driving increased utilization of biomass for energy is the adoption of Renewable Portfolio Standards (RPS) which mandate that a specified percentage of power plant capacity or generation come from renewable sources by a specified date. Texas and Florida, both of which have regions suitable for planting freeze tolerant *Eucalyptus*, have implemented mandatory Renewable Portfolio Standards (Pew, 2008). Other States are expected to adopt similar standards in the future and there continues to be discussion in Washington DC of a national RPS in the future.

Trees for Bioenergy Applications

In order to supply the volume of feedstock necessary to meet the demand expected from advanced biofuels and expanding bioenergy production, new sources of feedstock will be needed. A significant source of this supply is expected to come from a perennial energy crops. The “Billion Ton Report” published jointly by DOE and USDA (summarized below) identified energy crops as a key contributor to the future biomass supply (Perlack et al., 2005).

Oak Ridge National Laboratory published a map (Figure IX.D) of potential energy crops for six growth regions of the United States. Trees feature prominently in almost all these regions, and the analysis explicitly identified *Eucalyptus* as an ideal energy crop model for southern Florida (Wright, 1994). Freeze tolerant *Eucalyptus* extends the potential regions for growing *Eucalyptus* farther north providing an energy feedstock for a greater geography than that pictured.

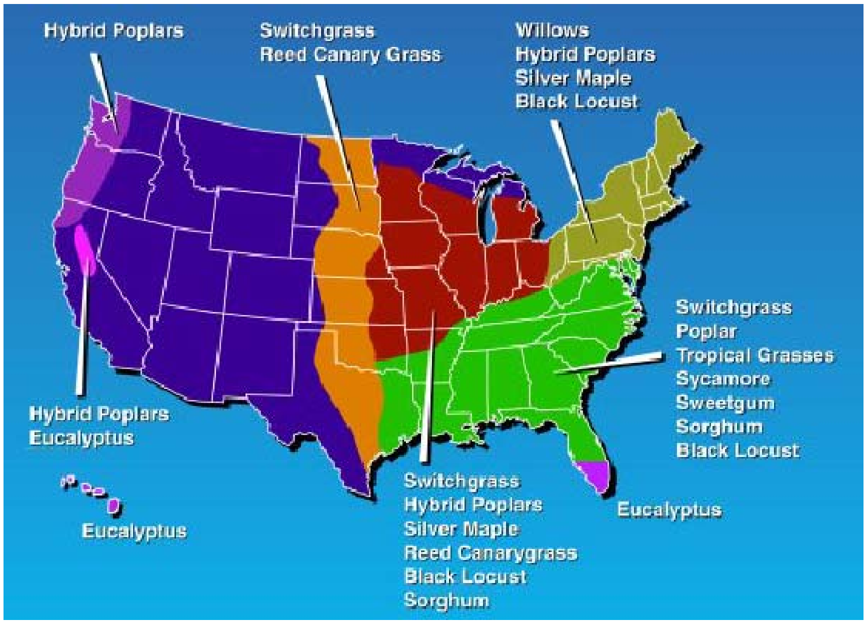


Figure IX.D. Woody and herbaceous species proposed as models for energy feedstock production in the US. From Kszos et al., 2000.

Trees and wood have been identified as part of the bioenergy solution in the “Billion Ton Report” (Perlack et al., 2005) that investigated the feasibility of producing the estimated 1 billion dry tons of biomass needed annually to meet the goal of replacing 30 percent of US petroleum consumption with biofuels by 2030. In this report, trees grown purposefully for bioenergy applications were included under the heading of agricultural resources as part of a broadly defined ‘perennial energy crops’. This group accounts for 377 million dry tons of the 1.37 billion dry ton total biomass resource potential (Figure IX.E) at projected yields of 8 dry tons per acre per year (Perlack et al., 2005). In Brazil the progenitor EH1 variety used to develop freeze tolerant *Eucalyptus* routinely produces yields at or in excess of 20 green tons per acre per year as harvested pulpwood. Our results predict comparable growth rates in the US. In addition, when managed for overall biomass production yield potentials of 30 or more green tons per acre per year may be possible. The report also identified 368 million dry tons of available biomass from forest residues and wastewood, which when combined with the production from trees and other perennial energy crops represents a total of 745 million dry tons of biomass available for bioenergy production (Perlack et al., 2005).

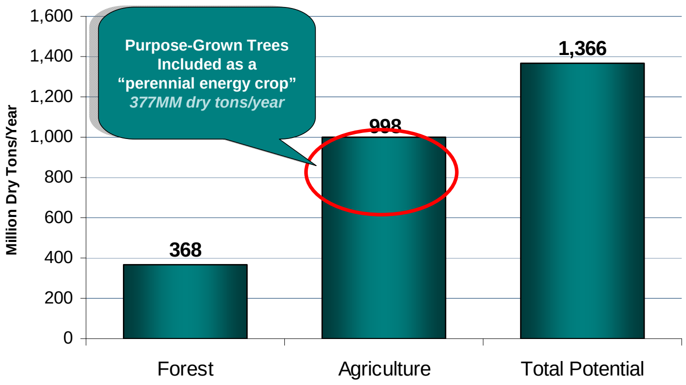
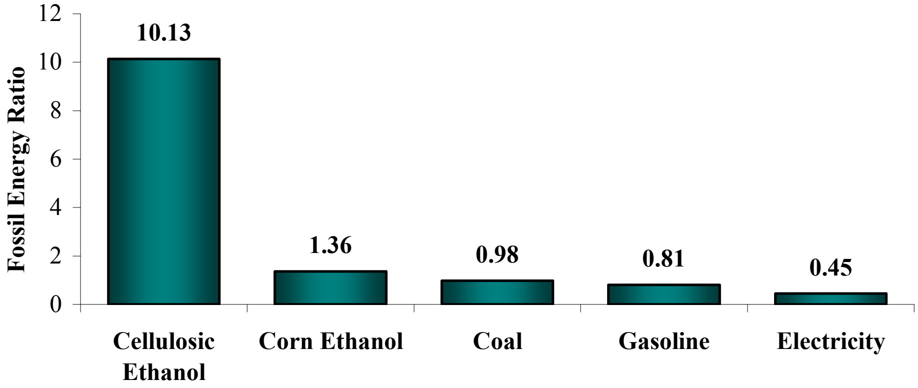


Figure IX.E. Annual biomass resource potential from forest and agricultural resources

Cellulose provides a higher net energy benefit compared with many other sources. The estimated Fossil Energy Ratio (energy contained in the fuel divided by the fossil energy input) of 10.31 for cellulosic ethanol relative to 1.36 for corn-based ethanol (Figure IX.F) giving cellulosic ethanol a much more positive net energy balance relative to current alternatives (Wang, 2005). The net energy balance affects the greenhouse gas profile of the renewable energy source. Corn ethanol reduces greenhouse gas emissions by between 18 and 29 percent while cellulosic ethanol results in an 85 to 86 percent emissions reduction (Wang, 2005).



Fossil Energy Ratio = energy in fuel/fossil energy input

Figure IX.F. Fossil energy ration (FER) by fuel type

The choice of energy crops must also be adapted to regional conditions and needs, both in minimizing transportation costs as well as avoiding the current long-distance distribution limitations of ethanol. In the southeastern US, where accessible inventory and harvesting infrastructure for forestry operations are already well established, trees provide a clear advantage for biomass production compared to annual crops.

Trees also have a variety of inherent logistical benefits and economic advantages relative to other feedstocks. Many of these advantages are driven by the fact that trees can typically be harvested year-round and continue growing year after year providing a ‘living inventory’ of available biomass:

- Reduced storage and inventory holding costs together with minimal shrinkage or degradation losses
- Mitigation against the risk of annual yield fluctuations due to drought, disease, pest pressures, and other biotic or abiotic stresses, allowing better matching of supply with demand. (To ensure full capacity production using annually harvested crops producers may contract for excess supply as a hedge against years with reduced growth.)
- Reduced infrastructure and capital needs for harvesting and transport as this is can be spread throughout the year rather than concentrated over a short seasonal period (Sims and Venturi, 2004)
- Minimized environmental impact since multi-year rotations allow for extended periods with limited disturbance. While a comparable total acreage may be needed, with trees only a fraction of that total would be planted or harvested in any given year, compared to harvesting this same sized footprint each year for an annual crop
- Landowner flexibility relative to other energy crops. Both in terms of choice of when to harvest, and the multiple end use pathways including traditional forest products such as pulp and paper, and a variety of energy use pathways including cellulosic ethanol and power generation through direct firing, co-firing, or wood pellet systems

While we believe that trees will play a significant role in helping to meet renewable energy standards, we recognize that to fully meet these targets will require multiple, integrated approaches with a variety of different crop species and production systems.

Specific Benefits of Freeze Tolerant Eucalyptus

The high productivity of freeze tolerant *Eucalyptus* makes it an ideal candidate for use as a short-rotation dedicated energy crop. High yields allow large volumes of biomass to be produced on a small land base close to the processing facility, minimizing transportation costs. The yields achievable with freeze tolerant *Eucalyptus* are predicted to meet or exceed those that have been defined by DOE and others for the long-term feasibility of renewable energy production (i.e., 8-10 dry tons/acre/year (English et al., 2006)). In typical forestry operations yield is determined based on merchantable pulpwood or sawtimber of the main tree stem. Cost effective total biomass-driven management systems could provide even more competitive returns to landowners while meeting delivered cost targets for bioenergy production. A study with *Eucalyptus grandis* in Florida showed total biomass productivity values exceeding 30 green tons (~15 dry tons) per acre per year, with the potential to reach 55 green tons/acre/year (Segrest et al., 1998).

Improvements in dedicated energy crops, such as freeze tolerant *Eucalyptus*, will be essential to meet expected demands for sustainable feedstock production for cellulosic ethanol and other bioenergy applications. Table IX.B summarizes the theoretical acreage needed to meet the “advanced biofuels” target in the 2007 Renewable Fuels Standard (RFS) in the southeastern US based on current productivity assumptions for pine and *Eucalyptus* under pulpwood and high-density coppicing scenarios. Fast-growing *Eucalyptus* would require a significantly smaller land footprint to meet the RFS target. Reduced acreage needs would allow for the sustainable production of biomass while still meeting existing demands for wood, and enabling the continued conservation of selected forested lands for other societal and environmental benefits today and in the future.

Table IX.B. Approximate total acreage needed to meet RFS in the US southeast using pine or *Eucalyptus*.

	Pine	*Eucalyptus*	
		Pulpwood Management	Total Biomass Management
Productivity (green tons/acre/year)	7	20[b]	30[c]
Acres (million) needed to meet target 118 million green tons/year[a]	17	6	4

[a] From Table IX.1
[b] ArborGen, unpublished data
[c] Estimated average over three coppice rotations (Sims et al., 2001)

As with many other hardwood species, an added benefit of freeze tolerant *Eucalyptus* as a bioenergy crop is its ability to coppice (production of new shoots from the cut stump following harvest) when managed appropriately. This allows for subsequent crops without the added costs of establishment (site preparation, seedling and planting costs) providing a higher return to landowners and limiting any environmental impacts of re-planting. Coppice crops can show increases in productivity relative to the initial single-stem harvest (Sims et al., 2001), however, as with any other species, coppice yields will eventually decline and re-planting with fresh stock would be desirable.

IX.C. Carbon Sequestration Applications

In 2002, the US government announced a comprehensive strategy to reduce the ratio of greenhouse gases to economic output by 18 percent over the 10-year period from 2002 to 2012, equivalent to more than 500 million metric tons (EPA, 2008). The role of forests and forest products in preventing and reducing GHG emissions is gaining wider recognition in market-based policy instruments for climate change mitigation. Forestry is one category of projects that can be used in trading carbon dioxide emission reduction credits to offset emissions from other sources, and one of the most promising areas for reducing GHG under such a credit scheme is the use of wood-based biofuels instead of fossil fuels to generate electric power.

It is estimated that US forests annually sequester more than 750 million tons of CO_2 equivalents (EPA, 2005). There are multiple pathways in which forests can be used to prevent or reduce greenhouse gas emissions including: substituting wood for fossil fuel-intensive products; the use of wood to produce bioenergy; and preventing land use change from forest to non-forest purposes (i.e., development, agricultural land, etc.). Each of these pathways could result in increased planting or replanting of forests allowing for the uptake of more carbon from the atmosphere. Substitution of wood in bioenergy applications allows for reduction in emissions through the displacement of fossil fuels. For every BTU of gasoline that is replaced by cellulosic ethanol, total life-cycle GHG emissions were estimated to be reduced by over 85 percent (Wang, 2005). This compares with a reduction of 18 to 29 percent for corn-based ethanol.

Specific Benefits of Freeze Tolerant Eucalyptus

All trees remove carbon dioxide from the atmosphere and store it in their roots, trunks and branches. Growth rate is a major factor influencing the rate at which trees are able to remove carbon dioxide from the atmosphere and thus the quantity of greenhouse gas emissions that can be displaced through carbon sequestration on a given acre of land (Malmsheimer et al., 2008). Highly productive trees such as freeze tolerant *Eucalyptus* allow for the sequestration of large amounts of carbon relative to other species. This high productivity of freeze tolerant *Eucalyptus*, along with desirable wood quality characteristics and the multiple potential end uses, is expected to increase the economic feasibility of growing hardwood plantations in the southeastern US. The increased value to landowners could drive increases in tree planting as well as reduce pressures to convert forestland to other uses, leading to an overall larger forest footprint and associated sequestration of carbon and offset of greenhouse gas emissions. The specific benefits of afforestation and reforestation with freeze tolerant *Eucalyptus* are expected to become more apparent as standards for the calculations of offsets and substitution benefits become formalized in the US.

IX.D. Conclusions of Socioeconomic Considerations

The inherent logistical benefits of trees in combination with the high productivity of freeze tolerant *Eucalyptus* make it an ideal feedstock for traditional end uses such as pulp and paper as well as various bioenergy conversion pathways ranging from cellulosic ethanol to electric power generation. Concentrating the growth of fast-growing trees such as freeze tolerant *Eucalyptus* on highly productive forest lands will help meet growing fiber needs for both traditional and emerging applications while allowing for the continued conservation of native forests for future generations. Together with other renewable energy sources freeze tolerant *Eucalyptus* has the potential to reduce US dependence on fossil fuels and increase energy independence while simultaneously providing a substantial rural development opportunity.

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Appendices

Appendix A: USDA-APHIS-BRS Notifications and Permits for Freeze Tolerant *Eucalyptus*

FTE Field Testing Notifications and Permits			
Year	**BRS Reference Number**	**ArborGen Reference Number**	**Approved Release Sites (by state)**
2005 Field Trial	05-256-03n	AR 162a	AL,SC
2006 Field Trials	06-135-01n	AR 162b	AL, FL, LA, SC
	06-150-02n	AR 202	AL, SC
	06-151-04n	AR 205	SC
2007 Field Trials	07-145-102n	AR 162b	AL, FL, LA, SC
	07-159-103n	AR 162d	AL, LA, MS, SC
	07-222-104n	AR 162d	FL, SC
	07-145-107n	AR 202	AL,SC
	07-093-113n	AR 202	AL, SC
	07-145-106n	AR 205	SC
	07-159-104n	AR 205a	SC
	07-253-105n	AR 235	SC
	06-325-111r	AR 162a	AL
2008 Field Trials	06-325-111r	AR 162a	AL
		AR 162b	
		AR 162d	
		AR 202	
		AR 202a	
	08-039-102rm	AR 162b	AL, FL,GA, LA, MS, SC, TX
		AR 162d	
		AR 162f	
		AR 202	
		AR 202a	
		AR 205	
		AR 205a	
	08-151-101r	AR 162b	FL
2009 Field Trials	06-325-111r	AR 162a	AL
		AR 162b	
		AR 162d	
		AR 202	
		AR 202a	
	08-039-102rm	AR 162b	AL, FL,GA, LA, MS, SC, TX
		AR 162d	
		AR 162f	
		AR 162i	
		AR 202	
		AR 202a	
		AR 205	
		AR 205a	
	08-151-101r	AR 162b	FL
	09-043-102n	AR 162g	FL

Continuation of Appendix A……

FTE Field Testing Notifications and Permits			
Year	**BRS Reference Number**	**ArborGen Reference Number**	**Approved Release Sites (by state)**
2010 Field Trials	06-325-111r	AR 162a	AL
	10-112-101n	AR 162b	
		AR 162d	
		AR 202	
		AR 202a	
	08-039-102rm	AR 162b	AL, FL,GA, LA, MS, SC, TX
		AR 162d	
		AR 162f	
		AR 162i	
		AR 202	
		AR 202a	
		AR 205	
		AR 205a	
		AR 262	
		AR 260b	
	08-011-106rm	AR 162d	AL, GA, LA, MS, SC, TX
		AR 162f	
		AR 162i	
	08-014-101m	AR 162f	FL
		AR 162i	
		AR 162j	
		AR 162k	
	08-151-101r	AR 162b	FL
	09-043-102n	AR 162f	FL
	10-196-102n	AR 162/202	SC
2011 Field Trials	10-112-101n	AR 162a	AL
		AR 162b	
		AR 162d	
		AR 202	
		AR 202a	
	08-039-102rm	AR 162i	FL, TX, SC
		AR 262	
		AR 260b	
	08-011-106rm	AR 162d	AL, GA, LA, MS, SC, TX
		AR 162f	
		AR 162i	
	08-014-101m	AR 162f	FL
		AR 162i	
		AR 162j	
		AR 162k	
	08-151-101r	AR 162b	FL

Continuation of Appendix A……

FTE Interstate Movement Notifications			
Year	**BRS Reference Number**	**ArborGen Reference Number**	**Approved Movement Authorization**
2007 Movement Notification	07-187-104n	AR 162a	AL- SC
2008 Movement Notification	08-016-119n	AR 162a	AL-SC
2009 Movement Notifications	09-033-114n	AR 162a-162b-162d-202-202a	FL, AL-SC
	09-142-101n	AR 162h	SC, GA, FL-FL
2010 Movement Notification	10-022-101n	AR 162a-162b-162d-202-202a	AL, FL-SC
	10-042-101n	AR 162j	SC, GA, FL-TX, FL
	10-174-101n	AR 260c	SC-FL
	10-187-101n	AR 162k	SC, GA, FL-FL
	10-190-102n	AR 260d	SC-AL
	10-200-102n	AR 162a-162b-162d-202-202a	Al, FL, GA, LA, MS, TX-SC
	10-333-107n	AR 162m	SC-FL
	10-334-103n	AR 162f	GA-SC

FTE Import Permits	
Year	**BRS Reference Number**
2005 Import	05-072-03m
2006 Import	05-355-01m
	05-362-01m
	06-180-05m
	06-347-104m
2007 Import	06-349-111m
	07-036-103m
	07-120-101m
2008 Import	07-352-107m
	08-224-101m
2009 Import	08-347-101m
	09-064-101m
	09-258-101m
2010 Import	10-118-102m-a1
	10-208-101m-a1

Appendix B: Site Descriptions and Statistical Analyses

Site description and field test establishment

At each location and for each experimental trial, preparations and tasks prior to and directly after planting were targeted at optimizing plant survival and productivity. At each location the methods used in establishing trials were tailored to local conditions including the suitability and availability of equipment and methods used to manage prior existing vegetation that existed at the site.

The components of each field test design (statistical design, number of treatment entries, number of replications, blocks, etc.) were adjusted to accommodate the conditions and dimensions at each site. A randomized field plan was generated detailing the arrangement of blocks and the arrangement of plants within each block. This allowed pre-sorting of the plants in the order in which they were to be planted before transport to the field. All transplanting was done manually. Labeled racks of pre-sorted, individually labeled containerized plantlets were transported to the field in an enclosed vehicle and racks hand-carried to the designated planting site. The pre-sorted labeled plantlets were placed at the appropriate planting spot according to the pre-determined field plan. For planting, a metal dibble bar was used to create a cavity in the soil at each designated planting spot, into which a plantlet was inserted making sure that the root mass of the seedling was planted 1 to 1.5'' below the soil surface. The soil surrounding the newly transplanted plantlet was then stamped firmly to close the hole and firm the soil surrounding the root mass. The container label specific to that transplant was placed at the base of each plant. Where possible plants were irrigated immediately following planting. For some sites irrigation was continued for several weeks to allow for good establishment and on an 'as needed' basis thereafter. At other sites irrigation was applied throughout the growing season (see details below).

Prior to planting and site preparation existing weeds were typically killed using glyphosate. A second glyphosate application was made as a pre-plant, vegetative burn down of any remaining weeds (typically 1 to 10 days) before the date of planting. Post-planting weed control was done as needed (typically two to four months after planting) using directed spray applications by hand to weeds with backpack sprayers using glyphosate at 2 percent (volume/volume) in a spray volume of ~40 gallons per acre, taking care to avoid spraying the trees or allowing any spray drift onto the foliage. If necessary this was repeated eight to ten months after planting. A complete fertilizer N-P-K (10-10-10) containing micronutrients (Ca, Fe, Cu, Mn, Mg, and Zn was used at approximately 100 grams of product per tree distributed by hand in a 3' circle centered at the base of each tree. This was typically done at most sites 4 - 6 weeks after planting.

1) Baldwin County, Alabama

Site preparation
This location has been an agricultural research station for more than 20 years. The location has been used for managed production of annual agricultural crops and forest trees. The soil type here is a Magnolia fine sandy loam with little to no slope. This site is in USDA Hardiness Zone 8b.

The trials established at this location were planted on land that most recently had been in cotton production. After cotton harvest, the woody stalks that remained were shredded with a flail mower and the resulting residues incorporated into the soil using a disc. A pre-plant burn down of existing weeds consisted of a 2 percent (volume/volume) solution of glyphosate herbicide applied in a spray volume of 15 to 18 gallons per acre. Primary tillage consisted of an off-set disk followed by a 5 point chisel plow set to 18-20” depth to fracture any traffic hardpans caused by the use of tractors and other equipment. Planting bed preparation was accomplished using a 4 row “ripper-hiller” which consisted of four gangs, 38” apart, with each gang having a single 24” deep shank centered between a pair of offset discs that formed a slightly raised bed centered over the furrow created by the shank. Prior to the day of planting, beds were smoothed flat with a rolling basket cultivator to produce a firm, finely textured planting bed directly over soil with deep tillage. Designated furrowed rows to be planted were marked by field flags set 9.5 feet apart. Designated planting spots within each row were established by placing field flags at 5, 6, or 8 foot spacing depending on trial type and research objectives.

After planting, overhead irrigation was used to apply approximately a half inch equivalent of rainfall per acre to reduce transplant shock. This was repeated periodically until the plantlets were established - typically 2-6 weeks after planting.

Pre-plant application of N-P-K (10-10-10) plus micro-nutrients fertilizer at a rate of 200 lbs per acre was done prior to establishment of study AR162a in November 2005. For subsequent studies, planting occurred without any pre-plant site fertilization but with hand application of fertilizer after planting as described above.

Trials at this site

AR162a:
This trial was established on November 8, 2005 on ~1.1 acres. A Random Complete Block Design (RCBD) using single trees plots with 48 translines plus 8 EH1 control trees per block and eight replicated blocks. A single border row of trees were planted which surrounding the entire trial. Trees were planted at a spacing of 9.5’ between rows and a 6’ between trees within rows.

AR162b:
Planted on July 11, 2006, two trial designs were established with five selected freeze tolerant lines. The trials covered ~1.4 acres. One trial was a RCBD with single tree plots in ten replicated blocks. Using non-transgenic EH1 plants, a perimeter border was established surrounding this trial. The second design consisted of 25-blocks configured in a “5x5”design (5 rows across and 5 trees deep). Each transline had four replicated blocks. Blocks of the EH1 non-transgenic control were also planted. There were no border rows in this trial. For both studies, trees were planted utilizing 9.5 feet x 8 feet spacing.

AR162d:
This trial was planted on July 31, 2007 covering ~2 acres. Two trials were established one RCBD trial with single tree plots using 12 selected translines plus EH1 controls in ten replicate blocks. The second trial used 25 block plots and a CRD design with 11 translines plus EH1 controls. Most translines (including line 427 and 435) had three replicated blocks while a few lines had a single block only due to limited plant availability. For both studies, trees were planted utilizing a 9.5 x 6 feet spacing, and there were no border rows.

2) Highlands County, Florida

Site preparation details
This location was previously used for managed production of citrus for at least 15 years. The planting area at this location had been used for field trials of transgenic *Eucalyptus* for more than 6 years. The soil type at this site is a Tavares sand. This site is in USDA Hardiness Zone 9a.

Existing citrus trees were cut and stumps removed. After a burn down of weeds with glyphosate the field was worked with a rotary tiller to establish rows 10 feet apart. Micro-sprinkler irrigation was installed prior to planting. The site was pre-irrigated to increase available soil moisture and improve the formation of a planting hole created by the metal dibble stick used in planting. Once planted, irrigation was applied typically every other day at ~0.3"/acre rainfall equivalent every other day for 6 weeks. Following this the trees were irrigated approximately twice each week through the year, adjusting amounts of water to compensate for rainfall.

Trial at this site

AR162b:
This trial was planted on July 18 2006. The trial consisted of both a single-tree and block design with five translines plus controls. The single-tree design had 10 replicated blocks with an external border row. The block plots had four replicates of 25 trees for each line. There was no border row used for the block plots. All trees were planted on a 10 x 8 feet spacing. Total area of the trial at this site was ~1.4 acres.

3) Charleston County, South Carolina

Site preparation
This location has been a managed forest plantation for more than 10 years. The location has been specifically used for short-term planting of hardwoods and softwood trees for forestry research. This site is in USDA Hardiness Zone 8a. The soil type is Chipley loamy fine sand. Initial site preparation typically involved the application of a 5 percent solution of glyphosate herbicide in a spray volume of 15-20 gallons per acre for adequate weed coverage to eliminate existing weeds. Primary tillage consisted of sub-soiling before planting to increase root penetration through a plow pan which was present on this site. Drip irrigation was installed and subsequent water and nutrient additions were applied as needed similar to that described above for Bamberg County, South Carolina.

Trials at this site

AR162a:
Established on November 4, 2005, this RCBD trial consisted of single trees plots of 38 translines plus EH1 controls in eight replicated blocks, with a perimeter border row of non-transgenic trees. Spacing was 10 x 6 feet. The area covered by the test was ~0.8 acres.

AR162b:
This trial was established on July 6, 2006. It consisted of single tree plots of five select lines plus controls in ten replicate blocks. Trees were planted on 10 x 8 feet spacing with a border row of non-transgenic EH1 trees. The trial covered ~0.3 acres.

AR162d:
This trial was established on July 19, 2007 with twelve select translines plus controls. The design was single tree plots with 10 replicates and no border row. Tree spacing was 10 x 8 feet. The area covered by this test was ~0.3 acres.

4) Bamberg County, South Carolina

Site preparation

This location has been a managed forest plantation for more than 14 years. The location has been specifically used for short-rotation planting of hardwoods and softwood trees for forestry research. The soil type is a Blanton sand. This site is in USDA Hardiness Zone 8a.

Typically, initial site preparation involved the application of glyphosate herbicide (2 to 5 percent vol/vol) solution in a spray volume to give adequate coverage of vegetation (10-20 gallons solution per acre) to eliminate existing weeds. Where trees had previously been harvested at this site existing stumps were allowed to decay or in some cases these were uprooted and removed from the site. Primary tillage consisted of sub-soiling before planting to allow better root development. Prior to planting, drip irrigation was installed in rows 10 feet apart and subsequent water and nutrient additions were applied as needed through this system. Rows were pin flagged to indicate each planting spot with either 5 feet or 8 feet between trees within a row (depending on trial objectives and design). Using the drip irrigation system water was applied at 0.2 inches rainfall equivalent every other day after planting to offset transplant shock and minimize mortality. This was done typically for 2-6 weeks. Once a trial was established, fertigation (water and liquid fertilizer, 7-0-7 plus micronutrients) was applied at a rate of ~0.8" per week throughout the growing season, adjusted depending on local rainfall. The fertilizer was calculated to meet a target for the year of ~40 lbs nitrogen per acre over the course of the year.

Trials at this site

AR162b:
Planted on July 5, 2006, a RCBD trial was established using single trees as plots in ten replicate blocks. The trial included a border row and covered ~0.3 acres. Trees were planted on a 10 x 8 feet spacing.

AR162d:
This trial was established July 18, 2007. Twelve translines were planted in single tree plots with ten replicated blocks. Spacing was 10 x 8 feet. Perimeter borders were not used. The trial covered ~0.3 acres.

AR162f:
This trial was established August 8, 2008. Four translines plus nontransgenic control trees were planted in single tree plots with ten replicated blocks. Spacing was 10 x 8 feet. Perimeter borders were not used. The trial covered ~0.2 acres.

5) Escambia County, Alabama

Site preparation
This location had previously been used as an intensely managed pasture for more than 5 years and was planted with grasses suitable for cattle grazing. The soil type is an Orangeburg fine sandy loam. The site is located in USDA Hardiness Zone 8a.

Initial site preparation involved an over the top application of glyphosate to eliminate existing bahia grass. Primary tillage consisted of subsoiling to allow root penetration through a plow pan which was present on this site. The area was then deep shanked (24" deep, 4 gangs 38" apart) prior to the establishment of on-site drip irrigation installed in rows 9.5 feet. Just prior to planting, a second application of glyphosate was made and the rows pin flagged so that trees within a row were 8 feet apart. Using the drip irrigation system water was applied at 0.2 inches rainfall equivalent every other day for the first 6 weeks than as needed for the remainder of the growing season.

Trial at this site

AR162d:
This trial was established on July 31, 2007. The design was single tree plots with ten replicates using 12 translines plus controls. No perimeter border row was established. Trees were planted at 9.5 x 8 feet spacing. The test covered an area of ~0.3 acres.

AR 162f:
This trial was established on July 15, 2008. The design was single tree plots with ten replicates using eight translines plus controls. No perimeter border row was established. Trees were planted at 10 x 8 feet spacing. The test covered an area of ~0.2 acres.

6) Berkeley County, South Carolina

Site preparation
This location has been a managed forest plantation for more than 7 years. The location has been specifically used for short rotation planting of cottonwood and *Eucalyptus* for forestry research. The site is close to the border between USDA Hardiness Zones 8a and 8b.

Initial site preparation involved using a rotary mower to cut established weeds down to ground level, followed by a pre-plant burn down application of glyphosate herbicide at 2% vol/vol using a boom sprayer. The area was then cultivated using a tandem offset disc to incorporate residue and to loosen the top 6-8" of soil. The soil type is a Rains fine sandy loam. A sub-soil shank, mounted behind a tractor was used to establish rows ten feet apart by subsoiling 18" deep. Drip irrigation was installed shortly before planting and planting spots were identified in each row with wire flags spaced 8' apart. Planting and post-planting weed control was done as described above. Water was applied through the drip irrigation system as needed during occasional droughty spells at ~0.2 inch/ acre rainfall equivalent per session as needed. Fertilizer was applied manually to each tree 6 weeks after planting.

Trials at this site

AR162b:
This trial was established using a RCBD with single tree plots of five selected lines plus controls on July 5, 2006. There were ten replicated blocks with a perimeter row of border trees of non-transgenic EH1. Tree spacing was 10 x 8 feet on an area of ~0.3 acres.

AR162d:
This trial was established on July 20, 2007. It included 12 translines plus controls in a single tree plot design with ten replicated blocks. No perimeter border row was established. Spacing was 10 x 6 feet. The test covered ~0.3 acres.

7) St. Landry Parish, Louisiana

Site preparation
This location has been an experimental agricultural farm for more than 25 years, used for conducting research experiments with soybean, cotton and wheat. This site is in USDA Hardiness Zone 8b. The soil type at this site is a Dundee silty clay loam. Prior to trial establishment, the prior crop had been soybeans planted on raised beds 38" apart as is typical for this region. After soybean harvest, wheat seed was broadcast planted to function as a winter cover crop to minimize soil erosion of the beds. Initial site preparation

involved a pre-plant burn down application of glyphosate herbicide (2% solution by volume at 18-20 gallons per acre) to kill the winter cover and existing weeds. Beds were reshaped using a combined shank and two offset disks to breakup up an existing traffic hardpan and to pitch soil gently on each side forming a mounded ridge with 9.5 feet between rows. The planting spots in each planting row were identified with wire flags spaced 8 feet apart.

Just prior to trial establishment an additional application of glyphosate was made. After planting, irrigation was applied using a water wagon placed adjacent to the site with delivery of water by hand to each tree (AR162b) or using flood irrigation (AR162d). This was repeated as needed for ~6 weeks.

Trials at this site

AR162b:
This trial was planted July 13, 2006. It consisted of a single-tree plot with five selected translines plus control and ten replicates. Tree spacing was 9.5 x 8 feet on an area of 0.3 acres. There was no border row.

AR162d:
This trial was established on August 1, 2007. The trial design was single tree plots with 12 translines plus controls and ten replicates. No border row was used. Tree spacing was 10 x 8 feet on an area of ~0.3 acres.

AR162f:
This trial was established on July 30, 2008. The trial design was single tree plots with 8 translines plus controls and ten replicates. No border row was used. Tree spacing was 10 x 8 feet on an area of ~0.2 acres.

8) Hardin, Texas

Site preparation
This location has been managed as a forest plantation for more than 30 years. A loblolly pine plantation was harvested in 2004 by the previous owner. The test site is within the larger harvested area that was bedded by the owner and planted as an operational plantation of *Eucalyptus macarthurii* in 2006. The existing trees in the test area were terminated with an application of glyphosate herbicide at 3% vol/vol using a boom sprayer in August 2008. The area was then cultivated using a forestry bedding plow disc pulled behind a tractor to establish rows approximately 12 feet apart. The height of the planting beds was approximately 15 inches. After establishment, the competition in the study area was controlled with glyphosate herbicide at 3% vol/vol applied as a direct spray. There were three applications of herbicide in the 2009 growing season and one application in 2010. Approximately 100 g of 10-10-10 fertilizer was applied to each tree six weeks after planting. The site is within the USDA Hardiness Zone 8b. The soil type is a Otanya fine sandy loam. The area surrounding of the test site consist of natural pine and mixed hardwood stands and managed loblolly pine plantations.

Trial at this site

AR162i:
This trial was planted on March 18, 2009 and consists of ~ 10 acres each of two translines. Tree spacing was 6.5 x 11 feet on an area of ~20 acres.

Statistical analyses for field studies

Statistical analyses of the phenotypic traits were performed using a standard analysis of variance procedure for a randomized complete block design (Williams and Matheson 1994). Differences between the means of the control and transgenic lines were declared to be significant if the probability value calculated by the procedure was less than or equal to 0.05 (equivalent to a 5% or lower probability that the means are not different). Where significant differences were detected by the analysis of variance, Dunnett's means comparison procedure (Zar 1999) was used to compare the mean of each transgenic line to the EH1 control mean. Dunnett's test is designed to determine if the mean of a control group differs significantly from each of the treatment means. It reduces the number of comparisons that need to be made because all pairs of means are not compared; only the control and treatment means are compared. Again, means were declared to be significantly different if the probability value associated with Dunnett's test statistic was less than or equal to 0.05 (5% or lower probability that the control mean is equal to the treatment mean). Analysis of variance and Dunnett's test were accomplished using JMP® (v7) software (SAS Institute 2007). Examples of the output from these analyses are shown below.

Example of an Analysis of Variance table produced in JMP®.

Trial AR162d Baldwin County, Alabama

Trait - Date	Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Height (ft) 04/08	Line #	2	96.814	48.407	128.185	0.0001*
	Error	27	10.196	0.378	.	.
	C. Total	29	107.010	.	.	.

* Prob>F ≤ 0.05 indicates that there are significant differences between line means.

Example of the results of Dunnett's test produced in JMP®.

Trial AR162d Baldwin County, Alabama

Trait - Date	Line #	N	Mean	Std Dev	Probability EH1 mean = Line mean
Height (ft) 04/08	427	9	3.79	0.66	<.0001
	435	9	3.74	0.92	<.0001
	EH1	12	0.10	0.00	

* A probability ≤ 0.05 indicates that the height means of lines 427 and 435 are both significantly different than the EH1 (control) mean.

Survival data, which was recorded as 0 or 1, was analyzed using a chi-square test to compare the frequencies of zeros and ones for each line and the control (Zar 1999). Two chi-square tests are shown, the log-likelihood and Pearson methods. The Pearson chi-square is the standard method, while the log-likelihood chi-square is recommended when cell frequencies are low. Both methods usually result in the same conclusion being reached. Frequencies were declared to be significantly different if the chi-square test produced a probability value of 0.05 or lower. Survival is expressed as a percent in the tables for ease of presentation. Correlations were performed using the CORREL function of the Microsoft® Excel Analysis ToolPack.

Example of a frequency table for survival used in the chi-square analysis.

Trial AR162d Baldwin County, Alabama

Line	Number of trees		Total
	0 (dead)	**1 (alive)**	
427	1	9	10
435	2	8	10
EH1	4	16	20
Total	7	33	40

Example of the results of Pearson and log-likelihood chi-square tests produced in JMP®.

Trial AR162d Baldwin County, Alabama

Line #	N	Survival	Chi-square test	X^2	Prob > X^2*
427	9	90%	Likelihood Ratio	0.516	0.4726
EH1	16	80%	Pearson	0.480	0.4884
435	8	80%	Likelihood Ratio	0.000	1.0000
EH1	16	80%	Pearson	0.000	1.0000

* Probability values ≤ 0.05 indicate the frequencies of living and dead trees are significantly different for the transgenic line and the EH1 control.

References:

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Williams, E. R. and A. C. Matheson. 1994. Experimental Design and Analysis for Use in Tree Improvement. CSIRO Information Services, East Melbourne, Australia.

Zar, J. H. 1999. Biostatistical Analysis 4th ed. Prentice Hall, Upper Saddle River, New Jersey.

Appendix C: Summary of Field Monitoring Observations

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162a	05-256-03n	Baldwin County, Alabama	11/8/2005	12/14/2005		x		x		x		x		x	x		N.A.	
	06-325-111r			1/6/2006		x		x		x	x			x	x		N.A.	
	10-122-101r			2/20/2006		x		x		x	x			x	x		N.A.	
				3/3/2006		x		x		x	x			x	x		N.A.	
				5/31/2006		x		x		x		x		x	x		N.A.	
				6/1/2006		x		x		x		x		x	x		N.A.	
				8/8/2006		x		x		x		x		x	x		N.A.	
				9/15/2006		x		x		x		x		x	x		N.A.	
				11/14/2006	x[a]			x		x		x		x	x		N.A.	
				1/18/2007		x		x		x	x			x	x		N.A.	
				2/23/2007		x		x		x	x			x	x		N.A.	
				3/13/2007		x		x		x	x			x	x		N.A.	
				4/10/2007		x		x		x		x		x	x		N.A.	
				6/27/2007		x		x		x		x	x		x		N.A.	
				7/10/2007		x		x		x		x	x		x		N.A.	
				8/6/2007		x		x		x		x	x		x		N.A.	
				9/4/2007		x		x		x		x		x	x		N.A.	
				10/10/2007		x		x		x		x		x	x		N.A.	
				11/2/2007		x		x		x		x		x	x		N.A.	
				12/4/2007		x		x		x		x		x	x		N.A.	
				1/22/2008		x		x		x		x		x	x			x
				1/24/2008		x		x		x		x		x	x			x
				2/14/2008		x		x		x	x			x	x			x
				3/13/2008		x		x		x	x			x	x			x
				4/29/2008		x		x		x	x			x	x			x
				5/22/2008		x		x		x		x		x	x			x
				8/19/2008		x		x		x		x			x			x
				12/3/2008		x		x		x	x				x			x
				12/17/2008		x		x		x	x				x			x
				1/28/2009		x		x		x	x				x			x
				3/4/2009		x		x		x		x			x			x
				4/17/2009		x		x		x		x			x			x
				4/29/2009		x		x		x		x			x			x
				6/16/2009		x		x		x		x			x			x
				7/21/2009		x		x		x		x	x		x			x
				8/25/2009		x		x		x		x	x		x			x
				9/15/2009		x		x		x		x		x	x			x
				10/29/2009		x		x		x		x		x	x			x
				11/18/2009		x		x		x		x		x	x			x
				1/19/2010		x		x		x		x		x	x			x
				3/9/2010		x		x		x				x	x			x
				5/10/2010		x		x		x				x	x			x
				7/8/2010		x		x		x				x	x			x
				8/10/2010		x	x			x				x	x			x
				9/27/2010		x		x		x				x	x			x

a: No incidence of diseases except Alternaria rust spots observed in some field trials. There was no difference between transgenic and non transgenic trees

b: No difference in growth and tree form except the damage caused by freeze/winter injury.

c: Observations made for vegetative and seed volunteers within and immediately surrounding the trial

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162b	06-135-01n	Baldwin County, Alabama	7/11/2006	8/8/2006		x		x		x		x		x	x		N.A.	
	07-145-102n			9/15/2006		x		x		x		x		x	x		N.A.	
	08-134-103n			11/14/2006	x[a]			x		x		x		x	x		N.A.	
	06-325-111r			1/18/2007		x		x		x	x			x	x		N.A.	
	10-122-101r			2/23/2007		x		x		x		x		x	x		N.A.	
				4/10/2007		x		x		x		x		x	x		N.A.	
				6/27/2007		x		x		x		x		x	x		N.A.	
				7/10/2007		x		x		x		x		x	x		N.A.	
				8/6/2007		x		x		x		x	x		x		N.A.	
				8/8/2007		x		x		x		x	x		x		N.A.	
				8/9/2007	x[a]			x		x		x	x		x		N.A.	
				9/8/2007		x		x		x		x		x	x		N.A.	
				9/8/2007		x		x		x		x		x	x		N.A.	
				9/19/2007		x		x		x		x		x	x		N.A.	
				10/10/2007		x		x		x		x		x	x		N.A.	
				12/4/2007		x		x		x		x		x	x		N.A.	
				1/22/2008		x		x		x		x		x	x		N.A.	
				1/23/2008		x		x		x		x		x	x		N.A.	
				1/24/2008		x		x		x		x		x	x		N.A.	
				3/13/2008		x		x		x		x		x	x		N.A.	
				4/29/2008		x		x		x		x		x	x		N.A.	
				5/22/2008		x		x		x		x			x		N.A.	
				8/19/2008		x		x		x		x			x		N.A.	
				12/3/2008		x		x		x	x				x		N.A.	
				12/17/2008		x		x		x	x				x		N.A.	
				1/28/2009		x		x		x	x				x			x
				3/4/2009		x		x		x		x			x			x
				4/17/2009		x		x		x		x			x			x
				4/29/2009		x		x		x		x			x			x
				6/16/2009		x		x		x		x			x			x
				7/21/2009		x		x		x		x	x		x			x
				8/25/2009		x		x		x		x	x		x			x
				9/15/2009		x		x		x		x		x	x			x
				10/29/2009		x		x		x		x		x	x			x
				11/18/2009		x		x		x		x		x	x			x
				1/19/2010		x		x		x		x		x	x			x
				3/9/2010		x		x		x		x		x	x			x
				5/10/2010		x		x		x		x		x	x			x
				7/8/2010		x		x		x		x		x	x			x
				8/10/2010		x	x			x		x		x	x			x
				9/27/2010		x		x		x		x		x	x			x

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 202	06-150-02n	Baldwin County, Alabama	8/8/2006	9/15/2006		x		x		x		x		x	x		N.A.	
	07-145-107n			11/14/2006	x[a]			x		x		x		x	x		N.A.	
	08-144-104n			1/18/2007		x		x		x	x			x	x		N.A.	
	06-325-111r			2/23/2007		x		x		x		x		x	x		N.A.	
	10-122-101r			6/27/2007		x		x		x		x		x	x		N.A.	
				7/11/2007		x		x		x		x	x		x		N.A.	
				8/9/2007		x		x		x		x	x		x		N.A.	
				9/7/2007		x		x		x		x		x	x		N.A.	
				9/10/2007		x		x		x		x		x	x		N.A.	
				9/19/2007		x		x		x		x		x	x		N.A.	
				10/10/2007		x		x		x		x		x	x		N.A.	
				12/4/2007		x		x		x		x		x	x		N.A.	
				1/22/2008		x		x		x	x			x	x		N.A.	
				1/23/2008		x		x		x	x			x	x		N.A.	
				1/24/2008		x		x		x	x			x	x		N.A.	
				3/13/2008		x		x		x	x			x	x		N.A.	
				4/29/2008		x		x		x	x			x	x		N.A.	
				5/22/2008		x		x		x	x			x	x		N.A.	
				8/19/2008		x		x		x		x			x		N.A.	
				12/3/2008		x		x		x	x				x		N.A.	
				12/17/2008		x		x		x	x				x		N.A.	
				1/28/2009		x		x		x	x				x			x
				3/4/2009		x		x		x		x			x			x
				4/17/2009		x		x		x		x			x			x
				4/29/2009		x		x		x		x			x			x
				6/16/2009		x		x		x		x			x			x
				7/21/2009		x		x		x		x	x		x			x
				8/25/2009		x		x		x		x	x		x			x
				9/15/2009		x		x		x		x		x	x			x
				10/29/2009		x		x		x		x		x	x			x
				11/18/2009		x		x		x		x		x	x			x
				1/19/2010		x		x		x		x		x	x			x
				3/9/2010		x		x		x		x		x	x			x
				5/10/2010		x		x		x		x		x	x			x
				7/8/2010		x		x		x		x		x	x			x
				8/10/2010		x	x			x		x		x	x			x
				9/27/2010		x		x		x		x	x		x			x

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 202a	07-093-113n 08-092-115n 06-325-111r 10-122-101r	Baldwin County, Alabama	6/27/2007	8/9/2007		x		x		x		x		x	x		N.A.	
				9/19/2007										x	x		N.A.	
				12/4/2007		x		x		x		x			x		N.A.	
				1/24/2008		x		x		x		x			x		N.A.	
				3/13/2008		x		x		x		x			x		N.A.	
				4/29/2008		x		x		x		x			x		N.A.	
				5/22/2008		x		x		x		x			x		N.A.	
				8/19/2008		x		x		x		x			x		N.A.	
				12/3/2008		x		x		x		x			x		N.A.	
				12/17/2008		x		x		x		x			x		N.A.	
				1/28/2009		x		x		x	x				x			x
				3/4/2009		x		x		x		x			x			x
				4/29/2009		x		x		x		x			x			x
				7/21/2009		x		x		x		x	x		x			x
				8/25/2009		x		x		x		x	x		x			x
				9/15/2009		x		x		x		x		x	x			x
				10/29/2009		x		x		x		x		x	x			x
				11/18/2009		x		x		x		x		x	x			x
				1/19/2010		x		x		x		x		x	x			x
				3/9/2010		x		x		x		x		x	x			x
				5/10/2010		x		x		x		x		x	x			x
				7/8/2010		x		x		x		x		x	x			x
				8/10/2010		x	x			x		x		x	x			x
				9/27/2010		x		x		x		x		x	x			x
AR 162d	07-159-103n 08-157-102n 06-325-111r 10-122-101r	Baldwin County, Alabama	7/31/2007	8/9/2007		x		x		x		x		x	x		N.A.	
				8/9/2007		x		x		x		x		x	x		N.A.	
				9/7/2007		x		x		x		x		x	x		N.A.	
				9/10/2007		x		x		x		x		x	x		N.A.	
				9/19/2007		x		x		x		x		x	x		N.A.	
				1/22/2008		x		x		x	x			x	x		N.A.	
				1/23/2008		x		x		x				x	x		N.A.	
				1/24/2008		x		x		x	x			x	x		N.A.	
				3/13/2008		x		x		x	x			x	x		N.A.	
				4/29/2008		x		x		x		x		x	x		N.A.	
				5/22/2008		x		x		x		x		x	x		N.A.	
				8/19/2008		x		x		x		x		x	x		N.A.	
				12/3/2008		x		x		x		x		x	x		N.A.	
				12/18/2008		x		x	x		x			x	x		N.A.	
				1/28/2009		x		x		x		x		x	x			x
				3/4/2009		x		x		x		x		x	x			x
				4/17/2009		x		x		x		x		x	x			x
				4/29/2009		x		x		x		x		x	x			x
				7/21/2009		x		x		x		x	x		x			x
				8/25/2009		x		x		x		x	x		x			x
				9/15/2009		x		x		x		x		x	x			x
				10/29/2009		x		x		x		x		x	x			x
				11/18/2009		x		x		x		x		x	x			x
				1/19/2010		x		x		x		x		x	x			x
				3/9/2010		x		x		x		x		x	x			x
				5/10/2010		x		x		x		x		x	x			x
				7/8/2010		x		x		x		x		x	x			x
				8/10/2010		x	x			x		x		x	x			x
				9/27/2010		x		x		x		x		x	x			x

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences^b		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed ^{c}		Seeded Volunteers Present^c	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162f	08-039-102rm 08-011-106rm	Baldwin County, Alabama	7/16/2008	8/19/2008		x		x		x					x		N.A.	
				12/2/2008		x		x		x	x				x		N.A.	
				12/18/2009		x		x		x					x		N.A.	
				1/28/2009		x		x		x	x				x		N.A.	
				3/4/2009		x		x		x					x		N.A.	
				4/17/2009		x		x		x					x		N.A.	
				4/29/2009		x		x		x					x		N.A.	
				6/16/2009		x		x		x		x			x		N.A.	
				7/21/2009		x		x		x			x		x		N.A.	
				7/28/2009									x				N.A.	
				8/3/2009									x				N.A.	
				8/12/2009										x			N.A.	
				8/25/2009		x		x		x				x	x		N.A.	
				9/8/2009									x				N.A.	
				9/15/2009		x		x		x				x	x		N.A.	
				10/7/2009										x			N.A.	
				10/29/2009		x		x		x				x	x		N.A.	
				11/18/2009		x		x		x		x		x	x		N.A.	
				1/19/2010		x		x		x		x		x	x		N.A.	
				3/9/2010		x		x		x		x		x	x		N.A.	
				5/10/2010		x		x		x		x		x	x		N.A.	
				7/8/2010		x		x		x		x		x	x			x
				8/10/2010		x	x			x		x	x		x			x
				9/27/2010		x		x		x		x	x		x			x
AR 162d	07-159-103n 08-157-102n 08-039-102rm 08-011-106rm	Escambia County, Alabama	7/31/2007	1/24/2008		x		x		x	x			x	x		N.A.	
				3/11/2008		x		x		x	x			x	x		N.A.	
				4/30/2008		x		x		x	x			x	x		N.A.	
				5/22/2008		x		x		x		x			x		N.A.	
				7/10/2008		x		x		x		x			x		N.A.	
				7/16/2008										x			N.A.	
				8/21/2008		x		x		x		x		x	x		N.A.	
				12/4/2008		x		x		x	x				x		N.A.	
				1/28/2009		x		x		x	x				x		N.A.	
				1/29/2009		x		x	x		x			x	x		N.A.	
				3/4/2009		x		x		x	x				x		N.A.	
				4/30/2009		x		x		x				x			N.A.	
				6/17/2009		x		x		x		x		x	x		N.A.	
				7/21/2009		x		x		x		x		x	x		N.A.	
				8/24/2009										x			N.A.	
				8/25/2009		x		x		x		x			x		N.A.	
				10/1/2009		x		x		x		x		x	x		N.A.	
				10/30/2009		x		x		x		x		x	x		N.A.	
				11/17/2009		x		x		x		x		x	x		N.A.	
				1/20/2010		x		x		x		x		x	x		N.A.	
				3/8/2010		x		x		x		x		x	x		N.A.	
				6/4/2010		x		x		x	x			x	x			x
				8/10/2010		x		x		x		x		x	x			x
				9/28/2010		x		x		x		x		x	x			x

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences^{b}		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed ^{c}		Seeded Volunteers Present^{c}	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162f	08-039-102rm 08-011-106rm	Escambia County, Alabama	7/15/2008	8/21/2008		x		x		x					x		N.A.	
				12/4/2008		x		x		x	x				x		N.A.	
				1/28/2009		x		x		x	x				x		N.A.	
				3/4/2009		x		x		x	x				x		N.A.	
				4/30/2009		x		x		x					x		N.A.	
				6/17/2009		x		x		x				x	x		N.A.	
				7/21/2009		x		x		x				x	x		N.A.	
				8/25/2009		x		x		x					x		N.A.	
				8/24/2009										x			N.A.	
				10/1/2009		x		x		x				x	x		N.A.	
				10/30/2009		x		x		x				x	x		N.A.	
				11/17/2009		x		x		x		x		x	x		N.A.	
				1/20/2010		x		x		x		x		x	x		N.A.	
				3/8/2010		x		x		x	x			x	x		N.A.	
				6/4/2010		x		x		x		x		x	x			x
				8/10/2010		x		x		x		x		x	x			x
				9/28/2010		x		x		x		x		x	x			x
AR 162e	07-222-104n 08-039-102rm	Bay County, Florida	10/23/2007	1/21/2008		x		x		x		x		x	x		N.A.	
				1/22/2008		x		x		x		x		x	x		N.A.	
				3/10/2008		x		x		x		x		x	x		N.A.	
				6/26/2008		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**6/26/2008 T**													N.A.	
				5/17/2009											x		N.A.	
				1/5/2010											x		N.A.	
AR 162f	08-039-102rm	Bay County, Florida	7/15/2008	8/18/2008		x		x		x					x		N.A.	
				12/8/2008		x		x		x					x		N.A.	
				10/16/2008		x		x		x					x		N.A.	
				11/20/2008		x		x		x					x		N.A.	
				1/29/2009		x		x		x	x				x		N.A.	
				3/3/2009		x		x		x	x				x		N.A.	
				4/14/2009		x		x		x					x		N.A.	
				5/8/2009		x		x		x					x		N.A.	
				6/19/2009										x			N.A.	
				6/29/2009										x			N.A.	
				7/20/2009										x			N.A.	
				7/20/2009		x		x		x					x		N.A.	
		post-termination monitoring		**7/20/2009 T**													N.A.	
				8/24/2009											x		N.A.	
				10/30/2009											x		N.A.	
				1/5/2010											x		N.A.	
				7/7/2010											x		N.A.	

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162f	08-039-102rm 08-014-101m	Gadsden County, Florida	7/16/2008	8/29/2008		x		x		x					x		N.A.	
				10/16/2008		x		x		x					x		N.A.	
				12/1/2008		x		x		x					x		N.A.	
				12/8/2008		x		x		x					x		N.A.	
				1/28/2009		x		x		x				x	x		N.A.	
				3/6/2009		x		x		x					x		N.A.	
				4/14/2009		x		x		x					x		N.A.	
				6/22/2009		x		x		x			x		x		N.A.	
				7/13/2009		x		x		x					x		N.A.	
				7/20/2009									x				N.A.	
				8/6/2009									x				N.A.	
				8/7/2009		x		x	x				x		x		N.A.	
				8/28/2009		x		x	x					x	x		N.A.	
				9/18/2009		x		x		x				x	x		N.A.	
				11/2/2009		x		x		x				x	x		N.A.	
				1/7/2010		x		x		x		x		x	x		N.A.	
				6/11/2010		x		x		x		x		x	x			x
				8/10/2010		x		x		x		x	x		x			x
				9/24/2010		x	x			x		x	x		x			x
AR 162e	07-222-104n 08-039-102rm	Glades County, Florida	10/10/2007	11/14/2007		x		x		x		x		x	x		N.A.	
				2/14/2008		x		x		x		x		x	x		N.A.	
				2/28/2008		x		x		x		x		x	x		N.A.	
				3/26/2008		x		x		x		x		x	x		N.A.	
				6/11/2008		x		x		x		x		x	x		N.A.	
				7/30/2008		x		x		x				x	x		N.A.	
				8/11/2008		x		x		x					x		N.A.	
				8/27/2008		x		x		x					x		N.A.	
				10/16/2008		x		x		x					x		N.A.	
				11/11/2008		x		x		x					x		N.A.	
				11/18/2008		x		x		x					x		N.A.	
				1/7/2009		x		x		x					x		N.A.	
				2/18/2009		x		x		x					x		N.A.	
				3/13/2009		x		x		x				x	x		N.A.	
				4/8/2009		x		x		x				x	x		N.A.	
				5/6/2009		x		x		x			x		x		N.A.	
				7/28/2009		x		x		x				x	x		N.A.	
		post-termination monitoring		**9/1/2009 T**													N.A.	
				3/31/2010											x		N.A.	
				6/15/2010											x		N.A.	
AR 162f	08-039-102rm	Glades County, Florida	10/16/2008	11/18/2008		x		x		x					x		N.A.	
				1/7/2009		x		x		x					x		N.A.	
				6/17/2009		x		x		x				x	x		N.A.	
				7/28/2009		x		x		x				x	x		N.A.	
		post-termination monitoring		**9/1/2009 T**													N.A.	
				3/31/2010											x		N.A.	
				6/15/2010											x		N.A.	

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162b	06-135-01n 07-145-102n 08-134-103n 08-151-101r	Highlands County, Florida	7/18-19/06	8/23/2006		x		x		x		x		x	x		N.A.	
				10/31/2006		x		x		x		x		x	x		N.A.	
				12/12/2006		x		x		x		x		x	x		N.A.	
				3/13/2007		x		x		x		x		x	x		N.A.	
				5/22/2007		x	x			x		x		x	x		N.A.	
				8/29/2007		x		x		x		x		x	x		N.A.	
				10/9/2007		x		x		x		x		x	x		N.A.	
				11/27/2007		x		x		x		x		x	x		N.A.	
				2/14/2008		x		x		x		x		x	x		N.A.	
				2/28/2008		x		x		x		x		x	x		N.A.	
				3/25/2008	x			x		x		x		x	x		N.A.	
				5/20/2008		x		x		x		x	x		x		N.A.	
				6/11/2008		x		x		x		x	x		x		N.A.	
				7/30/2008		x		x		x		x	x		x		N.A.	
				8/11/2008		x		x		x		x			x		N.A.	
				8/28/2008		x		x		x		x			x		N.A.	
				10/17/2008		x		x		x		x			x		N.A.	
				11/11/2008		x		x		x		x	x		x		N.A.	
				11/19/2008		x		x		x		x			x		N.A.	
				1/7/2009		x		x		x		x			x			x
				2/18/2009		x		x		x		x			x			x
				4/8/2009		x		x		x		x		x	x			x
				5/6/2009		x		x		x		x	x		x			x
				6/18/2009		x		x		x		x	x		x			x
				7/27/2009		x		x		x		x	x		x			x
				9/24/2009		x		x		x		x	x		x			x
				10/27/2009		x		x		x		x	x		x			x
				12/3/2009		x		x		x		x	x		x			x
				1/19/2010		x		x		x		x	x		x			x
				2/23/2010		x		x		x		x	x		x			x
				3/20/2010		x		x		x		x	x		x			x
				6/14/2010		x	x			x		x	x		x			x
				7/15/2010		x		x		x		x	x		x			x
				8/18/2010		x		x		x		x	x		x			x
				9/15/2010		x	x			x		x	x		x			x
AR 162f	08-039-102rm 08-014-101m	Marion County, Florida	8/26/2008	10/17/2008		x		x		x					x		N.A.	
				11/13/2008		x		x		x					x		N.A.	
				11/20/2009		x		x		x					x		N.A.	
				1/8/2009		x		x		x					x		N.A.	
				2/17/2009		x		x		x					x		N.A.	
				3/11/2009		x		x		x				x	x		N.A.	
				4/9/2009		x		x		x				x	x		N.A.	
				6/19/2009		x		x		x				x	x		N.A.	
				6/24/2009									x				N.A.	
				7/27/2009		x		x		x				x	x		N.A.	
				8/31/2009		x		x		x				x	x		N.A.	
				10/23/2009		x		x		x				x	x		N.A.	
				11/9/2009		x		x		x				x	x		N.A.	
				1/20/2010		x		x		x	x			x	x		N.A.	
				5/25/2010		x		x		x				x	x			x
				7/14/2010		x	x			x				x	x			x
				8/12/2010		x	x			x				x	x			x
				10/11/2010		x	x			x				x	x			x

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162f	08-039-102rm	Taylor County, Florida (site 1)	9/17/2008	10/14/2008		x	x			x					x		N.A.	
	08-014-101m			11/18/2008		x		x		x					x		N.A.	
				1/29/2009		x		x		x	x				x		N.A.	
				1/30/2009		x		x		x	x				x		N.A.	
				5/13/2009		x		x		x	x				x		N.A.	
				6/30/2009		x		x		x	x			x	x		N.A.	
				7/28/2009		x		x		x				x	x		N.A.	
				8/10/2009		x		x		x				x	x		N.A.	
				9/28/2009		x		x		x		x		x	x		N.A.	
				10/21/2009		x		x		x		x		x	x		N.A.	
				12/29/2009		x		x		x		x		x	x		N.A.	
				2/27/2010		x		x		x	x			x	x		N.A.	
				4/29/2010		x		x		x		x		x	x		N.A.	
				6/30/2010		x		x		x		x		x	x			x
				7/30/2010		x		x		x		x		x	x			x
				8/27/2010		x		x		x		x		x	x			x
				9/16/2010		x		x		x		x		x	x			x

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162f	08-039-102rm	Taylor County, Florida (site 2)	7/17/2008	7/31/2008		x		x		x					x		N.A.	
	08-014-101m			8/18/2008		x		x		x					x		N.A.	
				8/29/2008		x		x		x					x		N.A.	
				10/14/2008		x		x		x					x		N.A.	
				11/18/2008		x		x		x					x		N.A.	
				1/29/2009		x		x		x		x			x		N.A.	
				5/13/2009		x		x		x					x		N.A.	
				6/30/2009		x		x		x				x	x		N.A.	
				7/28/2009		x		x		x				x	x		N.A.	
				8/11/2009		x		x		x				x	x		N.A.	
				8/17/2009										x			N.A.	
				9/28/2009		x	x			x				x	x		N.A.	
				10/21/2009		x		x		x				x	x		N.A.	
				12/29/2009		x		x		x		x		x	x		N.A.	
				2/27/2010		x		x		x	x			x	x		N.A.	
				4/29/2010		x		x		x		x		x	x		N.A.	
				6/30/2010		x		x		x		x		x	x			x
				7/30/2010		x		x		x		x		x	x			x
				8/27/2010		x		x		x		x		x	x			x
				9/16/2010		x		x		x		x		x	x			x

Continuation of Appendix C….

Summary of Field Monitoring Observations																		
Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162i	08-039-102rm	Taylor County, Florida (site 2)	9/17/2008	10/14/2008		x		x		x					x		N.A.	
	08-014-101m			11/18/2008		x		x		x					x		N.A.	
				1/29/2009		x		x		x					x		N.A.	
				5/13/2009		x		x		x					x		N.A.	
				6/30/2009		x		x		x				x	x		N.A.	
				7/28/2009		x		x		x				x	x		N.A.	
				8/11/2009		x		x		x				x	x		N.A.	
				8/17/2009										x			N.A.	
				9/28/2009		x	x			x		x		x	x		N.A.	
				10/21/2009		x		x		x		x		x	x		N.A.	
				12/29/2009		x		x		x		x		x	x		N.A.	
				2/27/2010		x		x		x	x			x	x		N.A.	
				4/29/2010		x		x		x		x		x	x		N.A.	
				6/30/2010		x		x		x		x		x	x			x
				7/30/2010		x		x		x		x		x	x			x
				8/27/2010		x		x		x		x		x	x			x
				9/16/2010		x		x		x		x		x	x			x
AR 162f	08-039-102rm	Evans County, Georgia	8/26/2008	9/15/2008		x		x		x							N.A.	
	08-011-106rm			9/16/2008		x		x		x					x		N.A.	
				10/8/2008		x		x		x							N.A.	
				10/28/2008		x		x		x					x		N.A.	
				11/25/2008		x		x		x					x		N.A.	
				1/16/2009		x		x		x							N.A.	
				3/24/2009		x		x		x							N.A.	
				4/21/2009		x		x		x							N.A.	
				5/29/2009		x		x		x							N.A.	
				6/29/2009		x		x		x				x			N.A.	
				7/13/2009		x		x		x							N.A.	
				8/14/2009		x		x		x				x	x		N.A.	
				9/28/2009		x		x		x				x	x		N.A.	
				10/28/2009		x		x		x				x	x		N.A.	
				11/25/2009		x		x		x		x		x	x		N.A.	
				1/8/2010		x		x		x	x			x	x		N.A.	
				2/19/2010		x		x		x	x			x	x		N.A.	
				5/21/2010		x		x		x	x			x	x			x
				7/2/2010		x		x		x			x		x			x
				8/9/2010		x	x			x			x		x			x
				9/8/2010		x		x		x			x		x			x
				10/7/2010		x		x		x			x		x			x

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162b	06-135-01n	Saint Landry's Parish, Louisiana	7/13/2006	8/15/2006		x		x		x		x		x	x		N.A.	
	07-145-102n			9/15/2006		x		x		x		x		x	x		N.A.	
	08-134-103n			10/12/2006		x		x		x		x		x	x		N.A.	
	08-039-102rm			11/16/2006		x		x		x		x		x	x		N.A.	
				12/8/2006		x		x		x		x		x	x		N.A.	
				1/15/2007		x		x		x		x		x	x		N.A.	
				2/14/2007		x		x		x		x		x	x		N.A.	
				3/7/2007		x		x		x		x		x	x		N.A.	
				3/20/2007		x		x		x		x		x	x		N.A.	
				4/15/2007		x		x		x		x		x	x		N.A.	
				5/10/2007		x		x		x		x		x	x		N.A.	
				6/16/2007		x		x		x		x		x	x		N.A.	
				7/15/2007		x		x		x		x		x	x		N.A.	
				8/10/2007		x		x		x		x		x	x		N.A.	
				9/15/2007		x		x		x		x		x	x		N.A.	
				10/10/2007		x		x		x		x		x	x		N.A.	
				11/17/2007		x		x		x		x		x	x		N.A.	
				12/5/2007		x		x		x		x		x	x		N.A.	
				1/15/2008		x		x		x		x		x	x		N.A.	
				1/23/2008		x		x		x		x		x	x		N.A.	
				2/20/2008		x		x		x		x		x	x		N.A.	
				3/10/2008		x		x		x		x		x	x		N.A.	
				4/15/2008		x		x		x		x		x	x		N.A.	
				5/10/2008		x		x		x		x		x	x		N.A.	
				6/15/2008		x		x		x		x		x	x		N.A.	
				7/8/2008		x		x		x		x			x		N.A.	
				7/15/2008		x		x		x		x			x		N.A.	
				7/28/2008		x		x		x		x		x	x		N.A.	
				9/29/2008										x			N.A.	
				10/13/2008		x		x		x		x			x		N.A.	
				12/3/2008		x		x		x		x			x		N.A.	
				1/26/2009		x		x		x		x			x		N.A.	
				3/12/2009		x		x		x		x			x		N.A.	
				4/21/2009		x		x		x		x			x		N.A.	
				6/3/2009		x		x		x		x			x		N.A.	
		post-termination monitoring		**6/24/2009 T**													N.A.	
				1/7/2010											x		N.A.	
				2/26/2010											x		N.A.	
				5/11/2010											x		N.A.	
				9/22/2010											x		N.A.	

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences^b		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed ^{c}		Seeded Volunteers Present^c	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162d	07-159-103n	Saint Landry's Parish, Louisiana	8/1/2007	1/23/2008		x		x		x		x		x	x			
	08-157-102n			7/14/2008		x		x		x		x		x	x		N.A.	
	08-039-102rm			7/28/2008		x		x		x					x		N.A.	
				8/15/2008		x		x		x					x		N.A.	
				8/28/2008										x			N.A.	
				9/15/2008		x		x		x					x		N.A.	
				9/29/2008										x			N.A.	
				10/14/2008		x		x		x					x		N.A.	
				10/13/2008		x		x		x					x		N.A.	
				12/3/2008		x		x		x					x		N.A.	
				1/26/2009		x		x		x					x		N.A.	
				3/12/2009		x		x		x					x		N.A.	
				4/21/2009		x		x		x					x		N.A.	
				6/3/2009		x		x		x					x		N.A.	
				6/25/2009 T													N.A.	
		post-termination monitoring		1/7/2010											x		N.A.	
				2/26/2010											x		N.A.	
				5/11/2010											x		N.A.	
				9/22/2010											x		N.A.	
AR 162f	08-039-102rm	Saint Landry's Parish, Louisiana	7/29/2008	10/13/2003		x		x		x					x		N.A.	
	08-011-106rm			12/3/2008		x		x		x					x		N.A.	
				1/26/2009		x		x		x					x		N.A.	
				3/12/2009		x		x		x					x		N.A.	
				4/21/2009		x		x		x					x		N.A.	
				6/3/2009		x		x		x					x		N.A.	
				6/25/2009									x				N.A.	
				7/14/2009		x		x		x				x	x		N.A.	
				8/27/2009		x		x		x				x	x		N.A.	
				10/8/2009		x		x		x		x		x	x		N.A.	
				11/19/2009		x		x		x		x		x	x		N.A.	
				1/7/2010		x		x		x		x		x	x		N.A.	
				2/25/2010		x		x		x		x		x	x		N.A.	
				3/31/2010		x		x		x		x		x	x		N.A.	
				5/11/2010		x		x		x		x		x	x		N.A.	
				6/15/2010		x		x		x		x		x	x			x
				8/4/2010		x		x		x		x		x	x			x
				9/22/2010		x		x		x		x		x	x			x
AR 162d	07-159-103n	Marshall County, Mississippi	10/30/2007	12/7/2007		x		x		x		x		x	x		N.A.	
	08-157-102n			1/31/2008		x		x		x		x		x	x		N.A.	
	08-039-102rm			2/21/2008		x		x		x		x		x	x		N.A.	
				4/25/2008		x		x		x		x		x	x			
				5/23/2008		x		x		x		x		x	x			
				6/23/2008		x		x		x		x		x	x			
				8/5/2008 T													N.A.	
		post-termination monitoring		1/27/2009											x		N.A.	
				4/19/2009											x			
				10/16/2009											x		N.A.	

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162d	07-159-103n	Pearl River County, Mississippi	10/31/2007	12/11/2007		x	x			x		x		x	x		N.A.	
	08-157-102n			1/23/2008		x		x		x		x		x	x		N.A.	
	08-039-102rm			1/29/2008		x		x		x		x		x	x		N.A.	
	08-011-106rm			2/26/2008		x		x		x		x		x	x		N.A.	
				3/11/2008		x		x		x		x		x	x		N.A.	
				3/27/2008		x		x		x		x		x	x		N.A.	
				4/23/2008		x		x		x		x		x	x		N.A.	
				5/29/2008		x		x		x		x		x	x		N.A.	
				6/24/2008		x		x		x		x		x	x		N.A.	
				7/28/2009										x			N.A.	
				7/29/2008		x		x		x		x			x		N.A.	
				8/5/2008										x			N.A.	
				8/28/2008		x		x		x				x	x		N.A.	
				10/13/2008		x		x		x					x		N.A.	
				12/3/2008		x		x		x					x		N.A.	
				1/26/2009		x		x		x					x		N.A.	
				3/10/2009		x		x		x					x		N.A.	
				4/20/2009		x		x		x					x		N.A.	
				6/4/2009		x		x		x					x		N.A.	
				6/24/2009									x				N.A.	
				7/14/2009		x		x		x				x	x		N.A.	
				8/26/2009		x		x		x				x	x		N.A.	
				1/7/2010		x		x		x		x		x	x		N.A.	
				2/25/2010		x		x		x		x		x	x		N.A.	
				3/31/2010		x		x		x		x		x	x		N.A.	
				5/12/2010		x		x		x		x		x	x		N.A.	
				6/15/2010		x		x		x				x	x			x
				8/5/2010		x		x		x				x	x			x
				9/23/2010		x		x		x				x	x			x
AR 162f	08-039-102rm	Pearl River County, Mississippi	7/29/2008	8/28/2008		x		x		x					x		N.A.	
	08-011-106rm			10/13/2008		x		x		x					x		N.A.	
				12/3/2008		x		x		x					x		N.A.	
				1/26/2009		x		x		x					x		N.A.	
				3/10/2009		x		x		x					x		N.A.	
				4/20/2009		x		x		x					x		N.A.	
				6/4/2009		x		x		x					x		N.A.	
				6/24/2009									x				N.A.	
				7/14/2009		x		x		x				x	x		N.A.	
				8/26/2009		x		x		x				x	x		N.A.	
				1/7/2010		x		x		x				x	x		N.A.	
				2/25/2010		x		x		x				x	x		N.A.	
				3/31/2010		x		x		x				x	x		N.A.	
				5/12/2010		x		x		x				x	x		N.A.	
				8/5/2010		x	x			x				x	x			x
				9/23/2010		x		x		x				x	x			x

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences^b		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed ^{c}		Seeded Volunteers Present^c	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162b	06-135-01n 07-145-102n 08-134-103n 08-039-102rm	Bamberg County, South Carolina	7/5/2006	9/7/2006		x		x		x		x		x	x		N.A.	
				10/23/2006		x		x		x		x		x	x		N.A.	
				11/10/2006		x		x		x		x		x	x		N.A.	
				12/19/2006		x		x		x		x		x	x		N.A.	
				1/8/2007		x		x		x		x		x	x		N.A.	
				2/23/2007		x		x		x		x		x	x		N.A.	
				3/5/2007		x		x		x		x		x	x		N.A.	
				4/15/2007		x		x		x		x		x	x		N.A.	
				5/29/2007		x		x		x	x			x	x		N.A.	
				6/22/2007		x		x		x		x		x	x		N.A.	
				7/5/2007		x		x		x		x		x	x		N.A.	
				7/26/2007		x		x		x		x		x	x		N.A.	
				8/16/2007		x		x		x		x		x	x		N.A.	
				9/17/2007		x		x		x		x		x	x		N.A.	
				10/2/2007		x		x		x		x		x	x		N.A.	
				10/22/2007		x		x		x		x		x	x		N.A.	
				11/14/2007		x		x		x		x		x	x		N.A.	
				12/15/2007		x		x		x		x		x	x		N.A.	
				1/10/2008		x		x		x		x		x	x		N.A.	
				2/1/2008		x		x		x		x		x	x		N.A.	
				3/26/2008		x		x		x		x		x	x		N.A.	
				4/15/2008		x		x		x	x			x	x		N.A.	
				5/13/2008		x		x		x		x		x	x		N.A.	
				6/4/2008		x		x		x		x		x	x		N.A.	
				7/8/2008		x		x		x		x		x	x		N.A.	
				8/6/2008										x			N.A.	
				9/19/2008										x			N.A.	
				10/6/2008		x		x		x		x		x	x		N.A.	
				10/14/2008		x		x		x		x			x		N.A.	
				4/1/2009		x		x		x		x			x		N.A.	
				6/1/2009		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**7/23/2009 T**													N.A.	
				10/14/2009											x		N.A.	
				4/15/2010											x		N.A.	
AR 162d	07-159-103n 08-157-102n 08-039-102rm	Bamberg County, South Carolina	7/18/2007	1/10/2008		x		x		x		x		x	x		N.A.	
				2/1/2008		x		x		x	x			x	x		N.A.	
				3/26/2008		x		x		x	x			x	x		N.A.	
				5/13/2008		x		x		x	x			x	x		N.A.	
				6/4/2008		x		x		x	x			x	x		N.A.	
				7/8/2008		x		x		x	x			x	x		N.A.	
				7/9/2008										x			N.A.	
				8/6/2008										x			N.A.	
				9/19/2008										x			N.A.	
				10/6/2008		x		x		x	x			x	x		N.A.	
				10/14/2008		x		x		x	x				x		N.A.	
				4/1/2009		x		x		x		x			x		N.A.	
				6/1/2009		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**7/23/2009 T**													N.A.	
				10/14/2009		x		x		x		x		x	x		N.A.	
				4/15/2010		x		x		x		x		x	x		N.A.	

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 202	06-150-02n 07-145-107n 08-144-104n 08-039-102rm	Bamberg County, South Carolina	8/4/2006	9/7/2006		x		x		x		x		x	x		N.A.	
				10/23/2006		x		x		x		x		x	x		N.A.	
				11/10/2006		x		x		x		x		x	x		N.A.	
				12/12/2006		x		x		x		x		x	x		N.A.	
				1/8/2007		x		x		x		x		x	x		N.A.	
				2/23/2007		x		x		x		x		x	x		N.A.	
				3/20/2007		x		x		x		x		x	x		N.A.	
				4/15/2007		x		x		x		x		x	x		N.A.	
				5/29/2007		x		x		x	x			x	x		N.A.	
				6/22/2007		x		x		x	x			x	x		N.A.	
				7/5/2007		x		x		x		x		x	x		N.A.	
				7/26/2007		x		x		x		x		x	x		N.A.	
				8/16/2007		x		x		x		x		x	x		N.A.	
				9/17/2007		x		x		x		x		x	x		N.A.	
				10/2/2007		x		x		x		x		x	x		N.A.	
				10/22/2007		x		x		x		x		x	x		N.A.	
				11/14/2007		x		x		x		x		x	x		N.A.	
				1/10/2008		x		x		x		x		x	x		N.A.	
				2/1/2008		x		x		x		x		x	x		N.A.	
				3/25/2008		x		x		x		x		x	x		N.A.	
				5/13/2008		x		x		x	x			x	x		N.A.	
				6/4/2008		x		x		x	x			x	x		N.A.	
				7/8/2008		x		x		x		x		x	x		N.A.	
				8/6/2008										x			N.A.	
				9/19/2008										x			N.A.	
				10/6/2008		x		x		x	x				x		N.A.	
				10/14/2008		x		x		x	x				x		N.A.	
				4/1/2009		x		x		x		x			x		N.A.	
				6/1/2009		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**7/23/2009 T**													N.A.	
				10/14/2009											x		N.A.	
				4/15/2010											x		N.A.	
AR 162f	08-039-102rm 08-011-106rm	Bamberg County, South Carolina	8/8/2008	9/16/2008		x		x		x				x	x		N.A.	
				10/6/2008		x		x		x				x	x		N.A.	
				10/14/2008		x		x		x					x		N.A.	
				6/1/2009		x		x		x				x	x		N.A.	
				8/5/2009		x		x		x				x	x		N.A.	
				3/16/2010		x		x		x				x	x		N.A.	
				5/5/2010		x		x		x				x	x		N.A.	
				6/28/2010		x		x		x				x	x			x
				9/9/2010		x		x		x				x	x			x

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162b	06-135-01n	Berkeley County, South Carolina	7/5/2006	8/8/2006		x		x		x		x		x	x		N.A.	
	07-145-102n			9/12/2006		x		x		x		x		x	x		N.A.	
	08-134-103n			10/5/2006		x		x		x		x		x	x		N.A.	
	08-039-102rm			11/15/2006		x		x		x		x		x	x		N.A.	
				12/12/2006		x		x		x		x		x	x		N.A.	
				1/8/2007		x		x		x		x		x	x		N.A.	
				2/1/2007		x		x		x		x		x	x		N.A.	
				3/5/2007		x		x		x		x		x	x		N.A.	
				4/15/2007		x		x		x		x		x	x		N.A.	
				5/28/2007		x		x		x		x	x		x		N.A.	
				6/15/2007		x		x		x		x		x	x		N.A.	
				7/9/2007		x		x		x		x		x	x		N.A.	
				8/15/2007		x		x		x		x		x	x		N.A.	
				8/15/2007		x		x		x		x		x	x		N.A.	
				9/17/2007		x		x		x		x		x	x		N.A.	
				10/24/2007		x		x		x		x		x	x		N.A.	
				11/6/2007		x		x		x		x		x	x		N.A.	
				12/15/2007		x		x		x		x		x	x		N.A.	
				1/7/2008		x		x		x	x			x	x		N.A.	
				2/11/2008		x		x		x		x		x	x		N.A.	
				3/5/2008		x		x		x		x		x	x		N.A.	
				3/26/2008		x		x		x		x		x	x		N.A.	
				4/14/2008		x		x		x		x		x	x		N.A.	
				5/26/2008		x		x		x		x		x	x		N.A.	
				6/4/2008		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**7/14/2008 T**													N.A.	
				2/27/2009											x		N.A.	
				9/28/2009											x		N.A.	
AR 162d	07-159-103n	Berkeley County, South Carolina	7/20/2007	8/15/2007		x		x		x		x		x	x		N.A.	
	08-157-102n			8/15/2007		x		x		x		x		x	x		N.A.	
	08-039-102rm			11/6/2007		x		x		x		x		x	x		N.A.	
				1/7/2008		x		x		x	x			x	x		N.A.	
				3/5/2008		x		x		x	x			x	x		N.A.	
				3/26/2008		x		x		x	x			x	x		N.A.	
				5/26/2008		x		x		x		x		x	x		N.A.	
				6/4/2008		x		x		x		x		x	x		N.A.	
				7/11/2008		x		x		x				x	x		N.A.	
				8/13/2008		x		x		x					x		N.A.	
				9/22/2008		x		x		x				x	x		N.A.	
				10/9/2008		x		x		x			x		x		N.A.	
				11/3/2008		x		x		x					x		N.A.	
				11/13/2008		x		x	x		x				x		N.A.	
				12/10/2008		x		x		x		x			x		N.A.	
				1/5/2009		x		x		x		x			x		N.A.	
				2/27/2009		x		x	x		x				x		N.A.	
				3/30/2009		x		x	x		x				x		N.A.	
		post-termination monitoring		**6/22/2009 T**													N.A.	
				9/28/2009											x		N.A.	
				5/24/2010											x		N.A.	

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162b	06-135-01n	Charleston County, South Carolina	7/5/2006	8/15/2006		x		x		x		x		x	x		N.A.	
	07-145-102n			9/21/2006		x		x		x		x		x	x		N.A.	
	08-134-103n			10/5/2006		x		x		x		x		x	x		N.A.	
	08-039-102rm			11/6/2006		x		x		x		x		x	x		N.A.	
				12/5/2006		x		x		x		x		x	x		N.A.	
				12/29/2006		x		x		x		x		x	x		N.A.	
				1/4/2007		x		x		x		x		x	x		N.A.	
				2/2/2007		x		x		x	x			x	x		N.A.	
				3/7/2007		x		x		x	x			x	x		N.A.	
				4/16/2007		x		x		x	x			x	x		N.A.	
				5/15/2008		x		x		x	x			x	x		N.A.	
				6/20/2007		x		x		x	x			x	x		N.A.	
				7/23/2007		x		x		x		x		x	x		N.A.	
				7/24/2007		x		x		x		x		x	x		N.A.	
				8/16/2007		x		x		x		x		x	x		N.A.	
				8/16/2007		x		x		x		x		x	x		N.A.	
				9/5/2007		x		x		x		x		x	x		N.A.	
				9/5/2007		x		x		x		x		x	x		N.A.	
				9/27/2007		x		x		x		x		x	x		N.A.	
				10/23/2007		x		x		x		x		x	x		N.A.	
				11/15/2007		x		x		x		x		x	x		N.A.	
				12/11/2007		x		x		x		x		x	x		N.A.	
				1/11/2008		x		x		x	x			x	x		N.A.	
				1/14/2008		x		x		x	x			x	x		N.A.	
				3/4/2008		x		x		x		x		x	x		N.A.	
				3/26/2008		x		x		x		x		x	x		N.A.	
				4/13/2008		x		x		x		x		x	x		N.A.	
				5/15/2008		x		x		x		x		x	x		N.A.	
				6/3/2008		x		x		x		x		x	x		N.A.	
				7/21/2008		x		x		x		x		x	x		N.A.	
				8/4/2008										x			N.A.	
				8/15/2008		x		x		x		x			x		N.A.	
				8/21/2008										x			N.A.	
				10/13/2008		x		x		x		x			x		N.A.	
				11/20/2008		x		x		x		x			x		N.A.	
				11/24/2008		x		x		x	x	x			x		N.A.	
				1/15/2009		x		x		x	x				x		N.A.	
				4/1/2009		x		x		x		x		x	x		N.A.	
				7/22/2009 T													N.A.	
		post-termination monitoring		11/6/2009											x		N.A.	
				2/16/2010											x		N.A.	
				6/7/2010											x		N.A.	

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162d	07-159-103n	Charleston County, South Carolina	7/19/2007	9/5/2007		x		x		x		x		x	x		N.A.	
	08-157-102n			9/5/2007		x		x		x		x		x	x		N.A.	
	08-039-102rm			1/11/2008		x		x		x	x			x	x		N.A.	
				1/14/2008		x		x		x	x			x	x		N.A.	
				3/4/2008		x		x		x	x			x	x		N.A.	
				3/26/2008		x		x		x	x			x	x		N.A.	
				6/3/2008		x		x		x	x			x	x		N.A.	
				7/21/2008		x		x		x	x			x	x		N.A.	
				8/4/2008										x			N.A.	
				8/15/2008		x		x		x		x			x		N.A.	
				8/21/2008										x			N.A.	
				10/13/2008		x		x		x		x		x	x		N.A.	
				11/20/2008		x		x		x		x			x		N.A.	
				11/24/2008		x		x		x	x				x		N.A.	
				1/15/2009		x		x		x	x				x		N.A.	
				4/1/2009		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**7/22/2009 T**													N.A.	
				11/6/2009											x		N.A.	
				2/16/2010											x		N.A.	
				6/7/2010											x		N.A.	
AR 202	06-150-02n	Charleston County, South Carolina	8/15/2006	2/2/2007		x		x		x	x			x	x		N.A.	
	07-145-107n			4/16/2007		x		x		x	x			x	x		N.A.	
	08-144-104n			5/31/2007		x		x		x		x		x	x		N.A.	
	08-039-102rm			6/20/2007		x		x		x		x		x	x		N.A.	
				7/23/2007		x		x		x		x		x	x		N.A.	
				7/24/2007		x		x		x		x		x	x		N.A.	
				8/16/2007		x		x		x		x		x	x		N.A.	
				8/16/2007		x		x		x		x		x	x		N.A.	
				9/5/2007		x		x		x		x		x	x		N.A.	
				9/5/2007		x		x		x		x		x	x		N.A.	
				9/27/2007		x		x		x		x		x	x		N.A.	
				10/23/2007		x		x		x		x		x	x		N.A.	
				12/11/2007		x		x		x		x		x	x		N.A.	
				1/11/2008		x		x		x		x		x	x		N.A.	
				1/14/2008		x		x		x		x		x	x		N.A.	
				3/26/2008		x		x		x		x		x	x		N.A.	
				6/3/2008		x		x		x	x			x	x		N.A.	
				7/21/2008		x		x		x		x		x	x		N.A.	
				8/4/2008										x			N.A.	
				8/15/2008		x		x		x		x			x		N.A.	
				8/21/2008										x			N.A.	
				10/15/2008		x		x		x		x			x		N.A.	
				11/20/2008		x		x		x		x			x		N.A.	
				11/24/2008		x		x		x	x				x		N.A.	
				1/15/2009		x		x		x	x				x		N.A.	
				4/1/2009		x		x		x		x		x	x		N.A.	
		post-termination monitoring		**7/22/2009 T**													N.A.	
				11/6/2009											x		N.A.	
				2/16/2010											x		N.A.	
				6/7/2010											x		N.A.	

Continuation of Appendix C….

Summary of Field Monitoring Observations

Trial ID	APHIS-BRS Notification and Permit #	Trial Location	Date of Planting	Date of Monitoring	Damage from Plant Disease		Injury due to Insect Feeding		Growth and Form Differences[b]		Winter Injury/Freeze Damage		Developing Flowers Present		Volunteer Monitoring Performed [c]		Seeded Volunteers Present[c]	
					Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
AR 162d	07-159-103n	Marlboro County, South Carolina	8/24/2007	10/25/2007		x		x		x		x		x	x		N.A.	
	08-157-102n			1/11/2008		x		x		x	x			x	x		N.A.	
	08-039-102rm			2/7/2008		x		x		x	x			x	x		N.A.	
				5/14/2008		x		x		x	x			x	x		N.A.	
				6/20/2008		x		x		x	x			x	x		N.A.	
				7/21/2008		x		x		x		x		x	x		N.A.	
				8/6/2008										x			N.A.	
				8/14/2008		x		x		x		x			x		N.A.	
				11/17/2008		x		x		x		x			x		N.A.	
				1/23/2009		x		x		x		x			x		N.A.	
				2/25/2009		x		x	x		x			x	x		N.A.	
				3/31/2009		x		x	x		x			x	x		N.A.	
				4/29/2009		x		x	x		x			x	x		N.A.	
				5/29/2009		x		x		x					x		N.A.	
				5/29/2009		x		x	x						x		N.A.	
				7/1/2009		x		x	x						x		N.A.	
		post-termination monitoring		**7/22/2009 T**													N.A.	
				7/27/2009											x		N.A.	
				5/25/2010											x		N.A.	
AR 162i	08-039-102rm	Jasper County, Texas	8/27/2008	8/28/2008		x		x		x					x		N.A.	
	08-011-106rm			10/6/2008		x		x		x					x		N.A.	
				11/3/2008		x		x		x					x		N.A.	
				12/16/2009		x		x		x					x		N.A.	
				1/26/2009		x		x		x					x		N.A.	
				3/10/2009		x		x		x					x		N.A.	
				4/22/2009		x		x		x					x		N.A.	
				6/1/2009		x		x		x					x		N.A.	
				7/16/2009		x		x		x				x	x		N.A.	
				8/7/2009										x			N.A.	
				8/27/2009		x		x		x				x	x		N.A.	
				1/8/2010		x		x		x				x	x		N.A.	
				2/26/2010		x		x		x				x	x		N.A.	
				4/1/2010		x		x		x				x	x		N.A.	
				5/14/2010		x		x		x				x	x			x
				6/14/2010		x		x		x				x	x			x
				8/10/2010		x	x			x				x	x			x
				9/21/2010		x		x		x				x	x			x

Appendix D: Pollen Ablation Technology

Genetic ablation refers to the process or methodology of expressing a cytotoxic gene under control of a tightly regulated promoter. The outcome of genetic ablation is the targeted elimination of specific cells or tissues of living organisms without lethal effects (killing the organisms). It has been a powerful tool for the analysis of developmental processes and gene function in both mammalian (Breitman et al., 1987; Palmiter et al., 1987; Arase et al., 1999; Chung et al., 2007) and plant research (Mariani et al., 1990; Mariani et al., 1992; Thorsness et al., 1991). In plants, ablated plant cells and/or organs have included whole flowers (Nilsson et al., 1998; Lännenpää et al., 2005; Thorsness et al., 1993), pollen (Mariani et al., 1990: Kim and An, 1992; Uk Kim et al., 1998; Guerineau et al., 2003; Lee et al., 2003; Singh et al., 2003; Custers et al., 1997; Höfig et al., 2006), anthers (Roque et al., 2007; Koltunow et al., 1990; Day et al., 1995; Lauri et al., 2006), carpels (Liu and Liu, 2008), stigmas (Goldman et al., 1994; Kandasamy et al., 1993), embryos (Van Der Geest et al., 1995; Weijers et al., 2003), endosperms (Weijers et al., 2003), anther cells involved in dehiscence (Beals and Goldberg, 1997), and root cap cells (Tsugeki and Fedoroff, 1999). An excellent example of using genetic ablation technology to analyze control mechanism for floral developmental processes in plants is the targeted ablation of petal and stamen cells in *Arabidopsis* and tobacco (Day et al., 1995). Another example is using genetic ablation to ablate pollen in tobacco (Mariani et al., 1990). The tobacco *TA29* gene is specifically expressed in the tapetum of anthers and the promoter from this gene was used to drive the *barnase* gene, an RNase gene from *Bacillus amyloliquefaciens*. Approximately 92% of tobacco lines with this construct failed to produce pollen. These transgenic tobacco lacked a detectable tapetum and had collapsed pollen sacs with no visible microspores or pollen grains. However, the transgenic tobacco plants were identical to the untransformed control plants with respect to growth rate, height, morphology of vegetative and floral organ systems, time of flowering, and flower color patterns. The authors concluded that the function of the tapetum is to provide nutrients for pollen maturation and its continued presence is not necessary or required for the differentiation and/or function of anther cell types later in the development (Mariani et al., 1990).

The success of genetic ablation in plant research has lead to commercial application of this technology. Anther- and/or pollen-specific promoters driving cytotoxic genes have been employed to ablate anthers and/or pollen thereby facilitating the production of hybrid seeds in many plant species (Yanofsky, 2006; Fabijanski and Arnison, 2004; Nasrallah et al., 1999; Gomez Jimenez et al., 2006), including products that have been deregulated in the US (95-228-01p, 97-148-01p, 98-349-01p, 01-206-01p). *Barnase* has been the most commonly used cytotoxic gene although other RNases and other genes have also been utilized (Petition # 98-349-01p; Fabijanski and Arnison, 2004; Kandasamy et al., 1993, Day et al., 1995). Altered expression of floral specific genes, such as the MADS-box genes, has also been employed in the application of whole-flower ablation (Podila et al., 2006).

ArborGen's pollen ablation technology was developed based on the principles of tapetum ablation (Mariani et al., 1990). The tapetum is the inner-most layer of the pollen sac and it has long been understood to play a crucial role in the maturation of microspores or pollen (Shivanna et al., 1997). As noted above, *barnase* from *B. amyloliquefaciens* has been used extensively as a cytotoxic gene, however, even very low levels of expression of the native *barnase* gene can give rise to cell toxicity. As a result it is critical to use a promoter that is highly specific for the tissues to be ablated otherwise even extremely low levels of promoter activity can prevent the recovery of transgenic plants. A complementary approach has been to modulate *barnase* activity through site-directed mutagenesis. Histidine (H) at position 102 in the amino acid sequence, and part of the active site of the enzyme has been a target for such alterations (Mossakowska et al., 1989; Meiering et al., 1992; Axe et al., 1998: Jucovic and Hartley, 1995). A number of single amino acid substitutions were generated and tested by ArborGen. These were combined with a variety of tissue specific promoters and tested in tobacco transformation (data not shown). Based on these results, we selected BarnaseH102E in which the histidine at position 102 of *barnase* was replaced by glutamate (E). BarnaseH102E was combined with the PrMC2 promoter isolated from *Pinus radiata.* This promoter had been previously demonstrated to be active primarily in the tapetum of the pollen sac (Walden et al., 1999; Höfig et al., 2003), and was expected to give high specificity in *Pinus* species and other gymnosperms in which ArborGen has commercial interests.

D.1. Pollen ablation in tobacco

Two pollen ablation constructs containing a PrMC2::BarnaseH102E cassette were generated, pWVR220 and pAGF243. These cassettes differ in that the PrMC2 promoter in pAGF243 was modified by deleting 36 nucleotides at the 3' end of the promoter in pWVR220. This region in pWVR220 contains two extra in-frame ATG start codons which add 10 or 12 amino acids to the N-terminal of the *barnase* protein. Based on results from both constructs the additional amino acids do not affect *barnase* activity.

Eighteen transgenic tobacco lines carrying the PrMC2::barnaseH102E cassette (pWVR220) were generated and grown in a greenhouse. The transgenic tobacco plants carrying either pWVR220 or pAGF243 were comparable to the non-transformed controls with respect to growth rate, height, morphology of vegetative and floral organs, time of flowering, and flower color patterns. At the time of flowering the transgenic flowers and untransformed control flowers were visually observed for the presence of pollen. The results showed that none of the 18 transgenic lines produce pollen while the control flowers carried large quantities of pollen (Figure D.1.). Anther heads from transgenic lines and untransformed controls were observed under the microscope confirming that anthers from the transgenic lines did not contain any pollen and were empty, while anthers from the untransformed controls contained large quantities of pollen (bottom panel of Figure D.1.)

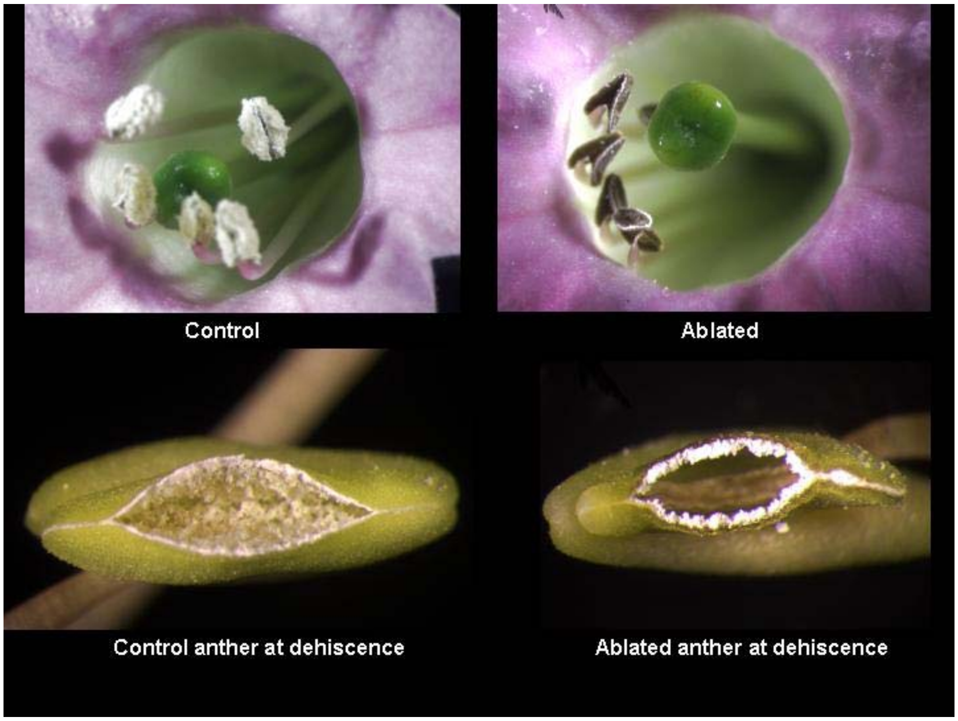

Figure D.1. Visual observation and dissection of flowers from transgenic and untransformed control tobacco lines

In a second experiment, 12 tobacco transgenic lines carrying pAGF243, with the modified version of the PrMC2 promoter, were generated. Visual observation of transgenic flowers indicated that none of the transgenic flowers produce pollen, comparable to the results obtained in transgenic tobacco carrying pWVR220, and confirming that both constructs gave effective pollen ablation in tobacco.

D.2. Pollen ablation in Eucalyptus

Multiple constructs carrying either the original PrMC2 promoter or modified PrMC2 promoter were tested in *Eucalyptus*. Initial evaluations were conducted using *E. occidentalis* as a model system. This species produces flowers starting at ~4 – 6 months from transplanting when grown in the greenhouse and was used as a model system for testing pollen control efficacy of constructs in *Eucalyptus*. Transgenic *E. occidentalis* were grown in containment in our greenhouse facilities in Berkeley County, South Carolina. Constructs containing genes of commercial interest combined with the pollen control cassette were also tested in the EH1, *E. grandis* x *urophylla* hybrid, in field trials at different locations (see below).

Pollen ablation in E. occidentalis

Multiple ramets of 22 *E. occidentalis* lines transformed with construct of pARB598 were grown in pots in a greenhouse. Construct pARB598 contains the pollen ablation cassette with original PrMC2 promoter (the same cassette as in pWVR220) together with a 4-Coumarate CoA ligase (4CL) cassette designed to alter lignin levels. Untransformed *E. occidentalis* were used as controls. Mature flowers were observed on these plants beginning at about 4 months in the greenhouse. The presence of pollen in the flowers was determined by two methods, visual observation of opened flowers in the greenhouse and microscopic observation of dissected anthers collected from individual flowers. In most cases 50 flowers were visually observed and 20 flowers were dissected and analyzed under a microscope for each tree. An artificial “flowering season” was created in the greenhouse by cutting the plants back and removing all flowers at the end of the “first flowering season”. Flowers developed on the newly-grown branches after about one month and were considered as a “second flowering season” (Table D.2.1.).

Both the visual and microscopic observations revealed that all flowers from 21 of the 22 transgenic lines did not produce any pollen (Table D.2.1.). Yellow-colored pollen grain clusters (appearing as a powdery substance on the surface of anther heads) was clearly seen on the flowers of the untransformed controls (Figure D.2.1.) while microscopic analysis showed the complete absence of any pollen-like structures in anthers from transgenic lines (Figure D.2.2). In one transgenic line (TEO500014) a very small amount of pollen, estimated at about 1% of normal levels, was observed in two of the four ramets analyzed in the first flowering season.

Table D.2.1. Results of visual and microscopic observation of flowers from *E. occidentalis* transgenic lines with pARB598 and untransformed controls for the presence of pollen

	Pollen Observed – First Flowering Season		Pollen Observed – Second Flowering Season	
Line ID	Visual	Microscopic	Visual	Microscopic
TEO500000	No	No	No	No
TEO500001	No	No	No	No
TEO500002	No	No	No	No
TEO500003	No	No	No	No
TEO500004	No	No	No	No
TEO500005	No	No	No	No
TEO500006	No	No	No	No
TEO500007	No	No	No	No
TEO500008	No	No	No	No
TEO500010	No	No	No	No
TEO500011	No	No	No	No
TEO500012	No	No	No	No
TEO500014*	No	No/reduced*	No	No
TEO500015	No	No	No	No
TEO500016	No	No	No	No
TEO500017	No	No	No	No
TEO500018	No	No	No	No
TEO500019	No	No	No	No
TEO500020	No	No	No	No
TEO500021	No	No	No	No
TEO500022	No	No	No	No
TEO500023	No	No	No	No
Untransformed control	Yes	Yes	Yes	Yes

* Of the 4 ramets of this transgenic line analyzed 2 produced a small quantity of pollen, which was determined to be about 1% of that of a flower from an untransformed control. The other 2 ramets did not produce any pollen. These two pollen-producing ramets were removed after the “first flowering season”.

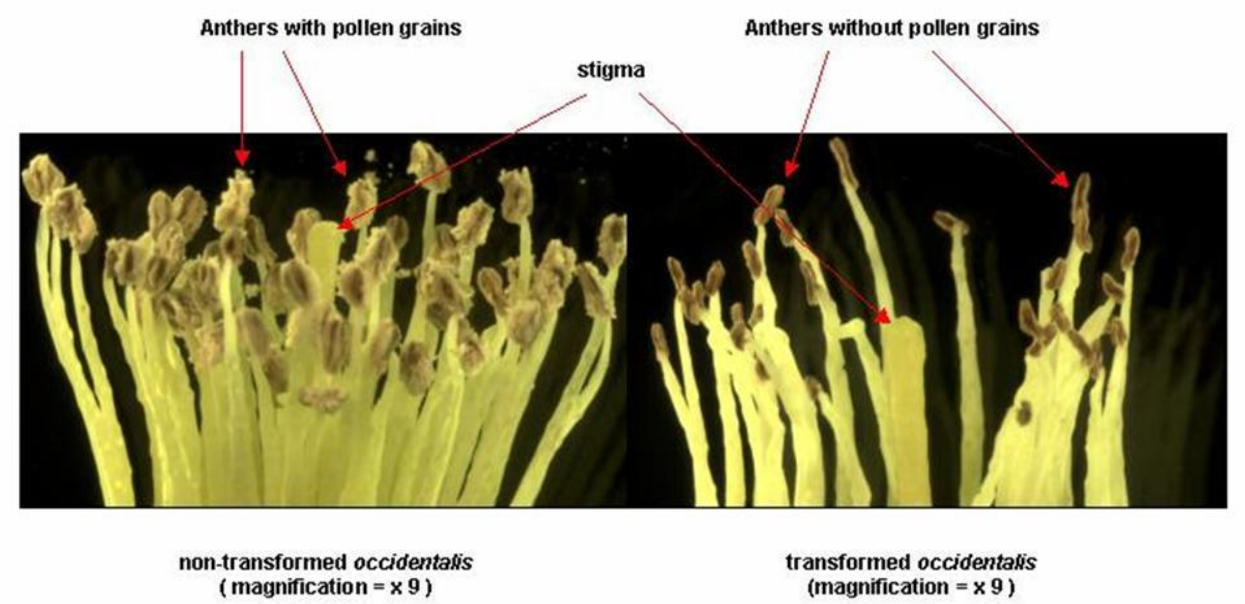

Figure D.2.1. Comparison of *E. occidentalis* floral anther heads between a transgenic flower containing a pollen ablation cassette (pARB598) and a flower from an untransformed control.

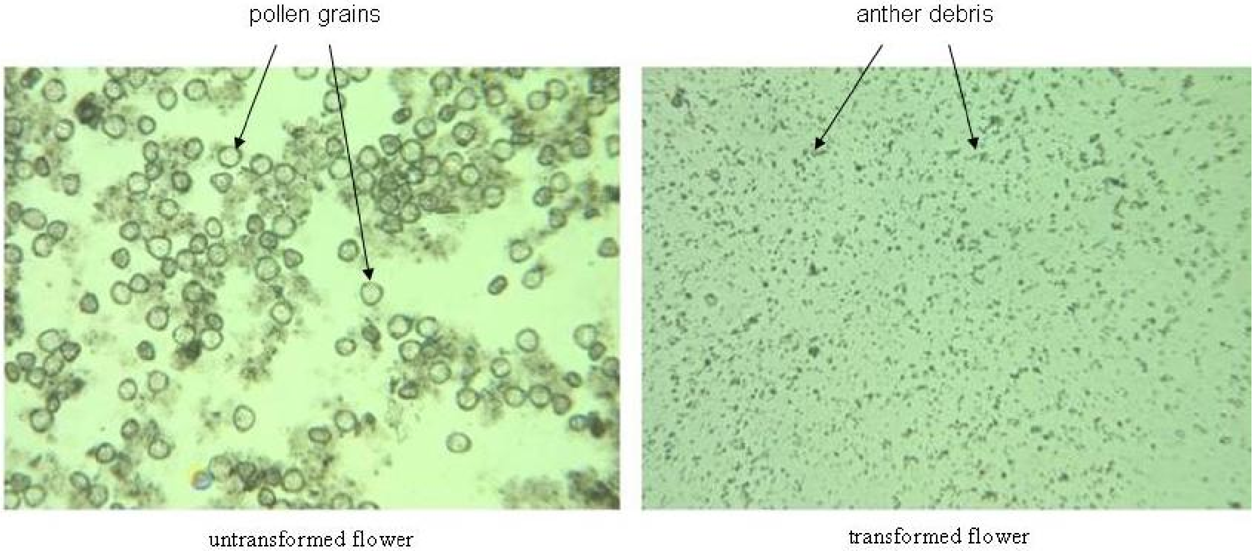

Figure D.2.2. Microscopic observation of dissected unopened *E. occidentalis* flowers from a transgenic line with pARB598 and an untransformed control. Magnification = X200

The pollen ablation cassette based on the modified PrMC2 promoter was also tested in *E. occidentalis*. Six transgenic lines carrying pAGF243 were grown and analyzed in the greenhouse. The transgenic flowers of the 6 lines did not produce pollen determined by both visual and microscopic observation (Table D.2.2)

Table D.2.2. Results of visual and microscopic observation of flowers from *E. occidentalis* transgenic lines with pAGF243 and untransformed controls for the presence of pollen

Line ID	Pollen Observed – First Flowering Season		Pollen Observed – Second Flowering Season	
	Visual	Microscopic	Visual	Microscopic
TEO521513	No	No	No	No
TEO521514	No	No	No	No
TEO521515	No	No	No	No
TEO521516	No	No	No	No
TEO521518	No	No	No	No
TEO521520	No	No	No	No
Untransformed control	Yes	Yes	Yes	Yes

Pollen ablation in hybrid Eucalyptus

Two altered lignin constructs containing the pollen ablation cassette were tested in field trials in central Florida from 2004 to 2007 (APHIS Notification # 04-246-03n). The constructs, pARB598 and pARB599 contain different versions of a modified *Eucalyptus* 4CL gene aimed at altering lignin levels. Both constructs contain the PrMC2-based pollen ablation cassette from pWVR220. Unopened immature flowers were collected from the transgenic trees in mid-summer 2006. Note that none of the trees were allowed to produce mature flowers in this trial. The immature flowers were returned to our laboratories where they were dissected and anthers placed in water and squashed to release any pollen. The solution was then observed under a microscope for the presence of pollen. Three immature flowers were dissected for each transgenic tree with a few transgenic lines having multiple ramets. In several cases where no pollen was observed it was deemed that the flowers were too immature to provide conclusive results. However, a total of 28 lines had flowers that were judged to be sufficiently mature to observe pollen if it was present. Table D.2.3 below shows the results of microscopic observation of the dissected flowers. Of the 28 lines which gave data 26 of these showed no pollen. Two lines had flowers that showed the presence of pollen (Table D.2.3) and trees for these lines were removed from the test.

In 2007, immature flowers were again collected and returned to the laboratory for analysis. Data were obtained for 9 transgenic lines none of which produced pollen (Table D.2.3).

Table D.2.3. Results of microscopic observation for the presence of pollen of dissected immature flowers of hybrid *Eucalyptus* with two constructs in indicated years

Line ID	Construct	Observation of Pollen in Dissected Flowers	
		2006	2007
EH1	none	Yes	Yes
TGU000070	pARB599	No	n/a
TGU000074	pARB599	No	n/a
TGU000078	pARB598	No	No
TGU000090	pARB598	No	n/a
TGU000094	pARB598	Yes	n/a
TGU000122	pARB598	No	n/a
TGU000130	pARB598	Yes	n/a
TGU000140	pARB598	No	No
TGU000141	pARB598	No	No
TGU000142	pARB598	No	n/a
TGU000156	pARB598	No	No
TGU000160	pARB598	No	No
TGU000161	pARB598	No	n/a
TGU000163	pARB598	n/a	No
TGU000165	pARB598	No	n/a
TGU000172	pARB598	No	n/a
TGU000186	pARB599	No	n/a
TGU000188	pARB598	No	No
TGU000198	pARB599	No	n/a
TGU000332	pARB599	No	n/a
TGU000340	pARB599	No	n/a
TGU000343	pARB599	No	n/a
TGU000344	pARB599	No	n/a
TGU000345	pARB599	No	No
TGU000346	pARB599	No	n/a
TGU000350	pARB599	No	n/a
TGU000368	pARB599	No	No
TGU000372	pARB599	No	n/a
TGU000392	pARB599	No	n/a

n/a: In some cases flowers were either too immature to obtain conclusive results or were not collected for that year.

D.3.Pollen Ablation in Pine

Test NRT0017

In order to test the pollen ablation cassette in a pine species we transformed Pitch x Loblolly (P x L) hybrid pine (*Pinus rigida* x *Pinus taeda*) with pWVR220. This hybrid is known to produce flowers earlier than other pines such as loblolly pine. To further expedite the collection of pollen ablation data young shoots of the transgenic hybrid pine were grafted on 7-year-old loblolly pine trees in a field trial at a site in southern Georgia in 2005 (Notification # 04-352-05n, Permit # 07-346-105r, ArborGen reference

NRT0017). The pWVR220 construct in these tests included the pollen ablation cassette and selectable marker only. The field test also included untransformed control grafts as well as lines transformed with a marker gene control construct without *barnase*. Grafting has been employed to promote early flowering on selected grafted individuals by the forest industry for many years in an effort to accelerate traditional pine breeding programs. The grafts were monitored for pollen cone development and selected pollen cone clusters were bagged using clear cellulose (sausage casing) bags to prevent release of transgenic pollen, with any remaining pollen cones being removed prior to maturation. The number of individual pollen cones in a cluster ranged from 1 to 26 with an average 10 for each cluster. The presence of pollen in the transgenic pollen cones was determined both by visual observation of bagged pollen cone clusters and microscopic observation of dissected individual pollen cones. Between one and three grafts were analyzed for each line and in most cases, three pollen cone clusters were bagged on each graft, although the development of pollen cone clusters on individual grafts differed between years. Where available, three individual pollen cones were sampled for dissection and microscopic observation from each bagged cluster. The sampled individual pollen cones were put into water in a microcentrifuge tube and pollen grains were released from the cones by applying crushing using a plastic pestle. The extracted pollen cone samples were observed under a compound microscope for the presence of pollen. Samples were compared with pollen cones from untransformed controls.

In 2006 (one year after grafting), 13 of the 17 transgenic lines in the test developed pollen cones. Visual observation suggested that all transgenic pollen cones degenerated and no pollen was found inside the bags (Table D.3.1.; Figures D.3.1. and D.3.2.). In contrast, control transgenic pollen cones (GUS) and untransformed pollen cones produced large quantities of pollen inside the bags. In the laboratory pollen cones were sampled from the bags and dissected then observed under a microscope. No pollen was present in the pollen compartment (the space between two scales) (Figure D.3.3.), and observation under higher magnification did not find individual pollen grains inside transgenic pollen cones (Figure D.3.4.).

In 2007, all 17 transgenic lines developed pollen cones. In 2008, the only surviving graft of one line had died during 2007 but grafts of the remaining 16 lines of grafts all developed pollen cones but no pollen was detected in the transgenic lines (Figure D.3.5.) except for GUS control lines. We therefore had three years' of pollen ablation data for 13 lines, with two years' data for three additional lines and one year data for one line. The results across all these observations are shown in Table D.3.1. In all cases except one none of the transgenic samples produced any detectable pollen. This one exception was in transgenic line TRT001343. In the 2006 observation, one graft of this line developed pollen cone clusters but no pollen was produced in any of the three clusters analyzed. In 2007, two of ten pollen cones collected from one graft of this line produced pollen comparable to the controls while the other 8 pollen cones from this graft, and cones from two other grafts of this line did not produce any pollen. In 2008, 26 pollen cones were analyzed for this graft of line TRT001343 and two were observed to produce a small amount of pollen. When observed under the microscope this pollen appeared small and undeveloped relative to wild-type pollen. None of the 24 other cones analyzed produced any pollen, nor did pollen cones from the other two grafts of this line. Over the three years of observations in this experiment approximately 3,700 male cones were visually inspected and 671 observed under the microscope. Across all of these samples only the four cones noted above on one graft of line TRT001343 produced any detectable pollen.

Table D.3.1. Results of visual and microscopic observation of pollen in the transgenic pollen cones carrying ArborGen pollen ablation cassette

	Presence of Pollen in Pollen Cones:					
	2006		2007		2008	
Line ID	Visual	Microscopic	Visual	Microscopic	Visual	Microscopic
TRT001305	No	No	No	No	No	No
TRT001308	N/A*	N/A	No	No	N/A	N/A
TRT001312	No	No	No	No	No	No
TRT001315	No	No	No	No	No	No
TRT001317	N/A	N/A	No	No	No	No
TRT001322	No	No	No	No	No	No
TRT001324	No	No	No	No	No	No
TRT001329	No	No	No	No	No	No
TRT001330	N/A	N/A	No	No	No	No
TRT001333	No	No	No	No	No	No
TRT001334	No	No	No	No	No	No
TRT001335	No	No	No	No	No	No
TRT001338	No	No	No	No	No	No
TRT001339	No	No	No	No	No	No
TRT001341	N/A	N/A	No	No	No	No
TRT001343	No	No	No/Yes**	No**	No/limited**	No**
TRT001344	No	No	No	No	No	No
GUS***	Yes	Yes	Yes	Yes	Yes	Yes
Untransformed control	Yes	Yes	Yes	Yes	Yes	Yes

* N/A, not applicable. No pollen cones developed or were analyzed in that year.

** In 2007 two of 10 pollen cones from one of three grafts produced pollen, while in 2008, 2 of 26 pollen cones from the same graft produced a small amount of abnormal pollen. The majority of the pollen cones collected from this graft plus two other grafts of this line did not produce pollen. See text for details.

*** GUS controls did not contain the pollen ablation cassette and had no effect on pollen formation.

Figure D.3.1. Images of bagged pollen clusters collected in 2006. No pollen was found inside the bag containing transgenic pollen cones (right), while large quantities of pollen in the transgenic control bag (left, GUS) can be easily seen.

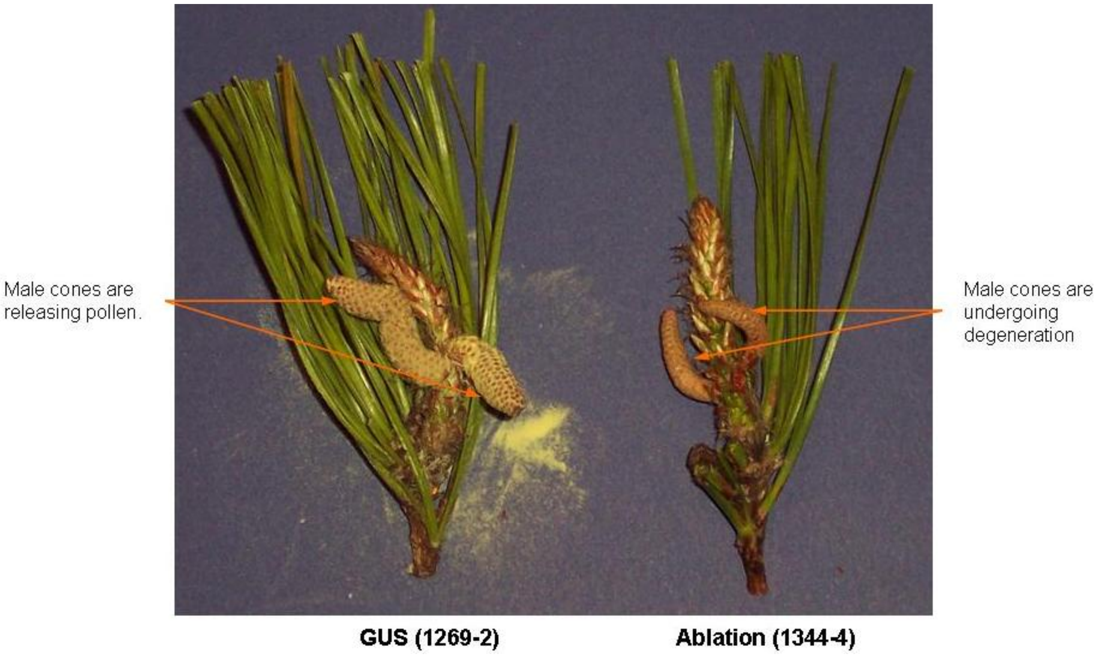

Figure D.3.2. Image of the pollen cones shown in Figure D.3.1. after removal from the bags. The transgenic cones were degenerated and no pollen was released.

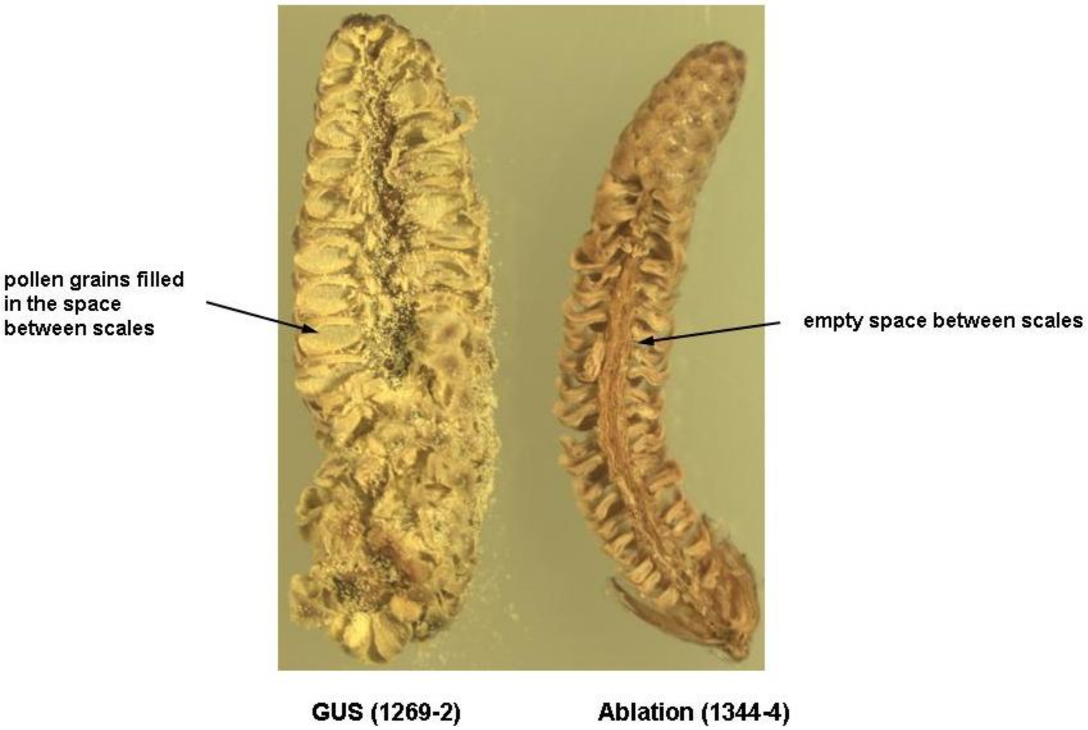

Figure D.3.3. Pollen cones shown in Figure D.3.2. cut along the axis of the cone and observed under a dissecting microscope. Pollen was not present in the pollen compartment (the space between two scales). Magnification = X6

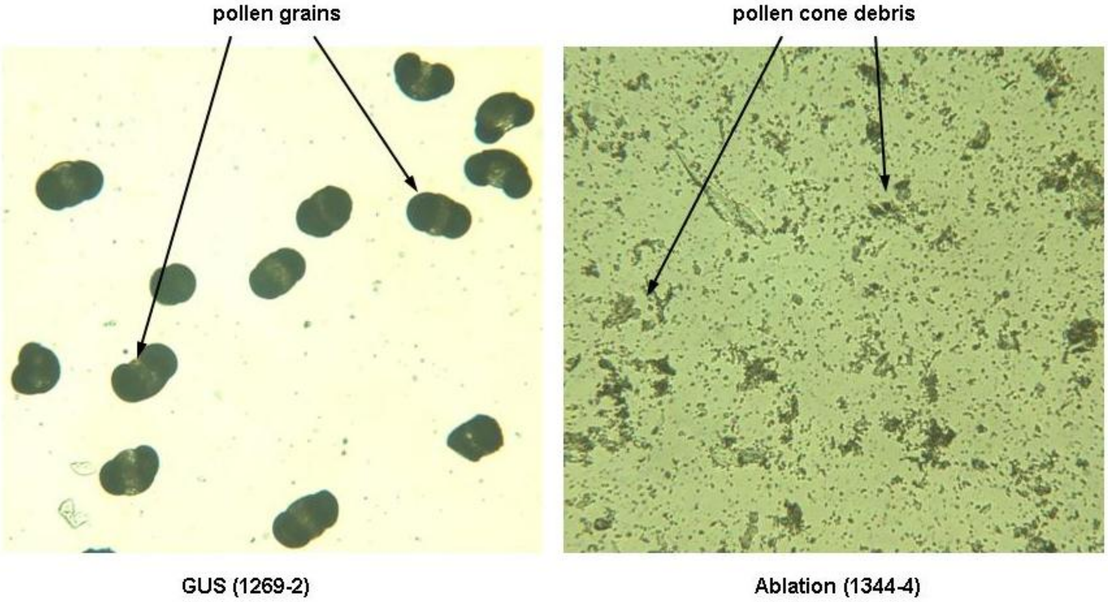

Figure D.3.4. Image of tissue sampled from the pollen cones shown in Figure D.3.3. under a compound microscope. Magnification = X200

Figure D.3.5. Five bags containing transgenic and 5 bags containing untransformed pollen cone clusters collected from grafts in 2008. Transgenic pollen cones carried the pollen ablation cassette in pWVR220. Yellow-colored pollen was clearly visible inside bags containing untransformed pollen cones, while no pollen was found inside the bags with transgenic pollen cones.

Test NRT0015

Lines from the grafting trial described above were also established in a field trial in Charleston County, South Carolina in the summer of 2004 (BRS Notifications # 04-103-01n, 07-102-103n, 08-101-104n, ArborGen reference NRT0015). Initiation of flower development in these field grown trees was delayed compared to grafted material and first occurred in spring of 2007. Developing male cones were bagged on trees for seven translines. Visual observation of 116 male cones did not detect any pollen formation. Twenty mature male cones were dissected in the laboratory for microscopic analysis and none of these showed any pollen development. In 2008 six lines developed male cones, four being the same as lines that were analyzed in 2007. Again, both visual and microscopic observations were made and none of these detected any pollen.

These results confirm the year-on-year stability of the pollen ablation phenotype in those lines for which two year data is available. More importantly, there were six lines in this test that also gave data from the NRT0017 grafting study (TRT001312, TRT001324, TRT001339, TRT001341, TRT001334 and TRT001344) demonstrating that under very different environmental, site, and physiological conditions pollen ablation in these lines was effective and consistent.

Test NRT0020

A second grafting study using pAGF243 that includes the modified PrMC2 promoter was established at the southern Georgia site in spring 2006 (BRS Notification # 05-336-01n, Permit # 07-346-105r, ArborGen reference NRT0020). There was poor graft survival in this trial which resulted in very few surviving lines. In spring 2007 male cones developed on three different translines. For two lines (one ramet and three ramets respectively) no pollen was produced, however, for one of the translines we observed pollen inside bags for both of the ramets that produced male cones. This is the first (and so far only) instance where a line was identified in which the pollen ablation appears to not be effective in pine. Extensive experience in transgenic plants has clearly demonstrated that not all lines express the desired phenotype and, understanding this, developers typically produce a large excess of translines from which to select lines with the desired phenotype.

In 2008 just a single line produced male cones. This was one of the two lines that did not produce pollen in 2007 and this phenotype was again observed in this second year.

Tests NRT0139c and NRT0139d

In spring 2007 grafts were established with constructs that contain genes for altered growth rate in combination with the pollen ablation cassette. Two sets of experiments were initiated: one with grafts on field grown trees at the Georgia site (BRS Notifications 06-283-04n, 07-337-108n and Permit # 07-346-105r, ArborGen reference NRT0139c) and a second with grafts on potted rootstock trees grown at our facilities in South Carolina (BRS Notifications 06-354-102n, 07-348-102n and Permit # 07-346-105r, ArborGen reference NRT0139d) with some overlap in lines between these sets. In spring 2008 both sets produced male cones. At the South Carolina site four lines representing one construct, and one line representing a different construct were analyzed (Table D.3.2). Male cones were examined both visually and microscopically and none of these lines produced pollen. At the Georgia site four lines representing three different constructs were analyzed. Again, none of these showed any evidence for pollen development. Notably, at the Georgia site one line, TRT1001934 gave data for three different grafts, and this same line gave data on one graft in the potted rootstock trees, again indicative of the consistency in the pollen ablation phenotype in lines at different sites and different physiological conditions.

Table D.3.2. Results of observation of pollen ablation with different constructs at two sites

Site	Line	Graft #	Construct	Bags or Pollen Clusters Examined	Presence of Pollen	
					Visual	Microscopic
Georgia	97LP0006*	1	None	1	Yes	N/A
	TRT001898	1	pAGK316	1	No	No
	TRT001934**	1	pWVK312	1	No	No
		2	pWVK312	2	No	No
		3	pWVK312	1	No	No
	TRT001963	1	pAGK316	1	No	No
	TRT002058	1	pAGK321	3	No	No
South Carolina	TRT001933	1	pWVK312	1	No	No
	TRT001934**	1	pWVK312	1	No	No
	TRT001942	1	pWVK312	1	No	No
	TRT002005	1	pWVK312	3	No	No
	TRT002086	1	pAGK321	1	No	No

* Non-transgenic control

** Line TRT1001934 gave data at both sites

From 2005 to 2008, across the different experiments in P x L pine, data were obtained from a total of 29 different lines, representing five different constructs. Only two lines showed pollen development and in one of these the pollen ablation phenotype was partially effective. Among those lines where pollen ablation was observed, stability and consistency in the phenotype were both demonstrated by several cases where multiple ramets were analyzed and data were obtained for the same lines growing at different sites under different conditions. In 2009 and 2010, a total of 35 additional P x L grafted translines and 28 Loblolly pine grafted translines carrying these constructs have been analyzed for pollen production and none of these translines produced pollen. From all the grafting and field studies in pine, thus far, pollen ablation data have been obtained from a total of 92 translines representing five different constructs. Only two translines showed production of underdeveloped pollen. It is therefore anticipated that in a small proportion (~2%) of translines the pollen ablation cassette may not function normally.

Overall, these results demonstrate the pollen ablation cassette is functionally stable and effective in a wide variety of species and over multiple growing seasons and under different environmental conditions. The data also confirm that the efficacy of the cassette is independent of any flanking genes (effective across a variety of different constructs) and physiological stage of the trees, and that these results for pollen ablation are highly reproducible.

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Appendix E: Environmental Report

ArborGen Environmental Report
Non-Regulated Status for Freeze Tolerant Hybrid *Eucalyptus* Lines

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LIST OF ABBREVIATIONS AND ACRONYMS

%	percent
AF&PA	American Forest & Paper Association
AFC	Alabama Forestry Commission
APHIS	Animal and Plant Health Inspection Service
BEA	Bureau of Economic Analysis
BMPs	Best Management Practices
BP	Before Present
BRS	Biotechnology Regulatory Services
Cal IPC	California Invasive Plant Council
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CIPC	California Invasive Plants Council
dB	decibels
dBA	A-weighted sound level
DNA	deoxyribonucleic acid
DOE	U.S. Department of Energy
EESI	Environmental and Energy Study Institute
ESA	Endangered Species Act
FABI	Forest Agriculture Biotechnology Institute of South Africa
FAO	Food and Agriculture Organization
FDA	U.S. Food and Drug Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLEPPC	Florida Exotic Pest Plant Council
FR	Federal Regulation
FTE	Freeze Tolerant Eucalyptus
GCRP	U.S. Global Climate Research Program
GE	genetically engineered
GFC	Georgia Forestry Commission
GHG	greenhouse gas
HGT	horizontal gene transfer
IFAS	Institute of Food and Agricultural Sciences
kg	kilograms
LDAF	Louisiana Department of Agriculture and Forestry
Ldn	day/night average sound level
Leq	Equivalent sound level
MDEQ	Mississippi Department of Environmental Quality
MFC	Mississippi Forestry Commission
MHT	major habitat types
mm	millimeters
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OSHA	Occupational Safety and Health Administration

LIST OF ABBREVIATIONS AND ACRONYMS

PO_4	phosphate
PPE	personal protective equipment
PPQ	Plant Protection and Quarantine
ROI	Region of Influence
SO_2	sulfur dioxide
TFS	Texas Forestry Service
RCW	red-cockaded woodpecker
SAD	Sudden Aspen Decline
SCFC	South Carolina Forestry Commission
U.S.	United States
USACE	U. S. Army Corps of Engineers
USCB	U.S. Census Bureau
U.S.C.	United States Code
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compound

Environmental Report

A. Description of Proposed Action and Alternatives

Proposed Action

The proposed action is for Animal and Plant Health Inspection Service-Biotechnology Regulatory Services (APHIS-BRS) to determine that freeze tolerant hybrid *Eucalyptus* lines 427 and 435, and plants propagated from these lines, should no longer be regulated under 7 Code of Federal Regulations (CFR) Part 340. Granting of non-regulated status would indicate that APHIS-BRS has determined that the genetically engineered (GE) organism is no more of a plant pest risk than an equivalent non-GE organism. Non-regulated status means that permits and notifications would no longer be required for introductions of the organism (APHIS, 2007). Thus, under the proposed action, GE freeze tolerant, hybrid *Eucalyptus* trees could be made available for unrestricted planting. As discussed in Section I, the predominant expected uses of these trees would be as a source of hardwood fiber for the pulp and paper industry and as a bioenergy feedstock.

Despite the improved resistance to cold damage exhibited by these GE freeze tolerant *Eucalyptus* (FTE) lines, successful cultivation of GE FTE would be limited to areas with a relatively moderate winter climate in combination with other favorable climatic characteristics, such as precipitation and humidity. These conditions occur mainly in the southern United States (U.S.) in a zone extending from the coastal plain of South Carolina south through Florida and west along the Gulf coastal plain to southeast Texas. Figure A shows this potential planting range within which climatic conditions are expected to support long-term growth of GE FTE and large-scale, commercial plantings may be economically practicable. This range was identified based on consideration of the climatic requirements of the GE FTE lines in conjunction with maps of climate zones (Sunset, 2010) and hardiness zones delineated using average annual minimum temperatures (U.S. Department of Agriculture [USDA], 1990). The northern limit of the planting range was determined by overlaying USDA Hardiness Zone 8b (average annual minimum temperature range 15 to 20 Fahrenheit [°F]) on Sunset climate zone 28 (growing zone delineated based on temperature, precipitation, humidity, seasonal variation) and conservatively basing the planting range on the northern-most limit of each zone in each location from east to west. The extent of the planting range at its western end in Texas was determined based on precipitation and does not extend west of a mapped precipitation zone in which the average annual precipitation is 40.1 to 50 inches per year (based on data from 1961 to 1990).

The southern boundary of the range generally follows the coast, except in Florida. The southern limit of the potential planting range in Florida was based on the southern limit of Sunset climate zone 28 because it approximates the northern limit of the zone in which the non-freeze tolerant parental EH1 *Eucalyptus* variety could be grown. EH1 is not subject to regulation or oversight by BRS. Although planting of GE FTE lines would be more expensive and non-freeze tolerant EH1 could be grown in Florida north to this zone, it is possible that some growers may elect to cultivate the GE FTE lines in central and southern Florida in order to the reduce the possibility of damage from the deep freezes that sometimes occur even in these areas. ArborGen's field trial data confirm that the physiological and growth characteristics of EH1 and the GE FTE lines 427 and 435 are essentially identical when they are grown in the absence of severe freezing temperatures. Thus, the environmental consequences of growing GE FTE lines 427 or 435 instead of EH1 in some locations within this region would be essentially identical for most environmental components. The principal differences between the GE FTE lines and the non-GE EH1 hybrid are the genetic modifications incorporated into the GE lines, and the principal differences in their environmental consequences potentially would be associated with possible gene flow and gene transfer.

Figure A. Potential Planting Range Map

In addition to the likely planting range in the southern U.S., climatic conditions potentially suitable for cultivation of GE FTE lines also may exist along the Pacific Coast from the San Francisco area northward into Oregon. However, substantial planting of GE FTE in this region is considered unlikely due to the demand for the higher-value agricultural crops already cultivated there.

Recent successes in the development of more freeze tolerant, non-GE *Eucalyptus* species in combination with potential new management options and applications in bioenergy have increased the likelihood that there will be a substantial expansion of the areas where non-GE FTE can be grown in the southern U.S. Non-GE FTE is expected to be widely planted within the potential planting range for GE FTE. Under the proposed action, GE FTE lines would become available for planting in place of non-GE FTE as well as other trees and crops within the planting range described above. Commercial growers are likely to prefer GE FTE lines over non-GE FTE because they are expected to have better growth rates than non-GE FTE. In addition, the GE FTE lines are modifications of a well characterized hybrid variety grown in South America and known to have superior wood quality and good tree form, which is advantageous for harvesting and transport, and is adaptable to a variety of soil types and environments.

No Action Alternative
Under the no action alternative, APHIS-BRS would deny the petition for determination of non-regulated status for GE FTE lines 427 and 435, and plants propagated from these lines. Consequently, these GE FTE lines would continue as a regulated article and would not become available for unrestricted introduction. Under the no action alternative, the existing conditions in potential silvicultural areas would not remain static but would continue to evolve in the absence of GE FTE. The growing demand for hardwood for use in the pulp and paper industry and for short-rotation, purpose-grown trees for use as bioenergy feedstock is expected to drive the introduction of non-GE FTE species, which are not regulated by APHIS-BRS, within the potential planting range for GE FTE described above. Therefore, impacts from the introduction of non-GE FTE are included in the evaluation of the no action alternative. These impacts would be expected to occur regardless of the determination made by APHIS-BRS regarding GE FTE and would not be considered in making that determination. Similarly, non-freeze tolerant EH1 hybrid *Eucalyptus* would continue to be grown in central and southern Florida, and their cultivation within these areas may expand under the no action alternative.

B.Affected Environment (within potential GE Eucalyptus growing range)

1. Forestry and Agriculture

a) Commercial forestry

(1) Current forestry commodities

Forestry commodities for the potential planting range include saw logs, veneer logs, pulpwood, composite panels, posts, poles, and fuelwoods of both hardwood and softwood varieties. The number and type of harvesting operations within the planting range for each state is provided in the next section. The majority of forestland in the southeast is privately owned. Reports of studies conducted do not generally provide specific information on forest types, locations, or practices in order to keep the anonymity of private owners.

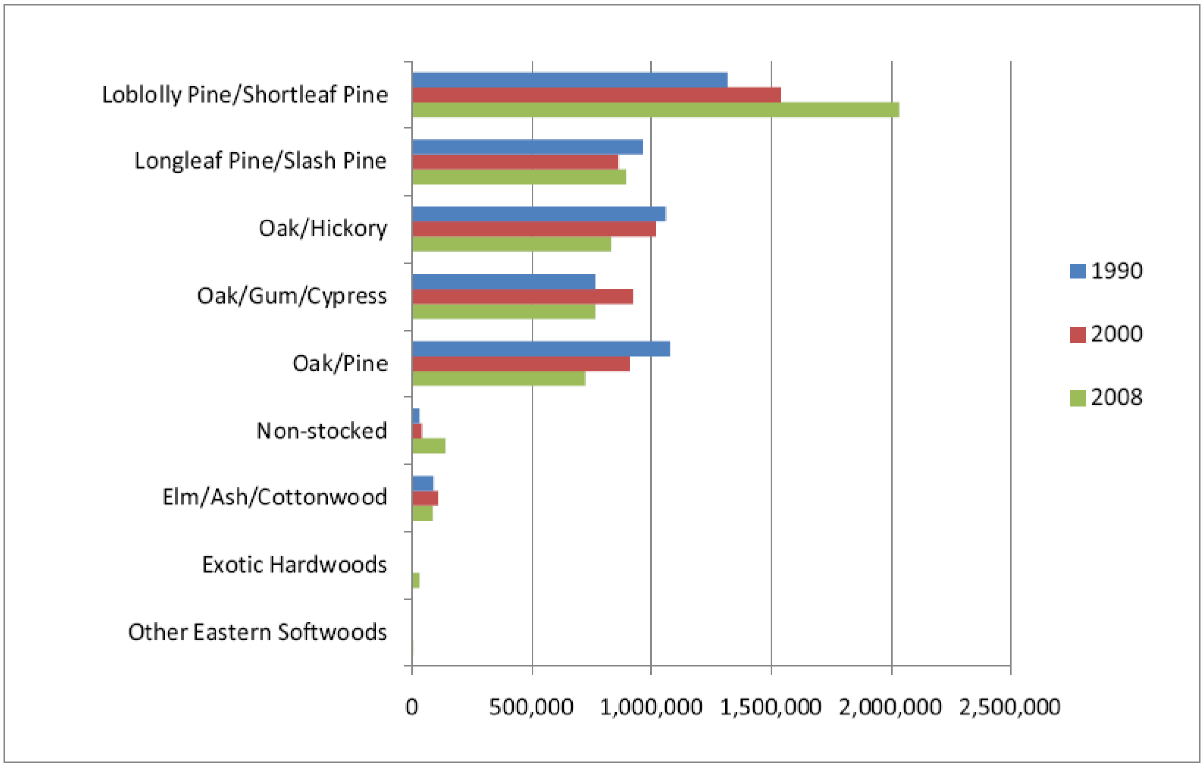
(2) Geographic areas/acreage in production

The following sections provide information on timber harvest and output within the planting range. The descriptions are provided by state.

Alabama

An assessment of timber product output and use (Schiller and Hendricks, 2007) reported that the timber product output for Alabama in 2007 was 1.10 billion cubic feet, of which 828 million cubic feet was comprised of softwoods. It is estimated that 86% of softwood produced consisted of loblolly pine (*Pinus taeda*) and shortleaf pine (*Pinus echinata*). Other softwoods included longleaf pine, slash pine (*Pinus elliottii*), and yellow pines. Hardwoods are primarily made up of oak (43%), sweetgum (20%), yellow poplar (10%), hickory (6%), maple (4%), blackgum (4%) and other hardwoods (13%). Across all products, 84% of the timber harvested is processed in Alabama mills along with imported materials (Schiller and Hendricks, 2007).

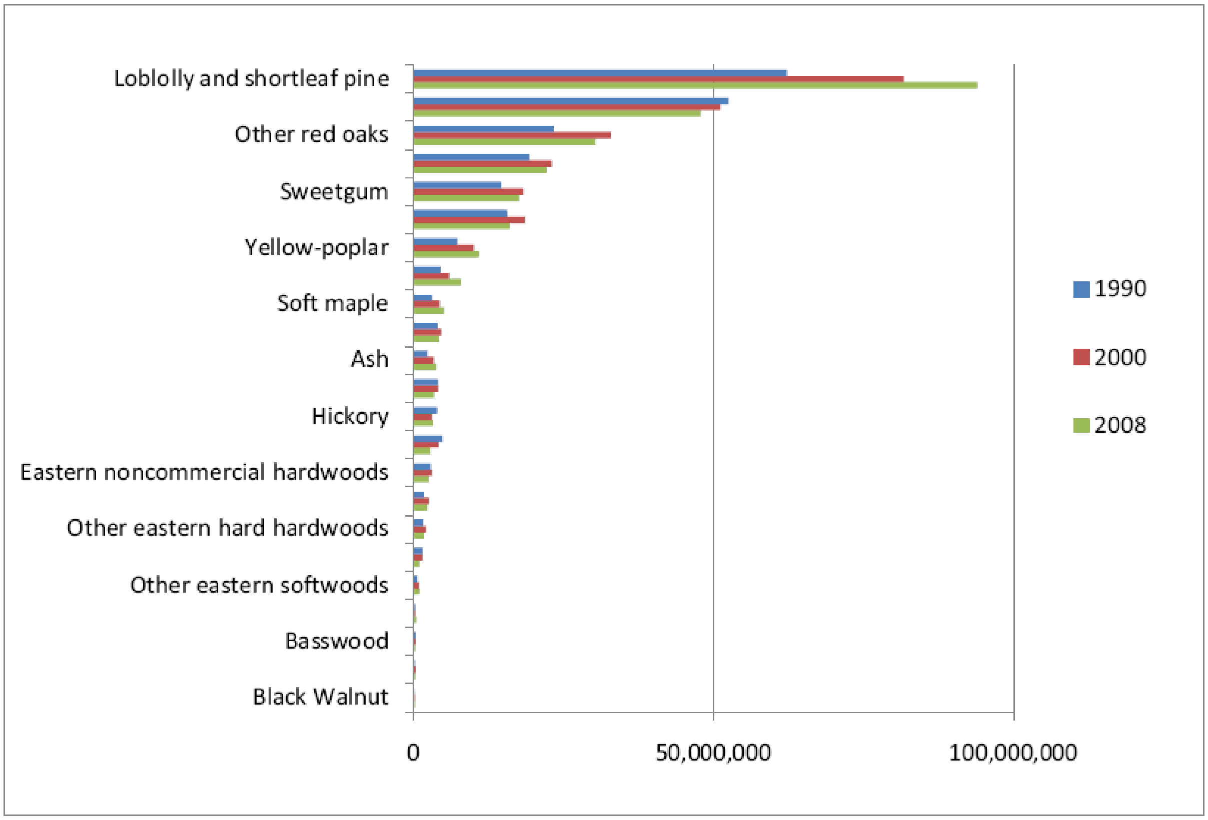
The portion of Alabama that falls within the potential planting range for GE FTE includes Baldwin and Mobile Counties, which are within the Gulf Plain Region. Figures B and C present the forested area and timber volumes produced in the Gulf Plain Region of Alabama.



Gulf Plain: Timberland Area by Forest Type Group and Year, 1990-2008
FIA data for Baldwin, Choctaw, Clarke, Conecuh, Covington, Escambia, Geneva, Houston, Mobile, Monroe, and Washington counties.

Figure B. Forested Area (in acres) within the Gulf Plain Region of Alabama (AFC, 2010)

Mobile County timber is harvested for a hardwood saw log operation and a softwood pole operation, while Baldwin County timber is harvested for a hardwood pulpwood operation and a softwood veneer operation. There are 70 timber harvesting operations state-wide (Bentley and Johnson, 2008a). An undetermined area of Alabama's forestland is impacted every year by oil and gas drilling and surface mining of coal, sand, gravel, and other natural resources, as well as urbanization. In addition, the forest products industry in Alabama is adversely affected by the increase in imports due to the expansion of short-rotation plantations in other countries (Alabama Forestry Commission [AFC], 2010).



Gulf Plain: Timberland Volume by Species Group (Tons) and Year, 1990-2008
FIA data for Baldwin, Choctaw, Clarke, Conecuh, Covington, Escambia, Geneva, Houston, Mobile, Monroe, and Washington counties.

Figure C. Volume of Timber Produced in the Gulf Plain Region of Alabama (AFC, 2010)

Florida

In 2007, Florida retained 83% of harvested timber for processing in Florida mills (Johnson et al., 2007). An assessment of the Florida timber product and output (Johnson et al., 2007) showed the total 2007 output to be 468 million cubic feet of softwood and 23 million cubic feet of hardwood. Thirty-six counties spanning the northeast and northwest regions of Florida are overlapped by the potential planting range for GE FTE. These counties contain the majority (70 of 82) of timber harvesting operations in the state. Harvesting operations in Florida are broken down into the following categories with the numbers of harvesting operations in 2008 shown for each (Bentley and Johnson, 2008b):

- Softwood saw log, 15
- Hardwood saw log, 6
- Softwood pulpwood, 11
- Hardwood pulpwood, 10
- Softwood composite panel, 4
- Softwood veneer, 8
- Softwood pole, 4
- Softwood post, 3

- Softwood mulch, 2
- Softwood fuelwood, 4
- Hardwood fuelwood, 3

Of the above forests, longleaf pine makes up 78% of the softwood harvested. Other softwoods include loblolly-shortleaf pines (11%), yellow pines (6%), cypress, and cedar (5%). The majority of hardwoods (38%) are oaks. Hardwood forests in Florida are also comprised of 14% blackgum, 10% sweetgum, 4% maple, 2% hickory, 2% yellow poplar and 30% other hardwoods (Johnson et al., 2007). Florida has a long growing season with high moisture, which results in highly productive, short–rotation, woody crops. These crops have been studied by the University of Florida for biomass potential since the late 1970s (Stricker et al., 2000).

Georgia

Portions of 32 counties in Georgia are within the potential planting range for GE FTE. Natural vegetation in this area consists largely of longleaf, loblolly, and slash pines; a small portion of the area is cypress/tupelo/gum forest. Forests in this area are classified as loblolly-shortleaf pine, longleaf-slash pine (largest), and oak-gum-cypress. Commercial forests cover approximately 50% to 91% of these counties (Coder, 1996). Table C provides the annual yield for the most common timber varieties in the potential planting range.

Table B.1.1.b(iii). Annual Yield for Common Timber Varieties in the Potential Planting Range

Timber Variety	**Production** (cubic feet/acre/year)
Longleaf pine	43-114
Slash pine	129-186
Shortleaf pine	92-102
White oak	43-114

Source: Georgia Forestry Commission (GFC), 2010a.

Hardwood forest types make up 41% of Georgia's forestland, softwood (mostly pine) makes up 45%, and mixed oak/pine accounts for 12%. Approximately 56% of forested lands in the state are family owned, 22% are corporate owned, 12% are owned by the forest industry, and the other 9% consist of public and national forests (GFC, 2010a).

Georgia has 182 primary forest products manufacturers with 94 saw mills, 11 veneer and panel product mills, 12 pulp mills, and 65 mills that produce other miscellaneous products (GFC, 2010a). Harvesting operations within the potential planting range for GE FTE includes eight softwood and one hardwood saw log operations; nine softwood and four hardwood pulpwood operations; two softwood and two hardwood veneer operations; three softwood pole and one softwood post operations (Bentley and Harper, 2004). These account for almost one-third of all harvesting operations in the State of Georgia.

Louisiana

The state of Louisiana had a timber product output and plant byproduct of 1.19 billion cubic feet in 2005 (Bentley et al., 2005a). Softwood product totaled 712 million cubic feet, of which 86% was loblolly and shortleaf pine and 13% was longleaf and slash pine. Cypress and other yellow pines made up the remainder of softwood product. Hardwood product was primarily from oaks (48%), sweetgum (19%), and other hardwoods (19%). The remaining varieties included blackgum, maples, hickory, and ash. Total hardwood product in 2005 was 175 million cubic feet (Bentley et al., 2005a). Louisiana has over 13.8 million acres of forestland and it is estimated that over 3 million tons of biomass could be generated each year from residue.

Figure D. Louisiana Timber Area Map (LDAF, 2010)

The potential planting range covers 43 counties in Louisiana. These counties fall within Areas 2, 3, 4, and 5 as denoted by the Louisiana Department of Agriculture and Forestry (LDAF; Figure D). Quarterly reports show the major products produced from these areas are pine and mixed hardwoods. Area 3, the southwestern portion of the state produces the largest volume of timber in the planting range (LDAF, 2010).

Mississippi

The 13 counties of Mississippi that fall within the planting range are forested with 3,714,265 acres within the East Gulf Coastal Plain Ecoregion (Mississippi Forestry Commission [MFC], 2010). Within these counties there are 14 sawmill, one veneer, one plywood, and two other mills. Loblolly and shortleaf pine accounted for 82% of the softwoods harvested in Mississippi. Longleaf and shortleaf pine accounted for 13%, with cypress, cedar, and other yellow pines accounting for 5%. Hardwood harvests consisted of oaks (50%), sweetgum (16%), yellow poplar (7%), other hardwoods (16%), hickory (5%), blackgum (4%), and maples (2%) (Bentley et al., 2005b). In 2005, the total timber product output for Mississippi was 1.42 billion cubic feet, of which, 781 million cubic feet was softwood products (Bentley et al., 2005b).

South Carolina

South Carolina’s total product output for 2007 was 613 million cubic feet (Johnson and Adams, 2007). The portion of the planting range that occurs within South Carolina includes eight counties. Eighteen of the state’s 99 harvesting operations fall within these eight counties. These 18 individual operations include the following types and numbers (Bentley and Johnson, 2006):

- Softwood saw log, 5
- Hardwood saw log, 3
- Softwood pulpwood, 5

- Hardwood pulpwood, 3
- Softwood veneer, 2

South Carolina has two fuelwood operations in the central region of the state (Bentley and Johnson, 2006). Loblolly and shortleaf pine provide the majority of South Carolina's softwood volume (88%). Longleaf and slash pines made up 7% of the softwood output, and a combination of pines and cypress account for the remaining 5% (Johnson and Smith, 2005). Softwood forests occupy 5.9 million acres in South Carolina (South Carolina Forestry Commission [SCFC], 2010). Hardwood production in South Carolina consists mainly of oaks (37% of the total output), followed by sweetgum (25%), other hardwoods (16%), blackgum (7%), yellow poplar (6%), maples (5%), and hickory (4%) (Johnson and Smith, 2005).

Texas

The 37 counties of Texas that lie wholly or partially in the potential planting range for GE FTE are within the Piney Woods, Western Gulf Coastal Plain, Post Oak Savannah, and Blackland Prairies ecoregions. Most of the commercial forestry operations occur in the Piney Woods, where about half of the region is forested. Loblolly-shortleaf pine is the predominant forest type in eastern Texas, accounting for 41% of all timber (TFS, 2009). The Western Gulf Coastal Plain is nearly at sea level and slowly drained. The Post Oak Savannah is forested mainly with post oak, and other oaks are widespread throughout the ecoregion. The Blackland Prairies ecoregion has rich soils and is largely plowed for crops (TFS, 2009).

Just over half of the counties were included in the Eastern Texas Harvest and Utilization Report conducted in 2003 (Bentley and Johnson, 2003). In the utilization report, the southeast region represents the easternmost portion of the potential planting range in Texas (Piney Woods and the northern part of the Western Gulf Coastal Plain ecoregions). Within these 19 counties there are 48 timber harvesting operations, including 11 softwood and three hardwood saw log operations; nine softwood and six hardwood pulpwood operations; 11 softwood and one hardwood veneer operations; four softwood and two hardwood composite panel operations; and one softwood pole operation (Bentley and Johnson, 2003).

(3) Forestry Practices

There are many Best Management Practices (BMPs) and guidelines for the forestry industry. The BMPs for the states in the potential planting range for GE FTE are as follows:

- Alabama's Best Management Practices for Forestry (AFC, 2007)
- Silviculture Best Management Practices (Florida) (FDACS, 2009)
- Georgia's Best Management Practices for Forestry (GFC, 2009)
- Recommended Forestry Best Management Practices for Louisiana (LDAF, 2008)
- Best Management Practices for Forestry in Mississippi (MFC, 2008)
- South Carolina's Best Management Practices for Forestry (SCFC, 1994)
- Texas Forestry Best Management Practices (TFS, 2010)

These primarily address requirements for harvesting and replanting to protect water quality and provide safety measures during prescribed burning. Described below are common forestry practices where guidelines are not as well defined.

Harvesting/Rotation

Harvests vary based on the desired product. Rotation of pine stands is typically 30 to 35 years. Harvests can be made as early as 15 years (Green Hill, 2010). Unmanaged loblolly pine stands can take 50 years to mature into saw timber size trees. Managed, loblolly pine will mature in 25 to 40 years. Density control is important to managing stands. The first thinning (removal of a subset of trees to encourage increased growth at wider spacing of the remaining trees) usually occurs 12 to 15 years after planting. Trees removed by thinning are typically used by the pulp and paper industry. Additional thinnings are typically continued in 5 to 8 year intervals. Final harvest occurs at 25 to 50 years depending on the management used and product desired (University of Arkansas, 2010).

Pesticide Use

The pesticides predominantly used in commercial forestry are herbicides (GFC, 2010b). Herbicides are used to control weeds for site preparation, herbaceous weeds during the first two years after planting, and competing woody vegetation in established trees (Alabama Cooperative Extension System, 2010). Pesticides are registered for use by the U.S. Environmental Protection Agency (USEPA) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The types, amounts, and application procedures are prescribed by BMPs established by the applicable state agriculture and/or forestry departments.

Transportation and Processing

A summary of the processing facilities existing within the geographic area is presented in Section B.1.1.b. Historically, the locations of wood products processing facilities have been established near commercial forestry areas in order to enable the greatest volume of materials to be processed at locations near the areas of harvest. The purpose in establishing these locations has been to minimize transportation distances for the relatively high-volume raw products, and then to transport the lower-volume finished products to their end-use location. However, due to declining inventories and slow hardwood growth rates, the distance between harvesting locations and the existing processing locations has been increasing in recent years, resulting in increases in transportation costs as well as environmental impacts associated with transportation, such as emissions of air pollutants, including greenhouse gas [GHG] emissions, and fossil-fuel use.

Prescribed Fire

Prescribed fire is deliberately used to alter, maintain, or restore vegetation communities (USDA, 2008). Prescribed fires are used in forestry to reduce the risk of wildfire through the buildup of underbrush and other flammable biomass and to eliminate competing vegetation. Prescribed fires are ideally conducted at approximately the same frequency as natural fires occurred historically. Fires are not limited to seasonal constraints; fire frequency is more important than seasonality. The U.S. Forest Service requires Forest Management Plans for all burnable acres located within federally controlled lands (USDA, 2008).

b) Agriculture

A variety of crops are common across the planting range, specifically corn, cereal crops, soybeans, hay, fruits and nuts, cotton and sugarcane. Crop information is shown by state in Table D, and acreages for the various crops were totaled for the counties included in the potential planting range for GE FTE. Many types of cultivation methods are practiced across the range. For instance, Florida utilizes intense irrigation methods due to the sandy soils, non-uniform rainfall distributions, and need for freeze protection in winter and cooling in the summer. In 1998, Florida's irrigated acreage totaled 2.25 million acres, up from 0.45 million acres in 1954. Irrigated crop types include fruit crops, field crops, vegetables, grass/hay (pasture and forage), and ornamentals (Smajstrla and Haman, 1998). As of 2001, about half of Georgia's total cropland was under irrigation. Within the entirety of all seven states, approximately 12.6 million acres were irrigated in 2000 (U.S. Geological Survey [USGS], 2000).

c) Bioenergy

Bioenergy is derived from biological sources. This renewable energy can be used for electricity, heat, and fuel (USDA, 2010a). Biodiesel feedstocks typically include soybean oil, peanut oil, sunflower seed oil, canola oil, chicken fat, and waste grease. Ethanol producing facilities feedstocks include corn, sugar cane, sugar beets, and sweet potatoes. Feedstocks for cellulosic ethanol facilities are switchgrass, wood, hay, plants and garbage (Georgia Environmental Finance Authority, 2010).

Harvesting and mill residues can also be used as bioenergy feedstock. Georgia's forest industry has historically used mill residues such as bark, sawdust, and otherwise unusable wood in addition to process fluids to produce their own energy. Approximately 2.4% of the electricity generated in Georgia is produced from this industry (GFC, 2010c). Table E provides the estimated annual residue from logging or harvesting operations. These estimates are based on the latest harvest and utilization reports available. Additional residues would be available from milling processes.

Table B.1.3(i). Cropland in the Potential Planting Range

Crop	Alabama		Florida		Georgia		Louisiana		Mississippi		South Carolina		Texas	
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
Corn	144	11,325	1,014	63,883	2,194	191,759	782	197,646	220	11,242	704	48,720	858	185,545
Other Cereals	106	10,289	337	23,894	626	55,733	1,963	593,029	21	2,742	252	22,069	1,744	554,476
Soybeans for Beans	194	38,859	387	39,790	748	72,404	2,196	847,686	56	29,202	306	34,606	507	142,360
Other Legumes	0	0	26	5,239	0	0	0	0	0	0	0	0	3	5
Total Hay[1]	1,083	41,289	3,279	158,715	3,485	100,796	5,872	261,861	1,643	69,105	434	17,164	17,386	695,890
Potatoes	19	1,572	40	6,429	13	9	16	44	6	5	0	0	22	243
Sweet Potatoes	16	1,862	5	24	17	35	73	7,246	3	0	0	0	0	0
Other Vegetables	221	2,212	1,151	28,851	1,046	40,116	434	1,852	197	1,296	359	7,176	243	716
Fruits & Nuts	526	9,744	2,192	78,398	3,055	216,288	795	5,952	509	4,679	140	1,428	1,722	30,572
Cotton	67	26,353	338	88,699	1,607	502,714	462	218,682	24	10,898	81	23,907	716	205,517
Tobacco	0	0	176	6,263	761	24,779	21	1,624	0	0	70	1,893	0	0
Other Herbs	0	0	4	11	0	0	34	21,012	0	0	0	0	12	18
Sugarcane	0	0	19	428	0	0	648	325,664	0	0	0	0	0	0
Sugarcane for Seed	0	0	0	0	0	0	431	67,230	0	0	0	0	0	0
Total	**2,376**	**143,505**	**8,968**	**500,624**	**13,552**	**1,204,633**	**13,727**	**2,549,528**	**2,679**	**129,169**	**2,346**	**156,963**	**23,213**	**1,815,342**

[1] Includes alfalfa, grain, wild hay, grass and corn silage, green chop etc.

Source: Purdue University, 2010.

Table B.1.3(ii). Estimated Annual Residue

State	Estimated Annual Residue (million cubic feet)
Alabama[1]	379
Florida[2]	129.3
Georgia[3]	18.7
Louisiana[4]	322
Mississippi[5]	391
South Carolina[6]	176
Eastern Texas[7]	79.5

1. Schiller and Hendricks, 2007
2. Bentley and Johnson, 2008b
3. GFC, 2010a
4. Bentley et al., 2005a
5. Bentley et al., 2005b
6. Johnson and Adams, 2007
7. Report for 19 of the counties included in the planting range; Bentley and Johnson, 2003.

2. Biological Resources

a) Biodiversity

Biodiversity is the number and variety of organisms, both plants and animals, found in a specific geographic region. Biodiversity can be measured by species richness, abundance, and evenness. Typically, a greater availability of complex habitat types results in increased biodiversity. Loss of habitat, habitat fragmentation, predation, invasive species, and diseases are among the factors that influence biodiversity by affecting the survival of individuals and populations (Linder et al., 2004). Patterns of geography and biodiversity are related through the concept of ecoregions. Ricketts et al. (1999) defined an ecoregion as “a relatively large area of land or water that contains a geographically distinct assemblage of natural communities.” They delineated 116 terrestrial ecoregions in North America, nine of which are overlapped by the potential planting range of GE FTE that extends from South Carolina through parts of Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas (Figure E). The potential planting range is the area within which climatic conditions are expected to support long-term growth of GE FTE and where large-scale, commercial plantings may be economically practicable. This range represents the area in which the growth of GE FTE would likely be optimal. However, it is not anticipated that GE FTE plantations would replace all or even most tree plantations within this range, and it is unlikely that they would replace remaining native forests or other natural communities. The brief descriptions of these nine ecoregions (Middle Atlantic Coastal Forests, Southeastern Conifer Forests, Florida Sand Pine Scrub, Southeastern Mixed Forests, Mississippi Lowlands Forests, Western Gulf Coastal Grasslands, Piney Woods Forests, Texas Blackland Prairies, and East Central Texas Forests) which follow provide an overview of the biodiversity within the potential planting range.

Ecoregions in the Potential Planting Range

Middle Atlantic Coastal Forests

The Middle Atlantic Coastal Forests ecoregion extends along the eastern seaboard from Delaware/Maryland south into Georgia, with the western boundary running approximately 65 miles parallel to the eastern shoreline (Figure E). The most diverse freshwater wetland communities in North America occur within this area, in addition to plant communities such as river swamp forests and bottomland forests comprised of bald cypress (*Taxodium distichum*), gum trees, Atlantic white cedar (*Chamaecyparis thyoides*), and swamp tupelo (*Nyssa sylvatica*). This biologically significant region ranks among the top 10 ecoregions in the U.S. and Canada in numbers of reptile, bird, and tree species. Within the potential planting range, this ecoregion type accounts for approximately 20,510 acres (less than 5% of the total acreage in the range) (Ricketts et al., 1999).

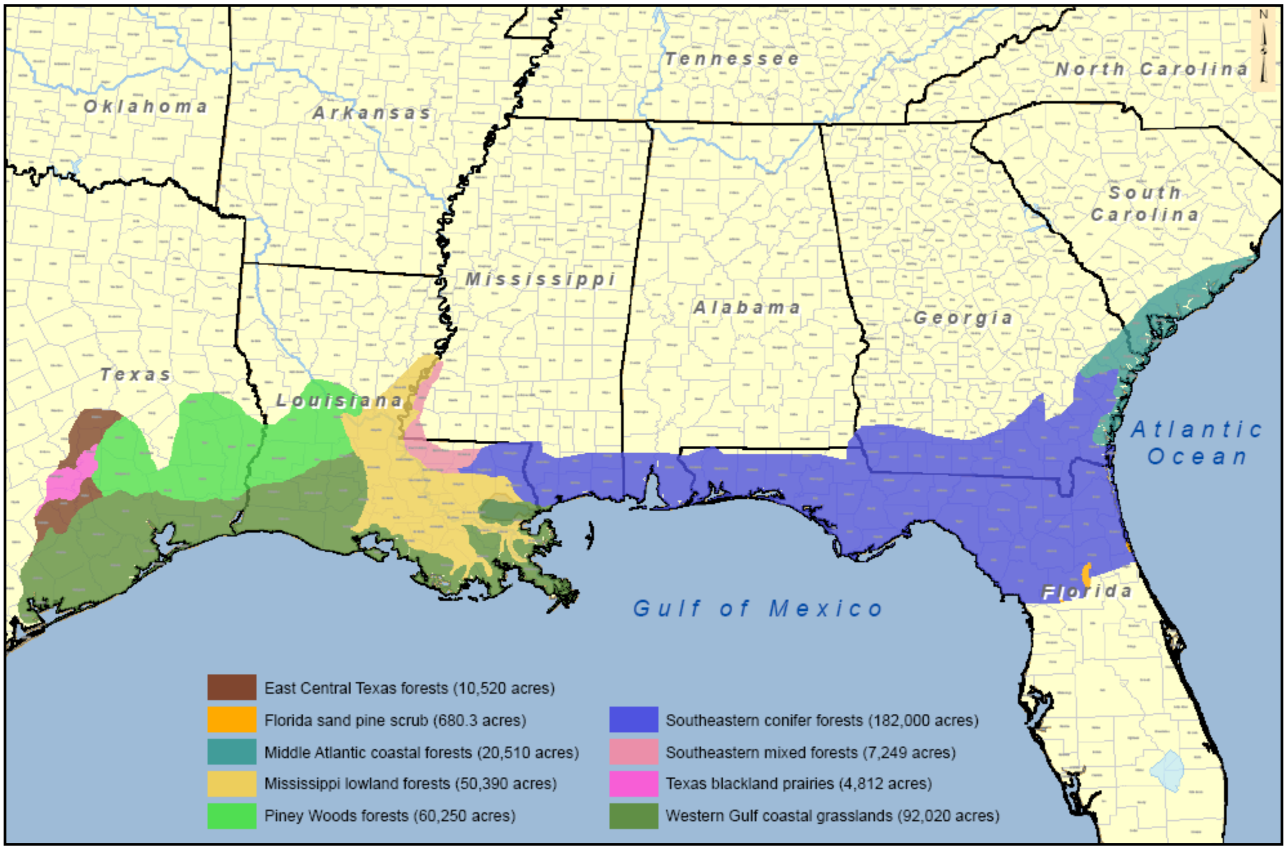


Figure E. Ecoregions (and acreages) within the Potential Planting Range
(Olsen et al., 2001)

Southeastern Conifer Forests

The Southeastern Conifer Forests ecoregion comprise several vegetation community types, including longleaf pine forest, pine savanna, flatwood, and xeric hardwood. This ecoregion covers the largest portion of the potential planting range, approximately 42% (182,000 acres). Southeastern conifer forests span the coastal plain of the southeastern U.S. from Louisiana through Mississippi, Alabama, Georgia, and into Florida; however, the majority of this habitat has been converted to agriculture or tree farms in the southeastern section (Ricketts et al., 1999).

Florida Sand Pine Scrub

The Florida Sand Pine Scrub ecoregion, one of the smallest ecoregions in the U.S., is limited to sandy ridges and limestone areas of central and southern Florida and a narrow area along the Gulf Coast. Scrub habitat accounts for only 680 acres of the potential planting range, along the far southeastern boundary (Figure E). The exceptional biodiversity found in this ecoregion is supported by the fact that 40% to 60% of scrub species are considered to be endemic (found nowhere else). Florida Sand Pine Scrub habitat is characterized by sandy, well-drained, infertile soils that support evergreen oaks and/or Florida rosemary (*Ceratiola ericoides*), with a possible overstory of sand pine (*Pinus clausa*). In recent years, citrus groves and housing developments have severely impacted natural scrub habitats, replacing approximately 85% to 90% of these communities (Ricketts et al., 1999).

Southeastern Mixed Forests

The Southeastern Mixed Forests ecoregion stretches along the piedmont zone through nine states from Maryland to Louisiana. Only the small portion of this ecoregion in southwestern Mississippi and Louisiana (approximately 7,250 acres) is within the potential planting range. Southeastern Mixed Forests have been heavily logged and are now largely converted to agriculture. While oak-hickory-pine forests were the natural vegetation of this geographic area, habitat loss has been consistent across this ecoregion. This is the most heavily settled ecoregion on the East Coast, and approximately 99% of this habitat has been heavily degraded or converted to other uses.

Mississippi Lowlands Forests

The Mississippi Lowland Forests ecoregion covers approximately 12% of the potential planting range (approximately 50,390 acres located mainly in Louisiana). It consists of floodplain habitats such as river swamp forests containing bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*), lower hardwood swamp forests containing a more diverse woody community, backwater flats, and upland transitional forests. The habitats of this ecoregion are an important part of a major flyway used by migratory birds. Over the last decade, the majority of the natural bottomland hardwood forests of this ecoregion have been lost to agriculture or timber. Currently, soybean cultivation is the major land use in this area. Only 4% to 9% of this habitat still exists (Ricketts et al., 1999).

Western Gulf Coastal Grasslands

The Western Gulf Coastal Grasslands ecoregion, extending along the Gulf Coast of Louisiana and Texas, originally was dominated by tallgrass coastal prairie but has experienced severe degradation. Upland portions of this ecoregion contain tall bunch grasses, whereas portions nearby to the Gulf contain sedges (*Carex* spp), gulf cordgrass (*Spartina spartinae*), and salt grass (*Distichlis spicata*). The temperate climate and proximity to the Gulf make this an important region for many grassland birds. The potential planting range includes approximately 92,000 acres of this habitat, including intertidal and estuarine marshes and wetlands; even so, less than 1% of Western Gulf coastal grasslands remain in near pristine condition. Agriculture related to row-crop and rice production and overgrazing is responsible for the greatest loss of this habitat type (Ricketts et al., 1999).

Piney Woods Forests

The Piney Woods Forests ecoregion covers portions of southwestern Arkansas, northwestern Louisiana, and eastern Texas. It accounts for approximately 14% of the potential planting range (approximately 60,250 acres). Pine plantations are common throughout this ecoregion, which is primarily includes oak-hickory-pine forest and shares many similarities with the Southeastern Conifer Forests and Southeastern Mixed Forests ecoregions. Many of the longleaf pine (*Pinus palustris*) forests that were formerly prevalent have been replaced with loblolly pine or slash pine plantations (Ricketts et al., 1999).

Texas Blackland Prairies

The Texas Blackland Prairies ecoregion comprises predominantly grasslands, savannas, and shrublands. Historically, upland tallgrass prairie dominated the natural vegetation of this area. Approximately 4,800 acres along the western boundary of the potential planting range, or slightly greater than 1% of the total potential planting range, is covered by this ecoregion; however, very little of the original vegetation of this region still exists (Ricketts et al., 1999).

East Central Texas Forests

The East Central Texas Forests ecoregion lies completely within Texas. It covers approximately 10,520 acres of the potential planting range. Natural vegetation of the area consists primarily of oak-hickory forests. These forests have greater tree densities and more open habitats with a greater component of hardwoods than the nearby Piney Woods forests. This ecoregion has been affected by a substantial increase in farming and ranching practices in recent years. Agriculture is the main contributor to habitat loss and degradation of natural vegetation in this area; approximately 75% of this area has been converted to agriculture (Ricketts et al., 1999).

Biodiversity of Southern Forests

Biodiversity in the potential planting range has changed with the influx of human population. Native forests have been replaced on a large scale by development, agriculture, and managed forests, or tree plantations. The Southeast experienced a large increase in urban land use between 1990 and 2000, potentially reducing diversity regionally by the elimination of forested habitat (Smith et al., 2009). Additionally, the fire regime has been altered in remaining forests. There are fewer naturally occurring forest fires and fewer prescribed burns allowed near population centers. This change in the fire regime results in an increase in the relative number of late successional species, including oak (*Quercus* spp.), hickory (*Carya* spp.), red maple (*Acer rubrum*), and sweetgum (*Liquidambar styraciflua*). This shift toward later successional species alters the species composition of forest communities. Fragmentation of forest habitat has also affected southern forest biodiversity (South and Buckner, 2004).

The South has been an important source of timber products since Colonial times. Through the early 1900s, forestry practices involved mainly clear cutting without reforestation. By the end of World War II, approximately 29 million acres of land were in need of reforestation. In the 1950s, many trees were planted on both public and private lands in association with the Soil Bank Program. Many of these trees were fast-growing pines due to the increase in demand for pulpwood. Trees were planted on both cutover sites and old agricultural fields. In the process, many methods were developed to combat hardwoods and herbaceous growth that competed with the pines (Fox et al., 2007). Between 1952 and 2000, over 30 million acres of pine plantations were established in the South (Smith et al., 2009). Over the years, intensive management methods such as fertilization regimes and new herbicides have greatly increased yield and shortened rotation times (Fox et al., 2007). As of 2007, the southern U.S. had the highest acreage of planted forest and the highest acreage of privately owned forest in the country. The region also has the largest number of acres of unreserved forestland not set aside for preservation of biodiversity or wildlife habitat. Ten percent of all U.S. forest is currently reserved from wood product use (Smith et al., 2009). As a result of both historical clear cutting practices and later intensive plantation management, the biodiversity of many southern forests has changed substantially compared to natural conditions.

Biodiversity of Tree Plantations

Biodiversity in the southern U.S. has been affected by the increased amount of land dedicated to tree plantations. Diversity is often increased when agricultural land is converted to tree plantations; however, it is often lost when natural forests are converted to tree plantations (Linder, 2004). Generally, the replacement of any natural forest with a plantation will result in a loss of diversity as the many tree species present may be replaced with a monoculture. Clearcutting has the most drastic impact on diversity. For example, between 1987 and 1994, over 2,400,000 acres of pine plantations were established in Mississippi, effectively reducing tree diversity statewide (Rosson and Amundsen, 2004).

Biodiversity can be reduced when the structural complexity of a habitat is reduced, which is common with tree plantations. Tree plantations are managed to produce specific types of trees, underbrush is cleared to prevent competition, and lower limbs may be removed to standardize tree size. Fire management can include both brush clearing and prescribed burning. Changes to the disturbance regime, such as changes in fire frequency and brush removal, can significantly impact biodiversity. When an intensively managed tree plantation replaces an existing natural forest, species abundance and richness typically decline. The species most affected are those that depend on three-dimensional complexity for nesting or cover (Linder, 2004). Three-dimensional complexity provides a variety of habitat types which can be used by a wider variety of species. Variability in temperature, light availability, and soil moisture can result in more diverse understory vegetation, and the variety of plants in turn can lead to a more diverse animal community (Carey, 2003).

There are currently two different approaches to forest management in the South: an intensive, production-based approach and a conservation-based approach. The production-based approach tends toward simplifying the habitat for ease of production, which can result in lower overall biodiversity; however, a benefit of this approach is that smaller areas of land can be used to produce a given quantity of wood products. More recently, the conservation-based approach is increasingly being used to enhance habitat quality and increase biodiversity (Linder, 2004). Some of the methods used to increase biodiversity in tree plantations include long harvest rotations, promoting cavities and snags, increased spacing, selective control of the mid-story, prescribed burning, choice of species, retaining slash after logging, creating travel corridors for wildlife between forest tracts, and maintaining riparian habitat (Ober et al., 2010). Thinning and increased spacing reduces the density of the overstory, which increases the habitat and species diversity in the understory. The amount of understory growth can also be related to the age of a stand. Younger stands (more open canopy) typically have more understory diversity than older stands (closed canopy) in both plant and animal species; however, the mid-story must be maintained over time, as colonization by hardwoods and vines will also shade out the more diverse herbaceous understory. Prescribed burning and herbicide applications also are used to maintain herbaceous diversity in the understory and prevent colonization by hardwoods. Debris left over from logging increases the complexity of the habitat and provides nesting areas and cover for many species (Andreu et al., 2010). A balance of both production-based and conservation-based approaches is likely to be used in the future (Linder, 2004) and already is being used by some forest products companies. This combined approach can involve intensive wood production on some sites while biodiversity and wildlife habitat are promoted on others, which may result in a range of forest types and habitats, greater forest diversity, and improved resistance to epidemics of insects or disease.

Allelopathy

Allelopathy is the process by which a plant chemically affects it neighbors. The plant can release chemicals by leaching, root exudation, volatilization, residue decomposition, and other processes. The effects can be either positive or negative by changing growth patterns, germination rates, reproduction, dominance, diversity, and other parameters in neighboring plants and communities. Exudates that have been identified to have allelopathic effects include phenolic compounds, flavonoids, terpenoids, alkaloids, steroids, carbohydrates, and amino acids. Some chemicals can also have a negative effect on one species and a positive effect on another. Most allelopathy research is conducted in laboratories where seeds, seedlings, and fully grown plants are exposed to leachates from other plants. Allelopathy is currently being investigated as a weed control method (Ferguson and Rathinasabapathi, 2003).

Forestry species for which allelopathy has been investigated include *Eucalyptus*, lead tree (*Leucaena leucocephala)*, *Acacia* spp., walnut (*Juglans major*), poplar (*Populus* spp.), bamboo, coffee (*Coffea* sp*.),* mesquite (*Prosopis* spp.), pines (*Pinus* spp*.),* and oaks (*Quercus* spp.). Pine leachates and extracts were reported by Nandal et al. (1994) to have allelopathic effects on agricultural food crops grown nearby. For example, soils from pine forests decreased germination of soybeans, but increased germination of horsebean. Decaying litter reduced germination in all tested crops and reduced growth of most crops. Native grasses also were reported to exhibit decreases in germination and growth rate when treated with pine leachates in Florida and Korea (Nandal et al., 1994). A review by Ferguson and Rathinasabapathi (2003) revealed that black walnut (*Juglans nigra*), lead tree (*Leucaeana* spp.)*, Lantana* spp.*,* sour orange (*Citrus aurantium*), red maple (*Acer rubrum*), swamp chestnut oak (*Quercus michauxii*), sweet bay magnolia (*Magnolia virginiana*), red cedar (*Juniperus* spp.), *Eucalyptus* spp., neem (*Azadirachta indica*), chaste tree (*Vitex agnus-castus*), box elder (*Acer negundo*), mango (*Mangifera indica*), tree of heaven (*Ailanthus altissima*), rye (*Secale cereale*), wheat (*Triticum* spp.) and broccoli (*Brassica oleracea*) can all have negative effects on other plants germinating or growing nearby. Some of these plants were also shown to have positive effects on neighboring plants, depending on the species tested (Ferguson and Rathinasabapathi, 2003). Other studies have revealed that instances that were previously thought to be allelopathy were actually a result of an increased concentration of herbivores (Bartholomew, 1970).

Many large tree plantations have been established in the southern U.S. within the potential planting range for GE FTE. Currently, most of these plantations are stocked with pine species. As part of the plantation establishment process, research has been conducted on allelopathic effects of other plants on the germination and growth of pine species. Some research, however, focused on the pines' possible effects on other species. Lodhi and Killingbeck (1982) found that decaying needles, needle leachate, and field soils of ponderosa pines reduced germination and growth of pine-associated herbaceous understory plants. Another study, by Ferguson et al. (2004), tested the allelopathic effects of several common mulch species with respect to weed control. The results revealed that mulch from swamp chestnut oak (*Quercus michauxii*) and southern red cedar (*Juniperus virginiana*) had the largest negative effect on lettuce seed germination, loblolly pine had minor negative effects, and a variety of hardwoods tested had minor negative effects or no effects (Ferguson et al., 2004). In general, it is difficult to eliminate variables such as shading, water use, and selective herbivore feeding in such studies (Nandal et al., 1994; Ong, 1993). Additionally, although chemical concentrates are often shown to have allelopathic impacts in a laboratory setting, rarely are there data describing the levels of these chemicals in the field. Results can also vary over time, with the first crops grown in a leachate-treated field being negatively affected, but the second year's crop being positively affected, possibly due to the breakdown of the chemicals in the soil and resulting increased nutrient levels. These complicated environmental interactions and difficulties relating lab to field studies make allelopathy a challenging phenomenon to analyze, with studies often concluding with conflicting results.

b) Threatened and Endangered Species

Section 7(a)(2) of the Endangered Species Act (16 United States Code [U.S.C.] 1531 *et seq*.) requires Federal agencies to consult with the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) to ensure that a proposed action is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat (USFWS and NMFS, 1998). Accordingly, federally listed species that could occur within the potential planting range for GE FTE (Figure A) were identified, and species that have been proposed for listing or are candidates for listing also were included. The process of identifying these species began by determining the counties in each state that would be even partially within the potential planting range.

This step identified 172 such counties. County-specific lists of listed species were obtained from USFWS websites and incorporated into a database. The data were sorted to create a master list of species from the seven states in the potential planting range. This list was refined by removing species that utilize habitat types that would not be affected by the proposed action or alternatives: marine mammals and reptiles, seabirds, and species that occur only in estuarine marshes and along coastlines. The remaining species utilize terrestrial, wetland, and freshwater aquatic habitats that may have some potential to be affected by commercial forestry activities. These potentially affected species are summarized in Table B.2.2. The table includes information on habitats and/or occurrence for each species.

Table B.2.2. Threatened and Endangered Species

Common Name	Scientific Name	Federal Status[1]	State[2]	Habitat / Occurrence[3]
Birds				
Attwater's greater prairie-chicken	*Tympanuchus cupido attwateri*	Endangered	TX	Coastal prairie grasslands of se TX.
Bachman's warbler	*Vermivora bachmanii*	Endangered	SC	Possibly extinct; historic breeding records in se SC. Breeding habitat is forests, usually of low, wet bottomlands.
Florida scrub-jay	*Aphelocoma coerulescens*	Threatened	GA, FL	Scrub and scrubby flatwoods on excessively drained sandy soils of central FL coasts and inland paleodunes and alluvial deposits.
Kirtland's warbler	*Dendroica kirtlandii*	Endangered	SC	Occurs in SC only during migration between midwest and Bahamas.
Mississippi sandhill crane	*Grus canadensis pulla*	Endangered	MS	Wet pine savannah of Gulf coastal plain.
northern Aplomado falcon	*Falco femoralis septentrionalis*	Endangered	TX	Within potential planting range, formerly inhabited coastal prairies of TX.
red-cockaded woodpecker	*Picoides borealis*	Endangered	GA, FL, LA, SC, TX	For nesting, open pine woodlands with large old pines (preferred longleaf, may use shortleaf); for foraging, mature pines with an open canopy, low densities of small pines, little or no hardwood or pine midstory, few or no overstory hardwoods, and abundant native bunchgrass and forb groundcovers -- including pine plantations.
whooping crane	*Grus americana*	Endangered	TX	Marshes and prairies.
wood stork	*Mycteria americana*	Endangered	AL, FL, GA, SC, TX	Freshwater and estuarine wetlands, including marshes and swamps.
Mammals				
Louisiana black bear	*Ursus americanus luteolus*	Threatened	LA, TX	Large, relatively remote tracts of forest, especially bottomland hardwoods. Currently extant in only two river basins in LA (ne and s central); only the Atchafalaya subpopulation is in potential planting range.
red wolf	*Canis rufus*	Endangered	FL, GA, SC, TX	Only current wild population (introduced)is in ne NC near Outer Banks; otherwise, extirpated in the wild.
Reptiles				
Alabama red-belly turtle	*Pseudemys alabamensis*	Endangered	AL, MS	Broad, vegetated expanses of shallow water in backwater areas of bays and along river channels of the lower Mobile Bay drainage in AL.
black pine snake	*Pituophis melanoleucus lodingi*	Candidate	AL	Upland longleaf pine forests with a fire-suppressed mid-story and dense, herbaceous groundcover on sandy, well-drained soils. Found relatively rarely in pine plantations and hardwood forests.
eastern indigo snake	*Drymarchon corais couperi*	Threatened	GA, FL	Pine flatwoods, scrubby flatwoods, upland pine forest, dry prairie, edges of freshwater marshes, agricultural fields, and human-altered habitats
gopher tortoise	*Gopherus polyphemus*	Threatened	AL, LA, MS	Uplands with well-drained sandy soils, abundant herbaceous groundcover, and a generally open canopy with sparse shrub layer; also, human-altered habitats such as pine plantations, fence rows, power line corridors, field edges, and pastures. Not listed in the other states where it occurs (FL, GA, SC).
Louisiana pine snake	*Pituophis ruthveni*	Candidate	LA, TX	Open pine forests, especially longleaf pine savannas, with moderate-to-sparse midstory, an understory dominated by grasses, and sandy, well-drained soils. Found mostly in pine forests, pine plantations, and clearcuts but rarely in grasslands, pine-hardwood, or hardwood habitats.
ringed map turtle	*Graptemys oculifera*	Threatened	LA, MS	Rivers with basking structures (logs and snags) protected from predation and suitable nesting areas (large, high sandbars adjacent to the river).
yellow-blotched map turtle	*Graptemys flavimaculata*	Threatened	MS	River segments with moderate currents, abundant basking sites, and sand bars for nesting.
Amphibians				
frosted flatwoods salamander	*Ambystoma cingulatum*	Threatened	SC, FL, GA	Endemic to lower se Coastal Plain in longleaf pine/wiregrass flatwoods and savannas. Breed and larvae develop in small, isolated, ephemeral ponds.
Houston toad	*Bufo houstonensis*	Endangered	TX	Areas of sandy soils, usually wooded (pine or mixed hardwood) interspersed with open, grassy areas; also coastal prairies. Breed in ponds, pools and ditches with water persisting for at least 60 days.
Mississippi gopher frog	*Rana capito sevosa*	Endangered	MS	Upland, sandy areas covered with longleaf pine forest; breed in isolated, temporary wetlands within the forest. Shelters in holes, tunnels, and burrows of gopher tortoise and mammals.
Fishes				
bayou darter	*Etheostoma rubrum*	Threatened	MS	Occurs only in a tributary of the Mississippi R., Bayou Pierre, and three streams that are tributaries to the bayou. Prefers shallow, meandering streams with moderate to swift current and riffles of gravel or sand.
Okaloosa darter	*Etheostoma okaloosae*	Endangered	FL	Occurs only in six stream systems in Okaloosa and Walton Counties of FL panhandle. Typically inhabits margins of small streams fed by groundwater seeping from surrounding sandhills; vegetation, woody debris, and root mats used as spawning substrate. Watersheds covered in longleaf pine/wiregrass/red oak sandhill communities.
Pearl darter	*Percina aurora*	Candidate	MS	Occurs only in the Pearl R. and other navigable waters of the Pascagoula R. drainage. Prefers deeper runs and pools in rivers and large creeks where current is moderate and substrate is mostly gravel.

Common Name	Scientific Name	Federal Status[1]	State[2]	Habitat / Occurrence[3]
sharpnose shiner	*Notropis oxyrhynchus*	Candidate	TX	Endemic to the Brazos River basin; prefers shallow water habitat of broad, open, sandy channels with moderate current.
smalleye shiner	*Notropis buccula*	Candidate	TX	Endemic to the Brazos River basin; prefers center of channels with turbid waters and shifting sand, often avoiding shallows and slow currents.
Mussels				
Alabama heelsplitter	*Potamilus inflatus*	Threatened	AL, LA	Slow-to-moderate currents of rivers (Amite R., LA, and Tombigbee R. and Black Warrior R, AL) in soft, stable substrates (sand, mud, silt, sandy-gravel).
Altamaha spinymussel	*Elliptio spinosa*	Proposed Endangered	GA	Swiftly flowing water and stable, coarse-to-fine sandy sediments of sandbars and sloughs of the Altamaha R. basin.
Chipola slabshell	*Elliptio chipolaensis*	Threatened	AL, FL	Large creeks and the main channel of the Chipola River with slow to moderate current in silty sand substrates.
fat pocketbook	*Potamilus capax*	Endangered	MS, LA,	Large rivers in substrate of mud or sand where current is slow.
fat three-ridge (mussel)	*Amblema neislerii*	Endangered	FL, GA,	Main channel of small to large rivers (Flint, Apalachicola, and Chipola R.) in slow to moderate current with substrate varying from gravel to cobble to mixtures of sand and sandy mud.
Gulf moccasinshell	*Medionidus penicillatus*	Endangered	AL, FL, GA	Channels of small-to-medium-sized creeks (Ecofina Creek, FL) to large rivers (Chattahoochee, Flint, Apalachicola, and Chipola R. drainages) with sand and gravel or silty sand substrates in slow to moderate currents.
Louisiana pearlshell	*Margaritifera hembeli*	Threatened	LA	Small creeks with shallow, flowing waters and stable substrates of sand or gravel.
narrow pigtoe	*Fusconaia escambia*	Candidate	GA, AL, FL	Small- to medium-size rivers (Escambia R. drainage in AL and FL and Yellow R. drainage in FL) with slow-to-moderate current; substrate of gravel or gravel mixed with sand or silt.
Ochlockonee moccasinshell	*Medionidus simpsonianus*	Endangered	FL	Areas with current in large creeks and the Ochlockonee R. in substrates of sand with some gravel.
oval pigtoe	*Pleurobema pyriforme*	Endangered	FL, GA, AL	Small-to-medium-sized creeks (Ecofina Creek, FL) to small rivers (Chattahoochee, Flint, Apalachicola, Chipola, Ochlockonee, Santa Fe, and Suwannee R. drainages) in silty sand to sand and gravel substrates, usually in slow to moderate current.
purple bankclimber	*Elliptoideus sloatianus*	Threatened	GA, FL	Small-to-large river channels (Chattahoochee, Flint, Apalachicola, Chipola, and Ochlockonee R. drainages) with slow to moderate current in substrates of sand or sand mixed with mud or gravel.
round ebonyshell	*Fusconaia rotulata*	Candidate	GA, AL, FL	Occurs in one main river channel (Conecuh/Escambia River) where current is moderate over sand/gravel substrate.
shinyrayed pocketbook	*Lampsilis subangulata*	Endangered	AL, FL, GA	Small creeks to rivers (Chattahoochee, Flint, Apalachicola, Chipola, and Ochlockonee R. drainages) with slow to moderate current in substrates of clean or silty sand.
southern sandshell	*Hamiota australis*	Candidate	AL	Clear creeks and rivers (Escambia R. drainage in AL, Yellow and Choctawhatchee R. drainages in AL and FL) with slow-to-moderate current and sandy substrate.
stirrupshell	*Quadrula stapes*	Endangered	AL, MS	No known extant populations or occupied habitat; all historical habitat in 2nd order river channels has been altered by dams in Tombigbee and Alabama Rivers.
upland combshell	*Epioblasma metastriata*	Endangered	AL	Rivers and streams of the Mobile River basin.
yellow blossom	*Epioblasma florentina florentina*	Endangered	AL	Likely to be extinct.
Crustaceans				
Squirrel Chimney cave shrimp	*Palaemonetes cummingi*	Threatened	FL	Endemic to a small, deep sinkhole (Squirrel Chimney) in Alachua County.
Flowering Plants				
American chaffseed	*Schwalbea americana*	Endangered	GA, LA, SC	Open pine flatwoods, savannas, other open areas in moist-to-dry, acidic, sandy or sandy peat loams.
Apalachicola rosemary	*Conradina glabra*	Endangered	FL	Occurs only in n Libery County in the FL panhandle. Endemic to xeric longleaf pine communities (sandhill) east of the Apalachicola R; also on edges of pine plantations and highway and utility rights-of-way. Favors open areas with various degrees of cover, in sun or light shade.
bog asphodel	*Narthecium americanum*	Candidate	SC	Wetlands in savannas, usually with water moving through the substrate, as well as in sandy bogs along streams and rivers.
Britton's beargrass	*Nolina brittoniana*	Endangered	FL	Xeric soils in scrub, high pine, and occasionally in hammocks and sandhills.
Canby's dropwort	*Oxypolis canbyi*	Endangered	SC	Peaty muck of shallow cypress ponds, wet pine savannas, and adjacent sloughs and drainage ditches.
Chapman rhododendron	*Rhododendron chapmanii*	Endangered	FL	Transitional areas between upland mesic or scrubby flatwoods and floodplain swamps or baygall wetlands, also in mesic pine flatwoods or lower elevations of sandhills. Two of three known populations in communities dominated by longleaf and/or slash pine and wiregrass.
Cooley's meadowrue	*Thalictrum cooleyi*	Endangered	FL, GA	Wet pine savannahs, grass-sedge bogs, and savanna-like areas of coastal plain, often at the border of intermittent drainages or swamp forests; on fine sandy loam soils that are at least seasonally (winter) moist or saturated and only slightly acidic.
Etonia rosemary	*Conradina etonia*	Endangered	FL	Deep, white-sand scrub dominated by sand pine and shrubby oaks.
Florida bonamia	*Bonamia grandiflora*	Threatened	FL	In sunny openings of scrub sand pine and evergreen scrub oaks, with reindeer moss, lichens, and herbs.
Florida skullcap	*Cutellaria floridana*	Threatened	FL	In full sun or light shade of wet longleaf pine flatwoods and wet prairies, in grassy seepage bogs at the edge of forested or shrubby wetlands, or in ecotones between mesic flatwoods and swamps.
fringed campion	*Silene polypetala*	Endangered	FL, GA	Mature hardwood or hardwood-pine forests on river bluffs, small stream terraces, moist slopes, and well-shaded ridge crests.

Common Name	Scientific Name	Federal Status[1]	State[2]	Habitat / Occurrence[3]
gentian pinkroot	*Spigelia gentianoides*	Endangered	FL	Well-drained upland pinelands with limestone outcrops and calcareous soils.
Godfrey's butterwort	*Pinguicula ionantha*	Threatened	FL	Herb bog habitats within longleaf pine savannas: seepage bogs, deep swampy bogs, ditches, and depressions in grassy pine flatwoods and savannahs. Survives in peat or sandy peat in wet areas and shallow standing water; carnivorous.
hairy rattleweed	*Baptisia arachnifera*	Endangered	GA	Sandy soils in open pine flatwoods, intensively managed slash pine plantations, and along road and powerline right-of-ways.
Harper's beauty	*Harperocallis flava*	Endangered	FL	Typically wet prairies, in transitions to wetter shrub zones, and in roadside ditches; also, on gentle slopes, seepage savannas between pinelands, and cypress swamps.
large-fruited sand-verbena	*Abronia macrocarpa*	Endangered	TX	Sandy openings in post oak woods.
longspurred mint	*Dicerandra cornutissima*	Endangered	FL	Open areas in sand pine or oak scrub, and in ecotones between these and turkey oak communities; can colonize edges of road rights-of-way.
Miccosukee gooseberry	*Ribes echinellum*	Threatened	FL	Mixed hardwood forest on mesic and well-drained soils.
Navasota ladies'-tresses	*Spiranthes parksii*	Endangered	TX	Post oak savanna of east-central TX.
Neches River rose-mallow	*Hibiscus dasycalyx*	Candidate	TX	Wetlands areas in open sun.
papery whitlow-wort	*Paronychia chartacea*	Threatened	FL	Xeric scrubby flatwoods and rosemary scrub on white, gray, or yellow sands.
pondberry	*Lindera melissifolia*	Endangered	GA, SC	Shallow depression ponds in sandhills, seasonally wet, low areas in bottomland hardwoods, and margins of cypress ponds.
relict trillium	*Trillium reliquum*	Endangered	GA	Hardwood forests.
scrub buckwheat	*Eriogonum longifolium* var. *gnaphalifolium*	Threatened	FL	Habitats intermediate between scrub and sandhills (high pine) and in turkey oak barrens from Putnam to Highlands County.
slender rush-pea	*Hoffmannseggia tenella*	Endangered	TX	Blackland prairies and creek banks, on clayey soils in association with short and midgrasses such as buffalograss and Texas grama.
telephus spurge	*Euphorbia telephioides*	Threatened	FL	Near the coast on low sand ridges among scrubby oaks.
Texas golden gladecress	*Leavenworthia texana*	Candidate	TX	On exposed outcrops of the Weches geologic formation (a layer of calcareous marine sediments overlying an impermeable clay layer), resulting in areas that are seepy and wet much of the year but hard and dry during summer, with thin, alkaline soils.
Texas prairie dawn-flower	*Hymenoxys texana*	Endangered	TX	Sparsely vegetated areas of fine, sandy soil in open grasslands; also, poorly drained depressions and saline swales.
Texas trailing phlox	*Phlox nivalis ssp. texensis*	Endangered	TX	Deep sandy to sandy-loam soils, in open, grassy areas of long-leaf pine savanna or mixed pine-hardwood forest.
white birds-in-a-nest	*Macbridea alba*	Threatened	FL	Grassy pine flatwoods. Appears to grow only on sites that have been disturbed; appears to persist on the edges of pine plantations.
white bladderpod	*Lesquerella pallida*	Endangered	TX	On exposed outcrops of the Weches geologic formation (a layer of calcareous marine sediments overlying an impermeable clay layer), resulting in areas that are seepy and wet much of the year but hard and dry during summer, with thin, alkaline soils; mostly in full sun of open, herbaceous communities, also at edge of shrubby thickets.
Conifers				
Florida torreya	*Torreya taxifolia*	Endangered	FL, GA	Tree endemic to ravine slopes on the eastern bank of the Apalachicola R. in n FL and sw GA.
Ferns and Allies				
Florida bristle fern	*Trichomanes punctatum floridanum*	Candidate	FL, GA	Shaded limestone outcrops, typically under a dense canopy of hardwoods.
Louisiana quillwort	*Isoetes louisianensis*	Endangered	LA, MS,	Semi-aquatic, occurring near or below water levels on sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland/bayhead forests of pine flatwoods and upland longleaf pine.
Lichens				
Florida perforate cladonia	*Cladonia perforata*	Endangered	FL	High, xeric, white sands of sand pine scrub, typically in open rosemary balds.

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[1] Federal status definitions:

Endangered -- species in danger of extinction throughout all or a significant portion of its range.

Threatened -- species likely to become endangered throughout all or a significant portion of its range.

Candidate -- species for which Federal listing agencies have sufficient information on biological vulnerability and threats to support proposing to list the species as endangered or threatened, but for which issuance of a proposed rule is precluded by higher-priority listing actions

Proposed -- species that has been proposed in the *Federal Register* to be listed under Section 4 of the Endangered Species Act of 1973.

[2] States in which the potential planting range for GE FTE overlaps one or more counties and in which the species is federally listed: Alabama (AL), Georgia (GA), Florida (FL), Louisiana (LA), Mississippi (MS), South Carolina (SC), and Texas (TX).

[3] Habitat/occurrence information source: The U.S. Fish and Wildlife Service (USFWS), 2010. Endangered Species Program website. Accessed at http://www.fws.gov/endangered/.

3. Hydrology

The proposed action would grant non-regulated status to the GE FTE lines, so the specific sites where GE FTE may be planted cannot be specified. Planting sites could include any suitable location within the potential planting range, so site-specific discussions of hydrologic conditions are not possible. Instead, this section describes the hydrologic conditions that may exist in the planting range, with an emphasis on those areas where hydrologic impacts potentially could be the greatest. The main concern regarding hydrologic impacts of *Eucalyptus* is related to potentially greater water use by *Eucalyptus* plantations as compared to other land uses. Thus, the areas in which hydrologic impacts could be the greatest would be those that are subject to reduced stream flows, lowered groundwater tables, and water use conflicts during droughts.

Hydrologic components within the potential planting range include soil moisture, groundwater, and surface water of streams, ponds, and wetlands. The availability and quality of water in these components may be affected by trees and other vegetation. The factors that affect water availability are depicted in Figure F.

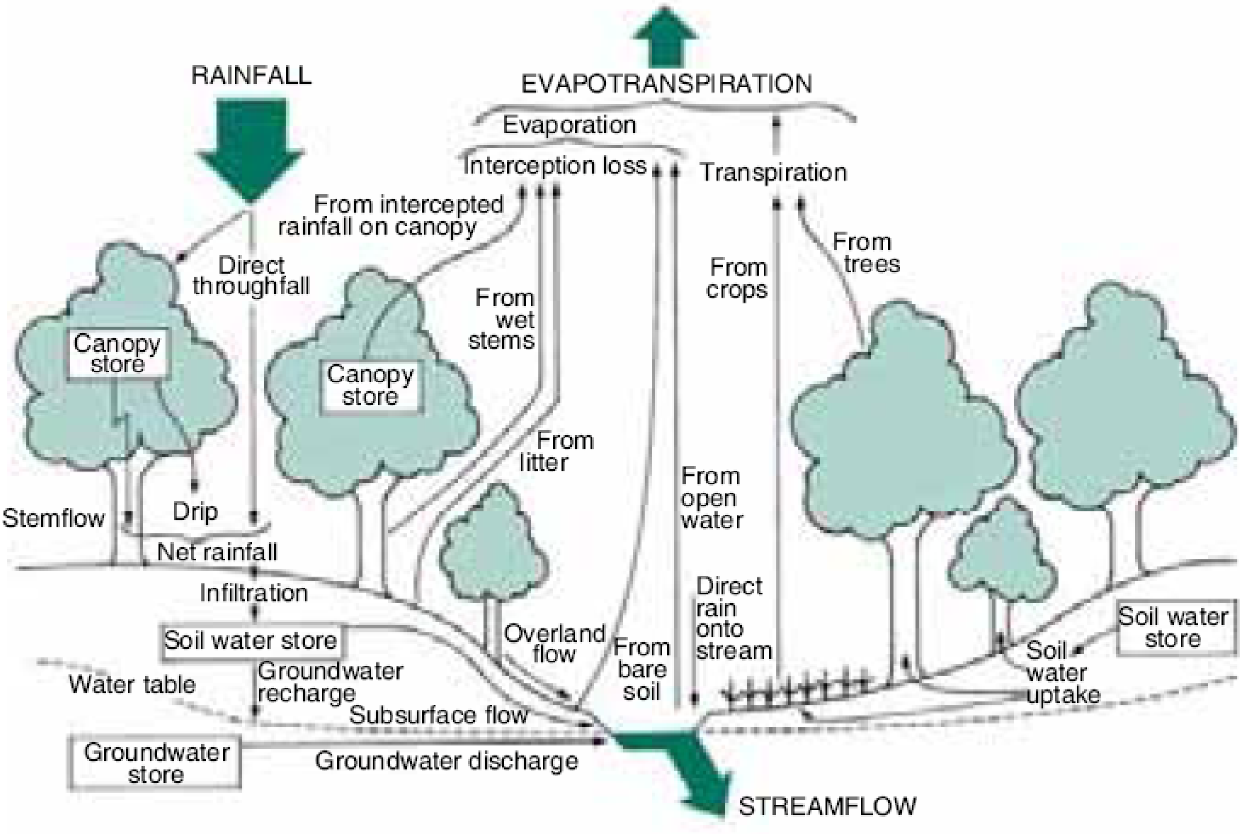

Figure F. The Hydrologic Cycle

The availability of water is a product of the amount of water added to the system and the amount of water removed from the system. Water input into the system is primarily from precipitation. Water removed is principally due to outflow, with a portion removed by evaporation and transpiration from the leaves of vegetation (evapotranspiration). Direct outflow also can be affected by urban and agricultural development, and evapotranspiration rates also can be affected by modification of vegetation types and amounts. The quality of the water is governed by the interaction of water with other media within the geographic area, including soil.

The geographic area of interest is generally located in the Humid Temperate Domain, Subtropical Division, within the Bailey Ecoregion classification system (Bailey, 1995). The Bailey Ecoregion system was developed by the U.S. Department of Agriculture (USDA) Forest Service based on climate, vegetation, and topography to assist land management agencies in regional and long-range planning. The Subtropical Division is characterized by high humidity, especially in summer, and the absence of cold winters. The area is temperate and rainy, with no specific dry season. Ample rainfall generally occurs all year and includes frequent thunderstorms and tropical cyclones and hurricanes during the summer. Soils are generally moist Ultisols, which are related to humid tropical climates. The area typically supports forest growth, and much of the coastal portion of the region is covered by second-growth forests of longleaf, loblolly, and slash pine (Bailey, 1995).

Being located within the Subtropical Division, the geographic area of interest is generally considered to have a moderate to high amount of rainfall, and, as a result, well-supported stream flow and high groundwater tables. The area has high annual precipitation (greater than 1,200 millimeters [mm] per year), high evapotranspiration rates (greater than 50% of precipitation), and moderate to high runoff rates (200 to 800 mm per year) (Wolock and McCabe, 1999; Jackson et al., 2004).

Although the potential planting range generally has substantial water resources, localized hydrologic impacts are possible due to drought, water use associated with urbanization, and changes in vegetation cover, including commercial forestry. In 2007, the southeastern U.S. was subject to a record-setting drought. As of December 2007, 90.4% of the region was abnormally dry or in drought status, with 41% classified as extreme or exceptional drought (National Oceanic and Atmospheric Administration [NOAA], 2007). Record low precipitation totals were recorded in Alabama, Tennessee, Georgia, North Carolina, Florida, and Mississippi (NOAA, 2010), and the drought reduced stream flow levels in Georgia to record levels (USGS, 2007). Although news reports and public speculation linked the drought to global warming and suggested that these events are becoming more frequent and more extreme, this view was contradicted by several researchers. Using tree ring studies to evaluate the duration and magnitude of droughts in the past millennium, as well as the results of anthropogenic climate change modeling, Seager et al. (2009) concluded that the drought was a typical event in terms of amplitude and duration.

The effects of the drought included impacts to agriculture (grain crops, citrus, and livestock feed), the landscaping and nursery industries, tourism associated with lakes and reservoirs, and production of hydropower. The most widely reported impacts in the press included severe concerns for the ability to continue providing municipal water supplies to populated areas, including Atlanta (NOAA, 2010). Reduced stream flows in freshwater rivers in the region also presented potential threats to aquatic life, including endangered species. These potential drought effects led to conflicts between the goal of water retention in reservoirs operated by the U.S. Army Corps of Engineers (USACE) for municipal use purposes and the need for releases to maintain minimum stream flows mandated by the USFWS to protect mussels and other aquatic life. Thus, although the potential planting range for GE FTE is generally considered to include abundant water resources, geographic and temporal variations in water availability can be substantial, and water use conflicts can occur and can be exacerbated by drought conditions.

4. Cultural Resources

a) Prehistoric and Historic Native American Cultures and Resources

The seven planting range states in this analysis were originally settled by a variety of Native American cultures. A number of significant prehistoric sites exist throughout the region. Representative sites include the Paleo-Indian Period (c. 16,000 to 12,000 Before Present [BP]), the Archaic Period (c. 12,000 to 3,000 BP), the Woodland Period (c. 3,000 to 1,000 BP), and the Mississippian Period (c. 1,150 to 300 BP). There is some overlap of dates, due to the time required for the rise of cultural and technological changes to spread throughout this broad area. It is anticipated that archaeological resources related to these pre-historic cultures would be present throughout the proposed planting range, particularly along coastal areas and major waterways. Numerous Native American tribes were recorded in this area from the Historic Period (c. 500 BP to 50 BP) (National Park Service Southeast Archaeological Center, 2010). Table B.4.1 below describes the major native cultures present in the planting range states at the time of first contact with European explorers, traders, and settlers to the area, and those state lands that are claimed by tribal governments as their traditional homelands and burial grounds. It is anticipated that archaeological resources related to these cultures would be present throughout the proposed planting range.

Table B.4.1. Former Native American Cultural Lands in the Planting Range States

State	**Native American Cultures**
Alabama	The southern coastal region of Alabama was home to the Muskogee (also known as Creek) in the east and the Choctaw to the west (extending into the western Florida panhandle). Biloxi tribal lands occupied the very western corner of the state.
Florida	The majority of the Florida planting range covers the Timucua tribal area that extended from Georgia to well past the southern extent of the Florida planting range boundary. The Florida panhandle historically included the tribal areas of the Miccosukee, the Creek, and the Apalachee and represented the eastern boundaries of the Choctaw cultures.
Georgia	The northern and eastern portions of the Georgia planting range was formerly Creek territory. Along the coast, the lands were inhabited by the now extinct Yamasee, Guale and Timucua tribes. The western boundary of the planting range crosses the historical lands of the Hitchiti, Oconee and Miccosukee. The southern section of the state was inhabited by the Apalachee culture.
Louisiana	The southern part of Louisiana was occupied by the Choctaw in the east, the Chitimacha in the southeast, and the Atakapa Indians (including the Taensa and Opelousas) in the southwest. The Houma occupied lands along the Mississippi River, the Natchez lived near the center of Louisiana, and the Caddo occupied the western portions of the state.
Mississippi	The southern tip of the state was home to the Biloxi to the east and the Choctaw the west. The area along the Mississippi River near the current city of Vicksburg was occupied by the Houma to the south and around the Vicksburg area, and the Natchez along the northern parts of the Mississippi.
South Carolina	The southeastern section of South Carolina was occupied by the now extinct Cusabo and Edisto peoples. A portion of the planting range includes parts of the eastern lands of the Creek, who occupied most of the southern part of the state.
Texas	The southeastern quarter of Texas included the historic Caddo tribal lands. The Tonkawa were located in the eastern area and the now extinct Karankawa tribes were present along the southeastern coast. Portions of the planting range cross into former Tawakoni and Kitsai lands in the eastern interior of the state. The northwestern section of the project area was the land of the now extinct Bidai culture.

Source: Native Languages of the Americas, 2010.

b) Historic Period Cultural Resources

The Historical Period in the southeastern U.S. begins with the arrival of non-native cultures to the areas in question to explore and/or settle. This period begins in the early 1500s with the first documented exploratory parties from Spain, France, and later England. During the Historic Period, the native cultures described above experienced catastrophic population changes as a result of the introduction of European diseases, warfare, and forced relocations.

As with the prehistoric and historical Native American cultures in the region, coastal areas and major river banks were the locations most heavily settled by newly arriving European settlers. As the planting range is located along the southern Atlantic and Gulf Coasts and includes several major river floodplains, it is highly likely there are a large number and variety of historic resources located throughout the proposed planting range. Such resources could include building foundations, remaining standing structures, remaining debris or artifacts from human occupation, historic cultivated plantation lands, burial sites, and more from at least three different European groups in addition to the historic Native American cultures. This region also includes a large number of battlefields from several different conflicts that occurred throughout the Historical Period. These battlefields are often historic resources in their own right and additionally are host to numerous artifacts. Battlefields typically span multiple acres and some of the largest can span thousands of acres. It is probable that at least some existing forestry plantations are located wholly or partially upon historic battlefields or campaign campsites.

Table B.4.2 provides a brief, summarized history of the Historical Period for each of the seven states within which the potential planting range is located. This historical summary demonstrates the rich history of the area and establishes a range of dates from which historical artifacts or structures may be present within the potential planting range.

Table B.4.2. Settlement History of the Planting Range

State	Brief History of Settlement
Alabama	The first documented exploration was by the Spanish in 1539 and led to encounters and conflict with the native populations. Settlement by the French in 1702 as the capital of their Louisiana territory. Alabama was later occupied by the British after the French-Indian War. Several battles between settlers, soldiers, and Native Americans occurred in the state up through the Civil War. Additionally, several battles between opposing sides occurred during the Civil War. Alabama was the site of several prison camps for POWs during World War II. (Alabama Department of Archives and History, 2010).
Florida	The first documented exploration was by the Spanish in 1513. Settled by the French in 1564, which prompted battles between the two colonial powers. In the 17th century, English settlers from the north began moving south into Florida, prompting additional warfare. Ownership of Florida fluctuated between the English and Spanish until it was finally turned over to control of the U.S. in 1822. Conflicts between the settlers and the Seminole tribe led to a series of wars in the 1800s. Several large battles were fought in the area during the Civil War (Wisconsin Historical Society, 2003).
Georgia	Initial exploration was first documented by the Spanish in the 1520s. English occupation began in 1732. Parts of Georgia were battlefields during the Revolutionary War and later during the Civil War. The 1829 Georgia Gold Rush created an influx of settlers and inflamed tensions with the Cherokee Indians,

State	Brief History of Settlement
	culminating in the Trail of Tears (Georgia Humanities Council, 2010).
Louisiana	The first documented exploration was in 1528. In the late 17th century, French expeditions established settlements along the Mississippi River and Gulf Coast. Though a French territory for some time, after the French-Indian War, the Spanish took greater control of the area. The Louisiana Purchase in 1803 transferred ownership of Louisiana to the U.S. government. Periodic warfare occurred in the state during the War of 1812 and the Civil War. New Orleans served as a key port and supplier of wartime landing craft during World War II (Louisiana Secretary of State, 2010).
Mississippi	The first documented expedition into the Mississippi area was by the Spanish in 1540. The French claimed the territory in 1699. Control of the Mississippi area fluctuated between the Spanish, French, and British and ultimately was deeded to the U.S. by England following the Revolutionary War. Several battles and skirmishes were fought in Mississippi during the Civil War (Wisconsin Historical Society, 2003).
South Carolina	Initially visited and abandoned by the Spanish and the French, in 1670 a permanent English settlement was established in South Carolina. During the Revolutionary War, more battles and skirmishes were fought in South Carolina than any other state. Additional battles occurred across the state during the Civil War (South Carolina State Library, 2010).
Texas	The first documented Spanish exploration of Texas occurred in 1528. In 1682 the French laid claim to much of the area as part of their Louisiana territory, though ultimately Spain regained control of this region. In 1821, Spain authorized American settlers to move into the territory. Cultural conflict between the new settlers and the established Spanish and Mexican population led to the Texas Revolution in 1835 and, temporarily, in the establishment of an independent Texas until Texas joined the U.S. in 1848. Some Civil War skirmishes occurred in Texas (Texas State Historical Association, 2010; Texas State Library & Archives Commission, 2010).

5. Public Health and Safety

a) Fire

Public health and safety can be adversely affected by uncontrolled fires on forested lands. Forestry practices used to reduce the hazards of wildfire include creating firebreaks, building suitable roads into the interior of plantations for emergency equipment access, removal of weeds and grasses, intercropping with agricultural crops (food or fodder plants), and prescribed burning (Davidson, 1995).

Several fire prevention and management policies have been established for the southern U.S. and other regions. A report published in 2008 by the Southern Group of State Foresters assesses fire risks in the southern states. This association is made up of foresters from the entire southern region, including 13 states between Virginia and Texas. The risk assessment reports that the southern regions are very fire prone, having the highest number of wildfires of any region in the U.S. Particularly high risk areas are at the wildland-urban interface due to the proximity of homes to unmaintained natural forest growth. Additionally, trees downed by severe storms, such as Hurricane Katrina, can produce huge amounts of fuel. The publication advises lowering fire risk by reducing the fuel load, positioning fire-fighting equipment at locations which provide the most access to fire prone areas, public education, and building fire-aware community development (Southern Group of State Foresters, 2008).

Mississippi State University and the USDA jointly produced guidelines for community design specifically to reduce wildfire risk. The discussion centers on the concept of 'defensible space' and ways to maximize its size, while minimizing maintenance costs. Optimal community design would include a cleared space, a fuel reduction area (maintained) followed by a perimeter fuel management area between the homes and the wildlands. The areas outside the development areas would constitute a managed greenbelt, where fuel loads would be considerably reduced, minimizing potential injuries and damage to homes from wildfires. Essentially, this area would act as a visually appealing firebreak. Within the guidelines, several other organizations are mentioned which have additional codes or guidelines that can be of use in reducing fire risk. These organizations include the USEPA, Firewise, the National Fire Protection Association (NFPA), USDA Forest Service Region 8, the Department of the Interior, the National Association of State Foresters, and the U.S. Fire Administration. Additionally, building and landscaping codes such as the NFPA 1144 Standard for Protecting Life and Property from Wildfire (2002 edition), NFPA 1411 Standard for Fire Protection Infrastructure for Land Development in Suburban and Rural Areas (2008 edition), the NFPA 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire (2008 edition), and the International Urban-Wildland Interface Code have been developed. Many smaller municipalities and states also have adopted codes aimed at reducing fire risk in new and existing developments. Most of these ordinances concentrate on the removal of vegetative fuel (Brzuszek et al., 2008).

The Florida Department of Agriculture and Consumer Services (FDACS) developed guidelines (BMPs) for use in the silviculture industry. These guidelines include detailed instructions for proper fireline construction (FDACS, 2009). The South Carolina BMPs for Forestry include fire prevention guidelines and specific instructions for prescribed burns (SCFC, 1994). The LDAF and the AFC have BMPs that include a section on fire management, with details regarding prescribed burns, fireline construction and maintenance, and wildfire control (LDAF; 2008; AFC, 2007). Although Mississippi's forestry BMPs are focused on water quality, they also contain BMP policies for prescribed burns, fire prevention access roads, and firebreaks (MFC, 2008). The Texas Forestry Service (TFS) BMPs have very detailed information on fire prevention and maintenance (TFS, 2010).

Most private foresters have invested a significant amount of capital in their plantations, and it is evident that it is in their best interest to prevent and manage fires as quickly and efficiently as possible. Therefore, private foresters are highly likely to adhere to local and national forestry BMPs for fire management and also to invest in additional fire prevention practices and extinguishing equipment.

b) Hazardous Materials and Waste Management

The commercial forestry industry in the southeastern U.S. uses hazardous materials in the form of fuels and fluids for heavy equipment and vehicles as well as in the form of pesticides and herbicides. In addition, the industry generates wood waste residues as part of the harvesting process and as part of the production of finished wood products. Some of these materials and wastes could potentially could impact human health and safety, as well as ecological receptors and water quality, if not managed and disposed of properly. Pesticide use was evaluated in Section B.1.1.c.ii.

Large-volume hazardous fuels and fluids used in planting, maintenance, and harvesting operations are expected to be limited to commercially available gasoline, diesel fuel, and other fuels. Other hazardous materials, in the form of solvents, paints, hydraulic fluid, and other materials, are expected to be used in very small quantities by forestry operations. The use and disposal of these materials is regulated by each of the states in the potential planting range under several environmental programs, including water quality and waste management programs. These regulations govern the manner in which the materials may be transported to the forestry sites, the manner in which they may be stored, response and reporting actions required in the event of a release, and approved methods of disposal.

Waste materials generated in the plantation would include normal forest litter and undergrowth generated as a result of the growth of the trees, and limbs, foliage, and other extraneous materials remaining following the removal of logs. Waste materials generated in the production facilities are expected to include sawdust, chipped material, and other small-sized remnant materials.

c) Noise

The areas potentially affected by noise include areas within a one-mile radius of potential forestry operations, including developed or residential areas within one mile of a tree plantation. Occupational noise and vibration levels for those working in the industry are regulated through the Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH). There are no Federal regulations directly regulating off-site (community) noise. Other Federal regulations applicable to noise are incorporated into state and local requirements. The USEPA noise guidelines are considered in developing local (municipal, county or city) requirements (Federal Noise Control Act of 1972: Title 40 CFR Section 204). Noise control regulations and ordinances are overseen primarily by state, regional, and/or local regulatory agencies. Regulations vary among the several states and many counties and urban areas within the extensive potential planting range.

Noise is generally defined as unwanted or objectionable sound. The effects of noise on people can include general annoyance, interference with speech communication, sleep disturbance, and, in the extreme, hearing impairment. Noise levels are measured as decibels (dB) on a logarithmic scale. Thus, doubling the energy of a noise source (e.g., traffic volume) would not double the noise level but would instead increase noise levels by three dB. In addition, the human ear is not equally sensitive to all frequencies within the sound spectrum. Sound heard by the human ear is typically characterized by the "A-weighted" sound level (dBA), which filters out noise frequencies not audible to the human ear, thereby weighting the frequencies audible by humans.

In addition to instantaneous noise levels, noise levels are measured and averaged over a period of time to assess noise limits and impacts. Typically, noise levels are averaged over one hour are expressed as an Equivalent Continuous Noise Level (dBA Leq). Time of day is also an important factor for noise assessment. Noise levels that could be acceptable during the day could interfere with the ability to sleep during evening or nighttime hours. Therefore, noise levels are averaged over a 24-hour period to represent the day/night average sound level (Ldn). The Ldn includes a 10 dBA penalty factor for the night hours from 10 PM to 7 AM as typically noise at this time of night creates a greater disturbance.

Generally, in the absence of other factors, noise levels are reduced by 6 dB when the distance between the source and the receiver is doubled. For example, a noise that is perceived at 95 dB at 50 feet away would be perceived at 89 dB at 100 feet away (Minnesota Pollution Control Agency, 1999). Noise levels also vary based on surrounding conditions of the existing environment. Factors such as topography, vegetation, and meteorological conditions play a role in how sound is distinguished. Trees, hills, and other obstacles between noise sources and receivers also will attenuate noise levels. Thirty meters of dense vegetation can reduce noise levels by 10 dB (Federal Highway Administration [FHWA], 2010a).

Due to the large amount of land necessary for a successful plantation enterprise, it is likely that most tree plantations are in relatively undeveloped portions of the study area. In areas adjacent to tree plantations, temporary noise increases occur during harvesting, and possibly during planting operations. These operations likely have similar noise levels to a large construction project as heavy equipment is used, including dozers, trucks, cranes, chainsaws, and limb removal equipment. Table B.5.3.c(i) lists some of the noise levels associated with general construction equipment and more specific forestry equipment. During the period when harvesting or planting are not actively in operation, occasional maintenance noise will be present. Activities would include firebreak and road maintenance, fertilization, and weed eradication. These activities would be less noisy than logging and planting operations. Workers in a logging operation are monitored by OSHA and appropriate noise-reducing equipment is expected to be provided by employers.

Table B.5.3.c(i): Average Noise Levels generated by equipment potentially used in the tree plantation industry

Equipment Type	**Noise Level at 50 feet (dBA)**
Dozers/scrappers/locomotives	82 [1]
Cranes/cherry pickers	81 [1]
Manlifts	75 [1]
Tractors/frontend loaders/backhoes	80 [1]
Diesel trucks	75 [1]
Compressors/pumps/generators	73 [1]
Dump truck	76 [1]
Equipment type	**Noise Level for operator (dBA)**
Chainsaw	110 [2]
Skidder under load	95 [2]
Knuckle boom loader	85 [2]
ATV	90-100 [3]
Wood chipper	107 [4]
skidder	72-102 [5]
cutter	76-96 [5]
Bulldozer	84-112 [5]
loader	78-108 [5]
chipper	100-105 [6]

Sources: [1] FHWA, 2010b
[2] Kolonoski et al., 2000
[3] Waters, 2004
[4] Brueck, 2008
[5] Noisebuster.net, 2010
[6] North Carolina Department of Labor, 2010.

d) Air Quality

Climate

The geographic area of interest is generally located within the Humid Temperate Domain, Subtropical Division within the Bailey Ecoregion classification system (Bailey, 1995). The climate within the Subtropical Division is characterized by high humidity, especially in summer, and the absence of cold winters. The area is temperate and rainy, with no specific dry season. The average annual precipitation rate is greater than 1,200 mm per year (Wolock and McCabe 1999; Jackson et al., 2004).

The region is prone to extreme temperature and precipitation events, including periods of heavy precipitation, as well as periods of drought. Heavy precipitation events are in the form of frequent thunderstorms in the summer, as well as tropical cyclones and hurricanes that occur in the region several times per year. Droughts also occur in the region. In 2007, the southeastern U.S. was subject to a record-setting drought. As of December 2007, 90.4% of the region was abnormally dry or in drought status, with 41% classified as extreme or exceptional drought (NOAA, 2007). Record low precipitation totals were recorded in Alabama, Tennessee, Georgia, North Carolina, Florida, and Mississippi (NOAA, 2010), and the drought reduced stream flow levels in Georgia to record levels (USGS, 2007).

Air Quality

Existing air quality conditions throughout the geographic area of interest are primarily a factor of proximity to urbanization and point sources of air emissions. Limited areas of the southeastern U.S. have been designated by the USEPA as non-attainment areas, indicating that ambient air quality conditions exceed National Ambient Air Quality Standards (NAAQS). Those areas include the following:

- Texas currently has nine areas that are designated as non-attainment areas. Three of these areas are within the potential planting range, including Beaumont-Port Arthur, Houston-Galveston-Brazoria, and a small portion of Victoria County. The Beaumont and Houston areas are out of attainment for Ozone and have designations pending for NO_2 and SO_2. The Victoria area has a maintenance plan for ozone and is pending classification for NO_2 and SO_2 (Texas Commission of Environmental Quality, 2010).

- Louisiana has two areas within the planting range that are out of attainment for ozone, Baton Rouge and Lake Charles (USEPA, 2010a).

- Mississippi is currently in attainment for all NAAQS pollutants (Mississippi Department of Environmental Quality [MDEQ], 2007).

- The portions of Alabama within the planting range are in attainment for all NAAQS pollutants (USEPA, 2010b).

- The Jacksonville area in Florida is the only portion of the planting range which has been historically out of attainment for ozone. However, as of 1995 it has been in attainment with a maintenance plan registered with the USEPA (USEPA, 1995).
- The portions of Georgia in the planting range are all in attainment for NAAQS pollutants (Georgia Environmental Protection Division, 2009).

- The portions of the planting range in South Carolina are all in attainment for NAAQS pollutants. Almost all of the state is participating in an Early Action Compact program which is aimed at reducing air pollutants in general (South Carolina Department of Health and Environment Control, 2010).

Climate Change

GHG emissions and their relationship to climate change is a subject of national and international interest. Based on the assessments of the U.S. Global Climate Research Program (GCRP) (Karl et al., 2009) and the National Academy of Sciences' National Research Council, the USEPA determined that potential changes in climate caused by GHG emissions endanger public health and welfare (74 Federal Regulation [FR] 66496). The USEPA indicated that, while ambient concentrations of GHGs do not cause direct adverse health effects (such as respiratory or toxic effects), public health risks and impacts can result indirectly from changes in climate. Therefore, consideration of GHG emissions was treated as an element of the air quality analysis in this assessment.

The GCRP (Karl et al., 2009) summarizes the state of knowledge of climate change, including specific observations and projections for the southeastern U.S. The average annual temperature of the southeast did not change significantly over the course of the twentieth century, but did rise by 2^{o}F between 1970 and 2009. The increase in temperature from the 1961 to 1979 baseline in the region is projected to be 1 to 3^{o}F through 2029, and 2 to 5^{o}F by 2059. Climate change is also expected to increase the intensity of rainfall associated with hurricane events, and to increase the frequency and duration of droughts in the region (Karl et al., 2009).

6. Socioeconomics

The Region of Influence (ROI) for potential socioeconomic impacts was determined to be the proposed potential planting range and the states within which the planting range is located (Figure A). A total of 172 counties in seven states are contained wholly or partially within the planting range: Alabama (3 counties), Florida (36 counties), Georgia (32 counties), Louisiana (43 parishes), Mississippi (13 counties), South Carolina (8 counties), and Texas (37 counties). For this socioeconomic analysis, data for the ROI were compiled on a county level for the 172 counties then summarized by state and compared to the data for the full planting range ROI. The individual county data are provided in Attachment A (Socioeconomic Data). In some cases, socioeconomic data were not available at the county level; therefore, the following discussion focuses on relevant data for each of the seven states.

Information on existing conditions for socioeconomic factors, including population, demographics, housing, and income and local economy, is presented in the following sections. A discussion of environmental justice is presented in Section B.6.5.

a) Population

Table F shows the summarized U.S. Census Bureau (USCB) year 2000 population counts and year 2009 population estimates for planting range counties within each of the seven planting range states in comparison with the state totals. Complete county population data are presented in Attachment A-1. In the year 2000, population ranged from a minimum of 588,401 in the Mississippi planting range counties to a maximum of 5,959,603 in the Texas planting range counties. The year 2000 total combined population of the 172 counties is 15,779,653. Individually, Harris County, Texas, has the highest 2000 population of all counties within the planting range at 3,400,578. Echols County, Georgia, has the lowest population at 3,754. Attachment A-2 presents the county population data sorted from largest to smallest for the April 2000 Census.

Table B.6.1(i). Population and Percent Growth in the Potential Planting Range and Planting Range States from 2000 to 2009

Geographic Area	April 2000 Census	July 2009 Estimate	% Change 2000 to 2009
State of Alabama	4,447,100	4,708,708	5.9
Alabama Planting range	629,045	691,684	10.0
State of Florida	15,982,378	18,537,969	16.0
Florida Planting range	3,194,307	3,708,185	16.1
State of Georgia	8,186,453	9,829,211	20.1
Georgia Planting range	995,958	1,100,530	10.5
State of Louisiana	4,468,976	4,492,076	0.5
Louisiana Planting range	3,606,244	3,623,905	0.5
State of Mississippi	2,844,658	2,951,996	3.8
Mississippi Planting range	588,401	600,530	2.1
State of South Carolina	4,012,012	4,561,242	13.7
South Carolina Planting range	806,095	958,590	18.9
State of Texas	20,851,820	24,782,302	18.8
Texas Planting range	5,959,603	7,153,568	20.0
Total States	60,793,397	69,863,504	14.9
Total Planting range	**15,779,653**	**17,836,992**	**13.0**

Source: USCB, 2010a.

In comparison, the 2000 population for the states within which the planting range is located ranges from a minimum of 2,844,658 in the State of Mississippi to a maximum of 20,851,820 in the State of Texas. The total 2000 combined population for the seven states is 60,793,397.

The planting range county population estimates for 2009 range from a minimum of 600,530 in the Mississippi planting range counties to a maximum of 7,153,568 in the Texas planting range counties. The total combined estimated population for the 10 counties is 17,836,992. The estimated annual growth rate for the planting range ROI from 2000 to 2009 is 1.4%. Individually, Harris County, Texas, has the highest 2009 estimated population within the planting range at 4,070,989. Baker County, Georgia, has the lowest estimated population at 3,637. Attachment A-3 includes the county population data sorted from largest to smallest for the July 2009 census estimate.

In comparison, the 2009 population estimates for the seven states within which the planting range is located range from a minimum of 2,951,996 in the State of Mississippi to a maximum of 24,782,302 in the State of Texas. The total combined estimated population for the seven states is 69,863,504. The estimated annual growth rate for the states between 2000 and 2009 is 1.7%.

Several large cities and metropolitan areas are located within the planting range in these seven states. Cities with a population above 50,000 are depicted on Figure G. Cities with a population above 70,000 are labeled on this figure.

Figure G. Major Cities and Metropolitan Areas within the Planting Range

Population Projections

Population projections for the years 2010, 2015, and 2020 are not available at the county level; therefore, the following analysis utilizes state-wide population projections. The 2000 Census population counts and projections for 2010, 2015, and 2020 for the seven states within which the planting range is located are presented in Table G. Population within the State of Texas, the most populous of the states, is projected to increase from 20,851,820 in 2000 to an estimated 28,634,896 in 2020. The State of Mississippi, with the smallest population, is projected to experience an increase in population from 2,844,658 in 2000 to an estimated 3,044,812 persons in 2020. The projected total 2020 population for the seven states that include the planting range is 80,200,638, which represents a 32% increase over the 2000 population. The projected annual growth rate for the seven states, from 2000 to 2020, is 1.6% (USCB, 2005).

Table B.6.1(ii). Population and Percent Growth in the Planting Range States in 2000 and Projected for 2010 to 2020

State	Census April 1, 2000	Projections July 1, 2010	Projections July 1, 2015	Projections July 1, 2020	% Increase 2000 to 2020
Alabama	4,447,100	4,596,330	4,663,111	4,728,915	6.3
Florida	15,982,378	19,251,691	21,204,132	23,406,525	46.5
Georgia	8,186,453	9,589,080	10,230,578	10,843,753	32.5
Louisiana	4,468,976	4,612,679	4,673,721	4,719,160	5.6
Mississippi	2,844,658	2,971,412	3,014,409	3,044,812	7.0
South Carolina	4,012,012	4,446,704	4,642,137	4,822,577	20.2
Texas	20,851,820	24,648,888	26,585,801	28,634,896	37.3
Total	**60,793,397**	**70,116,784**	**75,013,889**	**80,200,638**	**31.9**

Source: USCB, 2005.

b) Demographics

The 2000 Census data are the most recent measured demographic information currently available from the USCB (the USCB 2006 to 2008 American Community Survey provides three-year estimates of demographic data; however, these estimates are not available for all the counties within the ROI). The 2000 demographic profile for the 172-county ROI is presented by state in Table H. Persons self-designated as minority individuals comprise approximately 38.5% of the total population within the 172-county ROI. Within the ROI, the largest minority population is composed of Black or African American residents at 22.8%. Individual county demographic information is presented in Attachment A-4.

Table B.6.2. Demographic Profile of the Population in the Planting Range in 2000

	Planting Range Totals							Planting Range Total	Planting Range %
	Alabama	Florida	Georgia	Louisiana	Mississippi	South Carolina	Texas		
Total Population	**629,045**	**3,194,307**	**995,958**	**3,606,244**	**588,401**	**806,095**	**5,959,603**	**15,779,653**	
Race (Not Hispanic or Latino)									
White alone	434,943	2,347,860	626,425	2,276,812	421,959	504,208	3,087,137	9,699,344	61.5
Black or African American alone	168,905	597,999	310,733	1,127,637	139,239	256,895	999,004	3,600,412	22.8
American Indian and Alaska Native alone	3,707	14,757	2,825	19,976	1,978	2,796	15,050	61,089	0.4
Asian alone	6,678	56,441	8,693	49,305	7,887	8,400	245,163	382,567	2.4
Native Hawaiian and Other Pacific Islander alone	129	1,736	641	833	246	391	2,065	6,041	0.0
Some other race alone	478	4,260	980	4,300	432	753	6,684	17,887	0.1
Population of two or more races	5,730	47,029	9,894	32,684	5,823	8,146	68,545	177,851	1.1
Total Racial Minority	**185,627**	**722,222**	**333,766**	**1,234,735**	**155,605**	**277,381**	**1,336,511**	**4,245,847**	**26.9**
Number of counties with % racial minority exceeding % racial minority in planting range	1	7	20	26	5	7	5	71	
Ethnicity (Any Race)									
Hispanic or Latino	8,475	124,225	35,767	94,697	10,837	24,506	1,535,955	1,834,462	11.6
Number of counties with % Hispanic exceeding % Hispanic in planting range	0	0	2	0	0	0	19	21	
Total Minority	**194,102**	**846,447**	**369,533**	**1,329,432**	**166,442**	**301,887**	**2,872,466**	**6,080,309**	**38.5**
Number of counties with % minority exceeding % minority in planting range	0	4	11	12	4	5	10	46	

Source: USCB, 2000.

c) Housing

The 172-county ROI includes a mixture of rural, suburban, and urban areas across the planting range. The 2000 Census reported 6,522,107 housing units in the ROI, of which approximately 5,808,738 were occupied. Table I lists the total number of occupied and vacant housing units, vacancy rates, and median value in the 172-county ROI summarized by state. Individual county data are available in Attachment A-5. The median value of owner-occupied units ranged from $32,500 in Atkinson County, Georgia, to $168,100 in Beaufort County, South Carolina. The planting range counties located within the State of Georgia had the lowest median value ($59,606) while those located in the State of South Carolina had the highest median value ($90,013). Individual county data sorted by median value are presented in Attachment A-6. The vacancy rate was highest in Walton County, Florida (43.1%), and lowest in Fort Bend County, Texas (4.4%). The vacancy rate was highest in the planting range counties located in the State of South Carolina (14.7%) and lowest in the State of Texas (9.4%). Individual county data sorted by vacancy rate are presented in Attachment A-7.

The USCB 2006 to 2008 American Community Survey provides three-year estimates of housing characteristics; however, these estimated housing data are not available for all the counties within the ROI. Therefore, housing data for the year 2000 and the estimated data for 2008 are presented at the state level for this analysis (Table J). It is likely that these estimates do not accurately reflect current conditions, given recent trends in the housing markets across the country. However, more complete (county-specific) and up-to-date information will not be available until the release of the 2010 census data.

For the year 2000, the median value of owner-occupied units ranged from $64,700 in the State of Mississippi to $100,600 in the State of Georgia. In 2008, the median value of owner-occupied units ranged from $94,000 in the State of Mississippi to $226,300 in the State of Florida. The median house value in the planting range states was estimated to increase approximately $57,186 between the 2000 and 2008. The total number of housing units within the planting range states increased from approximately 25,468,774 units in 2000 to 29,309,841 units in 2008, while the total number of occupied units increased from 22,711,073 to 24,927,433. During the same period, the vacancy rate increased from 10.8% to 15% of total housing units.

Table B.6.3(i). Housing in the Planting Range Counties (2000 Census)

	Planting Range Totals							
Housing Parameter	**Alabama**	**Florida**	**Georgia**	**Louisiana**	**Mississippi**	**South Carolina**	**Texas**	**Total**
Total housing units	278,957	1,415,475	416,961	1,479,782	245,139	356,415	2,329,378	6,522,107
Occupied housing units	241,349	1,236,452	366,250	1,332,814	218,078	304,104	2,109,691	5,808,738
Owner-occupied housing units	172,331	861,992	247,323	903,402	158,304	212,234	1,320,411	3,875,997
Renter-occupied housing units	69,018	374,460	118,927	429,412	59,774	91,870	789,280	1,932,741
Vacant housing units	37,608	179,023	50,711	146,968	27,061	52,311	219,687	713,369
Vacancy rate	13.5%	12.6%	12.2%	9.9%	11.0%	14.7%	9.4%	10.9%
Median value (dollars)	$85,467	$72,064	$59,606	$66,637	$62,085	$90,013	$63,586	$71,351

Source: USCB, 2000.

Table B.6.3(ii). Housing in the Planting Range States (2000 Census and 2006 to 2008 Estimates)

	Alabama	Florida	Georgia	Louisiana	Mississippi	South Carolina	Texas	Planting Range States Total
2000 Census								
Total housing units	1,963,711	7,302,947	3,281,737	1,847,181	1,161,953	1,753,670	8,157,575	25,468,774
Occupied housing units	1,737,080	6,337,929	3,006,369	1,656,053	1,046,434	1,533,854	7,393,354	22,711,073
Owner-occupied housing units	1,258,686	4,441,711	2,029,293	1,124,995	757,151	1,107,619	4,717,294	2,757,701
Renter-occupied housing units	478,394	1,896,218	977,076	531,058	289,283	426,235	2,676,060	7,274,324
Vacant housing units	226,631	965,018	275,368	191,128	115,519	219,816	764,221	2,757,701
Vacancy rate	11.5%	13.2%	8.4%	10.3%	9.9%	12.5%	9.4%	10.8%
Median value (dollars)	$76,700	$93,200	$100,600	$77,500	$64,700	$83,100	$77,800	$81,943
2006 to 2008 Estimate								
Total housing units	2,135,236	8,684,100	3,953,206	1,852,222	1,248,334	2,018,762	9,417,981	29,309,841
Occupied housing units	1,811,009	7,080,705	3,421,866	1,590,100	1,079,088	1,686,571	8,258,094	24,927,433
Owner-occupied housing units	1,291,690	4,975,344	2,321,478	1,085,449	763,576	1,185,421	5,378,160	17,001,118
Renter-occupied housing units	519,319	2,105,361	1,100,388	504,651	315,512	501,150	2,879,934	7,926,315
Vacant housing units	324,227	1,603,395	531,340	262,122	169,246	332,191	1,159,887	4,382,408
Vacancy rate	15.2%	18.5%	13.4%	14.2%	13.6%	16.5%	12.3%	15.0%
Median value (dollars)	$114,700	$226,300	$163,500	$123,900	$94,000	$131,000	$120,500	$139,129

Source: USCB, 2000; USCB, 2010b.

d) Income and Local Economy

Income

Income information for the 172-county ROI and the seven states, including 1999 household and per capita incomes and poverty levels, is summarized in Table K. Complete county-level income data are presented in Attachment A-8 (Although the USCB 2006 to 2008 American Community Survey provides three-year estimates of income data, these estimates are not available for all the counties within the ROI). According to the 2000 Census, the average of the median 1999 household incomes within the 172-county planting range ROI was $33,317, which is lower than the seven-state average ($36,613). Median household income in the 172 planting range counties ranged from $18,447 in Jefferson County, Mississippi, to $63,831 in Fort Bend County, Texas. Individual county data sorted by median household income are presented in Attachment A-9. Per capita income in the 172 planting range counties ranged from $9,709 in Jefferson County, Mississippi, to $28,674 in St. Johns County, Florida. Average per capita income in the 172-county ROI ($16,531) was less than that of the seven states ($18,868). Individual county data sorted by per capita income are presented in Attachment A-10.

For 110 of the counties within the ROI, the percentage of individuals with incomes below the poverty level in 2000 was higher than the ROI average of 15.8%. The total number of individuals below the poverty level within the ROI was 2,412,343. For comparison, within the seven states, 8,749,189 individuals (14.8% of the population) had incomes below the poverty level in 2000.

For 109 counties within the ROI, the percentage of families with incomes below the poverty level in 2000 was higher than the ROI average of 12.3%. The total number of families below the poverty level within the ROI was 502,484. For comparison, within the seven states, 1,798,444 families (11.3% of the population) had incomes below the poverty level. Individual county data are presented in Attachment A-8.

Local Economy

Employment distribution data for the ROI is presented in Table L. Data on employment is not available on the county level; therefore, state-level data are provided here. A total of 30,902,463 individuals earn wage and salary employment in the seven planting range states. State and local government and retail trade are the largest sectors of employment in the planting range states. The State of Texas has the largest number of individuals employed, while the State of Mississippi has the least. This is consistent with the relative population levels for these states. The cities depicted on Figure G are major job and population centers within the planting range.

Table B.6.4(i). Income Information for the Potential Planting Range and Planting Range States

	Median Household Income 1999 (dollars)	Per Capita Income 1999 (dollars)	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
State of Alabama	34,135	18,189	4,334,919	698,097	16.1	1,223,185	153,113	12.5
Alabama Planting Range Total	36,130	18,921	617,797	99,713	16.1	173,155	22,783	13.2
State of Florida	38,819	21,557	15,605,367	1,952,629	12.5	4,238,409	383,131	9.0
Florida Planting Range Total	33,508	16,712	3,058,197	424,340	13.9	839,133	82,907	9.9
State of Georgia	42,433	21,154	7,959,649	1,033,793	13.0	2,126,360	210,138	9.9
Georgia Planting Range Total	31,017	15,297	957,989	166,135	17.3	262,038	36,233	13.8
State of Louisiana	32,566	16,912	4,334,094	851,113	19.6	1,163,191	183,448	15.8
Louisiana Planting Range Total	31,476	15,092	3,507,947	671,701	19.1	937,242	144,762	15.4
State of Mississippi	31,330	15,853	2,750,677	548,079	19.9	752,234	120,039	16.0
Mississippi Planting Range Total	29,283	14,563	571,383	96,116	16.8	157,453	21,724	13.8
State of South Carolina	37,082	18,795	3,883,329	547,869	14.1	1,078,736	115,899	10.7
South Carolina Planting Range Total	36,571	18,052	777,724	112,424	14.5	212,467	23,568	11.1
State of Texas	39,927	19,617	20,287,300	3,117,609	15.4	5,283,474	632,676	12.0
Texas Planting Range Total	35,232	17,079	5,809,955	841,914	14.5	1,506,573	170,507	11.3
State Total	**36,613**	**18,868**	**59,155,335**	**8,749,189**	**14.8**	**15,865,589**	**1,798,444**	**11.3**
Planting Range Total	**33,317**	**16,531**	**15,300,992**	**2,412,343**	**15.8**	**4,088,061**	**502,484**	**12.3**

Source: USCB, 2000.

Table B.6.4(ii). Total Employment by Industry within Planting Range States (2008)

Occupation	Alabama	Florida	Georgia	Louisiana	Mississippi	South Carolina	Texas	Total
Farm employment	51,219	84,686	56,363	32,731	44,257	29,578	263,291	562,125
Nonfarm employment	2,589,498	10,339,414	5,515,303	2,544,229	1,514,005	2,549,702	14,206,609	39,258,760
Private employment	2,177,238	9,132,055	4,706,587	2,146,463	1,229,596	2,147,670	12,269,508	33,809,117
Forestry, fishing, and related activities	15,277	63,132	22,339	17,941	14,269	10,391	56,074	199,423
Mining	11,375	16,972	9,148	67,847	11,734	2,944	358,669	478,689
Utilities	14,035	26,096	21,666	9,773	7,993	13,066	53,705	146,334
Construction	182,496	713,003	361,531	203,439	109,510	173,633	1,065,791	2,809,403
Manufacturing	292,780	402,191	427,857	160,459	164,406	249,986	985,013	2,682,692
Wholesale trade	88,676	384,531	236,499	82,318	40,710	78,383	581,681	1,492,798
Retail trade	290,656	1,161,381	568,624	270,490	171,012	286,112	1,473,120	4,221,395
Transportation and warehousing	78,202	326,086	221,236	97,201	55,510	69,542	547,914	1,395,691
Information	32,135	188,784	127,738	33,785	16,122	34,113	259,049	691,726
Finance and insurance	102,084	566,499	240,093	91,333	53,093	101,011	762,376	1,916,489
Real estate and rental and leasing	100,739	604,801	253,026	103,038	48,007	121,339	610,746	1,841,696
Professional, scientific, and technical services	144,912	696,341	361,490	133,650	58,185	121,512	938,144	2,454,234
Management of companies and enterprises	15,663	90,036	57,696	24,818	10,359	16,674	92,787	308,033
Administrative and waste services	158,942	848,152	410,088	148,341	80,471	175,468	965,770	2,787,232
Educational services	34,432	175,675	99,280	42,594	23,178	35,080	197,337	607,576
Health care and social assistance	222,994	1,068,315	461,186	259,140	136,992	190,256	1,289,772	3,628,655
Arts, entertainment, and recreation	33,774	287,148	91,479	51,336	20,748	46,868	225,775	757,128
Accommodation and food services	168,208	803,212	381,915	176,822	120,396	202,094	978,222	2,830,869
Other services, except public administration	189,858	709,700	353,696	172,138	86,901	219,198	827,563	2,559,054
Government and government enterprises	412,260	1,207,359	808,716	397,766	284,409	402,032	1,937,101	5,449,643
Federal, civilian	52,534	130,102	98,292	31,646	26,625	30,456	191,208	560,863
Military	32,110	100,787	101,595	36,751	31,246	55,350	185,530	543,369
State and local	327,616	976,470	608,829	329,369	226,538	316,226	1,560,363	4,345,411
State government	107,507	200,375	172,582	110,879	67,910	100,647	346,643	1,106,543
Local government	220,109	776,095	436,247	218,490	158,628	215,579	1,213,720	3,238,868
Total employment	**2,640,717**	**10,424,100**	**5,571,666**	**2,576,960**	**1,558,262**	**2,579,280**	**14,469,900**	**39,820,885**

(D) Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals; *Source:* Bureau of Economic Analysis (BEA), 2010.

As discussed in Section I and Section IX of the petition, the pulp and paper industry is a key economic sector in the southern U.S., including the seven states located within the planting range. Within the seven-state ROI there are a total of 199,423 persons employed in forestry, fishing and related activities. The majority of the forestry-related industry is located outside of the major population centers shown on Figure G. The State of Florida has the highest number of forestry, fishing and related activities jobs at 63,132 representing 0.78% of the total workforce. In Mississippi, forestry, fishing, and related activities jobs represent the highest percentage of the state workforce (14,269 persons, or 1.16% of total workers). South Carolina has the least forestry, fishing and related activities jobs at 10,391 representing 0.51% of the total workforce. All forestry, fishing and related activities employment data for the seven planting range states is presented in Table M.

Table B.6.4(iii). Forestry, Fishing, and Related Activities Employment Data for the Planting Range States (2008)

Occupation	Forestry, fishing, and related activities	% of Total Workers
Alabama	15,277	0.73
Florida	63,132	0.78
Georgia	22,339	0.52
Louisiana	17,941	0.88
Mississippi	14,269	1.16
South Carolina	10,391	0.51
Texas	56,074	0.51
Total	199,423	0.65

Source: BEA, 2010.

Within the planting range states, the pulp and paper industry employed 99,952 people in 2008; by 2010 this number had decreased to 69,660 (Table N). In 2008 there were 901 paper manufacturing facilities in these states with annual payrolls totaling $7,630,000 and annual shipments totaling $38,031,497. By 2010 there were 899 paper manufacturing facilities in these states. Despite the decrease in number of employees and number of paper manufacturing facilities, annual payrolls increased to $8,320,000 and annual paper shipments increased to $41,746,343, indicating an overall growth in the economic value of the pulp and paper industry in these states. Table N presents comparison details for the pulp and paper industry in the seven planting range states for 2008 and 2010 (the American Forest and Paper Association [AF&PA], 2008; 2010).

As discussed in Section IX.B of the petition, bioenergy is a growing industry in the U.S. as a result of the ongoing push for sustainable and renewable energy sources. As of 2008, in the seven planting range states there are 12 commercial, demonstration, and pilot stage cellulosic biorefineries that are complete, under construction, or in the planning stage. As defined by the U.S. Department of Energy (DOE), a commercial scale biorefinery uses at least 700 tons of feedstock per day to produce 10 to 20 million gallons per year of biofuel. Demonstration scale biorefineries are smaller using only about 70 tons of feedstock to produce at least 1 million gallons per year of biofuel. Pilot scale biorefineries are designed to test and develop new methods and technologies (the Environmental and Energy Study Institute [EESI], 2008). Biorefineries are present in five of the states within the planting range: Alabama (2), Florida (6), Georgia (1), Louisiana (2), and South Carolina (1). As of 2008 there were no biorefineries in Mississippi or Texas (EESI, 2008). A summary of total renewable net energy generation from biomass and from wood and derived fuels sources in the seven planting range states, as of 2007, is presented in Table O.

The State of Florida supports the development of cellulosic biofuels in three ways. First, the state provides matching research and development grants through their "Farm to Fuel" and Renewable Energy Technologies programs. Additionally, the state provides separate hydrogen and biofuels tax exemptions and tax credits (EESI, 2008). None of the other states in the planting range currently maintains specific programs or policies with regard to biofuels.

Table B.6.4(iv). Pulp and Paper Industry within Planting Range States (2008 and 2010)

	Year	Alabama	Florida	Georgia	Louisiana	Mississippi	South Carolina	Texas	Total
Pulp & Paper Employment	**2008**	14,474	10,361	24,205	9,548	5,611	13,900	21,853	99,952
	2010	13,680	9,891	20.861	8,353	4,835	13,263	19,617	69,660
Annual Pulp & Paper Payroll Income (dollars)	**2008**	$1,284,000	$722,000	$1,789,000	$737,000	$418,000	$1,041,000	$1,639,000	$7,630,000
	2010	$1,482,000	$844,000	$1,756,000	$736,000	$429,000	$1,191,000	$1,882,000	$8,320,000
Value of Paper Manufacturing Industry Shipments (dollars)	**2008**	$6,211,472	$3,596,960	$9,584,588	$4,456,284	$2,342,916	$5,549,268	$6,290,009	$38,031,497
	2010	$7,594,701	$3,979,432	$10,084,469	$4,906,866	$2,450,782	$6,340,684	$6,389,409	$41,746,343
Number of Paper Manufacturing Facilities	**2008**	85	159	182	60	58	98	259	901
	2010	85	159	182	59	58	98	258	899

Source: AF&PA, 2008; 2010.

Table B.6.4(v). Total Renewable Net Energy Generation (in thousand kilowatt hours) by Planting Range State (2007)

	Alabama	Florida	Georgia	Louisiana	Mississippi	South Carolina	Texas	Total
Biomass*	16,899	579,058	42,116	88,461	5,017	-	58,543	790,094
Wood and Derived Fuels	3,834,786	1,924,074	3,413,571	2,996,010	1,491,546	1,754,399	916,981	16,331,367

Source: Energy Information Administration, 2008.

e) Environmental Justice

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the selection of planting sites. In assessing the impacts, the following Council on Environmental Quality (CEQ) (1997) definitions of minority individuals and populations and low-income population were used:

- **Minority individuals.** Individuals who identify themselves as members of the following population groups: Hispanic or Latino, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races meaning individuals who identified themselves on a Census form as being a member of two or more races.

- **Minority populations.** Minority populations are identified when (1) the minority population of an affected area exceeds 50% or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

- **Low-income population.** Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the U.S. Census Bureau's Current Population Reports, Series PB60, on Income and Poverty.

This environmental justice analysis focuses on residents living within the areas where there could be potentially disproportionate adverse human health and/or environmental effects of the project alternatives on minority and/or low-income populations. For the purposes of this ER, the populations located within the proposed planting range were identified as potentially impacted. Census data and estimates from the planting range counties were used to determine the presence of communities of concern with regard to environmental justice.

The 172-county ROI ranges from rural to urban throughout the planting range. Population density varies across the ROI with the largest concentrations in urban cities. Table H identifies the demographic profile for the communities (i.e., counties) that occur within the planting range. Detailed county data are presented in Attachment A-4. The overall population within the planting range ROI was identified as 38.5% minority, including individuals self-identified as minority races or of Hispanic or Latino ethnicity. Within the planting range, the largest minority group was black or African American residents (3,600,412 persons or 22.8%), followed by Asian (382,567 persons or 2.4%). A total of 1,834,462 persons (11.6%) of the ROI population identified themselves as Hispanic or Latino ethnicity.

To determine the presence of environmental justice communities of concern, the minority population of the individual counties was compared to the minority population of the planting range ROI. Counties with a percent minority population greater than the ROI average (38.5%) were considered to be environmental justice communities of concern. Within the planting range, 46 counties were determined to have minority population percentages greater than the ROI average. Therefore, these counties would constitute environmental justice communities of concern. Summarized data for planting range counties in each of the seven planting range states are presented in Table H and individual county data are contained in Attachment A-4.

According to the 2000 Census, the number of individuals in the planting range ROI with a median 1999 household income below the poverty level was 2,412,343, representing 15.8% of the population. The number of families in the planting range living below the poverty level was 4,088,061 or 12.3% of the population. Poverty data are summarized in Table K and individual county data are provided in Attachment A-8.

Counties with a percentage of individuals living below the poverty threshold that exceeded the ROI average were considered to be environmental justice communities of concern. Within the planting range ROI, there were 110 counties that could be considered environmental justice communities of concern with respect to low-income populations (Attachment A-8). This represents 63.4% of the counties within the ROI.

C.Environmental Consequences

This section describes the environmental consequences from the proposed action and the no action alternative. The discussion of impacts generally is based on the components of the affected environment described in Section B. For each environmental component, impacts of the no action alternative are described first because it represents baseline conditions. Impacts of the proposed action then are described and compared to the impacts of the no action alternative in order to determine the relative magnitude and significance of impacts under the proposed action.

As discussed in Section A., the affected environment that currently exists in the potential planting range may be different from the baseline conditions under the no action alternative. The areas within the potential planting range where either GE FTE lines or non-GE FTE species may be planted in the future are likely to be in use currently for commercial forestry, and are likely to be planted in pines. Due to land use pressures from population growth and development in combination with protections for wetlands, habitats, and other environmental resources, the conversion of additional areas not currently used for commercial forestry, such as native woodlands, agricultural lands, and riparian areas, to FTE plantations is highly unlikely. Therefore, the affected environment within the potential planting range is expected to consist predominantly of areas that are currently in cultivation, especially areas used for commercial forestry. However, as discussed in Section A, conversion of existing pine plantations to non-GE FTE is not regulated, is currently under development within the potential planting range for GE FTE, and is expected to occur regardless of whether USDA-BRS grants non-regulated status for the GE FTE lines.

Environmental consequences due to the conversion from growing pines to growing non-GE FTE would occur under the no action alternative and are not relevant to the consideration of non-regulated status for the GE FTE lines evaluated under the proposed action. The relevant impacts under the proposed action are those resulting from the incremental differences between impacts from large-scale commercial cultivation of non-GE FTE and of GE FTE. Therefore, the no action alternative includes impacts that would occur in the future from the planting of non-GE FTE within the potential growing range for GE FTE, and these impacts are incorporated into the baseline conditions to which impacts from the proposed action are compared.

As discussed in Section A, the non-freeze tolerant parental EH1 *Eucalyptus* hybrid that currently may be grown in central and southern Florida potentially could be replaced in some plantations if growers elect to cultivate GE FTE lines 427 and 435 in these areas in order to reduce the possibility of damage from the deep freezes that sometimes occur there. ArborGen's field trial data confirm that the physiological and growth characteristics of EH1 and the GE FTE lines are essentially identical when they are grown in the absence of severe freezing temperatures. Thus, the environmental consequences of growing GE FTE lines 427 or 435 instead of EH1 in some locations within this region would be identical to the effects of growing EH1 for most environmental components. The principal differences between the GE FTE lines and the non-GE EH1 hybrid are the genetic modifications incorporated into the GE lines. If there are differences in their environmental consequences, these differences likely would be associated with the potential for biological effects from gene flow and gene transfer. Therefore, this report analyzes the environmental consequences from the cultivation of the GE FTE lines instead of the non-GE EH1 hybrid in central and southern Florida only for gene flow and gene transfer and not for other environmental components.

1. Forestry and Agriculture

a) Commercial Forestry

(1) Forestry Commodities

The commercial forestry commodities produced in the potential planting range could change as a result of the conversion of pine plantations to hardwood plantations growing non-GE FTE species, under no action, or GE FTE lines, under the proposed action. The types of wood products produced in the planting range likely would change under either scenario as discussed below.

No Action

Under the No Action Alternative, the GE FTE lines would not be available for commercial introduction. However, the existing commercial forestry commodities produced in the geographic area of the potential planting range would continue to evolve in response to other factors affecting the wood products industry, including the introduction of new products, level of demand, price of production relative to other sources, and modifications in the land area available for commercial forestry. Based on recent trends in these factors, the no action alternative likely would include a gradual conversion of an incremental portion of the current pine-based plantations to non-GE FTE species. These changes would be voluntary on the part of the landowners and the wood products industry, and would only be implemented as the landowners and industry make personal economic and business decisions to replace some fraction of the current stands of pine with *Eucalyptus*. As discussed in Section I, the qualities of *Eucalyptus* fiber make it the preferred raw material for use in manufacturing a wide range of paper products, and the relatively fast growth rates and high yields of non-GE FTE also are expected to make it superior to native hardwoods and pines as a source of bioenergy feedstock.

Proposed Action

Commercial forestry commodities produced as a result of the proposed action following the introduction and harvesting of the GE FTE lines would not be expected to differ from commodities produced from non-GE FTE species under the no action alternative. Therefore, the forestry commodities produced in the potential planting range under the proposed action would not differ significantly from the no action alternative.

Cumulative Impacts

Gradual modification of the quantities and composition of forest products produced from trees grown in the potential planting range would occur under the no action alternative or the proposed action in response to the cumulative effects of economic and environmental factors. These factors include the introduction of new products, the level of demand, the price of production relative to other sources of supply, and modifications in the land area available for commercial forestry due to development and regulatory constraints. These modifications in forest commodities produced would be voluntary on the part of the landowners and commercial wood products industry, as they would implement these changes in response to market forces. Under the no action alternative, the introduction of non-GE FTE could contribute substantially to cumulative effects on the production of forest commodities by providing a new, more productive source of U.S. hardwood pulp and bioenergy feedstock. The commodities produced from the use of GE FTE under the proposed action would be the same as those produced by a combination of pine and non-GE FTE under the no action alternative; however, the use of GE FTE would be expected to increase productivity, and therefore reduce costs for the producers.

(2) Geographic Areas/Acreage in Production

Under the no action alternative or the proposed action, the geographic areas and acreage associated with commercial forestry in the potential planting range could be affected by the introduction of faster-growing hardwoods, either non-GE FTE or GE FTE. The introduction on these trees may result in a substantial increase, decrease, or re-location of the areas currently used for commercial forestry, but these changes would be limited to the geographic area within the potential planting range.

No Action

Under the no action alternative, the GE FTE species would not be available for commercial introduction. The existing locations and total acreage used for commercial forestry in the geographic area encompassed by the potential planting range would not remain static but would continue to evolve in response to other factors affecting the wood products industry, including the level of demand, price of production relative to other sources, modifications in the land area available for commercial forestry, increased utilization of recycling, and improved product yields. Based on recent trends in these factors, the no action alternative likely would include a gradual reduction in acreage available for commercial forestry due to increased efficiency and productivity, as well as continued reduction in available land area due to urbanization and environmental protections. Increased efficiency and productivity would be achieved through improvements in forestry practices, use of recycled materials, and improvement of product yields. In addition, increased productivity would be achieved through the introduction of non-GE FTE species and could result in the ability to meet demand while using a reduced acreage of cultivation.

The acreage under production also would be affected by modifications to the current import/export conditions associated with wood products in the region. In general, imports have increased in recent years due to the expansion of short-rotation plantations in the southern hemisphere (AFC, 2010), suggesting that total acreage in production in the region should continue to decline unless short-rotation forestry can also be implemented domestically. However, one objective for the use of both non-GE and GE FTE species would be to make domestic production more competitive. If successful, the declining trend in acreage under cultivation could potentially be slowed or reversed.

Proposed Action

Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve any change in the areas or total acreage under production. The acreages would continue to change in response to other factors as discussed under the no action alternative. However, the proposed action would allow the use of GE FTE but would not, by itself, affect the areas that would be suitable for cultivation.

Cumulative Impacts

Because the proposed project would not result in any modification to the locations or total acreage under cultivation, it would also not contribute to adverse cumulative impacts to these areas. Gradual modification of these areas would continue to occur in response to market forces and reductions in available land area due to urbanization and environmental protections. Some of these modifications could result in adverse impacts by reducing or eliminating cultivation in some areas or introducing it into other areas. However, any adverse cumulative impacts would be a result of these other factors, and would not be affected by the proposed action.

(3) Forestry Practices

Harvesting/Rotation

Under the no action alternative or the proposed action, commercial forest harvesting and rotation practices could change relative to current practices.

No Action
Under the no action alternative, the GE FTE lines would not be available for commercial introduction. The existing harvesting methods and rotation practices would continue to evolve in response to attempts by the landowners and commercial forestry companies to improve efficiency through increased use of mechanization and to shorten rotation times. The development of non-GE FTE species is currently being implemented by these companies with one objective being the reduction of rotation times. Therefore, rotation times are likely to continue to decrease, and may decrease substantially, once the use of non-GE FTE species becomes more prevalent. However, these changes would be voluntary on the part of the landowners and forestry companies, and would only be implemented as they become available to improve their operations. Overall, these impacts are likely to be beneficial to the industry.

Proposed Action
Introduction of the GE FTE lines in place of non-GE FTE species would not involve substantial changes in harvesting practices or rotation times in comparison to non-GE FTE. The characteristics of the non-GE and GE FTE species would be similar, though the GE FTE lines are expected to exhibit more rapid growth. However, use of the GE FTE lines would not result in a noticeable effect on these forestry practices.

Cumulative Impacts
Changes in harvesting practices and rotation times would occur under the no action alternative or the proposed action in response to the cumulative effects of economic and environmental factors. Throughout the potential planting range, harvesting practices likely would continue to be modified through the increased use of mechanization, and rotation times would continue to be reduced through attempts by landowners and forestry companies to increase productivity. The introduction of faster

growing FTE is one of the modifications that would contribute to cumulative effects on these forestry practices. However, these modifications would be voluntary on the part of the landowners and forestry industry, and would not result in adverse impacts on the forestry industry under either the proposed action or the no action alternative.

Herbicide/Pesticide Use

Under the no action alternative or the proposed action, impacts to herbicide and pesticide use could occur if the non-GE FTE or GE FTE were to result in substantial changes in the types or amounts of these materials needed or their manner of application and management.

No Action

Under the no action alternative, the GE FTE species would not be available for commercial introduction. The existing herbicide and pesticide practices, including types, amounts, and application practices, would continue to evolve in response to changes both in the availability of herbicide and pesticide products, and in the types of trees used in commercial forestry. Because they are heavily regulated, any changes in the herbicide and pesticide products themselves are likely to include gradual elimination of potentially unsafe products and their replacement by products with a reduced level of environmental impacts. As hardwoods, including non-GE FTE, are typically more sensitive to herbicides than pines, existing herbicide practices will evolve with the conversion of existing pine plantations to non-GE FTE. Following standard herbaceous weed control practices prior to planting, as is common in many forestry operations, post-planting treatments likely include spot spraying rather than broadcast applications, possibly resulting in a reduction in overall herbicide use. All pesticide and herbicide use would still be regulated by the USEPA as well as the applicable state agriculture and/or forestry departments.

Proposed Action

Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve any change in the types, amounts, or application procedures associated with the use herbicides or pesticides.

Cumulative Impacts

Because the proposed action would not result in any modification to the types, amounts, or application procedures associated with herbicides and pesticides, it also would not contribute to adverse cumulative impacts from the use of these products. Although the types, amounts, and application procedures would evolve, these changes would occur within the framework of Federal and state regulation of the products and their use. The implementation of the GE FTE lines would not contribute to any cumulative impacts associated with their use.

Transportation and Processing

Under the no action alternative or the proposed action, transportation and processing associated with forestry products could be affected if the non-GE FTE or GE FTE were to require a different type or number of processing facilities or could result in substantial changes in the type or distance of transportation required.

No Action

Under the no action alternative, the GE FTE species would not be available for commercial introduction. The existing processing facilities and transportation network would continue to evolve in response to changes in the types of wood products provided, and the relative locations of the harvesting locations versus the end-product use locations. The introduction of non-GE FTE species is not expected to result in a modification of the types of wood products produced by the industry. However, because of their higher growth rate, the introduction of non-GE FTE species is expected to enable higher hardwood production rates in locations in close proximity to current processing facilities and end-use locations. As a result, the transportation distances currently associated with the industry could be reduced, with a resulting reduction in both cost and transportation-related impacts. Given the faster growth time and therefore more frequent harvesting of the *Eucalyptus*, it is possible that some localized transportation impacts may occur from more frequent passage of logging and transport vehicles. The major roadways should be large enough to accommodate this additional traffic without impact. Local impacts may be possible on smaller roadways.

Proposed Action

Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve any modification in the types of wood products produced by the industry. Like the non-GE FTE lines, the faster growth rate of the GE FTE species could enable higher production rates in closer proximity to processing facilities and end-use locations. Therefore, implementation of the proposed project could contribute to a reduction in transportation-related impacts.

Cumulative Impacts

Because the proposed project would not result in any adverse impacts to the current processing and transportation infrastructure, it would also not contribute to adverse cumulative impacts from the use of these products. Implementation of both the non-GE FTE lines and the GE FTE lines could potentially assist in reversing what has been an adverse trend in required transportation distances by enabling faster growth rates in close proximity to existing processing and end-use locations. Similarly, implementation of these short-rotation species in the planting range is likely to displace imports, thus reducing the need to transport products from overseas locations. Any reduction in transportation distances would have a beneficial impact by reducing the burning of fossil-fuels, and thus the release or air emissions and GHG.

Prescribed Fire

Under the no action alternative or the proposed action, forestry practices employed in the use of prescribed fire could be altered if the non-GE FTE or GE FTE were to require a greater duration or frequency of prescribed fires as a forest management tool. Adverse impacts could occur if prescribed fire were to be used closer to urban areas where air quality impacts already exist and homes and businesses could be at risk from an uncontrolled fire.

No Action

Under the no action alternative, the GE FTE species would not be available for commercial introduction. The management practice of using prescribed fire in commercially planted areas of the potential planting range would continue at its current level, and may evolve in response to changes in the types of tree species used in these areas. Although some current tree species are likely to be replaced by non-GE FTE species in the future, the non-GE FTE species are not expected to require any increase in the use of prescribed fire from current levels. A change to non-GE FTE species also would not result in prescribed burning occurring at locations in closer proximity to urbanized areas. Use of non-GE FTE species may enable a concentration of growth and harvesting in areas near the processing facilities, but these facilities are still expected to be located in rural areas which are designated as unclassified or attainment with respect to air quality impacts.

Proposed Action

Introduction of the GE FTE lines in place of non-GE FTE or other tree species would not involve any modification in the use of prescribed fire. A change to GE FTE species also would not result in prescribed burning occurring at locations in closer proximity to urbanized areas. Therefore, implementation of the proposed project would not result in any adverse impacts associated with prescribed fire practices.

Cumulative Impacts

Because the proposed project would not result in any adverse impacts as a result of the use of prescribed fire as a forest management tool, it would also not contribute to adverse cumulative impacts to air quality, or as a result of fire risks.

b) Agriculture

Under the no action alternative or the proposed action, agricultural resources potentially could be affected if the non-GE FTE or GE FTE were to displace agriculture as a land use in some areas of the potential planting range, or if the growth or management practices associated with these trees were to impact the growth of agricultural products on nearby parcels.

No Action
Under the no action alternative, the GE FTE species would not be available for commercial introduction. The current acreage associated with commercial forestry, which has been decreasing for many years, would be expected to continue to decrease. Therefore, commercial forestry would not substantially displace agriculture, and the acreage reduction could potentially make additional lands available for agriculture. Therefore, the No Action Alternative could potentially have a beneficial impact on the acreage available for agriculture.

Also under the No Action Alternative, a fraction of current pine plantations are expected to be replaced by non-GE FTE species in the future. While this practice would not reduce the land area available for agriculture, it could potentially conflict with the use of local resources, such as water, that would otherwise be necessary to support agricultural production on adjacent properties. Because of their higher growth rate, the parcels of non-GE FTE species would likely use a higher volume of water than the pine trees they would be displacing. If this were to occur in close proximity to water sources for agricultural production, such as near irrigation wells, then the non-GE FTE species could potentially result in an adverse impact to agricultural resources. This impact would occur regardless of the de-regulation decision made by APHIS with respect to the GE FTE lines. This impact would likely be mitigated through management practices, such as reduced stocking, designed to develop the non-GE FTE plantation in a manner consistent with the available water resources.

One purpose of the use of short-rotation species, such as *Eucalyptus*, is to provide biomass for bioenergy purposes. That purpose is currently met, in part, by a combination of wood by-products and slower-growing low-volume agricultural crops. If implemented in order to provide an increase in bioenergy resources, it is possible that *Eucalyptus* could displace the use of other agricultural crops which would otherwise have served this purpose. Therefore the displacement of other agricultural crops could potentially be considered to be an impact to agricultural resources.

Proposed Action
Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve an increase in the use of acreage, and therefore would not have an adverse impact on the land area available for agriculture. Like the non-GE lines, the GE FTE lines may enable a reduction in acreage used for commercial forestry, and therefore could beneficially impact agricultural resources. The impact of the GE FTE lines on agriculture as a result of water use would also be the same, and not any greater than, that associated with the non-GE lines under the No Action Alternative. Overall, the potential impact of the proposed action on agricultural resources would be either the same, or less than, those associated with the No Action Alternative.

Cumulative Impacts
Because the proposed project would not result in any adverse impacts to agricultural resources as compared to the No Action Alternative, it would also not contribute to adverse cumulative impacts to agriculture.

c) Bioenergy

Potential impacts related to bioenergy resources could potentially occur if the GE FTE species were to result in a substantial increase or decrease in the bioenergy industry. Currently in the region, there is no viable bioenergy industry, and the use of agricultural or forestry products for this purpose is only being studied. Therefore, there is no existing industry which could be affected by adverse impacts. However, the use of short-rotation species such as *Eucalyptus* could potentially provide a resource which could make such an industry viable. Therefore, any impact of the approval of the GE FTE lines on the bioenergy industry is expected to be beneficial.

(1) No Action

Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. The current bioenergy industry would likely increase in activity due to the increasing use of agricultural products, residues from the wood products industry, and increasing prices for other energy resources. Also, a fraction of existing pine plantations would likely be replaced by non-GE FTE species, partially with the intention of providing an additional resource for the bioenergy industry. Therefore, the No Action Alternative is likely to lead to a gradual improvement in the resources available to the bioenergy industry.

Also, by replacing slow-growth and low volume agricultural resources with a short-rotation resource, the implementation of the non-GE FTE lines would likely allow the growth of a greater amount of biomass in close proximity to bioenergy processing facilities, which would be the end-use location for the product. Currently, one of the greatest barriers to the development of a bioenergy industry in the region is the high cost of transportation of the relatively high-volume resource to its end use locations. Therefore, development of non-GE FTE plantations in close proximity to processing facilities would have a substantial beneficial impact on the development of the industry, and would also facilitate economic development in rural areas.

(2) Proposed Action

The effects of the introduction of the GE FTE lines in place of other tree species would be the same as those identified for the introduction of non-GE FTE species under the no action alternative. The faster growth rate of the FTEs, whether GE or non-GE, would provide a greater resource base to support the development of a bioenergy industry.

(3) Cumulative Impacts

Because the proposed project would not result in any adverse impacts to the bioenergy industry, it would also not contribute to adverse cumulative impacts to the industry.

2. Biological Resources

a) Biodiversity

Biodiversity can be measured in several ways, such as the number of species present (richness), the types of species present, and the evenness of the community structure. Effects on biodiversity under the no action alternative and the proposed action can be affected by three scenarios: the conversion of native forest, existing pine plantations, or agricultural lands to *Eucalyptus* plantations. Additionally, biodiversity of neighboring communities may be affected by allelopathy and the potential escape of plantation trees.

(1) No Action

Conversion of Native Forest to *Eucalyptus* Plantations

Under the no action alternative, it is possible but very unlikely that naturally occurring hardwood forest would be converted to tree plantations in the southern U.S. Tree plantations essentially are monocultures regardless of the species planted. The projected increase in the number of non-GE FTE planted under the no action alternative is unlikely to substantially reduce biodiversity unless it provides landowners with a sufficient incentive to harvest native forest and replace it with plantations of non-GE FTE. Biodiversity of species other than trees could be maintained with appropriate conservation management. Although there are management practices geared towards conservation, it is unlikely that all forest owners would adopt these methods instead of more intensive silvicultural methods. Due to the increase in the amount of land dedicated to tree monocultures, a loss of tree biodiversity is possible under the no action alternative.

Comparing the overall biodiversity of native, primary forest and tree plantations is highly complex and difficult. Many studies have been done in the southern tropics and southern hemisphere, but their conclusions often are confounded by issues of sample size and plot placement. These issues often under- or over- estimate the biodiversity of tree plantations due to their proximity to primary forest, plot and sample sizes, and general statistical validity. Also, some species are studied more often, such as birds. These studies do not include an estimate of overall diversity since they do not include all potential species in the sample plot, for example, soil biota and herbaceous cover. A study attempting to address these complications was recently completed. It compared the overall biodiversity of eucalypt tree plantations to that of primary and secondary forests in Brazil based on several different measurements and several different species groups. The results varied, depending on the species group; bird, tree, leaf litter amphibians and butterfly diversity was higher in primary forests, large mammals were equally diverse in primary and secondary forest and arachnids, lizards, dung beetles, and bat diversity was not significantly different between primary forest and eucalypt plantations. However, these results reflect only the numbers of taxa in each forest type. Biodiversity can be enumerated in several ways. For example, many more unique species were found in the primary forest, followed by the secondary forest; the eucalypt plantations had the lowest amount of unique species. Although the numbers of species within a group were not necessarily highly different between forest types, the individual species found in each habitat were different. Therefore, the primary forest could be considered more diverse than the eucalypt plantations. The authors also found that high numbers of primary forest species can be found in both native secondary and plantation forests with an understory of native shrubs, suggesting that plantations can have value as potential conservation habitats with high diversity (Barlow et al., 2007).

Studies have shown that species richness and evenness can be similar in unmanaged native oak and eucalypt forests in California. Community composition and the particular species found in each habitat, however, were different (Sax, 2002). These data may not necessarily be projected onto managed plantations, where disturbance regimes are artificially controlled. Additional studies reviewed in Sax (2002) did compare plantations with native forests, and found equal species richness of understory plants and birds amongst pine, eucalypt and native forests. Depending on the way that diversity is measured, results can be conflicting. Particular species may not be found in plantations due to specific habitat preferences; however, the overall number of species found in plantations compared to old growth forest can be similar. Complex species and habitat interactions could confound the results of diversity studies. Additionally, some species types can experience an increase in diversity while others decline in diversity. Therefore, a negative or a positive impact to overall biodiversity in the study area is possible, dependant on the methods used to measure diversity and the objectives of each particular study. Management practices would also have an impact on diversity, as some focus on conservation and others focus on economic return. As there are no set regulations for management of privately owned forest regarding diversity and conservation, potential impacts to diversity in individual forests are unpredictable at best.

Conversion of existing pine plantations to eucalypt plantations

Many plantations in South America are credited with relieving the pressure of wood demand on existing primary old growth forest. In theory, if the faster growing eucalypts can be harvested more often, a smaller amount of land needs to be dedicated to plantation forestry. Eucalypts are highly adaptable to new environments and can be grown in otherwise marginal soils. Additionally, due to the large amount of research already conducted to improve the efficiency of eucalypt plantations, even less land could be needed than for comparable pine plantations (Campinhos, 1999). If some portion of existing pine plantations is converted to eucalypt plantations, there could be a positive impact on diversity under the no action alternative. If the faster growing eucalypts were to replace the pines, it is possible that growing demand for wood products could be satisfied within the existing plantation areas. Some plantations may even begin to use conservation management practices due to increased return per unit of space. Therefore, replacing pine plantations with eucalypt plantations may cause a positive impact to diversity due to the need for less space (allowing some forest to return to a native state) and the potential for increased use of conservation management practices.

Conversion of old agricultural fields to eucalypt plantations

The conversion of abandoned and currently in use agricultural fields and pasture lands to eucalypt plantations could cause a positive impact to biodiversity in the region. Agricultural fields are monospecific with respect to plant life and are generally of very low diversity. The understory of a eucalypt forest has approximately seven years to mature before the trees are harvested. This understory has been shown to be highly diverse in species composition, both in plants and animals (Campinhos, 1999). Other studies have shown that eucalypt plantations have higher bird diversity than pasture lands (Lindenmayer et al., 2003). Some authors have suggested that plantations can be used to rehabilitate species richness in degraded agricultural areas with careful successional management. Plantation trees can supply shade, soil stability and three-dimensional habitat for animals while native tree species are colonizing the area (Lugo, 1997). Although weeds are often eliminated in the early stages of plantation forestry, once the trees are tall enough to become established, weeds are only managed for fire prevention, typically after four years (Couto and Betters, 1995). Therefore, if agricultural fields or pasture lands were converted to eucalypt plantations under the no action alternative, an increase in diversity could occur within the areas converted.

Allelopathy

The term allelopathy once referred to the harmful effects one plant can have on another. The current accepted definition includes both harmful and beneficial effects. This analysis will focus on the potential harmful effects eucalypts may have on nearby plants due to chemical excretions and leaf litter leachates. As the number of eucalypt plantations in the region increases, possible allelopathic effects may become more important, especially in plantations adjacent to food crops or sensitive ecological communities.

Due to their widespread use as agroforestry species, many field and laboratory studies have been completed regarding the potential allelopathic effects of eucalypt species. A review by Nandal et al. (1994) discussed many studies which were reported to show allelopathic effects of many different agroforestry species in various settings. Some of these effects were negative, while others were positive, depending on the species and sometimes the variety of plant studied. Any effects appeared to be reduced by distance from the trees. Plants grown in between the rows of eucalypts showed the highest levels of effects. The authors conclude that all agroforestry species have the potential for allelopathic influence on neighboring plants and communities, but that whether the effect is negative or positive depends on both the species of tree and the species adjacent (Nandal et al., 1994). White (1995) states that there is no direct evidence for negative allelopathic effects of eucalypts on crop plants, and cites unpublished research showing crop plants growing well both under eucalypt canopies and immediately after tree harvest. He also notes a lack of unambiguous research results due to the inter-related effects of allelopathy and competition for resources (White, 1995).

Poor experimental design, the lack of assessment of other reasons for changes in growth patterns and the lack of correlation amongst laboratory and field studies confounds all available conclusions regarding the potential allelopathic effects of eucalypts. Most laboratory studies are not replicated in the field, and field studies are done in a highly variable environment in which other factors such as nutrient or water limitation are not investigated (Davidson, 1995). For example, some laboratory research has indicated that concentrated extracts of eucalypt leaves can have negative impacts to germination and growth rates of other species. Effects were attributed to volatile compounds such as such as benzoic, cinnamic and phenolic acids (Kahn et al., 2004). Levels of these compounds were not investigated in an actual eucalypt stand. Another study investigated the differing levels of potentially allelopathic chemicals in different parts of the tree and their impacts on germination and growth (Kohli, 1994). Soil levels were measured in this study, however, all chemicals were bundled together in the soil studies as 'chemics' and there was no evidence presented that the chemicals found in the soil were coming from the eucalypts. There was no correlation amongst the levels and types of chemicals found in the soil and those used in the leachate experiments. Additionally, concentrations of the hypothesized allelopathic compounds in the leachates and extracts used in the growth experiment were not measured. Neither of these studies was replicated in the field, and it is unknown at what concentrations any of the individual chemicals could occur in a eucalypt stand. A third study revealed that germination and growth were reduced in plants grown with eucalypt leaf litter after the first planting. However, the crops from the second planting showed increased growth. The reduction in the first crop was attributed to nutrient immobilization due to litter decomposition, not to the eucalypt litter itself (Sanginga and Swift, 1992).

Generally, although there is evidence that high concentrations of eucalypt extracts can have a negative effect on growth of other species, these levels have not been shown to occur in the field. The possible inhibitory effects of eucalypts are more likely related to the density of the stand, the water regime and other environmental variables (Sunder, 1995; Davidson, 1995, Espinosa-Garcia et al., 2008). Although there is some evidence that extracts and chemical leachates of eucalypt trees can affect other plants in the laboratory, there is no compelling evidence that eucalypts in the field have significant allelopathic impacts to other plant assemblages. Additionally, research has shown that pines have a negative allopathic effect to eucalypts – although these studies were also done in a laboratory (Lodhi and Killingbeck, 1982). Therefore, is it unlikely that there would be any negative impact to the diversity of neighboring crop plants or sensitive ecological areas due to allelopathy under the no action alternative.

Escape

A plant species can 'escape' if it propagates outside its intended cultivation area. With proper management, this should not occur, especially with larger species such as are found in tree plantations. Eucalypts have escaped their planted areas in California, Hawaii, and South Africa. However, only some species are invasive in some areas. The Tasmanian blue gum (*E. globulus*) is considered invasive in coastal California by the California Invasive Plant Council (Cal IPC), and the Red River gum (*E. camuldalensis*), spider gum (*E. lehmannii*) and flooded gum (*E. grandis)* are invasive in South Africa (out of 140 cultivated species) (Forsyth et al., 2004; California Invasive Plants Council, 2010). The Mediterranean-like climate of coastal California is highly similar to the native Australian climate of *E.*

globulus. The trees are not considered invasive outside of this coastal zone (California Invasive Plants Council [CIPC], 2010). *Eucalyptus* spp. are not considered invasive by the Federal government, nor are they listed by California, Hawaii, or any of the states in the potential planting range (USDA, 2010b).

Due to the periodic freezes and the non-Mediterranean climate in the southern U.S., it is not likely that invasive propagation of eucalypts could occur in the potential planting range. As an additional preventative measure, tree plantation managers can easily establish buffer zones which can be monitored for unintentional growth periodically, thereby preventing an escape event. With proper management, the likelihood of trees colonizing areas outside of the plantation is highly unlikely in the southern U.S. A negative impact to biodiversity could be possible if the trees multiplied rapidly and out-competed other vegetation. However, due to the characteristics of the FTE described in Sections C.2.3 and C.2.4, eucalypts are not likely to thrive outside of a plantation environment. Therefore, impacts to diversity under the no action alternative would be very small or non-existent.

(2) Proposed Action

Conversion of primary forest to GE eucalypt plantation

Under the proposed action, there would be no impacts to diversity other than those associated with the no action alternative. The GE eucalypts would constitute a monoculture, as would a pine or non-GE eucalypt hybrid plantation. The resulting loss of tree diversity would be similar to installing plantations of other species. The impacts to overall biodiversity would also be similar to the no action alternative, dependent on measurement methods, type of species and management practices within the plantations.

Conversion of existing pine plantations to eucalypt plantations

Impacts to biodiversity if existing pine plantations are converted to GE eucalypt plantations as opposed to non GM plants, the impacts to biodiversity would be similar to those under the no action alternative. The GE eucalypts are only different with regard to cold tolerance and sexual reproduction. GE eucalypts would provide the same habitat structure and resources that non GE hybrids would. Therefore, management practices would dictate the levels of diversity within the plantation.

Allelopathy

As discussed in the petition, observations in ArborGen's field trials of freeze tolerant and other *Eucalyptus* confirm the lack of evidence for allelopathic effects in eucalypts. A variety of grasses and broad leaf weeds were routinely observed in test plots and actively managed using both mechanical and chemical methods. Indeed, in any operational forest plantation in the southeastern U.S., competition control is a key component of successful plantation establishment and productivity, and this is expected to be the same for FTE.

There is no evidence to suggest that GE FTE would have greater allelopathic effects than non-GE FTE. The GE lines have been modified for freeze tolerance and a lack of reproduction, which should not increase chemical exudates and leaching. Therefore, the potential loss of biodiversity due to allelopathic effects would be negligible and similar to the no action alternative.

Escape

Due to the characteristics of the GE FTE lines described in Sections C.2.3 and C.2.4, under the proposed action the impacts to biodiversity from potential escape would be negligible and potentially smaller than under the no action alternative.

(3) Cumulative Impacts

Because the proposed project is unlikely to result in any major modification to existing biodiversity in the region, it would also not contribute to adverse cumulative impacts to diversity. Throughout the region, plantation management practices will continue to be modified to balance demand, growth and sustainability. However, these modifications would be voluntary on the part of the industry, and would not result in an adverse impact.

b) Threatened and Endangered Species

Both the no action alternative and the proposed action involve changes in forestry in the southeastern U.S. that could affect threatened and endangered species, as well as species that are candidates or proposed for listing. The no action alternative includes the expected conversion from pines to hardwoods based on the development of non-GE FTE that can be grown commercially in the potential planting range. This change has the potential to adversely affect some listed species. The proposed action would allow the use of GE FTE as part of this conversion to growing hardwoods in the potential planting range.

(1) No Action

Under the no action alternative, the GE FTE lines would not be available for commercial introduction and planting. However, existing commercial forestry practices and commodities produced in the potential planting range would not remain static but would continue to evolve in response to other factors affecting the wood products industry, including the introduction of new species, level of demand, price of production relative to other sources, and modifications in the land area available for commercial forestry. Based on recent trends in these factors, the no action alternative is expected to include a gradual transition to the production of wood products from non-GE FTE species. These changes would be voluntary on the part of the commercial wood products industry and would be implemented only as companies and individuals make business decisions to replace their current stands of pine with non-GE FTE. The no action alternative also would be likely to include a gradual reduction in acreage used for commercial forestry due to increases in efficiency and productivity as well as continued reductions in available land area due to urbanization and environmental protections. Increased efficiency and productivity would be achieved through the introduction of non-GE FTE species as well as improvement in forestry practices, use of recycled materials, and increases in product yields. These changes could result in the ability to meet demand with less acreage in cultivation.

However, the acreage in production also would be affected by changes in current import/export conditions associated with wood products in the region. Imports of wood products generally have increased in recent years due to the expansion of short-rotation harvesting of hardwood plantations in the southern hemisphere (AFC, 2010). One objective for using non-GE FTE (and GE FTE) would be to make domestic hardwood production more competitive. Increased short-rotation harvesting of domestic plantations may slow or reverse the decline in plantation acreage under cultivation within the potential planting range.

Federally listed species that may occur within the potential planting range for GE FTE are identified in Table F, which also provides information on their listing status, habitats, and occurrence. Habitats utilized by the listed species in Table F generally fall into three broad categories: terrestrial (upland), wetland, and aquatic (streams and rivers). Many of these species have been adversely affected by historical forestry, agriculture, development, and other activities that have altered land use, causing or contributing to substantial reductions in habitats and ranges. The majority of these listed species currently occur in very localized areas within the extensive potential planting range for GE FTE. Consequently, listed species could be adversely affected principally by forestry-related activities if the activities take place within or adjacent to the specific, often very localized areas where the species currently occurs.

Aquatic species have been affected by the historical harvesting of riparian forests and by sedimentation resulting from activities in watersheds, such as timber clear cutting and agricultural practices that allowed exposed soil to erode and enter streams through stormwater runoff. Increased sediment in streams can have many adverse effects, including increased turbidity and temperatures, interference with reproduction and respiration, abrasion of exposed tissues, reductions in plant growth, and decreases in prey. Wetland species have been affected by the historical harvesting of wetland forests and the draining and filling of wetlands to provide land for cultivation. Wetland protection regulations and best management practices (BMPs) currently employed in commercial forestry and agriculture have reduced or eliminated many of the impacts on wetlands and streams that resulted from historical forestry and agricultural practices. Under the no action alternative, some forestry practices may be modified as non-GE FTE are introduced and replace pine plantations in many areas. Current forestry practices designed to minimize aquatic impacts from sediment (e.g., use of sediment barriers; maintenance of vegetated riparian buffer zones; stabilization of roads, trails, and stream crossings) are expected to continue and, if properly implemented, to minimize or prevent further impacts from forestry-related sedimentation on listed wetland and aquatic species in the potential planting range.

Another potential forestry-related impact on streams and wetlands is reduced stream flows and wetland water levels due to the hydrologic effects of tree plantations in the watershed. This issue is discussed in detail in Section C.iii. Under the no action alternative, it is assumed that pines in commercial plantations would be gradually replaced in many areas by non-GE FTE. Because of its faster growth rate, non-GE FTE would use more water than the same area of pine if planted and managed at the same density. This replacement of pines would adversely affect stream flows or wetland water levels only in locations where precipitation and stream flows are insufficient to support non-GE FTE or where plantations are not managed appropriately. These effects would be most likely to occur during periods of drought. Given the high precipitation rates in much of the potential planting range, growth of non-GE FTE is expected to be possible in most areas without adverse impacts on stream flow or wetlands. In the limited areas where reduction of stream flow or wetland water levels could occur, a reduction (15% or more) in planting densities of non-GE FTE relative to current planting densities of pine likely would minimize hydrologic effects while not substantially affecting the economic viability of the non-GE FTE plantations. Overall, faster-growing species such as non-GE FTE would be able to meet the demand for wood products by using a smaller area of land, thus reducing other aquatic, as well as terrestrial, impacts associated with tree plantations. The high water-use efficiency of non-GE FTE would allow it to be managed so as to maximize production in areas that can support it while minimizing hydrologic impacts. This likely would result in a reduction in the planting of trees in areas that are less suitable for tree plantations and, in turn, an overall reduction in hydrologic impacts associated with commercial forestry within the potential planting range.

Listed aquatic species with the potential to be affected by hydrologic changes associated with the introduction of non-GE FTE are those that inhabit small streams that are susceptible to drying during droughts. The potentially affected fish species in Table F, such as the bayou darter (*Etheostoma rubrum*) and Okaloosa darter (*Etheostoma okaloosae*), are highly mobile and likely are adapted to surviving such conditions by seeking refuge in downstream areas during periods of reduced flow. The potentially affected freshwater mussel species in Table F are those that can occur in small creeks, including the Gulf moccasinshell (*Medionidus pencillatus*), Louisiana pearlshell (*Margaritifera hembeli*), oval pigtoe (*Pleurobema pyriforme*), and shinyrayed pocketbook (*Lampsilis subangulata*). Mussels are relatively immobile and may be adversely affected by reduced flows and associated increases in temperature and reductions in dissolved oxygen in small creeks. Some mussels may be able to maintain sufficient moisture by burrowing into the sediments or migrating lower in the stream channel, but many species cannot survive the drying of their habitat (Haag and Warren, 2008). Listed wetland species with the potential to be affected by hydrologic changes associated with the introduction of non-GE FTE mainly are herbaceous flowering plants that inhabit seepage bogs or other wetlands dependent on groundwater discharge. The potentially affected plant species in Table F include bog asphodel (*Narthecium americanum*), Florida skullcap (*Cutellaria floridana*), Godfrey's butterwort (*Pinguicula ionantha*), and Harper's beauty (*Harperocallis flava*).

Adverse hydrologic effects on localized populations of these stream and wetland species potentially could occur under the no action alternative if pine plantations are present nearby and are converted to non-GE FTE at a planting density equal to that previously used for pines. The potential for tree plantations to be present adjacent to small streams and wetlands supporting populations of listed species or designated critical habitats is minimal, and the potential for non-GE FTE if planted and appropriately managed at such a location to substantially alter sedimentation, stream flow, or groundwater discharge also is minimal. Consequently, listed aquatic and wetland species are unlikely to be adversely affected by forestry-related changes under the no action alternative.

Listed terrestrial species in the potential planting range for GE FTE have been adversely affected historically by the harvesting of native forests, particularly old-growth longleaf pine (*Pinus palustris*) communities, and their replacement by pine plantations, agriculture, and development. The historical loss of native pine communities has been a major cause of the population declines of many of these species. Most of the terrestrial species thus affected have very specific habitat requirements that are not provided by the altered habitats available in tree plantations or agricultural areas. Pine plantations typically have closed canopies and thick mid-stories with limited herbaceous understories. Forest management strategies such as fire suppression, increased planting densities, bedding (preparing for planting by mounding soil above surrounding wet areas), and removal of downed trees and stumps, contribute to ongoing habitat loss. Site preparation for tree plantations often involves clearing of downed logs and stumps that serve as shelter for some species. Habitat losses are even more extreme when an area is converted to agriculture, as all vegetation is removed and the soil is often disked and compacted. Longleaf pine forest remaining in the southeast has been reduced to less than 5% of its original extent. The historic loss of longleaf pine habitat occurred mainly due to timber harvesting and subsequent conversion to intensively managed pine plantations, agriculture, and residential development. In addition to these historic habitat losses for species adapted to the longleaf pine ecosystem, species dependent on native forests continue to lose habitat currently due to continued development, incompatible forestry practices, and suppression of fire (USFWS, 2010a).

Under the no action alternative, the principal change from existing conditions expected to occur and to be relevant to the proposed action is the introduction of non-GE FTE to tree plantations. As discussed above and in Section C.i.1., the amount of land used for silviculture in the foreseeable future is likely to remain at levels similar to current conditions. However, the species grown at many locations are likely to be converted from pines to non-GE FTE, which would provide greater productivity for pulp and paper as well as bioenergy uses. The greater production of non-GE FTE would result in shorter rotations and less time between harvests. Consequently, there would be more frequent disturbance of listed species due to noise and physical impacts from harvesting activities. Highly mobile species such as birds could avoid direct impacts from these relatively short-duration activities; however, less mobile animals and plants if present in the area harvested could be injured or killed. Most of the planting and subsequent harvesting of non-GE FTE is expected to occur on lands where pines currently are grown, with some planting also possible on current pasture or other agricultural lands and minimal planting in areas currently supporting native forest or savanna.

Given the expectation that non-GE FTE would be planted predominantly on lands already in use as pine plantations (and possibly some agricultural lands), listed species that require natural habitats essentially unaltered by human activities, which is the case for the majority of listed terrestrial species in Table F, would not be affected by changes in tree species planted on historically cultivated lands. Therefore, the listed terrestrial species with the potential to be affected by the transition from pine to hardwood plantations of non-GE FTE are species that currently utilize habitats associated with pine plantations. These potentially affected terrestrial species include the red-cockaded woodpecker (RCW) (*Picoides borealis*), gopher tortoise (*Gopherus polyphemus*), eastern indigo snake (*Drymarchon corais couperi*), black pine snake (*Pituophis melanoleucus lodingi*), Louisiana pine snake (*Pituophis ruthveni*), and the wildflower white birds-in-a-nest (*Macbridea alba*). The characteristics of these species and their potential to be adversely affected under the no action alternative are discussed below.

Red-cockaded Woodpecker

The red-cockaded woodpecker (RCW) is listed as endangered. Its diet consists predominantly of insects found on or in mature pine trees. RCWs once were considered common throughout the longleaf pine ecosystem and open pine forests of the southeast from New Jersey, Maryland, and Virginia to Florida and west to Texas and north to portions of Oklahoma, Missouri, Tennessee, and Kentucky. The longleaf pine community initially disappeared from much of its original range because of early European settlement in the 1700s and widespread commercial timber harvesting and the naval stores/turpentine industry in the 1800s. Further reductions in longleaf pine community in the early to mid-1900s resulted from commercial tree farming, urbanization, and agriculture. Much of the current pine forest habitat is very different from historical pine forests in which RCWs evolved: many southern pine forests today are young and an absence of fire has created a dense pine/hardwood forest (USFWS, 2010b).

The RCW inhabits mature pine forests (longleaf pines averaging 80 to 120 years old or loblolly pines averaging 70 to 100 years old), breeding cooperatively and living in family groups (a breeding pair and up to four helpers). It prefers longleaf pines, but other southern pine species also are used. It is the only woodpecker that excavates cavities exclusively in living pine trees. Cavities are excavated over a period of several years in mature pines usually over 80 years old. Chosen trees suffer from a fungus that causes the inner heartwood to become inactive, soft, and free from resin. Cavity trees that are being used have numerous, small resin wells that exude sap, which the RCWs keep flowing as a cavity defense mechanism against snakes and possibly other predators. A group of cavity trees is called a cluster and may include 1 to 20 or more cavity trees on 3 to 60 acres. The average cluster covers around 10 acres. Cavity trees must be located in open stands with little or no hardwood midstory and few or no hardwoods in the overstory. RCW foraging habitat requirements include large, mature pines with an open canopy, low densities of small pines, little to no hardwood or pine midstory, few to no hardwoods in the overstory, and abundant native bunchgrass and forbs as groundcovers (USFWS, 2003; USFWS, 2010b). The RCW typically forages in pine and pine-hardwood stands that are 30- years-old or older in pine trees that are 10 inches or larger in diameter (USFWS, 2010c).

The dependence of the RCW on old-growth pine forest is in conflict with timber management policies on some public lands and almost all private lands (NatureServe, 2010). Private timber plantations in the southeastern U.S. generally are on relatively short rotations (less than 45 years) that prevent trees from reaching the size and age needed by the RCW for breeding (NatureServe, 2010). However, pine plantations approaching harvest age can provide foraging habitat suitable for use by the RCW.

Under existing conditions, many forest management practices adversely affect the RCW. Under the no action alternative, such practices likely would continue in many areas, and the introduction of non-GE FTE would be expected to substantially shorten rotation times and further change plantation forests from pines to hardwoods, which are not used by the RCW for foraging. In accordance with consultation requirements for federal agencies under Section 7 of the Endangered Species Act (ESA), conversion of pine forests on public lands to non-GE FTE likely would not be allowed by USFWS in locations where it could adversely affect RCW populations. However, RCW populations on private lands would be likely to be adversely affected if mature pine plantations in their vicinity are converted to non-GE FTE plantations under the no action alternative. Such a conversion, resulting in the loss of RCW habitat, may be considered by the USFWS as a “take” of the species under Section 9 of the ESA and may not be authorized without the issuance of an incidental take permit by USFWS.

Gopher Tortoise

The gopher tortoise, the only tortoise indigenous to the southeastern U.S., is listed as threatened in Alabama, Louisiana, and Mississippi. Its current range includes xeric, sandy habitats from extreme southern South Carolina through Florida and west to extreme southeastern Louisiana, approximately coinciding with the original range of the longleaf pine ecosystem. Gopher tortoises can occur in a wide range of upland habitat types; however, several habitat characteristics that they require include well-drained, sandy soils, which allow easy burrowing; an abundance of herbaceous groundcover; and a generally open canopy and sparse shrub cover, which allow sunlight to reach the forest floor and support growth of the herbaceous layer on which the tortoise feeds. Gopher tortoises also may be found in ruderal habitats modified by humans, such as pine plantations, fence rows, pastures, field edges, and power line right-of-ways (USFWS, 1990).

Although the preferred habitat of the gopher tortoise is open, frequently burned, longleaf pine forests, it also is found in loblolly or slash pine habitats when conditions are appropriate. These conditions include a low basal area (density of trees), the absence of a dominant woody midstory (hardwoods and shrubs), and a dense and diverse herbaceous understory. These conditions can be achieved in pine plantations through thinning and burning, though use of herbicides may be necessary to control excessive growth of hardwoods and shrubs (DeBerry and Pashley, 2004).

As discussed for the RCW, many forest management practices under existing conditions adversely affect the gopher tortoise. Under the no action alternative, such practices likely would continue, and the introduction of non-GE FTE would be expected to substantially shorten rotation times and further change plantation forests from pines to hardwoods, resulting in conditions which would not satisfy the habitat requirements of the gopher tortoise. In accordance with the ESA requirements, conversion of pine forests on public lands to non-GE FTE likely would not be allowed in locations where it could adversely affect listed gopher tortoise populations. However, gopher tortoise populations on private lands would be likely to be adversely affected if pine plantations in their vicinity that are currently managed in such a way that they provide suitable habitat for the gopher tortoise are converted to non-GE FTE plantations under the no action alternative. Such a conversion, resulting in the loss of gopher tortoise habitat, may be considered by the USFWS as a take of the species and may not be authorized without the issuance of an incidental take permit by USFWS.

Eastern Indigo Snake

At the time it was listed as threatened, the eastern indigo snake was considered a subspecies (*Drymarchon corais couperi*), but it currently is accepted by the scientific community as a separate species, *Drymarchon couperi*. It utilizes a wide variety of habitat types, including pine flatwoods, scrubby flatwoods, high pine, dry prairie, tropical hardwood hammocks, edges of freshwater marshes, agricultural fields, and other human-altered habitats. Underground shelters such as gopher tortoise burrows are used by the snake throughout the year. The eastern indigo snake is active, highly mobile, and estimated to need at least 2,500 acres of habitat. Because of its relatively large home range, principal threats to the eastern indigo snake include habitat loss, degradation, and fragmentation. Throughout its range, natural communities currently are, and under the no action alternative would continue to be, altered for agricultural, residential, and commercial purposes, most of which are incompatible with the habitat needs of the snake. Extensive tracts of natural habitat not fragmented by roads are the most important refuge for eastern indigo snake populations. Use of prescribed fire has not been adequate to maintain appropriate habitat in many areas (USFWS, 2008).

The eastern indigo snake uses tropical hardwood hammocks as habitat in Florida. It also uses human-altered habitats such as agricultural fields. Thus, it is likely to use pine plantations for foraging, though the expected absence in most plantations of gopher tortoise burrows for shelter and diverse habitats for prey may minimize their utility. If pine plantations are converted to hardwood plantations of non-GE FTE under the no action alternative, indigo snakes are likely to continue to use plantation habitats similarly to the way plantations are used currently. Consequently, local populations of the eastern indigo snake are not likely to be adversely affected if pine plantations within their home range are converted to non-GE FTE plantations under the no action alternative.

Black Pine Snake

The black pine snake is a candidate for listing. It is large (4 to 5 feet long), nonvenomous, spends much of its time in underground burrows, and preys mainly on rodents. Its forest habitat is characterized by sandy, well-drained soils with an overstory of longleaf pine, a mid-story suppressed by fire, and a dense groundcover of grasses and other herbs. Radiotelemetry studies found that it rarely used hardwood forests, riparian areas, or areas with a closed canopy, though it has been found in pine plantations. The black pine snake historically was distributed within the historical range of the longleaf pine ecosystem in extreme southwestern Alabama, extreme southeastern Louisiana, and southern Mississippi. The black pine snake likely has been extirpated from Louisiana and appears to survive in only three counties in Alabama (Clarke, Mobile, and Washington) and ten counties in Mississippi (Forrest, George, Greene, Harrison, Jackson, Jones, Marion, Perry, Stone, and Wayne). The distribution of populations within these counties has become very restricted due to the fragmentation of remaining longleaf pine habitat. In seven of the ten Mississippi counties, black pine snake populations are concentrated in the DeSoto National Forest. Populations outside the national forest appear be restricted to islands of suitable longleaf pine habitat and, thus, are small and isolated (USFWS, 2010a).

Although as a candidate species the black pine snake receives no formal Federal protection under the Endangered Species Act, the U.S. Forest Service would not be expected to allow the planting of non-GE FTE in DeSoto National Forest in locations where it could adversely affect black pine snake populations. Other occurrences of this species are on private lands, but there is only a low likelihood that the black pine snake occurs on pine plantations because data on habitat requirements of this species indicate that pine plantations do not meet the majority of its needs. Because the data on habitat requirements for this species indicate that tree plantations generally are not suitable habitat, it is unlikely that, if pine plantations are converted to hardwood plantations of non-GE FTE, suitable habitat would be lost on those sites. Consequently, localized populations of the black pine snake are not likely to be adversely affected if pine plantations are converted to non-GE FTE plantations under the no action alternative.

Louisiana Pine Snake

The Louisiana pine snake is a candidate for listing. It is large (4 to 5 feet long), nonvenomous, spends much of its time in underground burrows, especially pocket gopher burrow systems, and preys mainly on pocket gophers and other rodents. Its forest habitat is characterized by sandy, well-drained soils of open pine forests, especially longleaf pine savannas, with a moderate to sparse mid-story and a dense understory dominated by grasses. Radiotelemetry studies found that it used primarily pine forests and pine plantations. It was found rarely or not at all in hardwood, pine-hardwood, or grassland habitats. Baird's pocket gopher (*Geomys breviceps*) appears to be an essential component of Louisiana pine snake habitat, providing its major food source and extensive burrow systems in which the snake finds shelter. Populations of Baird's pocket gopher are dependent on loose, sandy soils for burrowing and abundant, herbaceous, groundcover vegetation for food, which in turn is dependent on a low density of trees and an open canopy that allows greater sunlight penetration. Pocket gopher mounds have been found commonly in pine forests and open pine plantations, but they are uncommon in other forest types and clearcuts (USFWS et al., 2003).

The Louisiana pine snake historically occurred in parts of northwest Louisiana and east-central Texas, an area that roughly corresponded with a disjunct area of longleaf pine ecosystem west of the Mississippi River. The historic longleaf and shortleaf pine savanna forests of the region have been replaced by dense plantations of fast-growing loblolly pine and slash pine. The Louisiana pine snake currently occurs in five counties in Texas, mainly within the Angelina and Sabine National Forests, and four parishes in Louisiana, mainly in Bienville Parish on industrial forest land owned by a paper company, which historically has managed these mature pine plantations using burning to reduce undergrowth. The Louisiana pine snake is restricted to only portions of its previous range, and the primary threats to the species in these remaining areas continue to be habitat loss, habitat fragmentation, and fire suppression (USFWS et al., 2003).

Although as a candidate species the Louisiana pine snake receives no formal Federal protection under the Endangered Species Act, the U.S. Forest Service would not be expected to allow the planting of non-GE FTE in Angelina and Sabine National Forests or other Federal lands in locations where it could adversely affect Louisiana pine snake populations. Other occurrences of this species are on private lands managed as pine plantations. Data on habitat use by the Louisiana pine snake indicate that pine plantations can provide suitable habitat but hardwood forest does not. The largest and densest existing population of the Louisiana pine snake occurs on industrial forestland in Bienville Parish, Louisiana. Thus, it is likely that, if pine plantations within the current range of the Louisiana pine snake are converted to hardwood plantations of non-GE FTE, suitable habitat would be lost at those sites. Consequently, localized populations of the Louisiana pine snake are likely to be adversely affected if pine plantations are converted to non-GE FTE plantations under the no action alternative.

White birds-in-a-nest

White birds-in-a-nest is an upright perennial herb about 1 foot tall with opposite leaves up to 4 inches long and 0.5-1 inch wide. The flowers are clustered at the top of the plant in a short spike with bracts, and each flower has a brilliant white corolla 1 inch long. White birds-in-a-nest is listed as threatened and occurs only in Bay, Gulf, Franklin, and Liberty Counties in the Florida panhandle. The largest populations are in Apalachicola National Forest. It occurs in habits with a range of moisture conditions, including mesic pine flatwoods, wet savannas, seepage slopes, and roadsides (USFWS, 2009). It seems to grow on sites where there has been some disturbance, possibly because it may require regular recruitment from seed and is a poor competitor with other plants, requiring bare ground to germinate and grow. White birds-in-a-nest appears able to persist on pine plantations through pulpwood harvest, site preparation, and planting. It does not survive the shaded, fire-free conditions of young slash pine plantations, but it may persist on the edges of pine plantations (USFWS, 1994). Primary threats to the species are habitat destruction and alteration, including suppression of fire. Frequent prescribed burnings (4 to 5 year intervals) are needed to maintain optimal populations (USFWS, 2009).

In accordance with requirements of the ESA, the U. S. Forest Service would not be expected to allow the planting of non-GE FTE in Apalachicola National Forest in locations where it could adversely affect white birds-in-a-nest populations. However, other occurrences of this species are on private lands, including pine plantations. Because the known habitats for this species do not include hardwood forests, it is unlikely that, if pine plantations are converted to hardwood plantations of non-GE FTE, suitable habitat would remain on those sites. Consequently, localized populations of white birds-in-a-nest are likely to be adversely affected if pine plantations on which they currently occur are converted to non-GE FTE plantations under the no action alternative. However, such a conversion resulting in the loss of habitat for the white birds-in-a-nest would be unlikely to be considered by the USFWS as a take of the species because the ESA does not prohibit incidental take of listed plant species (USFWS and NMFS, 1998).

Summary

Under the no action alternative, it is assumed that the planting of non-GE FTE would be likely and that these hardwoods would be planted predominantly on lands currently used for growing pines. Of the Federally listed terrestrial species in Table F that occur within the potential planting range, the six species discussed above can use managed pine forests/plantations as at least one of their habitats. Of these six species, the red-cockaded woodpecker, gopher tortoise, Louisiana pine snake, and white birds-in-a-nest would be the species most likely to be adversely affected if mature pine plantations used by local populations were converted to non-GE FTE plantations under the no action alternative. The eastern indigo snake and black pine snake would be unlikely to be adversely affected by forestry-related changes under the no action alternative.

(2) Proposed Action

The introduction of the GE FTE lines in place of non-GE FTE species in tree plantations within the potential planting range would not result in noticeable changes in effects on threatened and endangered species in comparison to the no action alternative. The adverse effects on certain listed species discussed under the no action alternative in conjunction with the conversion from pine to non-GE FTE would result principally from the replacement of pine forests by hardwoods and associated changes in management. These impacts essentially would not be affected by the use of GE FTE instead of non-GE FTE. Consequently, the introduction of GE FTE under the proposed action would not result in significantly greater impacts on threatened and endangered species than would occur in the absence of this introduction under the no action alternative.

(3) Cumulative Impacts

Cumulative adverse impacts on threatened and endangered species in the potential planting range occur currently and are expected to continue under the no action alternative as a result of ongoing urbanization, agriculture, forestry, and other human activities. Under no action, replacement of planted pine forests with fast-growing, short-rotation, non-GE FTE species in conjunction with other land use changes would cumulatively result in increased adverse effects on several threatened and endangered species, mainly due to further reductions in suitable habitat.

In addition to direct and indirect effects from human activities such as forestry, agriculture, and development, global climate change also could affect aquatic, wetland, and terrestrial listed species in the potential planting range for GE FTE. The U.S. Global Change Research Program (USGCRP) report *Global Climate Change Impacts in the United States* (USGCRP, 2009), summarizes the projected impacts of future climate changes in the U.S. The report divides the conterminous U.S. into six regions; the potential planting range for GE FTE is located in the Southeast region. The USGCRP climate models for this region project continued warming in all seasons and an increase of approximately 4.5°F by the 2080s. Additionally, climate models project that there will tend to be less rainfall in most of this area, particularly during spring, summer, and winter. The warming projected for the Southeast region could result in decreased water availability due to increased temperatures and longer periods between rainfall events, which would affect the region's aquatic ecosystems. In addition, the GCRP projects increases in sea level and storm surges in the potential planting range, resulting in inundation and loss of coastal wetlands and other low-lying areas.

Such short-term and long-term changes in precipitation and temperature would contribute to cumulative environmental impacts on threatened and endangered species throughout the potential planting range for GE FTE. Global climate change could lead to decreased precipitation, increased sea levels, varying freshwater inflow, increased temperatures, increased storm surges, greater intensity of coastal storms, and increased nonpoint source pollution from runoff during these storms, in streams and wetlands within the potential planting range. Such changes could change freshwater inflow, alter salinity, and reduce dissolved oxygen, which would directly affect aquatic habitats used by some threatened and endangered species. The effects from rising sea level likely would add to the effects from increased use of freshwater upstream in increasing downstream salinities. These stressors would result in shifts in ranges, habitats, and migratory behaviors of listed species and also could alter ecosystem processes on which these species depend (USGCRP, 2009).

Because the proposed action would not result in adverse impacts on threatened and endangered species noticeably greater than those that would occur under the no action alternative, cumulative impacts under the proposed action also would not be significantly greater than cumulative impacts under no action.

c) Gene Flow and Horizontal Gene Transfer Potential

(1) No Action

Under the no action alternative, the GE FTE lines would not be available for commercial introduction and planting; however, non-GE FTE species are expected to be planted and replace many current pine plantations. There could be a potential for gene flow between non-GE FTE species planted in close proximity. Gene flow involves the movement of genes from one population to another of the same or closely related species; in the case of plants, usually by the movement of pollen or seeds. However, based on information provided under the discussion of the proposed action, there is little if any significant risk of outcrossing to or from other *Eucalyptus* species because: 1) other *Eucalyptus* species that are or could be grown in the potential planting range are unlikely to be compatible; 2) it is unlikely that the flowering times of other *Eucalyptus* species would overlap and; 3) hybrids, in the event that they could form, would be expected to be of very low vigor (BRS, 2010). Horizontal gene transfer (HGT) is a process in which an organism incorporates genetic material from another organism without being the offspring of that organism. As discussed below for the proposed action, horizontal gene transfer among FTE species poses no environmental risk (BRS, 2010). Consequently, the no action alternative would be unlikely to result in significant biological impacts from gene flow or horizontal gene transfer involving the non-GE FTE species expected to be introduced and grown commercially under this scenario.

(2) Proposed Action

<u>Potential for Gene Flow Outside of Plantations</u>

Gene flow involves the movement of genes from one population to another of the same or closely related species; in the case of plants, usually by the movement of pollen or seeds. *Eucalyptus* is adapted for insect pollination, with bees being the predominant vector (Pacheco et al., 1986; Pacheco, 1987; House, 1997). Under ideal conditions of humidity and temperature, viable *Eucalyptus* pollen can be found only within approximately 100 meters from the edge of nearest stand of trees (Peters et al., 1990; Linacre and Ades, 2004). Pacheco (1987) verified that bees (*Apis* spp.) are the most effective pollinators of *Eucalyptus*, with activity increasing up to 100 meters from the beehive and decreasing beyond this distance. The minimum distance to prevent undesirable pollen contamination of seed producing areas was found by de Assis (1996) to be approximately 300 meters. Even if bees were to transport pollen farther from a GE FTE plantation, there are no sexually compatible native species with which they could cross and produce offspring (BRS, 2010).

There could be two possible routes of gene flow outside of a plantation of GE FTE trees to other *Eucalyptus* species. One could be to nearby plantations of GE FTE trees and the other could be to nearby non-GE FTE species. As discussed previously, there are several other species of cold-hardy *Eucalyptus* that possibly could be grown within the potential planting range for GE FTE within the southeast U.S., including *E. neglecta, E. niphophila, E. pauciflora, E. camphora, E. nova-anglica, E. macarthurii, E. gunnii*, and *E. cinerea*. The GE FTE lines are not likely to be sexually compatible with any of these cold hardy species. For example, *E. grandis* and *E. urophylla*, for which hybrids have been generated in directed breeding programs, are in the Salignae and Resiniferae series, respectively, of section Transversaria. In contrast, *E. cinerea*, and others of these cold hardy species are far removed genetically on the evolutionary scale from the genotype of lines 427 and 435 and reside within different Series and Sections of genus *Eucalyptus* (BRS, 2010).

Even among the closely related species of *Eucalyptus*, hybridization rates are generally very low (Volker 1995). The published literature supports the fact that natural hybridization among distantly related species within genus *Eucalyptus* is rare and hybrid inviability increases with increasing taxonomic distance between parents (Potts and Dungey, 2004). Where hybridization is possible, it often requires significant human intervention in directed breeding/crossing efforts. Potts and Dungey (2004) make reference to the high degree of inviability in F_1 hybrids (offspring). Inviability of these offspring may be expressed at germination, in the nursery, and even after planting in the field. Slower germination of hybrid seed often occurs, along with reduced survival of germinants in the nursery, and many seedlings have abnormal phenotypes. Griffin et al. (1987), surveyed natural and manipulated hybrids in the genus *Eucalyptu*s and discussed the challenges of developing even human-made hybrids from such wide crosses. To achieve the development of viable hybrids, sometimes hundreds of hand pollinations must be made to find a viable hybrid that will grow normally (BRS, 2010).

A further barrier to potential crossing between the transgenic trees and other species is the expected differences in flowering times between species (Gore and Potts, 1995; Potts et al., 2003). For example, the commonly planted ornamental *E. cinerea* flowers in spring, while GE FTE lines 427 and 435 initiate flowering in early summer with expected maturation in mid to late summer (BRS, 2010).

Based on the above information, there is little if any risk of outcrossing to or from other *Eucalyptus* species because: 1) to date, the GE FTE trees that have been allowed to flower have shown essentially no mature pollen formation due to the effectiveness of the barnase gene engineered into these GE lines; 2) other *Eucalyptus* species that are or could be grown in the area are unlikely to be compatible; 3) it is unlikely that flowering time in other *Eucalyptus* species will overlap with the GE FTE lines; and 4) hybrids, in the event that they could form, would be expected to be of very low vigor (BRS, 2010).

Similarly, there is little if any risk of gene flow between the GE FTE lines and the non-GE EH1 hybrid that may be grown in central and southern Florida as evidenced by the lack of any volunteer seedlings in ArborGen's trials. The potential for gene flow between the GE FTE and other non-GE *Eucalyptus* species, such as *E. grandis*, grown in more central and southern parts of Florida is also extremely low due to factors that include: 1) the effectiveness of the barnase gene engineered into these GE lines at preventing pollen formation, and 2) the very low potential for any seed, should it be produced, to germinate and survive.

Horizontal Gene Transfer to Other Organisms

HGT is a process in which an organism incorporates genetic material from another organism without being the offspring of that organism. HGT is a common phenomenon between bacteria but is not common between plants and other higher organisms (Keese, 2008). HGT to bacteria from these GE FTE and expression of DNA is unlikely to occur for several reasons. First, many genomes (or parts thereof) have been sequenced from bacteria that are closely associated with plants including *Agrobacterium* and *Rhizobium* (Kaneko et al., 2000; Wood et al., 2001; Kaneko et al., 2002). Yet, there is no evidence that these organisms contain genes derived from plants. Second, in cases where review of sequence data has implied that horizontal gene transfer occurred, these events are inferred to have occurred on an evolutionary time scale on the order of millions of years (Koonin et al., 2001; Brown, 2003). Third, transgene DNA promoters and coding sequences are optimized for plant expression, not bacterial expression. Thus, even if horizontal gene transfer occurred, proteins corresponding to the transgenes are not likely to be produced. Fourth, many common transgenes used in plant biotechnology are derived from bacteria commonly found in the environment. The FDA has evaluated horizontal gene transfer from the use of selectable marker genes and concluded that the likelihood of transfer of such genes from plant genomes to microorganisms in the gastrointestinal tract of humans or animals, or in the environment, is remote. Therefore horizontal gene transfer from GE FTE poses no environmental risk (BRS, 2010).

Conclusion

The proposed action would be unlikely to result in significant biological impacts from gene flow or HGT involving the GE FTE lines expected to be introduced and grown commercially under this scenario.

(3) Cumulative Impacts

Cumulative biological impacts from gene flow or HGT involving either the introduction of non-GE FTE under the no action alternative or the introduction of GE FTE under the proposed action would not result in significant adverse biological impacts or contribute significantly to cumulative biological impacts from other activities within the potential planting range.

d) Invasiveness/Weediness Potential

The origin of *Eucalyptus* and its hybrids and their reproductive biology are described in Section II. The potential for biological impacts from the widespread introduction of commercially grown FTE within the potential planting range is discussed below.

(1) No Action

Under the no action alternative, the GE FTE lines would not be available for commercial introduction and planting. However, the no action alternative is expected to include a gradual transition to the production of wood products from non-GE FTE species. These changes would be voluntary on the part of the commercial wood products industry and would be implemented as companies and individuals make business decisions to replace their current stands of pine with non-GE FTE. The potential for non-GE FTE species to be invasive is expected to be low based on characteristics discussed under the proposed action that are common among *Eucalyptus* species. Consequently, the no action alternative would be unlikely to result in significant biological impacts from invasiveness of the FTE species expected to be introduced and grown commercially under this scenario.

(2) Proposed Action

Eucalyptus variety EH1 is the progenitor of the GE FTE lines that are the subject of the proposed action. EH1 is a hybrid between *E. grandis* and *E. urophylla* that was developed in Brazil for its improved growth, superior wood quality, and adaptability to different soil types and environments. Since its introduction in 1994, EH1 has been planted in Brazil on approximately 370,657 acres with no indication of any notable spread beyond plantations. In addition, EH1 has been planted experimentally in Alabama and Florida, where the trees have been allowed to flower and produce seeds over several growing seasons and results suggest that this genotype does not spread beyond planted areas. Thus, there is no scientific evidence to suggest that this hybrid genotype is invasive or has the potential to be invasive.

In addition to these specific observations, there are several reasons to believe that variety EH1 is highly unlikely to be invasive: 1) absence of any wild relatives of eucalypts that occur naturally in the southeastern U.S.; 2) lack of cross-compatibility and hybridization between EH1 and other species grown in the southeastern U.S. that belong to distantly related subgenera and sections; 3) negligible potential for crossing of EH1 with other species due to asynchronous flowering and cross-incompatibility; 4) high degree of self incompatibility in eucalypts leading to reduced capsule production, low seed yield and poor seedling germination and vigor; 5) requirement of direct contact of seed with bare mineral soil devoid of competition in order for successful germination; 6) lack of seed dormancy; 7) limited seed dispersal potential; and 8) no evidence for spread via vegetative propagation.

Lack of potential for hybridization with other *Eucalyptus*

There are several species of *Eucalyptus* that can be grown in Florida and the southeastern U.S. *Eucalyptus grandis* has been grown commercially in southern Florida since the 1960s for mulch and pulpwood production (Meskimen et al., 1987). Other than *E. grandis*, the main species present in southern Florida include *E. robusta*, *E. camaldulensis*, *E. tereticornis*, *E. torelliana,* and *E. amplifolia. E. grandis* and *E. amplifolia* can be grown in central Florida as short rotation energy crops and for mulch (Stricker et al., 2000; Rockwood et al., 2004). Other species of *Eucalyptus* that have been grown on a small scale or in species screening trials in northern Florida include *E. pauciflora* (for ornamental foliage production near Barberville, Florida), *E. viminalis*, *E. nova-anglica*, *E. macarthurii*, *E. camphora, E. rubida*, *E. dalrympleana*, and *E. nitens* (Rockwood, Per.Com.). In addition to these species there are several cold-hardy species that can be grown in parts of the southeastern U.S. including *E. neglecta, E. niphophila, E. gunnii¸E. benthamii and E. dorrigoensis. E. cinerea,* which is also known as the silver dollar tree or Argyle Apple, is commonly grown in the southeast as an ornamental species.

The potential for crossing of an *E. urograndis* hybrid with other species is highly unlikely due to asynchronous flowering and cross-incompatibility (Potts and Dungey, 2004). For example, *E. grandis* and *E. urophylla*, for which hybrids have been generated in directed breeding programs, are in the Salignae and Resiniferae series, respectively, of section Transversaria. In contrast, *E. cinerea* and other cold hardy species mentioned above are far removed from *E. grandis* and *E. urophylla* on the evolutionary scale and reside within the distant Sections of genus *Eucalyptus*. The phenology (season, time and duration of flowering, intensity of flowering) of *Eucalyptus* also plays an important role in limiting the success of interspecific hybridization (Gore and Potts, 1995; Potts et al., 2003; Barbour et al., 2006). A further barrier to potential crossing of the *E. urograndis* hybrid with ornamental *E. cinerea* and other species grown in the southeastern U.S. would be their expected differences in phenology. For example, the *E. urograndis* hybrid genotype produces mature flowers in the mid-to-late summer whereas *E. cinerea* flowers in the late spring.

Limitations on potential spread by seed or vegetative propagation

In order to successfully germinate and establish, *Eucalyptus* seed need contact with bare mineral soil and little or no competition. Lack of competition can result from human intervention (weed control) or naturally following a fire event (Bell and Williams, 1997; Meskimen and Francis, 1990). After 40 years of breeding, developing, and growing *Eucalyptus* in Florida, D. Rockwood with the University of Florida (Per.Com.) noted only one instance in which conditions were suitable for germination and spread of *E. grandis* from a plantation setting. In this situation a fire in an 8-year-old *E. grandis* seed orchard consumed all understory vegetation, exposed moist soil, and encouraged capsule opening and heavy seed release from the trees resulting in abundant seedlings throughout the orchard. However, no seedlings developed in the unburned pasture and plantation adjacent to the orchard. Importantly, incidental observations by Rockwood of more than 19,750 acres of *E. grandis* plantations (approximately 3,707 trees/acre) over nearly 40 years of variable weather, understory conditions, fire events, harvesting and replanting activities have not detected a single established volunteer seedling. These observations confirm that this species has extremely low potential to seed propagate and to pose a weediness risk potential in Florida.

Under favorable conditions eucalypts can be regenerated by coppicing (sprouting) from the cut stumps (Reddy and Rockwood, 1989; Webley et al., 1986). Two or three coppice rotations are commonly harvested before replanting. Coppice shoots initially grow faster than seedlings, but that advantage is partially offset by stump mortality, which is typically about 5% per harvest (Stubbings and Schonau, 1979). There is no evidence for natural vegetative propagation of commercially grown *Eucalyptus* species and hybrids (Hartney, 1980). Coppicing can regenerate the tree from the cut stump but does not produce new or independent individuals. Although *Eucalyptus* often is propagated as vegetative cuttings, this process requires specific cultural treatments and controlled laboratory or greenhouse conditions (Watt et al., 1995; Yang et al., 1995; Fogaca and Fett-Neto, 2005).

Lack of weediness of planted *Eucalyptus*

The species belonging to genus *Eucalyptus* are generally characterized by production of large number of flowers, fruits, and seeds (House, 1997). Although *Eucalyptus* seed is light and very small, it is not adapted to wind dispersal, and the dispersal of seed is very limited, generally being confined within a radius of twice the tree or canopy height (approximately 50 m for a 25 m tall tree at harvest age) (Cremer, 1977; Linacre and Ades, 2004). Another consequence of the very small size of *Eucalyptus* seed is that they have very limited reserves and, therefore are very intolerant of shade or weedy competition. *Eucalyptus* seeds do not have any dormancy barriers to prevent germination (Grose, 1960; Wellington, 1989; Gill, 1997), and seed viability and storage of *Eucalyptus* seeds in soil is less than 1 year (Gill, 1997). *Eucalyptus* plantations are typically established using rooted plantlets because of poor establishment using direct seeding methods. Even for rooted plants, competition control is recommended for several months after planting to ensure optimal survival (Meskimen and Francis, 1990).

The Global Invasive Species Database of the world's top 100 invasive species (Fondation d'Entreprise Total, 2000) does not list any *Eucalyptus* species. Among several *Eucalyptus* species introduced in California (Santos, 1997; King and Krugman, 1980; Merwin, 1983), only two, *E. globulus* and *E. camaldulensis* are categorized as invasive by the California Invasive Plant Council (CIPC, 2007). *E. globulus,* in particular, is well adapted to the Mediterranean climate of parts of coastal California where frequent summer fog is conducive to seed germination in that species (Santos, 2007). *E. grandis* has been grown in California but with limited success (Merwin, 1987). In the U.S., weed risk assessments pertinent to *E. grandis* have been conducted in Hawaii, California, and Florida. A risk assessment adapted from an Australia Weed Risk Assessment model for importing *E. grandis* into Hawaii and other Pacific islands suggested that this species posed some risk at those locations (Daehler et al., 2004; http://www.botany.hawaii.edu/faculty/daehler /wra/full_table.asp). However, personal surveys conducted by N. Dudley, A. Yeh, N. Koch, and D. Rockwood of *E. grandis* plantations in Hawaii detected no escapes, suggesting that this species is unlikely to be invasive there (Rockwood, Per.Com.).

E. grandis has been planted commercially in Florida since the 1960s and now constitutes approximately 3,707 acres of mulchwood plantations (Rockwood, Per.Com.). As recently as 2005, the absence of any eucalypts on the Florida Exotic Pest Plant Council's 2005 Invasive Plants lists (FLEPPC, 2005) shows that *Eucalyptus* species had not demonstrated invasiveness characteristics in Florida. Several commercially important *Eucalyptus* species grown in Florida were evaluated according to the Institute of Food and Agricultural Sciences (IFAS) Assessment of the Status of Non-Native plants in Florida's Natural Areas (Fox et al., 2005). These species had not been documented in the undisturbed natural areas of Florida as of February 2008 (University of Florida, 2009). Based on recent assessments using the modified Australian Weed Risk Assessment model, *E. grandis*, one of the parents of the EH1 hybrid, was categorized as 'predicted to be invasive' (Gordon et al., 2008). As neither *E. urograndis* nor the *urophylla* parents have been widely grown in the U.S., there are limited data available for Florida. However, since its introduction in 1994, EH1 has been planted in Brazil on approximately 370,657 acres with no notable indication of its spread beyond plantations. In addition, experience with EH1 planted in Alabama and Florida where the trees have been allowed to flower and produce seeds over several growing seasons suggest that this genotype does not spread beyond planted areas. Thus, there is no scientific evidence to suggest that this hybrid genotype is invasive or has potential to be invasive.

Conclusion

Field tests of GE FTE lines 427 and 435 in which the trees have been allowed to flower and produce seeds over several growing seasons at sites in Alabama and Florida suggest that this genotype does not spread beyond the areas planted. There is no scientific evidence from other studies to suggest that these lines are invasive or have the potential to be invasive. Consequently, the proposed action would not result in significant biological impacts from invasiveness of the GE FTE lines if deregulated and grown commercially.

(3) Cumulative Impacts

Cumulative biological impacts from the introduction and spread of invasive species within the potential planting range occur currently and are expected to continue under the no action alternative and the proposed action. Because neither the introduction of non-GE FTE under the no action alternative nor the introduction of GE FTE under the proposed action would result in significant adverse biological impacts from invasiveness, these introductions would not contribute significantly to cumulative impacts from invasive species.

e) Plant Pests and Diseases

(1) No Action

The discussion under the proposed action of potential pests and diseases of *Eucalyptus* also is relevant to the introduction of non-GE FTE varieties. Similarly, it is expected that these plantings would be subject to the same occasional, periodic, severe winter kill that could occur in the GE FTE lines. As described below, in these instances, management practices likely would be implemented that would limit the occurrence of dead wood on site, so this would represent an insignificant incremental change from the natural dynamics of tree growth and death in surrounding native forests and existing pine plantations. Therefore, pests and diseases associated with non-GE FTE species are not expected to have any significant adverse impacts relative to other plants, including plantings of *Eucalyptus* that currently exist or are reasonably foreseeable in the future.

(2) Proposed Action

GE FTE Lines 427 and 435 are unlikely to be a source of new pests or diseases

Eucalypts, in their natural environments, are known to be affected by several insect pests and diseases (Keane et al., 2000). However, when *Eucalyptus* species and varieties are established outside of their natural habitats in managed plantations, they are relatively free of insect pests and diseases for the early part of their introduction. With the expansion of managed planted areas in a new environment, a few insect pests and diseases have spread to the area of their introduction (Gadgil et al., 2000). In the process of introducing plant material from one region to another, it is possible that some insect pests and diseases associated with the introduced species and varieties may be transferred to the new area of its introduction. The Plant Protection and Quarantine (PPQ) measures designed to reduce and prevent the introduction of foreign pests and diseases are, therefore, considered to be the first and most important line of defense. Importation of *Eucalyptus* plants into the U.S. is subject to post-entry quarantine as a precaution against the introduction of *Pestalotia disseminata* and leaf chlorosis virus (USDA, 2007). All importations and handling of imported *Eucalyptus* plant material have been in accordance with APHIS-PPQ requirements.

The plant material for control variety EH1 and the GE FTE lines 427 and 435 was imported into the U.S. as sterile tissue culture shoots or rooted plants under import permits issued by APHIS-BRS and APHIS-PPQ. The plants were inspected by the USDA at the port of entry for potential insect pests and diseases. The rooted tissue culture plants, or plants subsequently propagated from the stock material through rooted cuttings, were field tested under authorized APHIS-BRS and APHIS-PPQ permits. Field tests containing these plants have been subject to inspection by PPQ for at least two years, and these trees showed no indication of any symptoms for *Pestalotia disseminata* (also known as *Pestalotiopsis disseminata)*, leaf chlorosis virus, or any other pests and diseases of significant concern. The plant material that would be used to propagate trees for commercial plantings has been verified to be free of diseases or pests and has been released from any post-entry quarantine restrictions. Since the sterile tissue culture material imported under these authorized permits was determined to be free of any insect pests and diseases at the time of arrival and has not shown any pests and diseases of significant concern during the post-entry monitoring period, it is highly unlikely that the stock material or plants propagated from this material for lines 427 and 435 would be a source for introducing any new pests and diseases of *Eucalyptus* or other plants into the U.S.

After establishment of field tests of EH1 and GE FTE lines 427 and 435 across the southeastern U.S., the trees were extensively monitored at regular intervals for the occurrence of insect pests and diseases. The observations for plant pests and diseases were made by trained field test personnel walking through each field trial and comparing transgenic lines with the non-transgenic EH1 control trees. Over 580 such observations were made in the transgenic field trials. These observations were made on tests where trees were planted as single tree plot or block plots on multiple test sites and included thousands of trees of translines and non-transgenic control variety EH1. The results from these observations consistently showed that there were no differences in the occurrence of disease or insect pest susceptibility between freeze tolerant translines and non-transformed control trees of the EH1 hybrid genotype. As expected for an non-native species, for most of the observation dates, no incidence of diseases or insect pests was observed on any of the *Eucalyptus* trees. In very few instances, when observations noted symptoms of disease (such as rust) or evidence of insect damage (such as psyllids), these were not severe, were transient, and did not cause any significant injury to the trees. In all cases, no differences were observed in the occurrence of these symptoms between translines and control trees. The observational data indicate that there were no notable differences between the transgenic lines and control trees in plant morphology and susceptibility to diseases or insects. These observational data support the conclusion that GE FTE lines 427 and 435 show no unexpected phenotypes with respect to disease or pest susceptibility and are not expected to exhibit any increased plant pest risk.

Consideration of *Eucalyptus* pests and diseases already present in Florida

Although GE FTE lines 427 and 435 are not likely to be a source for introduction of new insect pests and diseases of *Eucalyptus*, plantations established with these trees may serve as additional hosts for the pests and diseases that exist on *Eucalyptus* trees already currently grown in the southeastern U.S. A few instances of insect pests and diseases have been reported for *E. grandis* and other *Eucalyptus* species grown in Florida (Barnard et al., 1987; Halbert et al., 2003). Among these, the fungal pathogens *Cryphonectria cubensis, Cryphonectria gyrosa*, and *Botryosphaeria dothidea*, causing canker diseases on non-native *Eucalyptus* plantations, are of some concern in the southeastern U.S. (Brown, 2000; Old and Davison, 2000; Forest Agriculture Biotechnology Institute of South Africa (FABI), 2002; Wingfield et al., 2001; FAO, 2007). These fungal pathogens have been found in association with *E. grandis* in Florida resulting, in adverse effects on growth and coppice regeneration (Barnard, 1988). In addition, *Cylindrocladium scoparium*, which is known to causes a range of symptoms including damping off, root rot, stem-girdling canker, and leaf blight (Park et al., 2000), has been found to infect *E. grandis* seedlings grown in Florida nurseries. However, this can be effectively controlled with alternating sprays of chlorothalonil and benomyl (Barnard, 1984).

Some other potential pests have been reported to infect *Eucalyptus* in Florida but have not caused significant economically relevant damage. These pests include guava rust (*Puccinia psidii*), redgum lerp psyllid (*Glycaspis brimblecombei*), *Eucalyptus* psyllid (*Blastopsylla occidentalis*), and bluegum chalcid (*Leptocybe invasa*). *Puccinia psidii* is believed to have originated on native Myrtaceae in South America and is considered a significant concern for introduced *Eucalyptus* planted in that region (Burgess and Wingfield, 2002). It also has been observed in Australia as a new pathogen of concern for *Eucalyptus* (Coutinho et al., 1998). This pathogen has many hosts, all of which are within family Myrtaceae (Coutinho et al., 1998).

Puccinia psidii, guava rust, is a fungus that primarily attacks trees two years of age or younger, including coppice trees. It targets young leaves and shoots, and infected leaves become deformed and then shrivel. Susceptibility of *E. grandis* varies in different varieties, and *E. urophylla* is reported to be susceptible (Rayachhetry et al., 2001). To date, this pathogen has not been a major threat to *Eucalpytus* in the southeastern U.S., though it has been a concern for guava plantations in these areas. Host specialization by *P. psidii* is known to occur, where isolates from one host do not infect other hosts that are known to be susceptible (Coutinho et al., 1998; Leahy, 2004). It is possible, therefore, that different strains of *P. psidii* are present on the guava and *Eucalyptus* in the southeastern U.S. A strain of this pathogen also has been investigated as a possible biological control agent for *Melaleuca*, an invasive species found in Florida that belongs to the Myrtaceae family (Rayachhetry et al., 2001). Guava rust can be effectively controlled by planting resistant genotypes and the use of fungicides in nursery operations.

There are over 100 native species of psyllids in North America, most of which do not cause any notable damage to plants (Paine and Dreistadt, 2007). *Glycaspis brimblecombei*, the redgum lerp psyllid, is native to Australia. The nymphs make conical white coverings known as lerps. It has become well established in California and was found for the first time in Florida in 2001 (Halbert et al., 2003). These psyllids feed on phloem sap, secrete honeydew, and cause premature leaf drop. This defoliation can cause increased susceptibility to insect damage. Healthy trees are less likely to show damage. In one study, only 3 of 21 species tested were found to be susceptible to *G. brimblecombei* (Brennan et al., 2001). *E. grandis* was found to be resistant in this study, though it was reported to be of intermediate resistance in a later study (Paine et al., 2006). For control, either systemic insecticides such as Imicide or Merit or biological control with an introduced wasp species are recommended (Paine et al., 2006). Topical treatments are less effective because the lerp protects the psyllids. Although psyllids were observed in 2007 on some of the trees at the field site (FLHIG01) in Highlands County, Florida, it is unlikely that these were the redgum lerp psyllid because there were no signs of lerp formation. At the observation date and site that the psyllids were observed, no damage was seen on the trees on this or subsequent observations and the psyllids did not return after treatment.

Blastopsylla occidentalis, the *Eucalyptus* psyllid, is also native to Australia and was found for the first time in Florida at a tourist park in 2001 (Halbert et al., 2003). This pest has been reported on *E. grandis* and *E. grandis x urophylla* in South America. The nymphs of this psyllid do not make lerps but they do secrete wax (Halbert et al., 2003). There are no reports of any significant damage to *Eucalyptus* in Florida by *B. occidentalis*. An exotic psyllid species (*Boreioglycaspis melaleucae*) was deliberately introduced by the USDA in Florida in 2002 as a biological control agent for Melaleuca, an invasive tree species in the Myrtaceae family (same family as *Eucalyptus*). This psyllid has been reported to be very specific to Melaleuca, and does not damage related species including *E. grandis* (Wineriter et al., 2003). The introduced psyllid has become established in large populations at the release sites, with estimated numbers of multiple millions per acre (Buckingham, 2006). Over one million individuals have been redistributed to nearly 100 locations in South Florida since 2002, and they have also been discovered as far south as Puerto Rico (Pratt et al., 2006). These psyllids have been observed at low levels on the FTE trees, but there has been no damage associated with their occurrence.

Leptocybe invasa, the blue gum chalcid native to Australia, was first found in Florida in 2008, and to date has been documented in Broward, Dade, Hendry, Glades, Lee, and Palm Beach counties (Wiley and Skelley, 2008; Halbert, 2009a,b). Damage from this small wasp occurs through formation of galls on petioles, leaf midribs, and stems of new foliage. Galling causes leaves to curl and may stunt growth and weaken trees. The exact species of *Eucalyptus* that is infected in Florida has not been determined yet (Wiley and Skelley, 2008). *L. invasa* was tested on seedlings of 36 *Eucalyptus* species, 10 of which were found to be suitable hosts, including *E. grandis* (Mendel et al., 2004). *L. invasa* in its native Australia is kept in check by natural enemies that keep levels below detection. The adult wasps of this species are very small and likely are unable to fly for long distances, so it is believed that *L. invasa* spreads through distribution of contaminated nursery stock (FABI, 2007). There is no known chemical control for this pest, but two insect parasitoids (*Quadrastichus mendeli* and *Selitrichodes kryceri*) are being evaluated as potential biological control agents (Kim et al., 2008). In cooperation with APHIS-PPQ and Florida Sate Pest control representatives, surveys for detection and mitigation of this pest currently are being conducted at the field trial sites.

As expected for any managed tree plantations, the plantations established with GE FTE lines 427 and 435 would be monitored by the owners on a regular basis for the occurrence of any pests and diseases. Regular inspections and application of best silvicultural practices for management of *Eucalyptus* plantations established with GE FTE lines 427 and 435 will play a role in minimizing the spread of existing pests and diseases in Florida.

Consideration of *Eucalyptus* pests and diseases in the southeastern U.S. outside of Florida

Other species within the family Myrtaceae are present in the southeastern U.S. and could act as a source or sink of *Eucalyptus* pests and diseases. Crape myrtle is in the same order (Myrtales) as *Eucalyptus* but would not be expected to share common pests with *Eucalyptus* species. The most significant members of the Myrtaceae family that may be present in the southeastern U.S. outside Florida are bottlebrush (*Callistemon* spp.), wax jambu (*Syzygium samarangense*), and *Melaleuca*. It is possible that pests present on these species could, under certain circumstances, also affect *Eucalyptus*. Conversely, pests affecting *Eucalyptus* could become pests of other nearby members of Myrtaceae under certain circumstances. Although these species related to *Eucalyptus* may be found in the region, they are not grown as commercial crops. As far as we are aware, there are no particular insect pests and diseases that are described as significant threat to these species. It is therefore highly unlikely that scattered or ornamental plantings of these species would serve as a source of insect pests and diseases for *Eucalyptus* plantations in the southeast or vice-versa.

Two closely related species of longhorned borer beetles (*Phoracantha semipunctata* and *Phoracantha recurva)*, which are native to Australia, have been found to attack *Eucalyptus* trees in California (Paine et al., 1995). *Eucalyptus grandis* is reported to be a susceptible host, but these pests have not been reported outside of California (Lawson, 2006; Paine et al., 2009). The borers mostly attack drought stressed trees and vigorously growing and well-managed trees are rarely the target for these pests. The tree damage occurs due to larvae feeding at the bark-cambium-xylem interface, which can functionally girdle the tree. Pesticides are reported to be ineffective, but biological control combined with management of trees in vigorous active growth and planting of resistant varieties or species are proposed as effective control measures (Paine et al., 1995, 2009).

An additional pest of *Eucalyptus* in some regions of the U.S. is *Atta texana*, the Texas leafcutting ant. These ants harvest leaves and buds from many plant species, including ornamentals, fruit and nut trees, and commercially planted pine. The harvested plant material is taken to the colonies where it is used to raise a fungus that the ants eat (Drees and Jackman, 1999). This pest is present only on well-drained sites in southeastern Texas and western Louisiana. To date, they have been observed in the vicinity of one FTE test planted in Texas; however, they were not present within the test area, and no damage was observed on the test trees. Where they are present, control of these ants is a standard element of all forestry programs, including pine and *Eucalyptus*, and involves application of Amdro® or similar agents.

It is difficult to assess the potential risk of pests and diseases that are either not present in the region or are present but do not cause significant damage. It is expected that routine management of *Eucalyptus* plantations would identify any changes in pest or disease prevalence should this occur. There is no evidence based on the extensive experience of introducing *Eucalyptus* into other countries (including examples where millions of acres of *Eucalyptus* have been grown over many decades) that diseases and pests of *Eucalyptus* have resulted in any concerns of damage to native species or crops other than the *Eucalyptus* themselves.

Dieback and potential impacts on occurrence of pests and diseases

Dieback and death of trees in *Eucalyptus* forests and managed plantations can be a consequence of a variety of environmental events including fire, temperature extremes, drought, severe storms, unsuitable soil conditions and other abiotic factors (Keane et al., 2000). The dieback or decay of trees may also result from attack by an insect pest or disease. Most often, the dieback caused by factors other than diseases or pests is not found associated with increased incidence of insect pests and diseases unless the dead and decaying wood is exposed over a long enough time to attract secondary infections. Field observations of both young and older trees across a large number of test sites where minor or severe dieback occurred as a result of freeze damage confirm that there has been no incidence of increased risk of pests and diseases.

Where freezing temperatures caused complete dieback of control EH1 trees within the test but only minor damage to the translines, the dead trees might hypothetically act as a substrate for pests and diseases that then attack the otherwise healthy translines. However, no evidence for increased pests on healthy trees due to the close proximity of multiple dead trees was observed. Standing dead trees (snags), fallen trees, and broken branches (often referred to as coarse woody debris) are all normal features of natural forests and can provide important habitat for wildlife. In a managed forest plantation setting where trees are harvested well before the age at which natural senescence occurs, levels of coarse woody debris are typically less than that of native forests but are not absent. In contrast, harvesting operations can leave large amounts of woody debris (cut tree tops and limbs) on site post-harvest. Therefore, there can be significant amounts of dead or decaying wood as part of the existing cycle of tree planting and harvesting. Notably, there is growing interest in using this woody residue material in bioenergy applications.

It is reasonably foreseeable that occasional extreme winter weather events could result in significant damage to GE FTE lines. Given the expectation that GE FTE would be grown in highly managed plantations, it is likely that one or more of the following actions will be undertaken in the event of an occasional severe winter kill. For small trees less than a few years old, if overall survival is less than acceptable to the land owner, the trees would likely be plowed under and the site replanted with *Eucalyptus*, other tree species, or another crop. If overall survival and resprouting from the base occurs at an acceptable frequency, the land owner may elect to maintain the planting or destroy the resprouts and replant. In each of these cases, on-site debris is expected to be limited in amount and transient. Older trees are likely to be cut and the harvested wood utilized, thereby removing much of the woody material from the site. Depending on the size of the trees, these may be used in pulp and paper manufacture or for bioenergy applications. Based on results from field trials, it is expected that there would be a high frequency of resprouting from the base of such trees. As a result, it is highly likely that the land owner would elect to allow the trees to re-grow as coppiced sprouts. Should the land owner choose to switch to another crop, resprouts can be effectively controlled using herbicides. Such management decisions are already well founded in existing forestry operations in the U.S. For example, hurricane-damaged trees are handled in much the same way: sites with young trees being likely to be replanted and older trees harvested wherever possible for use in commercial applications.

Therefore, dieback in freeze tolerant *Eucalyptus* following occasional extreme winters would be transient and would not be expected to have any significant impact on the prevalence of pests or diseases beyond what typically occurs in managed forests or native forestlands in the potential planting range within the southeastern U.S.

Conclusions

Eucalyptus species and varieties established outside of their natural habitats in managed plantations typically are free of insect pests and diseases during the early part of their introduction. With the expansion of managed planted areas in a new geography, there is increased potential for some insect pests and diseases to become established in the area of introduction. In this respect, PPQ measures are a critical component in preventing or reducing the introduction of foreign pests and diseases. The plant material for GE FTE lines 427 and 435 was imported into the U.S. as sterile tissue culture shoots or rooted plants under import permits issued by APHIS and was free of any insect pests and diseases at the time of arrival. Plants were established in field testing under authorized APHIS-BRS and APHIS-PPQ permits and have been monitored for the occurrence of pests and diseases for at least 2 years at all locations and have not shown any pests and diseases of significant concern during this time. Therefore, it is highly unlikely that the stock material and plants propagated from this material for lines 427 and 435 could be a source for introducing any new pests and diseases of *Eucalyptus*.

Field tests of GE FTE established at multiple sites across the southern U.S. were monitored at regular intervals for the occurrence of insect pests and diseases. These observational data support the conclusion that GE FTE lines show no unexpected changes with respect to susceptibility to pests or disease. Because the GE FTE lines would be established in intensively managed plantations, regular inspections and application of best silvicultural practices for management of *Eucalyptus* plantations could effectively minimize the prevalence and spread of pests and diseases should these occur. As a result, GE FTE lines 427 and 435 are not expected to exhibit increased plant pest risks. Pests and diseases that can occur on *Eucalyptus* are not known to cause economic losses to other important crops in the southeastern U.S. Thus, the proposed action would not result in significant biological impacts from pests or diseases associated with the GE FTE lines if deregulated and grown commercially.

(3) Cumulative Impacts

Cumulative biological impacts from the introduction and spread of plant pests and diseases within the potential planting range occur currently and are expected to continue under the no action alternative and the proposed action. Because neither the introduction of non-GE FTE under the no action alternative nor the introduction of GE FTE under the proposed action would result in significant adverse biological impacts from the spread of plant pests and diseases, these introductions would not contribute significantly to cumulative impacts from pests and diseases.

f) Soil Biology/Nutrients

(1) No Action

Under the no action alternative, the GE FTE lines would not be available for commercial introduction and planting. However, the no action alternative is expected to include a gradual transition to the planting of non-GE FTE species instead of pines. Concerns have been raised that *Eucalyptus* plantations deplete nutrients in the soil and aggressively compete with the surrounding vegetation, resulting in an unsustainable system for tree production. However, review of numerous studies and reports addressing this issue indicates that under the appropriate silvicultural regimes *Eucalyptus* plantations would be sustainable over many rotations and would not be expected to have a negative effect on the soil or the surrounding vegetation. For example, *Eucalyptus* plantations in Brazil have produced consistent or increased yields over successive rotations (Stape et al., 2001; Gonçalves et al., 2004). Some key findings reported in the literature are that *Eucalyptus* nutrient use is more efficient and nutrient consumption is lower or comparable to other planted tree species and agricultural crops, and when planted on marginal agricultural lands or other areas with degraded soils, *Eucalyptus* can improve soil fertility. In addition, a variety of silvicultural practices can be applied to *Eucalyptus* plantations to maintain soil productivity throughout successive rotations and ensure the long-term sustainability of the system. Consequently, the no action alternative would be unlikely to result in significant biological impacts from the depletion of soil nutrients by the non-GE FTE species expected to be introduced and grown commercially under this scenario.

(2) Proposed Action

The discussion under the no action alternative of the potential for non-GE FTE species to deplete soil nutrients also is applicable to the introduction of GE FTE lines under the proposed action. Cultivation of

GE FTE lines would be likely to have effects on soil nutrients similar to those of non-GE FTE that would be planted under the no action alternative. Because the GE FTE lines would be expected to have a faster growth rate than non-GE FTE, the transgenic lines potentially would utilize soil nutrients at a similarly faster rate. However, the efficiency of *Eucalyptus* in its use of nutrients and its ability to maintain or improve soil fertility indicate that the incrementally greater rate of nutrient use by GE FTE compared to non-GE FTE would not be biologically significant. Therefore, soil nutrient depletion associated with GE FTE lines would be unlikely to have any significant adverse impacts in comparison to non-GE FTE or other trees.

(3) Cumulative Impacts

Because neither the introduction of non-GE FTE under the no action alternative nor the introduction of GE FTE under the proposed action would result in significant depletion of soil nutrients, these introductions would not contribute significantly to cumulative biological impacts from the depletion of soil nutrients.

3. Hydrology

Potential impacts related to hydrologic resources could potentially occur if the GE FTE species were to result in water use conflicts. Because hydrologic impacts associated with commercial forestry in general, and *Eucalyptus* plantations in particular, have been documented, this section will summarize the following:

- The physiological and hydrological mechanisms which could potentially cause adverse hydrologic impacts;

- A summary of the historical literature regarding hydrologic impacts associated with eucalypts; and

- The relevance of the historical literature to the planting range.

Physiological and Hydrological Mechanisms of Forests

The mechanism for the development of hydrologic impacts from agriculture and forestry activities is related to the manner in which the physiology of all vegetation uses water. A summary of the manner in which water is used by vegetation is provided in Cossalter and Pye-Smith (2003), and a depiction of the water cycle is presented in Figure F. This figure shows how trees and other vegetation uptake water from its storage location within soil moisture and groundwater. Water absorbed from the soil and groundwater is removed from the local planting range by two mechanisms: incorporation into biomass, which is eventually removed by harvesting, and release to the atmosphere through transpiration. The removal of water stored as soil moisture and groundwater removes water that would have supported other vegetation and aquatic resources (including stream flow and wetlands) and that could have been available for irrigation or water supply purposes.

Because of the role of vegetation in removing water from the hydrologic system, the effect of changes in vegetation cover on hydrology is very predictable, well understood, and well documented. When vegetation is growing in an area, it is removing water at a rate that is, in general, proportional to its rate of growth and biomass production. Modification of the rate of growth and biomass production causes a change in the rate of water removal. When areas planted with trees are harvested, groundwater levels rise and stream flows increase. This is because the mechanisms that had been removing water from the system (transpiration and building of biomass) have been eliminated, releasing surplus water that adds to water storage volumes in soil moisture, groundwater, and ultimately surface water. Once such an area is replanted and biomass production increases again, removal of water by transpiration and biomass production also increases, and water storage volumes in groundwater, soil moisture, and surface water are observed to drop.

The hydrologic impacts that may potentially result from these changes in water availability include reductions in water available for municipal, residential, industrial, and agricultural uses; reductions in water runoff and discharge to surface water bodies and wetlands; and resulting alterations in aquatic habitats. Whether an actual impact occurs, and the magnitude of the impact, would depend on site-specific and time-specific factors such as the amount of water available, and the rate of water usage by the trees. In general, the rate of water usage by the trees is related to the rate of biomass growth, and therefore trees that have a faster growth rate would be expected to present a greater risk of adverse hydrologic impacts than slower-growing trees. However, impacts would only occur if the rate of water usage exceeded the available water supply. Therefore, any analysis of potential hydrologic impacts from commercial forestry operations must include both the water usage rate and the availability of water. Also, the analysis must acknowledge that the water usage rate can be deliberately modified by the operator, by using reduced stocking levels and other management techniques, in order to mitigate or avoid potential impacts.

Specific Water-Use Characteristics of Eucalypts

In many areas where *Eucalyptus* plantations have been established, depletion of water supplies has been noted and, rightly or wrongly, has been linked to *Eucalyptus*. In response to these concerns, extensive research and reporting on hydrologic impacts linked to *Eucalyptus* have been conducted in countries where large plantations of *Eucalyptus* have been established, including India, China, South Africa, and Brazil, as well as its native continent of Australia. These studies include:

- Laboratory-based physiological measurements of water use efficiency and transpiration rates of individual plants;

- Watershed studies that include site-specific measurements of groundwater levels, soil moisture, and stream flow at various stages in the life cycle of *Eucalyptus* plantations; and

- Literature reviews and syntheses.

These three different categories of studies are summarized in the following subsections.

Physiological Studies

Many of the available studies conclude that the physiological characteristics of *Eucalyptus* species are less efficient in water use than other species, thus creating greater potential hydrologic impacts. For example, in their study of the assessment of impacts to hydrology in support of the USDA analysis for petitions for field trials (numbers 08-011-106rm and 08-014-101rm), Ford and Vose (2010) estimate that a *Eucalyptus* plantation would transpire 883 mm/year, as compared to a range of 244 to 442 mm/year for native forests, and 490 mm/year for planted loblolly pine. This higher transpiration rate (about 80% higher for *Eucalyptus* versus loblolly pine) is consistent with the faster growth rate for *Eucalyptus*. However, this comparison does not consider the relative amounts of biomass that are produced by the two plants.

Other studies more accurately relate the water use to biomass production rate. In general, *Eucalyptus* evolved to be very efficient in its water use as the Australian continent became more dry, and it is generally accepted that *Eucalyptus* uses less water per unit weight of biomass produced than do many other trees and agricultural crops (Chaturvedi, 1987; Davidson, 1995; Patil, 1995; Silva et al., 2004). Davidson (1995) compared the water use per production of biomass of *Eucalyptus* versus various other vegetation types and demonstrated that *Eucalyptus* species, in general, have equal or lower water use per unit of biomass produced than most other types of vegetation. For instance, *Eucalyptus* species are estimated to use 510 liters (L) of water per kilogram (kg) of biomass produced, as compared to 1,000 L/kg for conifers. Davidson (1995) accurately notes that this higher biomass production under low rainfall conditions can reduce stream flows more than slower-growing trees. However, Davidson (1995) and other authors note that this water consumption can be managed through planting trees farther apart and thinning operations.

Site-Specific Hydrology Studies

The literature on hydrologic impacts associated with *Eucalyptus* presents numerous examples of sites where hydrologic impacts were occurring, as well as numerous examples in which hydrologic impacts did not occur. In order to assess the potential hydrologic impact of the proposed project, it is necessary to evaluate both types of examples to identify the technical reasons for the conclusions, and then apply that technical information to the proposed planting range.

In those cases where *Eucalyptus* has been shown to have negative impacts on hydrology, this has been associated mostly with afforestation in areas where trees are normally absent. Typically, these have been areas of low rainfall dominated by grass species. Notably, studies of native grasslands have documented negative impacts of *Eucalyptus* on the water balance in some areas of South Africa (Lesch and Scott, 1997; Scott and Lesch, 1997; Scott et al., 1998) and Argentina (Jobbagy and Jackson, 2004; Engel et al., 2005; Nosetto, 2005). In many of these cases, other introduced trees, including pines and other species, had similar impacts (Le Maitre et al., 2000, 2002). Calder and colleagues have reported similar impacts from afforestation efforts in parts of India (Calder et al., 1997), but also described cases where water use by *Eucalyptus* was comparable to indigenous forests (Calder, 1994).

Farley et al. (2005), in their analysis of the use of afforestation as a carbon sequestration mechanism, measured stream flow in 26 catchments to quantify the effects of *Eucalyptus* and pine plantations on stream flow and allow comparison to sites with native grassland and shrubland. When compared to grasslands, *Eucalyptus* plantations generally reduced stream flow by 75% while pine plantations reduced stream flow by 40%. Again, these observations are consistent with the faster growth rate of *Eucalyptus* but do not compare the biomass produced by *Eucalyptus* versus pine.

An Expert Consultation (White et al., 1995) sponsored by FAO recognized the potential benefits of *Eucalyptus* while noting that many of the criticisms were rooted in inappropriate government policies on afforestation or social concerns and public misconceptions rather than the biology of the trees themselves (see also Casson, 1997; Calder et al., 2004). The report concluded that while *Eucalyptus* can have negative effects in drier climates, in regions where rainfall is above 1,200 mm per year this is not expected to be a problem. As part of this expert consultation, Sunder (1995) reported that the equilibrium between rainfall and evapotranspiration in *Eucalyptus* does not differ significantly from other trees (see also: de Almeida and Riekerk, 1990). Patil (1995) noted no hydrological impacts of *Eucalyptus* on adjacent crops at multiple sites. White (1995) stated that large plantings of *Eucalyptus* may reduce water yield and lower water tables, but this varies from one situation to another and, most importantly, can be mitigated through proper management practices. Overall, the environmental considerations of *Eucalyptus* were considered the same as those for agricultural crops (see also: Binkley and Stape, 2004). Davidson (1995) noted that drawing water from shallow or deep wells to supply high-water-demand crops such as rice or cotton can have a greater impact on drawing down water tables than fast-growing tree plantations. Davidson also concluded that many potential adverse effects are reversible, as noted earlier by Poore and Fries (1985).

Oak Ridge National Laboratory (Couto and Betters, 1995) published a review of the potential environmental issues of *Eucalyptus* plantations in Brazil. This report concluded that the hydrology of *Eucalyptus* plantations was comparable to other tree plantations or natural forest cover, and that any observed effects would largely depend on management practices. Binkley and Stape (2004) also refer to the many hundreds of trials that have been conducted in Brazil, with particular reference to a very large watershed project comparing planted hybrid *Eucalyptus* and native forests (Almeida et al., 2007). They concluded that afforestation with any species of trees may increase water use, lower ground water levels, and reduce stream flows in semi-arid environments. However, with implementation of appropriate silvicultural management practices, *Eucalyptus* plantations can be a productive and sustainable source for wood products in many regions. Many other authors have concluded that the hydrological impacts of *Eucalyptus* are comparable to other tree species (for example Myers et al., 1996; Wullschleger et al., 1998).

Early comparative studies showed that for dry alpine conditions the water regime for *Eucalyptus* did not differ from adjacent grasslands (Lima, 1984; Poore and Fries, 1985) and was attributed to *Eucalyptus*' adaptation for survival under drought stress and ability to control the rate of transpiration. Lima et al. (1990), analyzed impacts of both *Eucalyptus* and pine plantations on the *cerrado* grasslands in Brazil and showed that in this region there was adequate rainfall to meet the evapotranspiration demands of the trees. A comparison of *Eucalyptus* and pine plantings showed levels of evapotranspiration comparable to herbaceous vegetation during the dry season (Lima, 1976; Lima and Freire, 1976). Similarly, an examination of the water balance of *Eucalyptus* plantations in China found they were not deleterious to water supplies (Lane et al., 2004). While evapotranspiration did exceed precipitation in the dry season in this region, water storages were replenished during the wet season.

One of the largest studies comparing *Eucalyptus* and native trees conducted to date was a study of a catchment area in Brazil consisting of 470 acres of planted hybrid *Eucalyptus* and almost 222 acres of native Atlantic rainforest. The study analyzed a number of hydrological parameters over a period of 6 to 8 years (Almeida and Soares, 2003; Almeida et al., 2007). Data from this study indicated that evapotranspiration was strongly influenced by precipitation. Stomatal conductance was steady over several months with adequate water and then dropped significantly as available water dropped, confirming results from other studies on stomatal control in *Eucalyptus*. In years with normal precipitation, the ratio of evapotranspiration to precipitation was comparable for both the *Eucalyptus* and native forest. In years with less than normal precipitation, evapotranspiration in native forest was higher than in *Eucalyptus* plantations and was much greater than precipitation. Over the length of the study, evapotranspiration was approximately 95% of precipitation in the *Eucalyptus* plantation areas. The authors concluded that the native forest had a greater consumption of water relative to the production growth cycle of the *Eucalyptus* because, in the first few years after planting, transpiration in the plantation was much less than the native forest. Notably, average precipitation and mean high temperatures at this site are comparable to much of the potential planting range in the southern U.S.

Literature Syntheses

Several review articles on the impact of *Eucalyptus* on hydrology are available, including those sponsored by the United Nations FAO (Lima, 1984; Poore and Fries, 1985; White et al., 1995; Sunder, 1995; Davidson, 1995; Patil, 1995; Calder et al., 2004). FAO has also released two annotated bibliographies (FAO, 2002a, b) that collate and summarize publications on environmental, social, and economic impacts of eucalypts.

Conclusion

Because of its history and reputation, any evaluation of hydrologic impacts associated with *Eucalyptus* must acknowledge that *Eucalyptus* plantations have been linked to water use conflicts in the past. Some of the reasons for this linkage are technical and related to the increase in water use associated with replacement of slower-growing grasses, agricultural crops, and other plantation species with faster-growing *Eucalyptus*. However, there also are likely to be other reasons that are not related to the characteristics of *Eucalyptus*, including instances of coincidence of *Eucalyptus* plantings with natural variations in precipitation, planting of *Eucalyptus* in unsuitable areas, and the use of outdated and unsuitable forest management practices for some *Eucalyptus* plantations. In their literature synthesis, Poore and Fries (1985) note that the use of poor management practices for many *Eucalyptus* plantations, unreasonable expectations from social forestry programs, and the failure of some government programs for watershed protection have historically led to a focus on *Eucalyptus* as a source of hydrologic impacts, even though many other forestry and agricultural practices have the same impacts yet escape criticism. Poore and Fries (1985) state: "… most crops in many parts of the world are of foreign origin. No one is surprised either that the soil under agricultural crops becomes depleted if these are continuously cropped without adding fertilizer. But both of these features are considered grounds for criticism in forestry."

Based on consideration of forest hydrology, *Eucalyptus* physiology, and the historical and more recent scientific literature, some general conclusions can be made regarding hydrologic impacts associated with the introduction of FTE species:

- Some of the negative public perceptions and controversy regarding *Eucalyptus* impacts on water resources are based on the fast growth characteristic of this vegetation type, some are based on observations of improperly sited and poorly managed *Eucalyptus* plantations, and some are based on general objections to afforestation for social and other reasons.

- Because *Eucalyptus* is a faster-growing species, a unit area of *Eucalyptus* plantation will use more water than the same area of pine planted and managed at the same density.

- Depending on the hydrologic characteristics of the site, this effect could result in three different scenarios:

    - The hydrologic characteristics of the site could be suitable for supporting the higher water use of the *Eucalyptus* without resulting in adverse water use impacts;
    - The hydrologic characteristics of the site could be unsuitable for both vegetation types, and impacts would result from either pine or *Eucalyptus* plantations; or
    - The hydrologic characteristics of the site could be somewhat intermediate between the requirements for *Eucalyptus* and for pine, resulting in water use impacts from *Eucalyptus* occurring in locations where water use impacts did not previously occur from pine cultivation.

- The amount of biomass produced in the *Eucalyptus* plantation would be much higher than that of the pine plantation.

- The amount of water used per amount of biomass produced would be lower for the *Eucalyptus* plantation than for the pine plantation.

- The planting density of *Eucalyptus* could be managed to maximize biomass production within the hydrologic limitations of the site in order to avoid causing hydrologic impacts.

By including reports from areas which were unsuitable for eucalypts, or where poor management practices were used, these reports generally do not acknowledge that *Eucalyptus* afforestation has been successfully used without hydrologic impacts in many areas, and can be successfully implemented without impacts by using proper management practices in areas which have adequate hydrologic resources. In considering the potential hydrologic impacts of the planting of non-GE FTE in the potential planting range, reports that are not applicable should be excluded, such as those based on non-scientific public opinion and those based on hydrologic impacts from afforestation projects in environments such as grasslands that are not relevant to the southern U.S.

Instead, it is critical that the evaluation focus on site-specific hydrologic conditions in currently forested and agricultural areas of the potential planting range, and the potential effects of non-GE FTE plantations in these areas. In addition, because it is possible for silviculture to cause depletion of water resources in some areas, any large-scale planting of trees or any agricultural vegetation type, including *Eucalyptus*, should be conducted with consideration of whether the proposed vegetation type and management practices are compatible with the environmental conditions at the site (Poore and Fries, 1985). Those conditions include hydrologic factors such as precipitation rates, pan evaporation rates, and groundwater depth, as well as soil type, nutrient availability, topography, and many other factors. Based on local conditions, there likely are some areas within the potential planting range where non-GE FTE plantations could have substantial hydrologic impacts and would not be an appropriate land use. However, there also are many areas where non-GE FTE would not have noticeable hydrological impacts and would be suitable for growth in plantations. Numerous authors, including Cossalter and Pye-Smith (2003), stress the need to avoid making generalizations about the relationship between forestry and hydrologic impacts and, instead, to assess each plantation individually.

a) No Action

Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. Existing hydrologic conditions within the potential planting range of GE FTE generally would continue as described in Section B.iii. However, if the proposed action does not occur, a major change in existing conditions nevertheless is expected to occur in areas suitable for silviculture because non-GE FTE are likely to be planted commercially and extensively. Growing demands for hardwood for use in the pulp and paper industry and for short-rotation, purpose-grown trees for use as bioenergy feedstock, is expected to drive the introduction of non-GE FTE species. The locations where hydrology potentially would be affected by these non-GE FTE species would largely coincide with those locations potentially affected by GE FTE lines under the proposed action. Accordingly, hydrologic impacts from the introduction of non-GE FTE species are the focus of the evaluation of the no action alternative.

As discussed in Section B.iii, conditions relevant to hydrology in the potential planting range include the following:

- Generally high water availability, including high annual precipitation (greater than 1,200 mm per year), high evapotranspiration rates (greater than 50% of precipitation), and moderate to high runoff rates (200 to 800 mm per year).

- Susceptibility to periodic droughts that can limit municipal and agricultural supplies, cause water use conflicts, and reduce stream flows and aquatic habitats, including those that support sensitive species.

- Widespread managed tree plantations planted primarily in loblolly pine.

Comparison of these conditions with the water use characteristics of *Eucalyptus* species discussed above suggests that a 1:1 replacement of current pine plantations with faster-growing non-GE FTE plantations, using the same planting density and management practices, would result in a higher amount of water use in any given area. As a result, 1:1 replacement of pine by non-GE FTE could reduce local stream flows and water tables, particularly during times of drought, and could create water use conflicts in places where such conflicts do not currently exist. The replacement of pine by non-GE FTE is not regulated by APHIS-BRS, and the identification of non-GE FTE species or hybrids for this application is currently occurring.

Another key conclusion based on these conditions is that these water use conflicts would occur only in areas where hydrology cannot support the higher biomass growth rate of the non-GE FTE and where plantations are not managed with consideration of site-specific hydrologic limitations. Conversely, conflicts would not occur in areas where precipitation and stream flow rates remain sufficient to support non-GE FTE or where plantations are managed appropriately.

One advantage of the use of non-GE FTE for the production of biomass in the southern U.S. is that, by generating a larger amount of biomass per amount of water used, *Eucalyptus* can be managed more easily than slower-growing species to meet the demand for wood products within the limitations of water availability and other resources. On a regional basis, if the current annual volume of wood product provided by pine were to be replaced by an equal volume of *Eucalyptus*, the overall water use associated with wood production in the potential planting range would be lower. Similarly, the land area required, transportation distances, and other factors that could have adverse impacts also would be reduced. While slower-growing trees may use less water per land area planted, they also cannot be managed as effectively to maximize production without requiring increases in land use. Faster growing species, on the other hand, can fill the demand for wood products by using a lesser amount of land area, thus reducing other impacts associated with plantations.

It is clear that the planting of non-GE FTE in the potential planting range potentially could have adverse effects on hydrology in specific, limited areas. Impacts would be particularly likely during drought events if the effects of drought on hydrologic resources were not considered in decisions on plantation siting and planting densities. For example, Ford and Vose (2010) state that a minimum 15% reduction in stocking would be required to benefit stream flows, and they conclude that this cannot be achieved because planting of *Eucalyptus* would require fully stocked stands. However, they assumed a plantation located where stream flows are reduced to such an extent that water use or aquatic ecology are affected. Given the high precipitation rates in the potential planting range, growth of *Eucalyptus* is expected to be possible within the hydrologic limitations of most areas without adverse impacts on stream flow. Second, in limited areas where reduction of stream flow levels could occur, a 15% or more reduction of stocking rates would not substantially affect the economic viability of non-GE FTE, which have biomass production rates more than double those for pine.

Overall, the high water use efficiency of non-GE FTE would allow it to be managed so as to maximize production in areas that can support it with minimal hydrologic impacts. This likely would result in a reduction in the planting of trees in areas that are less suitable and, in turn, an overall reduction in hydrologic impacts associated with commercial forestry in the region.

b) Proposed Action

Introduction of the GE FTE lines in place of non-GE FTE species would not likely result in substantial changes in water use as compared to the no action alternative. The growth rate of the GE FTE lines is expected to slightly higher (approximately 10% faster) than the non-GE FTE species. Based on the similar growth rate, the water use associated the GE FTE lines is expected to be comparable to the non-GE FTE species. Therefore, the introduction of GE FTE would not be expected to have any greater impact on local hydrology than the planting of non-GE FTE or other fast-growing trees species.

c) Cumulative Impacts

Because the proposed project would not result in any adverse impacts to hydrologic resources as compared to the other fast-growing species, it also would not contribute to adverse cumulative impacts to these resources. Cumulative adverse impacts to hydrologic resources in the planting range already occur as a result of urbanization, industrial use, and agricultural use. Although the region, in general, experiences high levels of rainfall and is considered to have extensive water resources, water use conflicts associated with human activity can become exacerbated during natural droughts, such as the one that occurred beginning on 2007.

Replacement of slow-growing plant species, including planted pine forests, with fast-growing, short-rotation species such as eucalypts will, in general, result in an increased amount of water use due to the physiological characteristics of faster-growing species. If implemented in areas with insufficient hydrologic resources, or if not managed properly, this replacement process could exacerbate water use conflicts in limited, localized areas. Therefore, any replacement of slower-growing species by short-rotation species should only be conducted following a consideration of the potential hydrologic impacts and development of BMPs to ensure that the proposed plantation is appropriate.

4. Cultural Resources

Cultural resources potentially affected by the proposed action or no action alternative would include archeological deposits, historic buildings, and visual aesthetics. Potential changes in land use from pine plantations or agriculture to hardwood plantations of FTE could impact these resources within the potential planting range.

a) No Action

Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. Non-GE FTE lines would continue to be introduced in portions of the planting range, primarily on existing plantations, and possibly on land converted from other agricultural purposes. Some land currently being used for non-plantation or non-agricultural purposes may be converted to plantations to support the non-GE FTE lines, however such land use changes would likely occur on a localized basis and therefore would only have impacts on local cultural resources. Conversion from existing pine plantations or agricultural fields to non-GE FTE *Eucalyptus* plantations could result in adverse impacts to adjacent cultural resources as a result of a change in the historic viewshed. These impacts would be localized and would be expected to be minor.

The transition from agricultural to forest plantation land uses, or from other tree species to non-GE FTE *Eucalyptus*, on existing plantations would result in a change in the root structure that could possibly impact undiscovered cultural resources. The *Eucalyptus* root system is substantially different from typical agricultural root systems, including pines that are the primary type of tree grown on most plantations through the planting range. For example, long leaf pine roots have an average lateral extent that reaches 35 feet from the trunk. Some pine roots may extend as much as 75 feet from the trunk. The tap root in pines begins nearly as large in diameter as the trunk and gradually decreases in size to a depth of approximately 10 to 15 feet (The Long Leaf Alliance, 2010). In contrast, the *Eucalyptus* requires a substantial root system to support its rapid growth, size, and water needs. While the *Eucalyptus* taproot typically extends to a depth of about 6 feet, the lateral distribution of the roots outward from the trunk may extend as much as 100 feet (Santos, 1997). It is possible that undiscovered or previously undisturbed cultural resources could be impacted by the broader root system and faster growth of the *Eucalyptus*. However these impacts would be localized.

Existing cultural resources throughout the planting range would generally remain in place barring disturbances from projects resulting from ongoing economic growth and change. Impacts on cultural resources as a result of commercial or residential growth or development would continue to be evaluated on a case by case basis in compliance with existing Federal and state cultural resources protection guidelines including the National Historic and Preservation Act (NHPA) of 1966 as amended.

b) Proposed Action

Under the Proposed Action, the GE FTE species would be available for commercial introduction.

GE FTE lines would be introduced throughout the planting range, primarily on existing plantations, and possibly on land converted from other agricultural purposes. Some land currently being used for non-plantation or non-agricultural purposes may be converted to plantations to support the new GE FTE lines. However such land use changes would likely occur on a localized basis and, therefore, would have limited impacts on cultural resources. Conversion from existing pine plantations or agricultural fields to GE FTE *Eucalyptus* plantations could result in adverse impacts to adjacent cultural resources as a result of a change in the historic viewshed. These impacts would be localized and would be expected to be minor.

Introduction of the GE FTE lines in place of non-GE FTE species would not result in a change in root structure. The growth characteristics associated the GE FTE lines are expected to be the same or similar to those of the non-GE FTE species. Therefore, the introduction of GE FTE would not be expected to have any greater impact on cultural resources than the planting of non-GE FTE tree species.

c) Cumulative Impacts

Because the proposed project would not be anticipated to result in significant adverse impacts to cultural resources in the planting range, it would also not contribute to adverse cumulative impacts. Impacts to cultural resources as a result of ongoing commercial or residential growth or development would continue to be evaluated on a case by case basis in compliance with existing Federal and state cultural resources protection guidelines including the NHPA.

5. Public Health and Safety

a) Fire

Land use type can have implications for fire safety and management. Forested areas have different fire regimes than urban and agricultural areas. There are Federal, state and county programs to address fire safety and control the spread of wildfires. These regulations will be appropriately enforced across the study area. Therefore, changes in land use type were not addressed in this section. This analysis focuses on the potential impacts to fire safety and frequency associated with changes in the species grown on existing plantations.

(1) No Action

For the purposed of this analysis, the current condition assumes that foresters growing trees for paper production are going to grow increasingly more eucalypts in the future due to their high growth rate, thus providing more product in a shorter time span. This will change the species composition on the plantations, but not the aerial extent or placement of the existing plantations.

Although it is universally thought that *Eucalyptus* is highly flammable due to its essential oil content, there is little scientific literature which supports this conclusion. Most of the scientific studies done comparing the flammability of eucalypts and other species result in the conclusion that eucalypts are not inherently more flammable (Proupin-Castineiras et al., 2002). Indeed, other plantation species are often equally or more flammable, including *Cupressus*, *Juniperus* and *Pinus* (Davidson, 1995). Flammability is more related to the amount of litter available, the type of litter and climatic conditions (Proupin-Castineiras et al., 2002; Scarff and Westoby, 2006). Climatic conditions conducive to fire include warm temperatures, dry conditions and high winds, regardless of tree species (Proupin-Castineiras et al., 2002). Litter types that are more flammable have larger particles which allow more air through the litter as it burns (Scarff and Westoby, 2006). Eucalypt plantations are often susceptible to fire because of the pre-existing plants on site – usually grasses, which are highly flammable (Davidson, 1995). Studies conducted in Brazil, comparing fuel loading of eucalypt and pine plantations revealed that loading is only slightly higher in eucalypt plantations (Soares et al., 2002).

Comparative flammability of eucalypts is more likely related to the life histories of certain species. Those with deciduous bark will be more at risk as the bark litter is deposited annually and builds up as fuel within the stand. Many areas in California are currently reducing fire hazards by removing or thinning *Eucalyptus* stands, removing litter and cutting back stands that are close to roads. Methods include mechanical removal of trees, removal of lower limbs, litter hauling and prescribed burning (National Park Service, 2006). *Eucalyptus grandis* bark is deciduous (Meskimen and Francis, 1990). A shift from pine plantations to eucalypt plantations is not likely to increase flammability, as long as existing BMPs are followed.

(2) Proposed Action

For the purposes of this analysis, potential impacts relative to the baseline condition of the no action alternative would occur if using GE FTE instead of non-GE FTE resulted in a change to existing fire risks. The genetic alterations of the GE FTE lines are unlikely to affect the flammability of the trees themselves. Given the similarity of the GE FTE trees to the non-GE FTE trees with respect to fire, there would be no increased risk of fire.

The large *Eucalyptus* fires in northern California's East Bay were all preceded by a freeze, during which the trees dropped large amounts of dead foliage and bark. The freezes played a major part in producing the fuel for the massive fires. Without the freeze, or with appropriate litter removal after the freeze, the fires may have not been as destructive (Santos, 1997). It is possible that GE FTE trees would experience less foliage death in the event of a freeze, thereby reducing the available fuel load. As previously discussed in Section C.2.5, Plant Pest and Diseases, since both GE and non-GE FTE will be grown in commercial plantations, management practices are expected to reduce or eliminate any build up of fuel in the event of an extreme winter. The genetically altered trees could, therefore, reduce fire risk on the plantations by reducing the amount of dead and dry material in the stands.

(3) Cumulative Impacts

Because the proposed project would not result in any modification to the existing fire regime and management practices, it would also not contribute to adverse cumulative impacts. Although the intensity and types of fire management may change over time, this evolution would occur within the framework of Federal and state regulation. The implementation of the GE FTE lines would not contribute to any cumulative impacts associated with fire safety.

b) Hazardous materials and waste management

Potential impacts related to the use of hazardous materials and the generation of waste products from commercial forestry operations associated with the proposed project could occur if the GE FTE species were to result in a larger volume of waste materials that would impact waste disposal capacity in the region, a greater risk of releases of hazardous materials, or a greater volume of wood waste materials that can be managed in the region.

(1) No Action

Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. The existing hazardous materials used and wood waste produced in the geographic area would not remain static, but would continue to evolve in response to other factors affecting the wood products industry, including evolving regulations regarding the management and disposal of materials, as well as changes to the market for beneficial re-use of the materials. Although the No Action Alternative would likely include a gradual transition from pine to non-GE FTE species, there would be no difference in the use of hazardous materials or in the production of wood waste associated with the non-GE FTE. Forestry operations would still be conducted in accordance with the regulations and forestry Best Management Practices manual from each state. In general, the trend associated with wood waste is an increase in the use of the waste for bioenergy purposes. Therefore, it is likely that disposal requirements for wood waste will continue to decrease in the region.

(2) Proposed Action

Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve any change in the use of hazardous materials or the generation of wood wastes. Therefore, the proposed action would not have an impact from the use of hazardous materials or the generation of wood wastes.

(3) Cumulative Impacts

Because the proposed project would not result in any adverse impacts associated with hazardous materials or wood wastes, it would also not contribute to adverse cumulative impacts associated with these materials.

c) Noise

Noise is generally defined as unwanted sound. Changes in the amount of noise in the study area would be extremely localized and only perceptible near to the plantations themselves. This analysis focuses on potential impacts to noise levels in the immediate area.

(1) No Action

Under the no action alternative, increasing amounts of land will be dedicated to short rotation eucalypt harvest. Depending on the location of the plantation, and the type of land use it is converted from, minor impacts to the general noise levels in the area are possible. For example, the installation of a eucalypt forest on an abandoned field would produce temporary noise increases during planting and also during harvest. Conversion from an existing pine plantation to a eucalypt forest would have very minor and temporary increases in noise, mainly due to the shortened crop rotation. The forest would be harvested more often; therefore the incidence of noise would increase, but not the noise levels. With appropriate personal protective equipment (PPE) and noise management, workers will not be exposed to damaging noise levels (Neitzel and Yost, 2004). The noise levels experienced by workers would not be experienced by people further away. Noise attenuates rapidly and the topography and tree cover should further reduce noise levels in the area.

(2) Proposed Action

Impacts to existing noise levels under the proposed action would be similar to those under the no action alternative.

(3) Cumulative Impacts

Because the proposed project is unlikely to result in any major modification to existing noise levels in the region, it would also not contribute to adverse cumulative impacts to noise. Throughout the region, plantation management practices will continue to be modified to balance demand, growth and sustainability. Individual state and county regulations would be adhered to independently by private plantation management.

d) Air Quality

Potential air quality impacts associated with the proposed project could occur only if the GE FTE species were to create an increase in emissions of criteria pollutants through one the following processes:

- An increase in heavy equipment and/or transportation-related emissions associated with the forestry practices required for the GE FTE species;
- A change in the frequency or intensity of natural or accidental fires;
- A change in the frequency or intensity of controlled burning required as part of the forestry management practices; or
- Direct emissions from the trees.

Climate Change
Potential climate change impacts associated with the proposed project could occur only if the GE FTE species were to create an increase in GHG emissions through one the following processes:

- An increase in heavy equipment and/or transportation-related GHG emissions associated with the forestry practices required for the GE FTE species; or
- Substantial increase or decrease in direct GHG absorption or emissions from the trees.

(1) No Action

Air Quality
Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. The existing air quality conditions in potential silvicultural areas would not remain static, but would continue to evolve in response to other human activities including urbanization, industrial development, agriculture, and forestry. Overall, the general trend in air quality in the region is improving due to the implementation of the Clean Air Act of 1990 and other state and Federal regulatory actions designed to reduce emissions and respond to designation of non-attainment areas.

The factors contributing to the evolution in air quality conditions would likely include an increase in the use of non-GE FTE species in the region. The air emissions associated with the increase in the use of these non-GE FTE species and their associated forestry management practices are not expected to be different from emissions associated with current forestry species and practices. The increase in the use of non-GE FTE species would likely result in an decrease in the overall acreage under plantation as compared to current forestry practices. Heavy equipment used for harvesting would be used more frequently within any given area, but because the total area would be reduced, there would no net increase in air emissions associated with harvesting. In contrast, overall emissions may decrease in some areas because the higher biomass growth rate of the *Eucalyptus* is expected to allow an increase in production of wood products in locations closer to their end-use location. Therefore, the introduction of non-GE FTE species is expected to reduce transport requirements, and their associated air emissions. Jawjit et al. (2006) studied the impact of *Eucalyptus* forestry practices on air quality in Thailand, and concluded that the contribution of the practices to air quality impacts was minimal. The study did determine that fertilizer use associated with the forestry practices contributed a small amount to overall nitrous oxide (N_2O) and phosphate (PO_4^{-3}) emissions (Jawjit et al., 2006). However, replacement of current pine plantations with non-GE FTE species in the southeastern U.S. is not expected to result in a change in fertilizer use, and therefore would not affect air emissions.

It is known that the metabolic process of all vegetation, including trees, results in the generation of emissions of volatile organic compounds (VOCs). VOCs are a criteria pollutant regulated by the USEPA for industrial emissions sources, and they react with nitrous oxides to produce ozone, another criteria pollutant. *Eucalyptus* is considered to be a variety that has relatively high VOC emissions (Cutler, 2007). Varshney (2007) measured the emission of VOCs from 51 plant species, including 9 tree species. Of the tree species, the *Eucalyptus* was found to have the highest average hourly emissions of VOCs (Varshney, 2007). VOC emissions, specifically isoprene emissions from deciduous trees, have been demonstrated in generate increased ground-level ozone concentrations in urban areas (Cutler 2007). However, this effect is only expected to occur in urban areas which have human-generated nitrogen oxides available to react with the VOCs (Cutler, 2007). In general, air quality concerns related to VOC emissions from trees are raised with respect to urban forestry projects, but are not expected to create adverse impacts in the rural areas which would be associated with the potential planting range.

Climate Change

Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. The existing GHG emissions in potential silvicultural areas would not remain static, but would continue to evolve in response to other human activities including urbanization, industrial development, agriculture, and forestry. In addition to human-generated GHG emissions to the atmosphere associated with these practices, GHG absorption due to growth of biomass in trees would also continue to occur. Overall, the general trend in GHG emissions in the planting range is likely to continue to increase, despite Federal and state policies developed to reduce the emissions.

The factors contributing to the evolution in GHG emissions would likely include an increase in the use of non-GE FTE species in the region. The GHG emissions associated with the increase in the use of these non-GE FTE species and their associated forestry management practices are not expected to be substantially different from emissions associated with current forestry species and practices. The increase in the use of non-GE FTE species is not expected to result in any net increase in the use of heavy equipment, as compared to current forestry practices. Overall GHG emissions may decrease because the higher biomass growth rate of the *Eucalyptus* is expected to allow an increase in production of wood products in locations closer to their end-use location, thereby reducing transport requirements and their associated GHG emissions. Also, because the non-GE FTE species have a higher biomass growth rate as compared to current species, it is likely that overall GHG absorption from the atmosphere would increase. This increased absorption is expected to be very small compared to overall human-generated GHG emissions in the region. Therefore, these changes in GHG emissions would not create any measurable adverse or beneficial impact to climate change.

(2) Proposed Action

Air Quality

Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve any change in air emissions associated with either the forestry management practices, or the trees themselves. The project would not require a different type or increase in the use of equipment that emits criteria pollutants. The GE FTE lines would not increase the frequency or intensity of fires, including controlled burning conducted by the company managing the area. The GE FTE lines would not have higher emissions of any criteria pollutants, such as VOCs, than non-GE FTE species. Therefore, the proposed project will not have any adverse impact on air quality.

Climate Change

Introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) would not involve any change in GHG emissions associated with either the forestry management practices, or the trees themselves. The project would not require a different type or increase in the use of equipment that emits GHGs. The GE FTE lines would not increase the frequency or intensity of fires, including controlled burning conducted by the company managing the area. The GHG absorption rate of the GE FTE lines is expected to be substantially the same as the non-GE FTE, and will therefore have the same slight beneficial impact as discussed for the No Action Alternative. Therefore, the proposed project will not have any beneficial or adverse impact on climate change.

(3) Cumulative Impacts

Air Quality

Because the proposed project would not result in any increase in air emissions, it would also not contribute to adverse cumulative impacts associated with air emissions. Several human-caused factors, including urbanization, industrial development, and agricultural practices have created adverse, cumulative air quality impacts in several parts of the region, as discussed in Section B.v.4. However, the proposed project would not contribute emissions that could result in increasing the magnitude of these impacts, or could result in the designation of additional areas as non-attainment.

Climate Change

Because the proposed project would not result in any significant change in GHG emissions, it would also not contribute to adverse cumulative impacts associated with climate change. Human-generated GHG emissions are still expected to have impacts to global temperature and precipitation patterns, as discussed in the GCRP report (Karl et al., 2009) and summarized in Section B.v.4. However, the proposed project would not contribute GHG emissions or absorption that could result in increasing or decreasing the magnitude of these impacts.

6. Socioeconomics

Potential impacts to socioeconomics within the potential planting range for GE FTE would include changes in employment levels, income, taxes, and demographics. For example, an increase in employment in forestry services could cause an increase in the number of people living in areas close to tree plantations. This analysis focuses on the socioeconomic impacts associated with the potential conversion of pine plantations to hardwood plantations growing non-GE FTE or GE FTE within the potential planting range extending across the southern tier of states.

a) No Action

Under the No Action Alternative, the GE FTE lines would not be available for commercial introduction. The existing socioeconomic conditions in the potential planting range would not remain static, but would continue to evolve in response to the general trend of slow population growth. This growth will result in corresponding changes in urbanization, industrial development, agriculture, and forestry.

Under the no action alternative, there is anticipated to be an increase in the use of non-GE FTE species in the region. The majority of non-GE FTE lines would be planted on existing pine plantations and this conversion would not be expected to cause changes in population, demographics, or housing. It could have beneficial effects on income and employment, however, through minor increases in local job opportunities or through economic growth for those companies involved in the planting, harvesting, and processing of the plantation trees.

While it is possible that under the no action alternative some land owners may choose to convert land currently used for other purposes to tree plantation uses, this is considered highly unlikely and would not be expected to affect a significant number of acres within the potential planting range. Such potential land use conversions could affect income or the economy on a local scale. These impacts would likely be minor and limited in scope, and they would not be expected to affect population levels, demographics, or housing.

b) Proposed Action

Introduction of the GE FTE lines in place of non-GE FTE species would not be expected to impact population levels, demographics, or housing in the potential planting range. The majority of GE FTE lines would be planted on existing plantations currently growing pines or non-GE FTE species. This conversion could have beneficial impacts on income and employment through minor increases in local job opportunities or through economic growth for those companies involved in the planting, harvesting, and processing of the plantation trees.

It is possible that the opportunity to plant GE FTE lines may result in some land owners choosing to convert agricultural land, or land currently used for other purposes, into plantation land. However, this is considered highly unlikely given land use pressures from population growth and development as well as existing protections for wetlands, habitats, and other environmental resources. If these land use conversions were to occur, there would be impacts on income and employment on a local scale. These impacts would likely be minor and limited in scope. Such conversions would not be expected to affect population growth, demographics, or housing. In summary, the proposed action would be expected to have a minor beneficial impact on local income and employment in the potential planting range.

Implementation of the proposed action would be expected to have beneficial impacts for the pulp and paper industry. Use of GE FTE lines would allow the planting of the fast growing and freeze resistant

Eucalyptus throughout the planting range. As described in Section I.A of the petition, use of the GE FTE lines at pulp and paper plantations would allow for the replacement of slower growing species and, therefore, reduce the plantation rotation times. This would result in higher yields and increased industry income and profits. Additionally, as described in Section I.B, *Eucalyptus* is a preferred fiber source for the pulp and paper industry because of its bulk, opacity, formation, softness, porosity, smoothness, absorbency, and dimensional stability (Foelkel, 2007). Therefore, commercial planting of GE FTE across the proposed planting range would result in additional benefits to the pulp and paper industry through increased demand and increased product quality.

If the bioenergy industry continues to develop its use of woody materials as bioenergy feedstocks and sources of cellulosic ethanol and continues to expand in the southern U.S., as discussed in Section IX.B of the petition, beneficial socioeconomic impacts could occur in the potential planting range as a result of the proposed action. The bioenergy industry may potentially utilize the fast-growing GE FTE lines, which would result in increased income and employment opportunities within the planting range.

c) Cumulative Impacts

Because the proposed project would be expected to have a minor beneficial impact on socioeconomic resources in the potential planting range, it would not contribute to adverse cumulative impacts. Gradual population growth in this geographic area would be expected to continue, and corresponding growth in the local economy, housing market, and job opportunities would be anticipated. The beneficial impacts of the proposed project on local income and employment would contribute to potential cumulative impacts from ongoing growth in the economy of the potential planting range. In response to the introduction of the faster crop rotation, the level of demand, and the price of production relative to other tree species, potential impacts would be anticipated to be beneficial and complementary to other cumulative growth areas, especially in the pulp and paper and bioenergy industries.

7. Environmental Justice

Environmental justice must be considered for Federal actions under the NEPA process. EO 12898 (59 Federal Register 7629) directs Federal agencies to identify and address, as appropriate, potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations.

The CEQ provides the following information in *Environmental Justice: Guidance Under the National Environmental Policy Act* (CEQ, 1997):

- Disproportionately High and Adverse Human Health Effects**.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as defined by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group (CEQ, 1997).

- Disproportionately High and Adverse Environmental Effects. A disproportionately high environmental impact that is significant (as defined by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as defined by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered (CEQ, 1997).

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from introduction of the GE FTE lines in place of other tree species (including non-GE FTE species) within the proposed potential planting range. An adverse effect is considered disproportionate when it is predominantly experienced by a minority or low-income segment of the population; that is, where it is more severe for that segment than for other population segments.

This analysis addresses environmental justice matters through (1) identification of minority and low-income populations that may be affected by the proposed action and (2) examining any potential human health or environmental effects on these populations to determine if these effects may be disproportionately high and adverse. In identifying the potentially affected populations, the CEQ (CEQ, 1997) definitions of minority individuals and populations and low-income population were used, as presented in Section 1.7.5, Environmental Justice Populations. The environmental justice analysis focuses on residents living within the areas where there could most likely be potentially adverse environmental impacts. For the purposes of this ER, the areas within the potential planting range where GE FTE lines may be planted were identified as the potentially impacted areas.

In examining potential human health or environmental effects on those populations, results of the analysis of impacts for all resource categories presented in this ER were used.

As discussed in Section B.6.5, the overall population of the 172-county planting range is 38.5% minority, including individuals self-identified as minority races or of Hispanic or Latino ethnicity. To determine the presence of environmental justice communities of concern with respect to demographics, the minority population of the individual counties was compared to the minority population of the planting range ROI. Counties with a percent minority population greater than the ROI average were considered to be environmental justice communities of concern. Within the planting range, 46 counties (26.7% of the planting range) were determined to have minority population percentages greater than the ROI average. Therefore, these counties would constitute environmental justice communities of concern. Figure H depicts the areal distribution of the 46 counties with minority populations greater than the ROI average. The majority of these counties are clustered near major population centers and along the Mississippi River. In general, these elevated-minority counties tend to occur in clusters, not as isolated occurrences.

To determine the presence of environmental justice communities of concern with respect to income, the percentage of individuals living below the poverty level in individual counties was compared to the ROI average. Counties with a percentage of individuals living below the poverty threshold that exceeded the ROI average percentage were considered to be environmental justice communities of concern. Within the planting range, 109 counties (63% of the planting range) constitute environmental justice communities of concern with respect to low-income populations. Figure I depicts the areal distribution of the 109 counties in which the percentage of individuals living below the poverty level is greater than the ROI percentage. A majority of the counties that constitute environmental justice communities of concern with respect to income are rural in nature.

Based on the impact analysis results, it was determined that there would be no significant adverse human health impacts on residents in the study area. There are no anticipated public health impacts associated with the introduction of GE FTE species with respect to herbicides/pesticides, prescribed burns, fire risk, agriculture, hazardous materials or waste generation, noise, air quality, or climate change. Therefore, there would be no disproportionate and adverse impacts felt by environmental justice communities of concern with respect to public health concerns. Similarly, given the lack of potential significant environmental effects on the physical environment (land, water, biological resources, air, noise) and the built environment (land use, infrastructure, transportation), there would be no disproportionately high and adverse impacts on environmental justice communities of concern because of negative environmental effects. The results of the environmental justice analysis of socioeconomic impacts are discussed below.

a) No Action

Under the No Action Alternative, the GE FTE species would not be available for commercial introduction. There is anticipated to be an increase in the use of non-GE FTE species in the region, however, which could have beneficial impacts on income and employment through minor increases in local job opportunities or through economic growth for those companies involved in the planting, harvesting, and processing of the plantation trees. With regard to environmental justice, these impacts are expected to be localized and could have the potential of being beneficial if they result in additional jobs or improvements in the local economy.

b) Proposed Action

Under the proposed action, the GE FTE lines would be introduced in place of other tree species (including non-GE FTE species). As mentioned above, the majority of the 46 counties with minority populations greater than the ROI average are clustered near major population centers and along the Mississippi River. The minority populations located within the more urban and suburban population centers would not likely be impacted by the increasing use of GE FTE lines. There are likely few plantations located within these areas, and it is unlikely that current land uses in these highly populated areas would be changed from urban/suburban to plantation uses as a result of introduction of GE FTE lines. It is possible that small numbers of GE FTE lines may be introduced in major population centers as ornamental trees; however, these would not be anticipated to cause impacts with respect to environmental justice communities.

With 63% of the counties in the planting range having elevated low-income populations, there could be impacts to environmental justice communities as a result of implementation of the proposed action. As mentioned above, the majority of the counties that constitute environmental justice communities of concern with respect to income are rural in nature. Therefore, introduction of the GE FTE lines in these areas could have the potential of disproportionately impacting those communities. As discussed above, introduction of GE FTE lines in the rural areas could have impacts on income and the economy, as well as land use. With regard to environmental justice, these impacts are expected to be localized and could have the potential of being beneficial if they result in additional jobs or improvements in the local economy.

It is possible that with the growth of the bioenergy industry, GE FTE may become a desirable commodity and may replace other agricultural crops that would otherwise have served this process. This could result in potential impacts to agriculture, but as these crops are used for energy purposes, it would not constitute an adverse impact with respect to environmental justice communities of concern. In fact, if such a change were to result in additional bioenergy activities in environmental justice communities of concern, it could constitute a localized beneficial impact.

c) Cumulative Impacts

Because the proposed project would be expected to have a minor beneficial impact on environmental justice communities within the planting range, it would not contribute to adverse cumulative impacts. It is likely that the demographic distributions of minority and ethnic groups will continue to change in the planting range states as it changes throughout the U.S. Gradual population growth in the geographic area would be expected to continue and corresponding growth in the local economy, housing market, and job opportunities would be anticipated. The beneficial impacts of the proposed project on local income and employment, which would potentially benefit environmental justice communities, would contribute to potential cumulative impacts from ongoing growth in the economy of the planting range. Therefore, there would be no cumulative adverse impacts on environmental justice communities of concern under the proposed actions and no disproportionately high and adverse impacts to minority or low-income populations would be expected.

Figure H. Counties in the planting range with a minority population greater than the planting range ROI which constitute environmental justice communities of concern

Figure I. Counties in the Planting Range with a Percentage of Individuals Living Below the Poverty Level Greater than the Planting Range ROI, which Constitute Environmental Justice Communities of Concern

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Attachment A
Socioeconomic Data

Appendix F: Attachment A for the Environmental Report

Attachment A-1 Potential Planting Range County Population Sorted by State

Geographic Area	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Baldwin County, Alabama	140,415	179,878	28.1	3.1
Houston County, Alabama	88,787	100,085	12.7	1.4
Mobile County, Alabama	399,843	411,721	3.0	0.3
Alabama Planting Range Total	*629,045*	*691,684*	*10.0*	*1.1*
State of Alabama	**4,447,100**	**4,708,708**	**5.9**	**0.7**
Alachua County, Florida	217,955	243,574	11.8	1.3
Baker County, Florida	22,259	26,336	18.3	2.0
Bay County, Florida	148,217	164,767	11.2	1.2
Bradford County, Florida	26,088	29,235	12.1	1.3
Calhoun County, Florida	13,017	13,821	6.2	0.7
Clay County, Florida	140,814	186,756	32.6	3.6
Columbia County, Florida	56,513	69,264	22.6	2.5
Dixie County, Florida	13,827	14,824	7.2	0.8
Duval County, Florida	778,879	857,040	10.0	1.1
Escambia County, Florida	294,410	303,343	3.0	0.3
Flagler County, Florida	49,832	91,622	83.9	9.3
Franklin County, Florida	11,057	11,280	2.0	0.2
Gadsden County, Florida	45,087	47,474	5.3	0.6
Gilchrist County, Florida	14,437	17,116	18.6	2.1
Gulf County, Florida	13,332	15,755	18.2	2.0
Hamilton County, Florida	13,327	14,592	9.5	1.1
Holmes County, Florida	18,564	19,099	2.9	0.3
Jackson County, Florida	46,755	50,930	8.9	1.0
Jefferson County, Florida	12,902	14,010	8.6	1.0
Lafayette County, Florida	7,022	7,949	13.2	1.5
Leon County, Florida	239,452	265,714	11.0	1.2
Levy County, Florida	34,450	39,147	13.6	1.5
Liberty County, Florida	7,021	7,983	13.7	1.5
Madison County, Florida	18,733	18,901	0.9	0.1
Marion County, Florida	258,916	328,547	26.9	3.0
Nassau County, Florida	57,663	70,576	22.4	2.5
Okaloosa County, Florida	170,498	178,473	4.7	0.5
Putnam County, Florida	70,423	72,893	3.5	0.4
St. Johns County, Florida	123,135	187,436	52.2	5.8
Santa Rosa County, Florida	117,743	151,759	28.9	3.2
Suwannee County, Florida	34,844	40,149	15.2	1.7
Taylor County, Florida	19,256	21,400	11.1	1.2
Union County, Florida	13,442	14,584	8.5	0.9
Wakulla County, Florida	22,863	32,815	43.5	4.8
Walton County, Florida	40,601	55,105	35.7	4.0
Washington County, Florida	20,973	23,916	14.0	1.6
Florida Planting Range Total	*3,194,307*	*3,708,185*	*16.1*	*1.8*
State of Florida	**15,982,378**	**18,537,969**	**16.0**	**1.8**

Attachment A-1 Potential Planting Range County Population Sorted by State

Geographic Area	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Atkinson County, Georgia	7,609	8,230	8.2	0.9
Bacon County, Georgia	10,103	10,601	4.9	0.5
Baker County, Georgia	4,074	3,637	-10.7	-1.2
Berrien County, Georgia	16,235	17,044	5.0	0.6
Brantley County, Georgia	14,629	15,643	6.9	0.8
Brooks County, Georgia	16,450	16,354	-0.6	-0.1
Bryan County, Georgia	23,417	32,559	39.0	4.3
Camden County, Georgia	43,664	48,277	10.6	1.2
Charlton County, Georgia	10,282	10,725	4.3	0.5
Chatham County, Georgia	232,048	256,992	10.7	1.2
Clinch County, Georgia	6,878	6,988	1.6	0.2
Coffee County, Georgia	37,413	40,868	9.2	1.0
Colquitt County, Georgia	42,053	45,596	8.4	0.9
Cook County, Georgia	15,771	16,603	5.3	0.6
Decatur County, Georgia	28,240	28,838	2.1	0.2
Early County, Georgia	12,354	11,568	-6.4	-0.7
Echols County, Georgia	3,754	4,213	12.2	1.4
Effingham County, Georgia	37,535	53,541	42.6	4.7
Glynn County, Georgia	67,568	76,820	13.7	1.5
Grady County, Georgia	23,659	25,187	6.5	0.7
Lanier County, Georgia	7,241	8,423	16.3	1.8
Liberty County, Georgia	61,610	62,186	0.9	0.1
Long County, Georgia	10,304	12,234	18.7	2.1
Lowndes County, Georgia	92,115	106,814	16.0	1.8
McIntosh County, Georgia	10,847	11,378	4.9	0.5
Miller County, Georgia	6,383	6,228	-2.4	-0.3
Mitchell County, Georgia	23,932	23,800	-0.6	-0.1
Pierce County, Georgia	15,636	18,580	18.8	2.1
Seminole County, Georgia	9,369	9,094	-2.9	-0.3
Thomas County, Georgia	42,737	46,188	8.1	0.9
Ware County, Georgia	35,483	35,914	1.2	0.1
Wayne County, Georgia	26,565	29,407	10.7	1.2
Georgia Planting Range Total	*995,958*	*1,100,530*	*10.5*	*1.2*
State of Georgia	**8,186,453**	**9,829,211**	**20.1**	**2.2**
Acadia Parish, Louisiana	58,861	60,095	2.1	0.2
Allen Parish, Louisiana	25,440	25,636	0.8	0.1
Ascension Parish, Louisiana	76,627	104,822	36.8	4.1
Assumption Parish, Louisiana	23,388	22,874	-2.2	-0.2
Avoyelles Parish, Louisiana	41,481	42,511	2.5	0.3
Beauregard Parish, Louisiana	32,986	35,419	7.4	0.8
Calcasieu Parish, Louisiana	183,577	187,554	2.2	0.2
Cameron Parish, Louisiana	9,991	6,584	-34.1	-3.8
Catahoula Parish, Louisiana	10,920	10,460	-4.2	-0.5
Concordia Parish, Louisiana	20,247	18,989	-6.2	-0.7
East Baton Rouge Parish, Louisiana	412,852	434,633	5.3	0.6
East Feliciana Parish, Louisiana	21,360	20,970	-1.8	-0.2

Attachment A-1 Potential Planting Range County Population Sorted by State

Geographic Area	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Evangeline Parish, Louisiana	35,434	35,330	-0.3	0.0
Grant Parish, Louisiana	18,698	20,164	7.8	0.9
Iberia Parish, Louisiana	73,266	75,101	2.5	0.3
Iberville Parish, Louisiana	33,320	32,505	-2.4	-0.3
Jefferson Parish, Louisiana	455,466	443,342	-2.7	-0.3
Jefferson Davis Parish, Louisiana	31,435	31,097	-1.1	-0.1
Lafayette Parish, Louisiana	190,503	210,954	10.7	1.2
Lafourche Parish, Louisiana	89,974	93,682	4.1	0.5
La Salle Parish, Louisiana	14,282	13,964	-2.2	-0.2
Livingston Parish, Louisiana	91,814	123,326	34.3	3.8
Natchitoches Parish, Louisiana	39,080	39,255	0.4	0.0
Orleans Parish, Louisiana	484,674	354,850	-26.8	-3.0
Plaquemines Parish, Louisiana	26,757	20,942	-21.7	-2.4
Pointe Coupee Parish, Louisiana	22,763	22,447	-1.4	-0.2
Rapides Parish, Louisiana	126,337	133,937	6.0	0.7
St. Bernard Parish, Louisiana	67,229	40,655	-39.5	-4.4
St. Charles Parish, Louisiana	48,072	51,611	7.4	0.8
St. Helena Parish, Louisiana	10,525	10,551	0.2	0.0
St. James Parish, Louisiana	21,216	21,054	-0.8	-0.1
St. John the Baptist Parish, Louisiana	43,044	47,086	9.4	1.0
St. Landry Parish, Louisiana	87,700	92,326	5.3	0.6
St. Martin Parish, Louisiana	48,583	52,217	7.5	0.8
St. Mary Parish, Louisiana	53,500	50,815	-5.0	-0.6
St. Tammany Parish, Louisiana	191,268	231,495	21.0	2.3
Tangipahoa Parish, Louisiana	100,588	118,688	18.0	2.0
Tensas Parish, Louisiana	6,618	5,609	-15.2	-1.7
Terrebonne Parish, Louisiana	104,503	109,291	4.6	0.5
Vermilion Parish, Louisiana	53,807	56,141	4.3	0.5
Vernon Parish, Louisiana	52,531	46,616	-11.3	-1.3
Washington Parish, Louisiana	43,926	45,669	4.0	0.4
West Baton Rouge Parish, Louisiana	21,601	22,638	4.8	0.5
Louisiana Planting Range Total	*3,606,244*	*3,623,905*	*0.5*	*0.1*
State of Louisiana	**4,468,976**	**4,492,076**	**0.5**	**0.1**
Adams County, Mississippi	34,340	30,722	-10.5	-1.2
Claiborne County, Mississippi	11,831	10,755	-9.1	-1.0
George County, Mississippi	19,144	22,681	18.5	2.1
Hancock County, Mississippi	42,967	40,962	-4.7	-0.5
Harrison County, Mississippi	189,601	181,191	-4.4	-0.5
Jackson County, Mississippi	131,420	132,922	1.1	0.1
Jefferson County, Mississippi	9,740	8,928	-8.3	-0.9
Lamar County, Mississippi	39,070	49,980	27.9	3.1
Marion County, Mississippi	25,595	25,732	0.5	0.1
Pearl River County, Mississippi	48,621	57,860	19.0	2.1
Perry County, Mississippi	12,138	12,035	-0.8	-0.1
Stone County, Mississippi	13,622	16,619	22.0	2.4

Attachment A-1 Potential Planting Range County Population Sorted by State

Geographic Area	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Wilkinson County, Mississippi	10,312	10,143	-1.6	-0.2
Mississippi Planting Range Total	588,401	600,530	2.1	0.2
State of Mississippi	**2,844,658**	**2,951,996**	**3.8**	**0.4**
Beaufort County, South Carolina	120,937	155,215	28.3	3.1
Berkeley County, South Carolina	142,651	173,498	21.6	2.4
Charleston County, South Carolina	309,969	355,276	14.6	1.6
Colleton County, South Carolina	38,264	39,246	2.6	0.3
Dorchester County, South Carolina	96,413	130,417	35.3	3.9
Georgetown County, South Carolina	55,797	60,703	8.8	1.0
Hampton County, South Carolina	21,386	21,014	-1.7	-0.2
Jasper County, South Carolina	20,678	23,221	12.3	1.4
South Carolina Planting Range Total	806,095	958,590	18.9	2.1
State of South Carolina	**4,012,012**	**4,561,242**	**13.7**	**1.5**
Angelina County, Texas	80,130	83,675	4.4	0.5
Austin County, Texas	23,590	27,248	15.5	1.7
Brazoria County, Texas	241,767	309,208	27.9	3.1
Brazos County, Texas	152,415	179,992	18.1	2.0
Burleson County, Texas	16,470	16,570	0.6	0.1
Calhoun County, Texas	20,647	20,573	-0.4	0.0
Chambers County, Texas	26,031	31,431	20.7	2.3
Colorado County, Texas	20,390	20,650	1.3	0.1
Fort Bend County, Texas	354,452	556,870	57.1	6.3
Galveston County, Texas	250,158	286,814	14.7	1.6
Grimes County, Texas	23,552	26,011	10.4	1.2
Hardin County, Texas	48,073	53,424	11.1	1.2
Harris County, Texas	3,400,578	4,070,989	19.7	2.2
Houston County, Texas	23,185	22,363	-3.5	-0.4
Jackson County, Texas	14,391	14,274	-0.8	-0.1
Jasper County, Texas	35,604	34,370	-3.5	-0.4
Jefferson County, Texas	252,051	243,237	-3.5	-0.4
Lavaca County, Texas	19,210	18,539	-3.5	-0.4
Leon County, Texas	15,335	16,923	10.4	1.2
Liberty County, Texas	70,154	75,779	8.0	0.9
Madison County, Texas	12,940	13,333	3.0	0.3
Matagorda County, Texas	37,957	36,978	-2.6	-0.3
Montgomery County, Texas	293,768	447,718	52.4	5.8
Nacogdoches County, Texas	59,203	64,117	8.3	0.9
Newton County, Texas	15,072	13,667	-9.3	-1.0
Orange County, Texas	84,966	81,816	-3.7	-0.4
Polk County, Texas	41,133	46,530	13.1	1.5
Sabine County, Texas	10,469	10,208	-2.5	-0.3
San Augustine County, Texas	8,946	8,574	-4.2	-0.5

Attachment A-1 Potential Planting Range County Population Sorted by State

Geographic Area	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
San Jacinto County, Texas	22,246	24,902	11.9	1.3
Trinity County, Texas	13,779	13,897	0.9	0.1
Tyler County, Texas	20,871	20,556	-1.5	-0.2
Victoria County, Texas	84,088	87,790	4.4	0.5
Walker County, Texas	61,758	64,119	3.8	0.4
Waller County, Texas	32,663	36,530	11.8	1.3
Washington County, Texas	30,373	32,893	8.3	0.9
Wharton County, Texas	41,188	41,000	-0.5	-0.1
Texas Planting Range Total	5,959,603	7,153,568	20.0	2.2
State of Texas	**20,851,820**	**24,782,302**	**18.8**	**2.1**
Source: USCB 2010				

Attachment A-2 Potential Planting Range County Population Sorted by the Year 2000 Census

State	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
State of Texas	20,851,820	24,782,302	18.8	2.1
State of Florida	15,982,378	18,537,969	16.0	1.8
State of Georgia	8,186,453	9,829,211	20.1	2.2
State of Louisiana	4,468,976	4,492,076	0.5	0.1
State of Alabama	4,447,100	4,708,708	5.9	0.7
State of South Carolina	4,012,012	4,561,242	13.7	1.5
State of Mississippi	2,844,658	2,951,996	3.8	0.4
State Planting Range	**April 2000 Census**	**July 2009 Estimate**	**Percent Change 2000 to 2009**	**Annual Average Rate of Change 2000 to 2009**
Texas Planting Range Total	*5,959,603*	*7,153,568*	*20.0*	*2.2*
Louisiana Planting Range Total	*3,606,244*	*3,623,905*	*0.5*	*0.1*
Florida Planting Range Total	*3,194,307*	*3,708,185*	*16.1*	*1.8*
Georgia Planting Range Total	*995,958*	*1,100,530*	*10.5*	*1.2*
South Carolina Planting Range Total	*806,095*	*958,590*	*18.9*	*2.1*
Alabama Planting Range Total	*629,045*	*691,684*	*10.0*	*1.1*
Mississippi Planting Range Total	*588,401*	*600,530*	*2.1*	*0.2*
County	**April 2000 Census**	**July 2009 Estimate**	**Percent Change 2000 to 2009**	**Annual Average Rate of Change 2000 to 2009**
Harris County, Texas	3,400,578	4,070,989	19.7	2.2
Duval County, Florida	778,879	857,040	10.0	1.1
Orleans Parish, Louisiana	484,674	354,850	-26.8	-3.0
Jefferson Parish, Louisiana	455,466	443,342	-2.7	-0.3
East Baton Rouge Parish, Louisiana	412,852	434,633	5.3	0.6

Attachment A-2 Potential Planting Range County Population Sorted by the Year 2000 Census Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Mobile County, Alabama	399,843	411,721	3.0	0.3
Fort Bend County, Texas	354,452	556,870	57.1	6.3
Charleston County, South Carolina	309,969	355,276	14.6	1.6
Escambia County, Florida	294,410	303,343	3.0	0.3
Montgomery County, Texas	293,768	447,718	52.4	5.8
Marion County, Florida	258,916	328,547	26.9	3.0
Jefferson County, Texas	252,051	243,237	-3.5	-0.4
Galveston County, Texas	250,158	286,814	14.7	1.6
Brazoria County, Texas	241,767	309,208	27.9	3.1
Leon County, Florida	239,452	265,714	11.0	1.2
Chatham County, Georgia	232,048	256,992	10.7	1.2
Alachua County, Florida	217,955	243,574	11.8	1.3
St. Tammany Parish, Louisiana	191,268	231,495	21.0	2.3
Lafayette Parish, Louisiana	190,503	210,954	10.7	1.2
Harrison County, Mississippi	189,601	181,191	-4.4	-0.5
Calcasieu Parish, Louisiana	183,577	187,554	2.2	0.2
Okaloosa County, Florida	170,498	178,473	4.7	0.5
Brazos County, Texas	152,415	179,992	18.1	2.0
Bay County, Florida	148,217	164,767	11.2	1.2
Berkeley County, South Carolina	142,651	173,498	21.6	2.4
Clay County, Florida	140,814	186,756	32.6	3.6
Baldwin County, Alabama	140,415	179,878	28.1	3.1
Jackson County, Mississippi	131,420	132,922	1.1	0.1
Rapides Parish, Louisiana	126,337	133,937	6.0	0.7
St. Johns County, Florida	123,135	187,436	52.2	5.8
Beaufort County, South Carolina	120,937	155,215	28.3	3.1
Santa Rosa County, Florida	117,743	151,759	28.9	3.2
Terrebonne Parish, Louisiana	104,503	109,291	4.6	0.5
Tangipahoa Parish, Louisiana	100,588	118,688	18.0	2.0
Dorchester County, South Carolina	96,413	130,417	35.3	3.9
Lowndes County, Georgia	92,115	106,814	16.0	1.8
Livingston Parish, Louisiana	91,814	123,326	34.3	3.8
Lafourche Parish, Louisiana	89,974	93,682	4.1	0.5
Houston County, Alabama	88,787	100,085	12.7	1.4
St. Landry Parish, Louisiana	87,700	92,326	5.3	0.6
Orange County, Texas	84,966	81,816	-3.7	-0.4
Victoria County, Texas	84,088	87,790	4.4	0.5
Angelina County, Texas	80,130	83,675	4.4	0.5
Ascension Parish, Louisiana	76,627	104,822	36.8	4.1
Iberia Parish, Louisiana	73,266	75,101	2.5	0.3
Putnam County, Florida	70,423	72,893	3.5	0.4
Liberty County, Texas	70,154	75,779	8.0	0.9
Glynn County, Georgia	67,568	76,820	13.7	1.5
St. Bernard Parish, Louisiana	67,229	40,655	-39.5	-4.4
Walker County, Texas	61,758	64,119	3.8	0.4
Liberty County, Georgia	61,610	62,186	0.9	0.1

Attachment A-2 Potential Planting Range County Population Sorted by the Year 2000 Census Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Nacogdoches County, Texas	59,203	64,117	8.3	0.9
Acadia Parish, Louisiana	58,861	60,095	2.1	0.2
Nassau County, Florida	57,663	70,576	22.4	2.5
Columbia County, Florida	56,513	69,264	22.6	2.5
Georgetown County, South Carolina	55,797	60,703	8.8	1.0
Vermilion Parish, Louisiana	53,807	56,141	4.3	0.5
St. Mary Parish, Louisiana	53,500	50,815	-5.0	-0.6
Vernon Parish, Louisiana	52,531	46,616	-11.3	-1.3
Flagler County, Florida	49,832	91,622	83.9	9.3
Pearl River County, Mississippi	48,621	57,860	19.0	2.1
St. Martin Parish, Louisiana	48,583	52,217	7.5	0.8
Hardin County, Texas	48,073	53,424	11.1	1.2
St. Charles Parish, Louisiana	48,072	51,611	7.4	0.8
Jackson County, Florida	46,755	50,930	8.9	1.0
Gadsden County, Florida	45,087	47,474	5.3	0.6
Washington Parish, Louisiana	43,926	45,669	4.0	0.4
Camden County, Georgia	43,664	48,277	10.6	1.2
St. John the Baptist Parish, Louisiana	43,044	47,086	9.4	1.0
Hancock County, Mississippi	42,967	40,962	-4.7	-0.5
Thomas County, Georgia	42,737	46,188	8.1	0.9
Colquitt County, Georgia	42,053	45,596	8.4	0.9
Avoyelles Parish, Louisiana	41,481	42,511	2.5	0.3
Wharton County, Texas	41,188	41,000	-0.5	-0.1
Polk County, Texas	41,133	46,530	13.1	1.5
Walton County, Florida	40,601	55,105	35.7	4.0
Natchitoches Parish, Louisiana	39,080	39,255	0.4	0.0
Lamar County, Mississippi	39,070	49,980	27.9	3.1
Colleton County, South Carolina	38,264	39,246	2.6	0.3
Matagorda County, Texas	37,957	36,978	-2.6	-0.3
Effingham County, Georgia	37,535	53,541	42.6	4.7
Coffee County, Georgia	37,413	40,868	9.2	1.0
Jasper County, Texas	35,604	34,370	-3.5	-0.4
Ware County, Georgia	35,483	35,914	1.2	0.1
Evangeline Parish, Louisiana	35,434	35,330	-0.3	0.0
Suwannee County, Florida	34,844	40,149	15.2	1.7
Levy County, Florida	34,450	39,147	13.6	1.5
Adams County, Mississippi	34,340	30,722	-10.5	-1.2
Iberville Parish, Louisiana	33,320	32,505	-2.4	-0.3
Beauregard Parish, Louisiana	32,986	35,419	7.4	0.8
Waller County, Texas	32,663	36,530	11.8	1.3
Jefferson Davis Parish, Louisiana	31,435	31,097	-1.1	-0.1
Washington County, Texas	30,373	32,893	8.3	0.9
Decatur County, Georgia	28,240	28,838	2.1	0.2
Plaquemines Parish, Louisiana	26,757	20,942	-21.7	-2.4
Wayne County, Georgia	26,565	29,407	10.7	1.2
Bradford County, Florida	26,088	29,235	12.1	1.3

Attachment A-2 Potential Planting Range County Population Sorted by the Year 2000 Census Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Chambers County, Texas	26,031	31,431	20.7	2.3
Marion County, Mississippi	25,595	25,732	0.5	0.1
Allen Parish, Louisiana	25,440	25,636	0.8	0.1
Mitchell County, Georgia	23,932	23,800	-0.6	-0.1
Grady County, Georgia	23,659	25,187	6.5	0.7
Austin County, Texas	23,590	27,248	15.5	1.7
Grimes County, Texas	23,552	26,011	10.4	1.2
Bryan County, Georgia	23,417	32,559	39.0	4.3
Assumption Parish, Louisiana	23,388	22,874	-2.2	-0.2
Houston County, Texas	23,185	22,363	-3.5	-0.4
Wakulla County, Florida	22,863	32,815	43.5	4.8
Pointe Coupee Parish, Louisiana	22,763	22,447	-1.4	-0.2
Baker County, Florida	22,259	26,336	18.3	2.0
San Jacinto County, Texas	22,246	24,902	11.9	1.3
West Baton Rouge Parish, Louisiana	21,601	22,638	4.8	0.5
Hampton County, South Carolina	21,386	21,014	-1.7	-0.2
East Feliciana Parish, Louisiana	21,360	20,970	-1.8	-0.2
St. James Parish, Louisiana	21,216	21,054	-0.8	-0.1
Washington County, Florida	20,973	23,916	14.0	1.6
Tyler County, Texas	20,871	20,556	-1.5	-0.2
Jasper County, South Carolina	20,678	23,221	12.3	1.4
Calhoun County, Texas	20,647	20,573	-0.4	0.0
Colorado County, Texas	20,390	20,650	1.3	0.1
Concordia Parish, Louisiana	20,247	18,989	-6.2	-0.7
Taylor County, Florida	19,256	21,400	11.1	1.2
Lavaca County, Texas	19,210	18,539	-3.5	-0.4
George County, Mississippi	19,144	22,681	18.5	2.1
Madison County, Florida	18,733	18,901	0.9	0.1
Grant Parish, Louisiana	18,698	20,164	7.8	0.9
Holmes County, Florida	18,564	19,099	2.9	0.3
Burleson County, Texas	16,470	16,570	0.6	0.1
Brooks County, Georgia	16,450	16,354	-0.6	-0.1
Berrien County, Georgia	16,235	17,044	5.0	0.6
Cook County, Georgia	15,771	16,603	5.3	0.6
Pierce County, Georgia	15,636	18,580	18.8	2.1
Leon County, Texas	15,335	16,923	10.4	1.2
Newton County, Texas	15,072	13,667	-9.3	-1.0
Brantley County, Georgia	14,629	15,643	6.9	0.8
Gilchrist County, Florida	14,437	17,116	18.6	2.1
Jackson County, Texas	14,391	14,274	-0.8	-0.1
La Salle Parish, Louisiana	14,282	13,964	-2.2	-0.2
Dixie County, Florida	13,827	14,824	7.2	0.8
Trinity County, Texas	13,779	13,897	0.9	0.1
Stone County, Mississippi	13,622	16,619	22.0	2.4
Union County, Florida	13,442	14,584	8.5	0.9
Gulf County, Florida	13,332	15,755	18.2	2.0

Attachment A-2 Potential Planting Range County Population Sorted by the Year 2000 Census Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Hamilton County, Florida	13,327	14,592	9.5	1.1
Calhoun County, Florida	13,017	13,821	6.2	0.7
Madison County, Texas	12,940	13,333	3.0	0.3
Jefferson County, Florida	12,902	14,010	8.6	1.0
Early County, Georgia	12,354	11,568	-6.4	-0.7
Perry County, Mississippi	12,138	12,035	-0.8	-0.1
Claiborne County, Mississippi	11,831	10,755	-9.1	-1.0
Franklin County, Florida	11,057	11,280	2.0	0.2
Catahoula Parish, Louisiana	10,920	10,460	-4.2	-0.5
McIntosh County, Georgia	10,847	11,378	4.9	0.5
St. Helena Parish, Louisiana	10,525	10,551	0.2	0.0
Sabine County, Texas	10,469	10,208	-2.5	-0.3
Wilkinson County, Mississippi	10,312	10,143	-1.6	-0.2
Long County, Georgia	10,304	12,234	18.7	2.1
Charlton County, Georgia	10,282	10,725	4.3	0.5
Bacon County, Georgia	10,103	10,601	4.9	0.5
Cameron Parish, Louisiana	9,991	6,584	-34.1	-3.8
Jefferson County, Mississippi	9,740	8,928	-8.3	-0.9
Seminole County, Georgia	9,369	9,094	-2.9	-0.3
San Augustine County, Texas	8,946	8,574	-4.2	-0.5
Atkinson County, Georgia	7,609	8,230	8.2	0.9
Lanier County, Georgia	7,241	8,423	16.3	1.8
Lafayette County, Florida	7,022	7,949	13.2	1.5
Liberty County, Florida	7,021	7,983	13.7	1.5
Clinch County, Georgia	6,878	6,988	1.6	0.2
Tensas Parish, Louisiana	6,618	5,609	-15.2	-1.7
Miller County, Georgia	6,383	6,228	-2.4	-0.3
Baker County, Georgia	4,074	3,637	-10.7	-1.2
Echols County, Georgia	3,754	4,213	12.2	1.4

Source: USCB 2010

Attachment A-3 Potential Planting Range County Population Sorted by the Year 2009 Estimate

State	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
State of Texas	20,851,820	24,782,302	18.8	2.1
State of Florida	15,982,378	18,537,969	16.0	1.8
State of Georgia	8,186,453	9,829,211	20.1	2.2
State of Alabama	4,447,100	4,708,708	5.9	0.7
State of South Carolina	4,012,012	4,561,242	13.7	1.5
State of Louisiana	4,468,976	4,492,076	0.5	0.1
State of Mississippi	2,844,658	2,951,996	3.8	0.4

Attachment A-3 Potential Planting Range County Population Sorted by the Year 2009 Estimate Continued…

State Planting Range	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Texas Planting Range Total	*5,959,603*	*7,153,568*	*20.0*	*2.2*
Florida Planting Range Total	*3,194,307*	*3,708,185*	*16.1*	*1.8*
Louisiana Planting Range Total	*3,606,244*	*3,623,905*	*0.5*	*0.1*
Georgia Planting Range Total	*995,958*	*1,100,530*	*10.5*	*1.2*
South Carolina Planting Range Total	*806,095*	*958,590*	*18.9*	*2.1*
Alabama Planting Range Total	*629,045*	*691,684*	*10.0*	*1.1*
Mississippi Planting Range Total	*588,401*	*600,530*	*2.1*	*0.2*
County	**April 2000 Census**	**July 2009 Estimate**	**Percent Change 2000 to 2009**	**Annual Average Rate of Change 2000 to 2009**
Harris County, Texas	3,400,578	4,070,989	19.7	2.2
Duval County, Florida	778,879	857,040	10.0	1.1
Fort Bend County, Texas	354,452	556,870	57.1	6.3
Montgomery County, Texas	293,768	447,718	52.4	5.8
Jefferson Parish, Louisiana	455,466	443,342	-2.7	-0.3
East Baton Rouge Parish, Louisiana	412,852	434,633	5.3	0.6
Mobile County, Alabama	399,843	411,721	3.0	0.3
Charleston County, South Carolina	309,969	355,276	14.6	1.6
Orleans Parish, Louisiana	484,674	354,850	-26.8	-3.0
Marion County, Florida	258,916	328,547	26.9	3.0
Brazoria County, Texas	241,767	309,208	27.9	3.1
Escambia County, Florida	294,410	303,343	3.0	0.3
Galveston County, Texas	250,158	286,814	14.7	1.6
Leon County, Florida	239,452	265,714	11.0	1.2
Chatham County, Georgia	232,048	256,992	10.7	1.2
Alachua County, Florida	217,955	243,574	11.8	1.3
Jefferson County, Texas	252,051	243,237	-3.5	-0.4
St. Tammany Parish, Louisiana	191,268	231,495	21.0	2.3
Lafayette Parish, Louisiana	190,503	210,954	10.7	1.2
Calcasieu Parish, Louisiana	183,577	187,554	2.2	0.2
St. Johns County, Florida	123,135	187,436	52.2	5.8
Clay County, Florida	140,814	186,756	32.6	3.6
Harrison County, Mississippi	189,601	181,191	-4.4	-0.5
Brazos County, Texas	152,415	179,992	18.1	2.0
Baldwin County, Alabama	140,415	179,878	28.1	3.1
Okaloosa County, Florida	170,498	178,473	4.7	0.5
Berkeley County, South Carolina	142,651	173,498	21.6	2.4
Bay County, Florida	148,217	164,767	11.2	1.2
Beaufort County, South Carolina	120,937	155,215	28.3	3.1
Santa Rosa County, Florida	117,743	151,759	28.9	3.2
Rapides Parish, Louisiana	126,337	133,937	6.0	0.7
Jackson County, Mississippi	131,420	132,922	1.1	0.1
Dorchester County, South Carolina	96,413	130,417	35.3	3.9
Livingston Parish, Louisiana	91,814	123,326	34.3	3.8
Tangipahoa Parish, Louisiana	100,588	118,688	18.0	2.0

Attachment A-3 Potential Planting Range County Population Sorted by the Year 2009 Estimate Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Terrebonne Parish, Louisiana	104,503	109,291	4.6	0.5
Lowndes County, Georgia	92,115	106,814	16.0	1.8
Ascension Parish, Louisiana	76,627	104,822	36.8	4.1
Houston County, Alabama	88,787	100,085	12.7	1.4
Lafourche Parish, Louisiana	89,974	93,682	4.1	0.5
St. Landry Parish, Louisiana	87,700	92,326	5.3	0.6
Flagler County, Florida	49,832	91,622	83.9	9.3
Victoria County, Texas	84,088	87,790	4.4	0.5
Angelina County, Texas	80,130	83,675	4.4	0.5
Orange County, Texas	84,966	81,816	-3.7	-0.4
Glynn County, Georgia	67,568	76,820	13.7	1.5
Liberty County, Texas	70,154	75,779	8.0	0.9
Iberia Parish, Louisiana	73,266	75,101	2.5	0.3
Putnam County, Florida	70,423	72,893	3.5	0.4
Nassau County, Florida	57,663	70,576	22.4	2.5
Columbia County, Florida	56,513	69,264	22.6	2.5
Walker County, Texas	61,758	64,119	3.8	0.4
Nacogdoches County, Texas	59,203	64,117	8.3	0.9
Liberty County, Georgia	61,610	62,186	0.9	0.1
Georgetown County, South Carolina	55,797	60,703	8.8	1.0
Acadia Parish, Louisiana	58,861	60,095	2.1	0.2
Pearl River County, Mississippi	48,621	57,860	19.0	2.1
Vermilion Parish, Louisiana	53,807	56,141	4.3	0.5
Walton County, Florida	40,601	55,105	35.7	4.0
Effingham County, Georgia	37,535	53,541	42.6	4.7
Hardin County, Texas	48,073	53,424	11.1	1.2
St. Martin Parish, Louisiana	48,583	52,217	7.5	0.8
St. Charles Parish, Louisiana	48,072	51,611	7.4	0.8
Jackson County, Florida	46,755	50,930	8.9	1.0
St. Mary Parish, Louisiana	53,500	50,815	-5.0	-0.6
Lamar County, Mississippi	39,070	49,980	27.9	3.1
Camden County, Georgia	43,664	48,277	10.6	1.2
Gadsden County, Florida	45,087	47,474	5.3	0.6
St. John the Baptist Parish, Louisiana	43,044	47,086	9.4	1.0
Vernon Parish, Louisiana	52,531	46,616	-11.3	-1.3
Polk County, Texas	41,133	46,530	13.1	1.5
Thomas County, Georgia	42,737	46,188	8.1	0.9
Washington Parish, Louisiana	43,926	45,669	4.0	0.4
Colquitt County, Georgia	42,053	45,596	8.4	0.9
Avoyelles Parish, Louisiana	41,481	42,511	2.5	0.3
Wharton County, Texas	41,188	41,000	-0.5	-0.1
Hancock County, Mississippi	42,967	40,962	-4.7	-0.5
Coffee County, Georgia	37,413	40,868	9.2	1.0
St. Bernard Parish, Louisiana	67,229	40,655	-39.5	-4.4
Suwannee County, Florida	34,844	40,149	15.2	1.7
Natchitoches Parish, Louisiana	39,080	39,255	0.4	0.0

Attachment A-3 Potential Planting Range County Population Sorted by the Year 2009 Estimate Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Colleton County, South Carolina	38,264	39,246	2.6	0.3
Levy County, Florida	34,450	39,147	13.6	1.5
Matagorda County, Texas	37,957	36,978	-2.6	-0.3
Waller County, Texas	32,663	36,530	11.8	1.3
Ware County, Georgia	35,483	35,914	1.2	0.1
Beauregard Parish, Louisiana	32,986	35,419	7.4	0.8
Evangeline Parish, Louisiana	35,434	35,330	-0.3	0.0
Jasper County, Texas	35,604	34,370	-3.5	-0.4
Washington County, Texas	30,373	32,893	8.3	0.9
Wakulla County, Florida	22,863	32,815	43.5	4.8
Bryan County, Georgia	23,417	32,559	39.0	4.3
Iberville Parish, Louisiana	33,320	32,505	-2.4	-0.3
Chambers County, Texas	26,031	31,431	20.7	2.3
Jefferson Davis Parish, Louisiana	31,435	31,097	-1.1	-0.1
Adams County, Mississippi	34,340	30,722	-10.5	-1.2
Wayne County, Georgia	26,565	29,407	10.7	1.2
Bradford County, Florida	26,088	29,235	12.1	1.3
Decatur County, Georgia	28,240	28,838	2.1	0.2
Austin County, Texas	23,590	27,248	15.5	1.7
Baker County, Florida	22,259	26,336	18.3	2.0
Grimes County, Texas	23,552	26,011	10.4	1.2
Marion County, Mississippi	25,595	25,732	0.5	0.1
Allen Parish, Louisiana	25,440	25,636	0.8	0.1
Grady County, Georgia	23,659	25,187	6.5	0.7
San Jacinto County, Texas	22,246	24,902	11.9	1.3
Washington County, Florida	20,973	23,916	14.0	1.6
Mitchell County, Georgia	23,932	23,800	-0.6	-0.1
Jasper County, South Carolina	20,678	23,221	12.3	1.4
Assumption Parish, Louisiana	23,388	22,874	-2.2	-0.2
George County, Mississippi	19,144	22,681	18.5	2.1
West Baton Rouge Parish, Louisiana	21,601	22,638	4.8	0.5
Pointe Coupee Parish, Louisiana	22,763	22,447	-1.4	-0.2
Houston County, Texas	23,185	22,363	-3.5	-0.4
Taylor County, Florida	19,256	21,400	11.1	1.2
St. James Parish, Louisiana	21,216	21,054	-0.8	-0.1
Hampton County, South Carolina	21,386	21,014	-1.7	-0.2
East Feliciana Parish, Louisiana	21,360	20,970	-1.8	-0.2
Plaquemines Parish, Louisiana	26,757	20,942	-21.7	-2.4
Colorado County, Texas	20,390	20,650	1.3	0.1
Calhoun County, Texas	20,647	20,573	-0.4	0.0
Tyler County, Texas	20,871	20,556	-1.5	-0.2
Grant Parish, Louisiana	18,698	20,164	7.8	0.9
Holmes County, Florida	18,564	19,099	2.9	0.3
Concordia Parish, Louisiana	20,247	18,989	-6.2	-0.7
Madison County, Florida	18,733	18,901	0.9	0.1
Pierce County, Georgia	15,636	18,580	18.8	2.1

Attachment A-3 Potential Planting Range County Population Sorted by the Year 2009 Estimate Continued…

County	April 2000 Census	July 2009 Estimate	Percent Change 2000 to 2009	Annual Average Rate of Change 2000 to 2009
Lavaca County, Texas	19,210	18,539	-3.5	-0.4
Gilchrist County, Florida	14,437	17,116	18.6	2.1
Berrien County, Georgia	16,235	17,044	5.0	0.6
Leon County, Texas	15,335	16,923	10.4	1.2
Stone County, Mississippi	13,622	16,619	22.0	2.4
Cook County, Georgia	15,771	16,603	5.3	0.6
Burleson County, Texas	16,470	16,570	0.6	0.1
Brooks County, Georgia	16,450	16,354	-0.6	-0.1
Gulf County, Florida	13,332	15,755	18.2	2.0
Brantley County, Georgia	14,629	15,643	6.9	0.8
Dixie County, Florida	13,827	14,824	7.2	0.8
Hamilton County, Florida	13,327	14,592	9.5	1.1
Union County, Florida	13,442	14,584	8.5	0.9
Jackson County, Texas	14,391	14,274	-0.8	-0.1
Jefferson County, Florida	12,902	14,010	8.6	1.0
La Salle Parish, Louisiana	14,282	13,964	-2.2	-0.2
Trinity County, Texas	13,779	13,897	0.9	0.1
Calhoun County, Florida	13,017	13,821	6.2	0.7
Newton County, Texas	15,072	13,667	-9.3	-1.0
Madison County, Texas	12,940	13,333	3.0	0.3
Long County, Georgia	10,304	12,234	18.7	2.1
Perry County, Mississippi	12,138	12,035	-0.8	-0.1
Early County, Georgia	12,354	11,568	-6.4	-0.7
McIntosh County, Georgia	10,847	11,378	4.9	0.5
Franklin County, Florida	11,057	11,280	2.0	0.2
Claiborne County, Mississippi	11,831	10,755	-9.1	-1.0
Charlton County, Georgia	10,282	10,725	4.3	0.5
Bacon County, Georgia	10,103	10,601	4.9	0.5
St. Helena Parish, Louisiana	10,525	10,551	0.2	0.0
Catahoula Parish, Louisiana	10,920	10,460	-4.2	-0.5
Sabine County, Texas	10,469	10,208	-2.5	-0.3
Wilkinson County, Mississippi	10,312	10,143	-1.6	-0.2
Seminole County, Georgia	9,369	9,094	-2.9	-0.3
Jefferson County, Mississippi	9,740	8,928	-8.3	-0.9
San Augustine County, Texas	8,946	8,574	-4.2	-0.5
Lanier County, Georgia	7,241	8,423	16.3	1.8
Atkinson County, Georgia	7,609	8,230	8.2	0.9
Liberty County, Florida	7,021	7,983	13.7	1.5
Lafayette County, Florida	7,022	7,949	13.2	1.5
Clinch County, Georgia	6,878	6,988	1.6	0.2
Cameron Parish, Louisiana	9,991	6,584	-34.1	-3.8
Miller County, Georgia	6,383	6,228	-2.4	-0.3
Tensas Parish, Louisiana	6,618	5,609	-15.2	-1.7
Echols County, Georgia	3,754	4,213	12.2	1.4
Baker County, Georgia	4,074	3,637	-10.7	-1.2

Source: USCB 2010

Attachment A-4 Potential Planting Range County Demographics

	Baldwin County, Alabama	Houston County, Alabama	Mobile County, Alabama	Alabama Total	Alabama Percent	Alachua County, Florida	Baker County, Florida
Total Population	140,415	88,787	399,843	629,045	100.0	217,955	22,259
Race Alone:							
White alone	120,868	64,312	249,763	434,943	69.1	151,817	18,389
Black or African American alone	14,357	21,703	132,845	168,905	26.9	41,597	3,083
American Indian and Alaska Native alone	753	318	2,636	3,707	0.6	476	82
Asian alone	531	548	5,599	6,678	1.1	7,630	88
Native Hawaiian and Other Pacific Islander alone	37	13	79	129	0.0	61	7
Some other race alone	104	55	319	478	0.1	369	5
Population of two or more races:	1,299	716	3,715	5,730	0.9	3,512	186
Total Racial Minority	17,081	23,353	145,193	185,627	29.5	53,645	3,451
Percent Racial Minority	12.2	26.3	36.3	29.5		24.6	15.5
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	1		0	0
County Count Total by State				1	33.3		
Ethnicity (Any Race):							
Hispanic or Latino	2,466	1,122	4,887	8,475	1.3	12,493	419
Percent Hispanic	1.8	1.3	1.2	1.3		5.7	1.9
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0		0	0
County Count Total by State				0	0.0		
Total Minority	19,547	24,475	150,080	194,102	30.9	66,138	3,870
Percent Minority	13.9	27.6	37.5	30.9		30.3	17.4
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0		0	0
Number of counties with percent minority exceeding percent minority in Planting Range				0	0.0		

Attachment A-4 Potential Planting Range County Demographics Continued…

	Bay County, Florida	Bradford County, Florida	Calhoun County, Florida	Clay County, Florida	Columbia County, Florida	Dixie County, Florida	Duval County, Florida
Total Population	148,217	26,088	13,017	140,814	56,513	13,827	778,879
Race Alone:							
White alone	122,708	19,559	10,105	119,587	44,058	12,132	494,747
Black or African American alone	15,526	5,367	2,028	9,243	9,522	1,231	214,473
American Indian and Alaska Native alone	1,096	82	154	599	268	59	2,375
Asian alone	2,534	154	69	2,754	372	34	20,871
Native Hawaiian and Other Pacific Islander alone	111	21	5	96	20	4	431
Some other race alone	164	24	14	192	36	2	1,407
Population of two or more races:	2,487	259	150	2,284	691	116	12,629
Total Racial Minority	21,918	5,907	2,420	15,168	10,909	1,446	252,186
Percent Racial Minority	14.8	22.6	18.6	10.8	19.3	10.5	32.4
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	3,591	622	492	6,059	1,546	249	31,946
Percent Hispanic	2.4	2.4	3.8	4.3	2.7	1.8	4.1
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	25,509	6,529	2,912	21,227	12,455	1,695	284,132
Percent Minority	17.2	25.0	22.4	15.1	22.0	12.3	36.5
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Escambia County, Florida	Flagler County, Florida	Franklin County, Florida	Gadsden County, Florida	Gilchrist County, Florida	Gulf County, Florida	Hamilton County, Florida
Total Population	294,410	49,832	11,057	45,087	14,437	13,332	13,327
Race Alone:							
White alone	208,678	41,636	8,822	16,174	12,812	10,492	7,336
Black or African American alone	62,548	4,295	1,762	25,632	996	2,247	4,967
American Indian and Alaska Native alone	2,525	119	47	87	50	81	43
Asian alone	6,440	576	19	105	22	53	26
Native Hawaiian and Other Pacific Islander alone	321	11	2	9	1	6	1
Some other race alone	420	85	10	24	7	4	7
Population of two or more races:	5,543	573	127	274	145	179	100
Total Racial Minority	77,797	5,659	1,967	26,131	1,221	2,570	5,144
Percent Racial Minority	26.4	11.4	17.8	58.0	8.5	19.3	38.6
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	1	0	0	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	7,935	2,537	268	2,782	404	270	847
Percent Hispanic	2.7	5.1	2.4	6.2	2.8	2.0	6.4
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	85,732	8,196	2,235	28,913	1,625	2,840	5,991
Percent Minority	29.1	16.4	20.2	64.1	11.3	21.3	45.0
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	1	0	0	1
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Holmes County, Florida	Jackson County, Florida	Jefferson County, Florida	Lafayette County, Florida	Leon County, Florida	Levy County, Florida	Liberty County, Florida
Total Population	18,564	46,755	12,902	7,022	239,452	34,450	7,021
Race Alone:							
White alone	16,501	32,086	7,522	5,286	153,474	28,654	5,233
Black or African American alone	1,190	12,273	4,903	989	69,049	3,734	1,276
American Indian and Alaska Native alone	177	291	40	33	634	134	114
Asian alone	72	160	37	8	4,507	129	10
Native Hawaiian and Other Pacific Islander alone	6	10	4	1	98	10	0
Some other race alone	30	26	4	7	322	50	4
Population of two or more races:	230	548	102	56	2,961	400	68
Total Racial Minority	1,705	13,308	5,090	1,094	77,571	4,457	1,472
Percent Racial Minority	9.2	28.5	39.5	15.6	32.4	12.9	21.0
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	0	1	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	358	1,361	290	642	8,407	1,339	316
Percent Hispanic	1.9	2.9	2.2	9.1	3.5	3.9	4.5
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	2,063	14,669	5,380	1,736	85,978	5,796	1,788
Percent Minority	11.1	31.4	41.7	24.7	35.9	16.8	25.5
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Madison County, Florida	Marion County, Florida	Nassau County, Florida	Okaloosa County, Florida	Putnam County, Florida	St. Johns County, Florida	Santa Rosa County, Florida
Total Population	18,733	258,916	57,663	170,498	70,423	123,135	117,743
Race Alone:							
White alone	10,378	208,232	51,323	138,059	53,087	109,622	104,919
Black or African American alone	7,475	29,370	4,436	15,232	11,898	7,688	4,899
American Indian and Alaska Native alone	55	998	228	931	265	290	1,125
Asian alone	60	1,777	251	4,144	294	1,162	1,498
Native Hawaiian and Other Pacific Islander alone	4	41	18	222	27	57	85
Some other race alone	5	231	32	379	40	90	171
Population of two or more races:	156	2,651	502	4,229	644	982	2,078
Total Racial Minority	7,755	35,068	5,467	25,137	13,168	10,269	9,856
Percent Racial Minority	41.4	13.5	9.5	14.7	18.7	8.3	8.4
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	0	0	0	0	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	600	15,616	873	7,302	4,168	3,244	2,968
Percent Hispanic	3.2	6.0	1.5	4.3	5.9	2.6	2.5
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	8,355	50,684	6,340	32,439	17,336	13,513	12,824
Percent Minority	44.6	19.6	11.0	19.0	24.6	11.0	10.9
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	1	0	0	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Suwannee County, Florida	Taylor County, Florida	Union County, Florida	Wakulla County, Florida	Walton County, Florida	Washington County, Florida	Florida Total
Total Population	34,844	19,256	13,442	22,863	40,601	20,973	3,194,307
Race Alone:							
White alone	28,262	14,817	9,659	19,393	35,425	16,876	2,347,860
Black or African American alone	4,177	3,640	3,038	2,586	2,801	2,828	597,999
American Indian and Alaska Native alone	123	175	84	124	486	307	14,757
Asian alone	165	85	33	56	175	71	56,441
Native Hawaiian and Other Pacific Islander alone	7	2	3	7	14	13	1,736
Some other race alone	12	11	3	20	42	11	4,260
Population of two or more races:	395	231	145	234	778	384	47,029
Total Racial Minority	4,879	4,144	3,306	3,027	4,296	3,614	722,222
Percent Racial Minority	14.0	21.5	24.6	13.2	10.6	17.2	22.6
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							7
Ethnicity (Any Race):							
Hispanic or Latino	1,703	295	477	443	880	483	124,225
Percent Hispanic	4.9	1.5	3.5	1.9	2.2	2.3	3.9
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							0
Total Minority	6,582	4,439	3,783	3,470	5,176	4,097	846,447
Percent Minority	18.9	23.1	28.1	15.2	12.7	19.5	26.5
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							4

Attachment A-4 Potential Planting Range County Demographics Continued…

	Florida Percent	Atkinson County, Georgia	Bacon County, Georgia	Baker County, Georgia	Berrien County, Georgia	Brantley County, Georgia	Brooks County, Georgia
Total Population	100.0	7,609	10,103	4,074	16,235	14,629	16,450
Race Alone:							
White alone	73.5	4,760	8,068	1,889	13,761	13,712	9,303
Black or African American alone	18.7	1,477	1,562	2,038	1,843	579	6,429
American Indian and Alaska Native alone	0.5	23	14	9	42	20	35
Asian alone	1.8	9	28	0	47	13	38
Native Hawaiian and Other Pacific Islander alone	0.1	0	0	1	13	1	1
Some other race alone	0.1	3	7	2	14	3	8
Population of two or more races:	1.5	47	82	24	131	149	131
Total Racial Minority	22.6	1,559	1,693	2,074	2,090	765	6,642
Percent Racial Minority		20.5	16.8	50.9	12.9	5.2	40.4
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)		0	0	1	0	0	1
County Count Total by State	19.4						
Ethnicity (Any Race):							
Hispanic or Latino	3.9	1,290	342	111	384	152	505
Percent Hispanic		17.0	3.4	2.7	2.4	1.0	3.1
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)		1	0	0	0	0	0
County Count Total by State	0.0						
Total Minority	26.5	2,849	2,035	2,185	2,474	917	7,147
Percent Minority		37.4	20.1	53.6	15.2	6.3	43.4
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)		0	0	1	0	0	1
Number of counties with percent minority exceeding percent minority in Planting Range	11.1						

Attachment A-4 Potential Planting Range County Demographics Continued…

	Bryan County, Georgia	Camden County, Georgia	Charlton County, Georgia	Chatham County, Georgia	Clinch County, Georgia	Coffee County, Georgia	Colquitt County, Georgia
Total Population	23,417	43,664	10,282	232,048	6,878	37,413	42,053
Race Alone:							
White alone	19,138	31,975	7,014	125,802	4,713	24,701	27,252
Black or African American alone	3,272	8,719	2,990	93,463	2,019	9,629	9,812
American Indian and Alaska Native alone	69	195	39	517	27	98	77
Asian alone	174	429	35	3,992	8	204	89
Native Hawaiian and Other Pacific Islander alone	16	32	6	128	0	9	8
Some other race alone	22	70	3	311	3	14	19
Population of two or more races:	261	659	114	2,432	54	208	242
Total Racial Minority	3,814	10,104	3,187	100,843	2,111	10,162	10,247
Percent Racial Minority	16.3	23.1	31.0	43.5	30.7	27.2	24.4
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	1	1	1	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	465	1,585	81	5,403	54	2,550	4,554
Percent Hispanic	2.0	3.6	0.8	2.3	0.8	6.8	10.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	4,279	11,689	3,268	106,246	2,165	12,712	14,801
Percent Minority	18.3	26.8	31.8	45.8	31.5	34.0	35.2
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	1	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Cook County, Georgia	Decatur County, Georgia	Early County, Georgia	Echols County, Georgia	Effingham County, Georgia	Glynn County, Georgia	Grady County, Georgia
Total Population	15,771	28,240	12,354	3,754	37,535	67,568	23,659
Race Alone:							
White alone	10,526	15,800	6,159	2,688	31,493	46,566	14,954
Black or African American alone	4,565	11,227	5,901	252	4,853	17,711	7,074
American Indian and Alaska Native alone	24	59	23	43	112	155	185
Asian alone	62	86	23	3	168	406	72
Native Hawaiian and Other Pacific Islander alone	5	4	7	0	9	32	1
Some other race alone	3	3	5	1	30	56	5
Population of two or more races:	101	156	84	28	339	623	146
Total Racial Minority	4,760	11,535	6,043	327	5,511	18,983	7,483
Percent Racial Minority	30.2	40.8	48.9	8.7	14.7	28.1	31.6
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	1	1	0	0	1	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	485	905	152	739	531	2,019	1,222
Percent Hispanic	3.1	3.2	1.2	19.7	1.4	3.0	5.2
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	1	0	0	0
County Count Total by State							
Total Minority	5,245	12,440	6,195	1,066	6,042	21,002	8,705
Percent Minority	33.3	44.1	50.1	28.4	16.1	31.1	36.8
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Lanier County, Georgia	Liberty County, Georgia	Long County, Georgia	Lowndes County, Georgia	McIntosh County, Georgia	Miller County, Georgia	Mitchell County, Georgia
Total Population	7,241	61,610	10,304	92,115	10,847	6,383	23,932
Race Alone:							
White alone	5,122	27,244	6,678	55,992	6,607	4,456	11,746
Black or African American alone	1,845	26,025	2,429	31,128	3,971	1,845	11,423
American Indian and Alaska Native alone	35	279	63	305	40	11	41
Asian alone	26	1,053	58	1,081	32	2	61
Native Hawaiian and Other Pacific Islander alone	3	254	25	37	3	5	8
Some other race alone	6	199	16	104	3	0	8
Population of two or more races:	78	1,534	165	1,021	92	20	154
Total Racial Minority	1,993	29,344	2,756	33,676	4,141	1,883	11,695
Percent Racial Minority	27.5	47.6	26.7	36.6	38.2	29.5	48.9
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	1	0	1	1	1	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	126	5,022	870	2,447	99	44	491
Percent Hispanic	1.7	8.2	8.4	2.7	0.9	0.7	2.1
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	2,119	34,366	3,626	36,123	4,240	1,927	12,186
Percent Minority	29.3	55.8	35.2	39.2	39.1	30.2	50.9
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0	1	1	0	1
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Pierce County, Georgia	Seminole County, Georgia	Thomas County, Georgia	Ware County, Georgia	Wayne County, Georgia	Georgia Total	Georgia Percent
Total Population	15,636	9,369	42,737	35,483	26,565	995,958	100.0
Race Alone:							
White alone	13,425	5,734	24,875	24,434	19,838	626,425	62.9
Black or African American alone	1,691	3,224	16,497	9,907	5,333	310,733	31.2
American Indian and Alaska Native alone	34	15	116	62	58	2,825	0.3
Asian alone	25	17	172	166	114	8,693	0.9
Native Hawaiian and Other Pacific Islander alone	8	0	14	11	0	641	0.1
Some other race alone	5	0	26	23	8	980	0.1
Population of two or more races:	91	32	303	192	201	9,894	1.0
Total Racial Minority	1,854	3,288	17,128	10,361	5,714	333,766	33.5
Percent Racial Minority	11.9	35.1	40.1	29.2	21.5	33.5	
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	1	0	1	
County Count Total by State						20	62.5
Ethnicity (Any Race):							
Hispanic or Latino	357	347	734	688	1,013	35,767	3.6
Percent Hispanic	2.3	3.7	1.7	1.9	3.8	3.6	
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	
County Count Total by State						2	6.3
Total Minority	2,211	3,635	17,862	11,049	6,727	369,533	37.1
Percent Minority	14.1	38.8	41.8	31.1	25.3	37.1	
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	0	0	0	
Number of counties with percent minority exceeding percent minority in Planting Range						11	34.4

Attachment A-4 Potential Planting Range County Demographics Continued…

	Acadia Parish, Louisiana	Allen Parish, Louisiana	Ascension Parish, Louisiana	Assumption Parish, Louisiana	Avoyelles Parish, Louisiana	Beauregard Parish, Louisiana	Calcasieu Parish, Louisiana
Total Population	58,861	25,440	76,627	23,388	41,481	32,986	183,577
Race Alone:							
White alone	47,150	17,329	58,378	15,565	28,147	27,513	133,716
Black or African American alone	10,705	6,175	15,466	7,303	12,173	4,229	43,769
American Indian and Alaska Native alone	110	436	191	67	409	209	532
Asian alone	87	142	249	53	71	189	1,163
Native Hawaiian and Other Pacific Islander alone	3	3	18	0	1	16	45
Some other race alone	29	9	40	2	29	13	213
Population of two or more races:	239	200	402	114	247	349	1,676
Total Racial Minority	11,173	6,965	16,366	7,539	12,930	5,005	47,398
Percent Racial Minority	19.0	27.4	21.4	32.2	31.2	15.2	25.8
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0	1	1	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	538	1,146	1,883	284	404	468	2,463
Percent Hispanic	0.9	4.5	2.5	1.2	1.0	1.4	1.3
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	11,711	8,111	18,249	7,823	13,334	5,473	49,861
Percent Minority	19.9	31.9	23.8	33.4	32.1	16.6	27.2
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Cameron Parish, Louisiana	Catahoula Parish, Louisiana	Concordia Parish, Louisiana	East Baton Rouge Parish, Louisiana	East Feliciana Parish, Louisiana	Evangeline Parish, Louisiana	Grant Parish, Louisiana
Total Population	9,991	10,920	20,247	412,852	21,360	35,434	18,698
Race Alone:							
White alone	9,244	7,785	12,172	227,445	10,989	24,730	15,859
Black or African American alone	388	2,942	7,573	164,853	10,012	10,041	2,212
American Indian and Alaska Native alone	37	21	33	793	33	75	157
Asian alone	44	14	47	8,534	48	51	24
Native Hawaiian and Other Pacific Islander alone	1	0	1	109	1	3	5
Some other race alone	0	0	11	427	17	34	5
Population of two or more races:	62	57	110	3,328	103	132	223
Total Racial Minority	532	3,034	7,775	178,044	10,214	10,336	2,626
Percent Racial Minority	5.3	27.8	38.4	43.1	47.8	29.2	14.0
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	1	1	1	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	215	101	300	7,363	157	368	213
Percent Hispanic	2.2	0.9	1.5	1.8	0.7	1.0	1.1
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	747	3,135	8,075	185,407	10,371	10,704	2,839
Percent Minority	7.5	28.7	39.9	44.9	48.6	30.2	15.2
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	1	1	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Iberia Parish, Louisiana	Iberville Parish, Louisiana	Jefferson Parish, Louisiana	Jefferson Davis Parish, Louisiana	Lafayette Parish, Louisiana	Lafourche Parish, Louisiana	La Salle Parish, Louisiana
Total Population	73,266	33,320	455,466	31,435	190,503	89,974	14,282
Race Alone:							
White alone	47,122	16,202	298,062	25,138	137,762	73,937	12,225
Black or African American alone	22,451	16,486	103,376	5,571	45,149	11,287	1,732
American Indian and Alaska Native alone	216	58	1,808	113	498	2,020	91
Asian alone	1,401	84	13,948	61	2,041	596	25
Native Hawaiian and Other Pacific Islander alone	15	4	120	3	47	16	1
Some other race alone	143	11	563	7	197	44	6
Population of two or more races:	817	132	5,171	230	1,489	790	85
Total Racial Minority	25,043	16,775	124,986	5,985	49,421	14,753	1,940
Percent Racial Minority	34.2	50.3	27.4	19.0	25.9	16.4	13.6
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	1	1	0	0	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	1,101	343	32,418	312	3,320	1,284	117
Percent Hispanic	1.5	1.0	7.1	1.0	1.7	1.4	0.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	26,144	17,118	157,404	6,297	52,741	16,037	2,057
Percent Minority	35.7	51.4	34.6	20.0	27.7	17.8	14.4
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Livingston Parish, Louisiana	Natchitoches Parish, Louisiana	Orleans Parish, Louisiana	Plaquemines Parish, Louisiana	Pointe Coupee Parish, Louisiana	Rapides Parish, Louisiana	St. Bernard Parish, Louisiana
Total Population	91,814	39,080	484,674	26,757	22,763	126,337	67,229
Race Alone:							
White alone	85,882	22,357	128,871	18,412	13,720	83,059	56,723
Black or African American alone	3,846	14,917	323,392	6,227	8,553	38,298	5,095
American Indian and Alaska Native alone	329	393	852	549	38	892	309
Asian alone	160	171	10,919	696	56	1,071	872
Native Hawaiian and Other Pacific Islander alone	10	6	88	3	0	39	6
Some other race alone	27	227	961	91	38	91	37
Population of two or more races:	543	443	4,765	346	113	1,148	762
Total Racial Minority	4,915	16,157	340,977	7,912	8,798	41,539	7,081
Percent Racial Minority	5.4	41.3	70.4	29.6	38.7	32.9	10.5
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	1	1	1	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	1,017	566	14,826	433	245	1,739	3,425
Percent Hispanic	1.1	1.4	3.1	1.6	1.1	1.4	5.1
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	5,932	16,723	355,803	8,345	9,043	43,278	10,506
Percent Minority	6.5	42.8	73.4	31.2	39.7	34.3	15.6
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	0	1	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	St. Charles Parish, Louisiana	St. Helena Parish, Louisiana	St. James Parish, Louisiana	St. John the Baptist Parish, Louisiana	St. Landry Parish, Louisiana	St. Martin Parish, Louisiana	St. Mary Parish, Louisiana
Total Population	48,072	10,525	21,216	43,044	87,700	48,583	53,500
Race Alone:							
White alone	33,901	4,859	10,538	21,946	49,160	31,813	33,051
Black or African American alone	12,043	5,480	10,444	19,204	36,762	15,464	16,945
American Indian and Alaska Native alone	119	10	19	100	117	136	725
Asian alone	265	10	10	222	177	440	854
Native Hawaiian and Other Pacific Islander alone	4	1	0	10	12	2	8
Some other race alone	52	3	3	31	153	41	46
Population of two or more races:	342	58	72	301	525	282	719
Total Racial Minority	12,825	5,562	10,548	19,868	37,746	16,365	19,297
Percent Racial Minority	26.7	52.8	49.7	46.2	43.0	33.7	36.1
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	1	1	1	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	1,346	104	130	1,230	794	405	1,152
Percent Hispanic	2.8	1.0	0.6	2.9	0.9	0.8	2.2
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	14,171	5,666	10,678	21,098	38,540	16,770	20,449
Percent Minority	29.5	53.8	50.3	49.0	43.9	34.5	38.2
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	1	1	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	St. Tammany Parish, Louisiana	Tangipahoa Parish, Louisiana	Tensas Parish, Louisiana	Terrebonne Parish, Louisiana	Vermilion Parish, Louisiana	Vernon Parish, Louisiana	Washington Parish, Louisiana
Total Population	191,268	100,588	6,618	104,503	53,807	52,531	43,926
Race Alone:							
White alone	163,061	69,300	2,842	76,548	44,026	37,483	29,396
Black or African American alone	18,788	28,388	3,642	18,517	7,527	8,782	13,781
American Indian and Alaska Native alone	788	222	3	5,460	153	712	99
Asian alone	1,413	387	7	836	971	786	71
Native Hawaiian and Other Pacific Islander alone	52	5	0	14	4	152	1
Some other race alone	387	62	0	117	18	84	21
Population of two or more races:	2,042	688	41	1,380	366	1,421	223
Total Racial Minority	23,470	29,752	3,693	26,324	9,039	11,937	14,196
Percent Racial Minority	12.3	29.6	55.8	25.2	16.8	22.7	32.3
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1	0	0	0	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	4,737	1,536	83	1,631	742	3,111	334
Percent Hispanic	2.5	1.5	1.3	1.6	1.4	5.9	0.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	28,207	31,288	3,776	27,955	9,781	15,048	14,530
Percent Minority	14.7	31.1	57.1	26.8	18.2	28.6	33.1
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	West Baton Rouge Parish, Louisiana	Louisiana Total	Louisiana Percent	Adams County, Mississippi	Claiborne County, Mississippi	George County, Mississippi	Hancock County, Mississippi
Total Population	21,601	3,606,244	100.0	34,340	11,831	19,144	42,967
Race Alone:							
White alone	13,394	2,276,812	63.1	15,701	1,783	16,976	38,180
Black or African American alone	7,649	1,127,637	31.3	18,026	9,892	1,681	2,925
American Indian and Alaska Native alone	44	19,976	0.6	49	6	45	248
Asian alone	39	49,305	1.4	85	16	30	374
Native Hawaiian and Other Pacific Islander alone	4	833	0.0	4	0	0	15
Some other race alone	10	4,300	0.1	12	2	12	20
Population of two or more races:	148	32,684	0.9	190	38	93	430
Total Racial Minority	7,894	1,234,735	34.2	18,366	9,954	1,861	4,012
Percent Racial Minority	36.5	34.2		53.5	84.1	9.7	9.3
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	1		1	1	0	0
County Count Total by State		26	60.5				
Ethnicity (Any Race):							
Hispanic or Latino	313	94,697	2.6	273	94	307	775
Percent Hispanic	1.4	2.6		0.8	0.8	1.6	1.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0		0	0	0	0
County Count Total by State		0	0.0				
Total Minority	8,207	1,329,432	36.9	18,639	10,048	2,168	4,787
Percent Minority	38.0	36.9		54.3	84.9	11.3	11.1
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0		1	1	0	0
Number of counties with percent minority exceeding percent minority in Planting Range		12	27.9				

Attachment A-4 Potential Planting Range County Demographics Continued…

	Harrison County, Mississippi	Jackson County, Mississippi	Jefferson County, Mississippi	Lamar County, Mississippi	Marion County, Mississippi	Pearl River County, Mississippi	Perry County, Mississippi
Total Population	189,601	131,420	9,740	39,070	25,595	48,621	12,138
Race Alone:							
White alone	136,141	97,461	1,263	33,090	17,063	41,181	9,194
Black or African American alone	39,694	27,308	8,373	5,027	8,106	5,888	2,713
American Indian and Alaska Native alone	797	416	8	61	58	212	38
Asian alone	4,874	2,033	10	245	53	130	14
Native Hawaiian and Other Pacific Islander alone	151	49	1	4	1	12	6
Some other race alone	222	101	0	12	6	39	0
Population of two or more races:	2,812	1,245	21	205	150	473	51
Total Racial Minority	48,550	31,152	8,413	5,554	8,374	6,754	2,822
Percent Racial Minority	25.6	23.7	86.4	14.2	32.7	13.9	23.2
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	0	1	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	4,910	2,807	64	426	158	686	122
Percent Hispanic	2.6	2.1	0.7	1.1	0.6	1.4	1.0
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Total Minority	53,460	33,959	8,477	5,980	8,532	7,440	2,944
Percent Minority	28.2	25.8	87.0	15.3	33.3	15.3	24.3
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Stone County, Mississippi	Wilkinson County, Mississippi	Mississippi Total	Mississippi Percent	Beaufort County, South Carolina	Berkeley County, South Carolina	Charleston County, South Carolina
Total Population	13,622	10,312	588,401	100.0	120,937	142,651	309,969
Race Alone:			0				
White alone	10,724	3,202	421,959	71.7	81,477	95,314	188,542
Black or African American alone	2,591	7,015	139,239	23.7	28,654	37,739	106,337
American Indian and Alaska Native alone	30	10	1,978	0.3	288	700	712
Asian alone	21	2	7,887	1.3	938	2,636	3,410
Native Hawaiian and Other Pacific Islander alone	3	0	246	0.0	50	98	142
Some other race alone	6	0	432	0.1	84	177	339
Population of two or more races:	77	38	5,823	1.0	1,238	2,052	3,053
Total Racial Minority	2,728	7,065	155,605	26.4	31,252	43,402	113,993
Percent Racial Minority	20.0	68.5	26.4		25.8	30.4	36.8
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0		0	1	1
County Count Total by State			5	38.5			
Ethnicity (Any Race):			0				
Hispanic or Latino	170	45	10,837	1.8	8,208	3,935	7,434
Percent Hispanic	1.2	0.4	1.8		6.8	2.8	2.4
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0		0	0	0
County Count Total by State			0	0.0			
Total Minority	2,898	7,110	166,442	28.3	39,460	47,337	121,427
Percent Minority	21.3	68.9	28.3		32.6	33.2	39.2
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0		0	0	1
Number of counties with percent minority exceeding percent minority in Planting Range			4	30.8			

Attachment A-4 Potential Planting Range County Demographics Continued…

	Colleton County, South Carolina	Dorchester County, South Carolina	Georgetown County, South Carolina	Hampton County, South Carolina	Jasper County, South Carolina	South Carolina Total	South Carolina Percent
Total Population	38,264	96,413	55,797	21,386	20,678	806,095	100.0
Race Alone:							
White alone	21,081	67,578	33,011	8,831	8,374	504,208	62.5
Black or African American alone	16,021	24,067	21,393	11,832	10,852	256,895	31.9
American Indian and Alaska Native alone	240	679	74	39	64	2,796	0.3
Asian alone	94	1,077	120	36	89	8,400	1.0
Native Hawaiian and Other Pacific Islander alone	12	63	16	1	9	391	0.0
Some other race alone	10	91	25	14	13	753	0.1
Population of two or more races:	255	1,136	239	86	87	8,146	1.0
Total Racial Minority	16,632	27,113	21,867	12,008	11,114	277,381	34.4
Percent Racial Minority	43.5	28.1	39.2	56.1	53.7	34.4	
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	1	1	1	1	1	
County Count Total by State						7	87.5
Ethnicity (Any Race):							
Hispanic or Latino	551	1,722	919	547	1,190	24,506	3.0
Percent Hispanic	1.4	1.8	1.6	2.6	5.8	3.0	
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	
County Count Total by State						0	0.0
Total Minority	17,183	28,835	22,786	12,555	12,304	301,887	37.5
Percent Minority	44.9	29.9	40.8	58.7	59.5	37.5	
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	1	0	1	1	1	0	
Number of counties with percent minority exceeding percent minority in Planting Range						5	62.5

Attachment A-4 Potential Planting Range County Demographics Continued…

	Angelina County, Texas	Austin County, Texas	Brazoria County, Texas	Brazos County, Texas	Burleson County, Texas	Calhoun County, Texas	Chambers County, Texas
Total Population	80,130	23,590	241,767	152,415	16,470	20,647	26,031
Race Alone:							
White alone	55,615	16,964	158,052	100,647	11,361	10,774	20,210
Black or African American alone	11,656	2,475	20,183	16,146	2,443	521	2,525
American Indian and Alaska Native alone	173	47	828	360	54	55	84
Asian alone	524	68	4,776	6,066	25	665	172
Native Hawaiian and Other Pacific Islander alone	15	1	54	69	3	7	0
Some other race alone	20	34	215	170	11	16	25
Population of two or more races:	631	196	2,596	1,704	162	161	205
Total Racial Minority	13,019	2,821	28,652	24,515	2,698	1,425	3,011
Percent Racial Minority	16.2	12.0	11.9	16.1	16.4	6.9	11.6
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	11,496	3,805	55,063	27,253	2,411	8,448	2,810
Percent Hispanic	14.3	16.1	22.8	17.9	14.6	40.9	10.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	1	1	1	1	1	1	0
County Count Total by State							
Total Minority	24,515	6,626	83,715	51,768	5,109	9,873	5,821
Percent Minority	30.6	28.1	34.6	34.0	31.0	47.8	22.4
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	1	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Colorado County, Texas	Fort Bend County, Texas	Galveston County, Texas	Grimes County, Texas	Hardin County, Texas	Harris County, Texas	Houston County, Texas
Total Population	20,390	354,452	250,158	23,552	48,073	3,400,578	23,185
Race Alone:							
White alone	13,165	163,788	157,851	14,772	42,941	1,432,264	14,775
Black or African American alone	2,962	69,579	38,179	4,667	3,310	619,694	6,442
American Indian and Alaska Native alone	40	621	893	50	133	7,103	51
Asian alone	42	39,545	5,152	61	108	173,026	53
Native Hawaiian and Other Pacific Islander alone	3	97	88	10	4	1,392	4
Some other race alone	0	544	268	8	20	4,499	2
Population of two or more races:	154	5,407	2,788	197	334	42,849	119
Total Racial Minority	3,201	115,793	47,368	4,993	3,909	848,563	6,671
Percent Racial Minority	15.7	32.7	18.9	21.2	8.1	25.0	28.8
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0	0	0	0	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	4,024	74,871	44,939	3,787	1,223	1,119,751	1,739
Percent Hispanic	19.7	21.1	18.0	16.1	2.5	32.9	7.5
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	1	1	1	1	0	1	0
County Count Total by State							
Total Minority	7,225	190,664	92,307	8,780	5,132	1,968,314	8,410
Percent Minority	35.4	53.8	36.9	37.3	10.7	57.9	36.3
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	0	0	0	1	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Jackson County, Texas	Jasper County, Texas	Jefferson County, Texas	Lavaca County, Texas	Leon County, Texas	Liberty County, Texas	Madison County, Texas
Total Population	14,391	35,604	252,051	19,210	15,335	70,154	12,940
Race Alone:							
White alone	9,546	27,320	130,604	15,579	12,366	52,289	7,801
Black or African American alone	1,081	6,302	84,482	1,287	1,583	8,952	2,915
American Indian and Alaska Native alone	42	125	654	28	45	284	30
Asian alone	55	111	7,236	26	23	218	50
Native Hawaiian and Other Pacific Islander alone	6	5	68	3	1	18	3
Some other race alone	6	10	185	18	12	69	5
Population of two or more races:	104	347	2,286	86	92	664	94
Total Racial Minority	1,294	6,900	94,911	1,448	1,756	10,205	3,097
Percent Racial Minority	9.0	19.4	37.7	7.5	11.5	14.5	23.9
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	0	0	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	3,551	1,384	26,536	2,183	1,213	7,660	2,042
Percent Hispanic	24.7	3.9	10.5	11.4	7.9	10.9	15.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	1	0	0	0	0	0	1
County Count Total by State							
Total Minority	4,845	8,284	121,447	3,631	2,969	17,865	5,139
Percent Minority	33.7	23.3	48.2	18.9	19.4	25.5	39.7
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	1	0	0	0	1
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Matagorda County, Texas	Montgomery County, Texas	Nacogdoches County, Texas	Newton County, Texas	Orange County, Texas	Polk County, Texas	Sabine County, Texas
Total Population	37,957	293,768	59,203	15,072	84,966	41,133	10,469
Race Alone:							
White alone	19,900	239,150	41,620	11,157	72,955	30,723	9,115
Black or African American alone	4,778	10,076	9,815	3,100	7,080	5,357	1,039
American Indian and Alaska Native alone	125	1,118	169	78	391	649	29
Asian alone	891	3,167	398	39	652	156	9
Native Hawaiian and Other Pacific Islander alone	6	80	23	5	19	3	3
Some other race alone	23	281	25	2	21	5	2
Population of two or more races:	336	2,746	493	120	775	379	83
Total Racial Minority	6,159	17,468	10,923	3,344	8,938	6,549	1,165
Percent Racial Minority	16.2	5.9	18.5	22.2	10.5	15.9	11.1
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	0	0	0
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	11,898	37,150	6,660	571	3,073	3,861	189
Percent Hispanic	31.3	12.6	11.2	3.8	3.6	9.4	1.8
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	1	1	0	0	0	0	0
County Count Total by State							
Total Minority	18,057	54,618	17,583	3,915	12,011	10,410	1,354
Percent Minority	47.6	18.6	29.7	26.0	14.1	25.3	12.9
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	1	0	0	0	0	0	0
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	San Augustine County, Texas	San Jacinto County, Texas	Trinity County, Texas	Tyler County, Texas	Victoria County, Texas	Walker County, Texas	Waller County, Texas
Total Population	8,946	22,246	13,779	20,871	84,088	61,758	32,663
Race Alone:							
White alone	6,066	17,972	11,289	17,290	44,490	37,090	16,289
Black or African American alone	2,484	2,796	1,635	2,491	5,137	14,672	9,496
American Indian and Alaska Native alone	11	81	50	87	197	169	88
Asian alone	18	63	31	41	635	464	121
Native Hawaiian and Other Pacific Islander alone	0	15	0	4	9	25	3
Some other race alone	1	11	1	17	39	70	26
Population of two or more races:	46	224	105	199	622	556	296
Total Racial Minority	2,560	3,190	1,822	2,839	6,639	15,956	10,030
Percent Racial Minority	28.6	14.3	13.2	13.6	7.9	25.8	30.7
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	1	0	0	0	0	0	1
County Count Total by State							
Ethnicity (Any Race):							
Hispanic or Latino	320	1,084	668	742	32,959	8,712	6,344
Percent Hispanic	3.6	4.9	4.8	3.6	39.2	14.1	19.4
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	1	1	1
County Count Total by State							
Total Minority	2,880	4,274	2,490	3,581	39,598	24,668	16,374
Percent Minority	32.2	19.2	18.1	17.2	47.1	39.9	50.1
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0	0	1	1	1
Number of counties with percent minority exceeding percent minority in Planting Range							

Attachment A-4 Potential Planting Range County Demographics Continued…

	Washington County, Texas	Wharton County, Texas	Texas Total	Texas Percent	Planting Range Total	Planting Range Percent
Total Population	30,373	41,188	5,959,603	100.0	**15,779,653**	**100.0**
Race Alone:						
White alone	21,515	21,832	3,087,137	51.8	**9,699,344**	**61.5**
Black or African American alone	5,604	6,060	999,004	16.8	**3,600,412**	**22.8**
American Indian and Alaska Native alone	49	59	15,050	0.3	**61,089**	**0.4**
Asian alone	363	113	245,163	4.1	**382,567**	**2.4**
Native Hawaiian and Other Pacific Islander alone	1	18	2,065	0.0	**6,041**	**0.0**
Some other race alone	8	15	6,684	0.1	**17,887**	**0.1**
Population of two or more races:	186	203	68,545	1.2	**177,851**	**1.1**
Total Racial Minority	6,211	6,468	1,336,511	22.4	**4,245,847**	**26.9**
Percent Racial Minority	20.4	15.7	22.4		**26.9**	
Percent Racial Minority Greater Than Planting Range (1 = yes, 0 = no)	0	0	0			
County Count Total by State			5	13.5	**71**	**41.3**
Ethnicity (Any Race):						
Hispanic or Latino	2,647	12,888	1,535,955	25.8	**1,834,462**	**11.6**
Percent Hispanic	8.7	31.3	25.8		**11.6**	
Percent Hispanic Greater Than Planting Range (1 = yes, 0 = no)	0	1				
County Count Total by State			19	51.4	**21**	**12.2**
Total Minority	8,858	19,356	2,872,466	48.2	**6,080,309**	**38.5**
Percent Minority	29.2	47.0	48.2		**38.5**	
Percent Minority Greater Than Planting Range (1 = yes, 0 = no)	0	1	1			
Number of counties with percent minority exceeding percent minority in Planting Range			10	27.0	**46**	**26.7**

Source: USCB 2000

Attachment A-5 Potential Planting Range Housing Data (2000)

Geographic Area	Total Housing	Occupied			Vacant		Median Value
		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Baldwin County, Alabama	74,285	55,336	44,036	11,300	18,949	25.5%	$105,300
Houston County, Alabama	39,571	35,834	24,893	10,941	3,737	9.4%	$74,500
Mobile County, Alabama	165,101	150,179	103,402	46,777	14,922	9.0%	$76,600
Alabama Planting Range Total	*278,957*	*241,349*	*172,331*	*69,018*	*37,608*	13.5%	*$85,467*
State of Alabama	**1,963,711**	**1,737,080**	**1,258,686**	**478,394**	**226,631**	**11.5%**	**$76,700**
Alachua County, Florida	95,113	87,509	48,084	39,425	7,604	8.0%	$88,400
Baker County, Florida	7,592	7,043	5,723	1,320	549	7.2%	$65,500
Bay County, Florida	78,435	59,597	40,892	18,705	18,838	24.0%	$83,700
Bradford County, Florida	9,605	8,497	6,709	1,788	1,108	11.5%	$64,000
Calhoun County, Florida	5,250	4,468	3,584	884	782	14.9%	$50,200
Clay County, Florida	53,748	50,243	39,120	11,123	3,505	6.5%	$97,400
Columbia County, Florida	23,579	20,925	16,137	4,788	2,654	11.3%	$63,300
Dixie County, Florida	7,362	5,205	4,500	705	2,157	29.3%	$45,100
Duval County, Florida	329,778	303,747	191,722	112,025	26,031	7.9%	$86,100
Escambia County, Florida	124,647	111,049	74,690	36,359	13,598	10.9%	$81,700
Flagler County, Florida	24,452	21,294	17,900	3,394	3,158	12.9%	$109,400
Franklin County, Florida	7,180	4,096	3,245	851	3,084	43.0%	$74,600
Gadsden County, Florida	17,703	15,867	12,379	3,488	1,836	10.4%	$61,200
Gilchrist County, Florida	5,906	5,021	4,326	695	885	15.0%	$63,600
Gulf County, Florida	7,587	4,931	3,995	936	2,656	35.0%	$67,900
Hamilton County, Florida	4,966	4,161	3,218	943	805	16.2%	$45,900
Holmes County, Florida	7,998	6,921	5,645	1,276	1,077	13.5%	$53,200
Jackson County, Florida	19,490	16,620	12,943	3,677	2,870	14.7%	$59,300
Jefferson County, Florida	5,251	4,695	3,798	897	556	10.6%	$69,900
Lafayette County, Florida	2,660	2,142	1,723	419	518	19.5%	$60,800
Leon County, Florida	103,974	96,521	55,014	41,507	7,453	7.2%	$100,600
Levy County, Florida	16,570	13,867	11,588	2,279	2,703	16.3%	$55,100
Liberty County, Florida	3,156	2,222	1,816	406	934	29.6%	$49,900
Madison County, Florida	7,836	6,629	5,197	1,432	1,207	15.4%	$51,900
Marion County, Florida	122,663	106,755	85,171	21,584	15,908	13.0%	$70,100
Nassau County, Florida	25,917	21,980	17,732	4,248	3,937	15.2%	$98,000
Okaloosa County, Florida	78,593	66,269	43,972	22,297	12,324	15.7%	$96,800
Putnam County, Florida	33,870	27,839	22,265	5,574	6,031	17.8%	$54,100
St. Johns County, Florida	58,008	49,614	37,889	11,725	8,394	14.5%	$140,700
Santa Rosa County, Florida	49,119	43,793	35,198	8,595	5,326	10.8%	$96,300
Suwannee County, Florida	15,679	13,460	10,903	2,557	2,219	14.2%	$57,900
Taylor County, Florida	9,646	7,176	5,725	1,451	2,470	25.6%	$53,900
Union County, Florida	3,736	3,367	2,509	858	369	9.9%	$56,000
Wakulla County, Florida	9,820	8,450	7,116	1,334	1,370	14.0%	$79,900
Walton County, Florida	29,083	16,548	13,072	3,476	12,535	43.1%	$77,500
Washington County, Florida	9,503	7,931	6,492	1,439	1,572	16.5%	$64,400
Florida Planting Range Total	*1,415,475*	*1,236,452*	*861,992*	*374,460*	*179,023*	12.6%	*$72,064*
State of Florida	**7,302,947**	**6,337,929**	**4,441,711**	**1,896,218**	**965,018**	**13.2%**	**$93,200**
Atkinson County, Georgia	3,171	2,717	2,015	702	454	14.3%	$32,500
Bacon County, Georgia	4,464	3,833	2,870	963	631	14.1%	$46,400
Baker County, Georgia	1,740	1,514	1,175	339	226	13.0%	$50,200
Berrien County, Georgia	7,100	6,261	4,733	1,528	839	11.8%	$53,900
Brantley County, Georgia	6,490	5,436	4,723	713	1,054	16.2%	$39,400
Brooks County, Georgia	7,118	6,155	4,731	1,424	963	13.5%	$55,400

Attachment A-5 Potential Planting Range Housing Data (2000) Continued

Geographic Area	Total Housing	Occupied			Vacant		Median Value
		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Bryan County, Georgia	8,675	8,089	6,312	1,777	586	6.8%	$94,900
Camden County, Georgia	16,958	14,705	9,299	5,406	2,253	13.3%	$79,200
Charlton County, Georgia	3,859	3,342	2,697	645	517	13.4%	$51,400
Chatham County, Georgia	99,683	89,865	54,288	35,577	9,818	9.8%	$91,500
Clinch County, Georgia	2,837	2,512	1,818	694	325	11.5%	$43,700
Coffee County, Georgia	15,610	13,354	9,935	3,419	2,256	14.5%	$49,800
Colquitt County, Georgia	17,554	15,495	10,333	5,162	2,059	11.7%	$55,500
Cook County, Georgia	6,558	5,882	4,408	1,474	676	10.3%	$53,200
Decatur County, Georgia	11,968	10,380	7,525	2,855	1,588	13.3%	$61,800
Early County, Georgia	5,338	4,695	3,401	1,294	643	12.0%	$46,600
Echols County, Georgia	1,482	1,264	957	307	218	14.7%	$56,700
Effingham County, Georgia	14,169	13,151	10,871	2,280	1,018	7.2%	$87,400
Glynn County, Georgia	32,636	27,208	17,818	9,390	5,428	16.6%	$97,200
Grady County, Georgia	9,991	8,797	6,449	2,348	1,194	12.0%	$64,100
Lanier County, Georgia	3,011	2,593	1,979	614	418	13.9%	$50,300
Liberty County, Georgia	21,977	19,383	9,824	9,559	2,594	11.8%	$73,800
Long County, Georgia	4,232	3,574	2,366	1,208	658	15.5%	$53,700
Lowndes County, Georgia	36,551	32,654	19,865	12,789	3,897	10.7%	$79,800
McIntosh County, Georgia	5,735	4,202	3,510	692	1,533	26.7%	$53,500
Miller County, Georgia	2,770	2,487	1,913	574	283	10.2%	$49,000
Mitchell County, Georgia	8,880	8,063	5,803	2,260	817	9.2%	$55,500
Pierce County, Georgia	6,719	5,958	4,808	1,150	761	11.3%	$52,000
Seminole County, Georgia	4,742	3,573	2,887	686	1,169	24.7%	$52,200
Thomas County, Georgia	18,285	16,309	11,409	4,900	1,976	10.8%	$68,100
Ware County, Georgia	15,831	13,475	9,472	4,003	2,356	14.9%	$52,500
Wayne County, Georgia	10,827	9,324	7,129	2,195	1,503	13.9%	$56,200
Georgia Planting Range Total	*416,961*	*366,250*	*247,323*	*118,927*	*50,711*	12.2%	*$59,606*
State of Georgia	**3,281,737**	**3,006,369**	**2,029,293**	**977,076**	**275,368**	**8.4%**	**$100,600**
Acadia Parish, Louisiana	23,209	21,142	15,259	5,883	2,067	8.9%	$54,800
Allen Parish, Louisiana	9,157	8,102	6,160	1,942	1,055	11.5%	$51,800
Ascension Parish, Louisiana	29,172	26,691	21,952	4,739	2,481	8.5%	$89,900
Assumption Parish, Louisiana	9,635	8,239	6,928	1,311	1,396	14.5%	$58,400
Avoyelles Parish, Louisiana	16,576	14,736	10,968	3,768	1,840	11.1%	$52,000
Beauregard Parish, Louisiana	14,501	12,104	9,664	2,440	2,397	16.5%	$55,600
Calcasieu Parish, Louisiana	75,995	68,613	49,085	19,528	7,382	9.7%	$70,300
Cameron Parish, Louisiana	5,336	3,592	3,061	531	1,744	32.7%	$51,000
Catahoula Parish, Louisiana	5,351	4,082	3,390	692	1,269	23.7%	$38,000
Concordia Parish, Louisiana	9,148	7,521	5,723	1,798	1,627	17.8%	$47,200
East Baton Rouge Parish, Louisiana	169,073	156,365	96,305	60,060	12,708	7.5%	$96,600
East Feliciana Parish, Louisiana	7,915	6,699	5,517	1,182	1,216	15.4%	$67,000
Evangeline Parish, Louisiana	14,258	12,736	8,837	3,899	1,522	10.7%	$48,300
Grant Parish, Louisiana	8,531	7,073	5,776	1,297	1,458	17.1%	$50,900
Iberia Parish, Louisiana	27,844	25,381	18,628	6,753	2,463	8.8%	$64,700
Iberville Parish, Louisiana	11,953	10,674	8,249	2,425	1,279	10.7%	$64,000
Jefferson Parish, Louisiana	187,907	176,234	112,534	63,700	11,673	6.2%	$102,800
Jefferson Davis Parish, Louisiana	12,824	11,480	8,596	2,884	1,344	10.5%	$56,400
Lafayette Parish, Louisiana	78,122	72,372	47,803	24,569	5,750	7.4%	$91,400
Lafourche Parish, Louisiana	35,045	32,057	24,988	7,069	2,988	8.5%	$71,100

Attachment A-5 Potential Planting Range Housing Data (2000) Continued

Geographic Area	Total Housing	Occupied			Vacant		Median Value
		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
La Salle Parish, Louisiana	6,273	5,291	4,416	875	982	15.7%	$43,300
Livingston Parish, Louisiana	36,212	32,630	27,337	5,293	3,582	9.9%	$79,600
Natchitoches Parish, Louisiana	16,890	14,263	9,200	5,063	2,627	15.6%	$61,500
Orleans Parish, Louisiana	215,091	188,251	87,535	100,716	26,840	12.5%	$88,100
Plaquemines Parish, Louisiana	10,481	9,021	7,114	1,907	1,460	13.9%	$68,900
Pointe Coupee Parish, Louisiana	10,297	8,397	6,523	1,874	1,900	18.5%	$68,400
Rapides Parish, Louisiana	52,038	47,120	32,055	15,065	4,918	9.5%	$68,300
St. Bernard Parish, Louisiana	26,790	25,123	18,758	6,365	1,667	6.2%	$82,900
St. Charles Parish, Louisiana	17,430	16,422	13,370	3,052	1,008	5.8%	$96,300
St. Helena Parish, Louisiana	5,034	3,873	3,291	582	1,161	23.1%	$55,100
St. James Parish, Louisiana	7,605	6,992	5,984	1,008	613	8.1%	$69,300
St. John the Baptist Parish, Louisiana	15,532	14,283	11,569	2,714	1,249	8.0%	$79,000
St. Landry Parish, Louisiana	36,216	32,328	22,869	9,459	3,888	10.7%	$53,800
St. Martin Parish, Louisiana	20,245	17,164	14,022	3,142	3,081	15.2%	$59,400
St. Mary Parish, Louisiana	21,650	19,317	14,275	5,042	2,333	10.8%	$63,100
St. Tammany Parish, Louisiana	75,398	69,253	55,732	13,521	6,145	8.2%	$116,000
Tangipahoa Parish, Louisiana	40,794	36,558	26,805	9,753	4,236	10.4%	$73,000
Tensas Parish, Louisiana	3,359	2,416	1,676	740	943	28.1%	$42,500
Terrebonne Parish, Louisiana	39,928	35,997	27,193	8,804	3,931	9.8%	$72,200
Vermilion Parish, Louisiana	22,461	19,832	15,267	4,565	2,629	11.7%	$58,900
Vernon Parish, Louisiana	21,030	18,260	10,360	7,900	2,770	13.2%	$56,400
Washington Parish, Louisiana	19,106	16,467	12,592	3,875	2,639	13.8%	$52,800
West Baton Rouge Parish, Louisiana	8,370	7,663	6,036	1,627	707	8.4%	$74,400
Louisiana Planting Range Total	*1,479,782*	*1,332,814*	*903,402*	*429,412*	*146,968*	9.9%	*$66,637*
State of Louisiana	**1,847,181**	**1,656,053**	**1,124,995**	**531,058**	**191,128**	**10.3%**	**$77,500**
Adams County, Mississippi	15,175	13,677	9,602	4,075	1,498	9.9%	$57,900
Claiborne County, Mississippi	4,252	3,685	2,960	725	567	13.3%	$42,200
George County, Mississippi	7,513	6,742	5,814	928	771	10.3%	$60,100
Hancock County, Mississippi	21,072	16,897	13,457	3,440	4,175	19.8%	$82,100
Harrison County, Mississippi	79,636	71,538	44,845	26,693	8,098	10.2%	$82,000
Jackson County, Mississippi	51,678	47,676	35,548	12,128	4,002	7.7%	$75,400
Jefferson County, Mississippi	3,819	3,308	2,661	647	511	13.4%	$41,900
Lamar County, Mississippi	15,433	14,396	10,912	3,484	1,037	6.7%	$86,000
Marion County, Mississippi	10,395	9,336	7,506	1,830	1,059	10.2%	$52,800
Pearl River County, Mississippi	20,610	18,078	14,426	3,652	2,532	12.3%	$70,200
Perry County, Mississippi	5,107	4,420	3,738	682	687	13.5%	$46,900
Stone County, Mississippi	5,343	4,747	3,861	886	596	11.2%	$69,900
Wilkinson County, Mississippi	5,106	3,578	2,974	604	1,528	29.9%	$39,700
Mississippi Planting Range Total	*245,139*	*218,078*	*158,304*	*59,774*	*27,061*	11.0%	*$62,085*
State of Mississippi	**1,161,953**	**1,046,434**	**757,151**	**289,283**	**115,519**	**9.9%**	**$64,700**
Beaufort County, South Carolina	60,509	45,532	33,363	12,169	14,977	24.8%	$168,100
Berkeley County, South Carolina	54,717	49,922	37,042	12,880	4,795	8.8%	$79,900
Charleston County, South Carolina	141,031	123,326	75,291	48,035	17,705	12.6%	$117,700
Colleton County, South Carolina	18,129	14,470	11,612	2,858	3,659	20.2%	$62,200

Attachment A-5 Potential Planting Range Housing Data (2000) Continued

Geographic Area	Total Housing	Occupied			Vacant		Median Value
		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Dorchester County, South Carolina	37,237	34,709	26,027	8,682	2,528	6.8%	$92,200
Georgetown County, South Carolina	28,282	21,659	17,606	4,053	6,623	23.4%	$83,700
Hampton County, South Carolina	8,582	7,444	5,817	1,627	1,138	13.3%	$51,400
Jasper County, South Carolina	7,928	7,042	5,476	1,566	886	11.2%	$64,900
South Carolina Planting Range Total	*356,415*	*304,104*	*212,234*	*91,870*	*52,311*	14.7%	*$90,013*
State of South Carolina	**1,753,670**	**1,533,854**	**1,107,619**	**426,235**	**219,816**	**12.5%**	**$83,100**
Angelina County, Texas	32,435	28,685	20,775	7,910	3,750	11.6%	$57,000
Austin County, Texas	10,205	8,747	6,754	1,993	1,458	14.3%	$84,400
Brazoria County, Texas	90,628	81,954	60,682	21,272	8,674	9.6%	$81,000
Brazos County, Texas	59,023	55,202	25,147	30,055	3,821	6.5%	$88,200
Burleson County, Texas	8,197	6,363	5,064	1,299	1,834	22.4%	$53,100
Calhoun County, Texas	10,238	7,442	5,416	2,026	2,796	27.3%	$51,400
Chambers County, Texas	10,336	9,139	7,637	1,502	1,197	11.6%	$71,100
Colorado County, Texas	9,431	7,641	5,858	1,783	1,790	19.0%	$60,200
Fort Bend County, Texas	115,991	110,915	89,628	21,287	5,076	4.4%	$110,800
Galveston County, Texas	111,733	94,782	62,790	31,992	16,951	15.2%	$81,900
Grimes County, Texas	9,490	7,753	6,032	1,721	1,737	18.3%	$57,100
Hardin County, Texas	19,836	17,805	14,694	3,111	2,031	10.2%	$62,100
Harris County, Texas	1,298,130	1,205,516	667,129	538,387	92,614	7.1%	$84,200
Houston County, Texas	10,730	8,259	6,283	1,976	2,471	23.0%	$48,400
Jackson County, Texas	6,545	5,336	3,935	1,401	1,209	18.5%	$52,200
Jasper County, Texas	16,576	13,450	10,840	2,610	3,126	18.9%	$52,900
Jefferson County, Texas	102,080	92,880	61,253	31,627	9,200	9.0%	$58,300
Lavaca County, Texas	9,657	7,669	6,012	1,657	1,988	20.6%	$61,500
Leon County, Texas	8,299	6,189	5,125	1,064	2,110	25.4%	$60,800
Liberty County, Texas	26,359	23,242	18,362	4,880	3,117	11.8%	$55,100
Madison County, Texas	4,797	3,914	3,014	900	883	18.4%	$55,300
Matagorda County, Texas	18,611	13,901	9,287	4,614	4,710	25.3%	$56,700
Montgomery County, Texas	112,770	103,296	80,750	22,546	9,474	8.4%	$95,600
Nacogdoches County, Texas	25,051	22,006	13,540	8,466	3,045	12.2%	$65,500
Newton County, Texas	7,331	5,583	4,718	865	1,748	23.8%	$43,100
Orange County, Texas	34,781	31,642	24,436	7,206	3,139	9.0%	$57,100
Polk County, Texas	21,177	15,119	12,343	2,776	6,058	28.6%	$50,600
Sabine County, Texas	7,659	4,485	3,868	617	3,174	41.4%	$47,000
San Augustine County, Texas	5,356	3,575	2,916	659	1,781	33.3%	$45,100
San Jacinto County, Texas	11,520	8,651	7,602	1,049	2,869	24.9%	$54,200
Trinity County, Texas	8,141	5,723	4,622	1,101	2,418	29.7%	$48,300
Tyler County, Texas	10,419	7,775	6,531	1,244	2,644	25.4%	$46,400
Victoria County, Texas	32,945	30,071	20,257	9,814	2,874	8.7%	$68,600
Walker County, Texas	21,099	18,303	10,959	7,344	2,796	13.3%	$67,700
Waller County, Texas	11,955	10,557	7,649	2,908	1,398	11.7%	$77,500
Washington County, Texas	13,241	11,322	8,327	2,995	1,919	14.5%	$85,600
Wharton County, Texas	16,606	14,799	10,176	4,623	1,807	10.9%	$56,700
Texas Planting Range Total	*2,329,378*	*2,109,691*	*1,320,411*	*789,280*	*219,687*	9.4%	*$63,586*
State of Texas	**8,157,575**	**7,393,354**	**4,717,294**	**2,676,060**	**764,221**	**9.4%**	**$77,800**

Attachment A-6 Potential Planting Range Housing Data Sorted by Median Value (2000)

	Total	Occupied			Vacant		Median
State	**Housing**	**Total**	**Owner Occupied**	**Renter Occupied**	**Vacant**	**Vacancy Rate**	**Value**
State of Georgia	**3,281,737**	**3,006,369**	**2,029,293**	**977,076**	**275,368**	**8.4%**	**$100,600**
State of Florida	**7,302,947**	**6,337,929**	**4,441,711**	**1,896,218**	**965,018**	**13.2%**	**$93,200**
State of South Carolina	**1,753,670**	**1,533,854**	**1,107,619**	**426,235**	**219,816**	**12.5%**	**$83,100**
State of Texas	**8,157,575**	**7,393,354**	**4,717,294**	**2,676,060**	**764,221**	**9.4%**	**$77,800**
State of Louisiana	**1,847,181**	**1,656,053**	**1,124,995**	**531,058**	**191,128**	**10.3%**	**$77,500**
State of Alabama	**1,963,711**	**1,737,080**	**1,258,686**	**478,394**	**226,631**	**11.5%**	**$76,700**
State of Mississippi	**1,161,953**	**1,046,434**	**757,151**	**289,283**	**115,519**	**9.9%**	**$64,700**

	Total	Occupied			Vacant		Median
State Planting Range	**Housing**	**Total**	**Owner Occupied**	**Renter Occupied**	**Vacant**	**Vacancy Rate**	**Value**
South Carolina Planting Range Total	*356,415*	*304,104*	*212,234*	*91,870*	*52,311*	14.7%	*$90,013*
Alabama Planting Range Total	*278,957*	*241,349*	*172,331*	*69,018*	*37,608*	13.5%	*$85,467*
Florida Planting Range Total	*1,415,475*	*1,236,452*	*861,992*	*374,460*	*179,023*	12.6%	*$72,064*
Louisiana Planting Range Total	*1,479,782*	*1,332,814*	*903,402*	*429,412*	*146,968*	9.9%	*$66,637*
Texas Planting Range Total	*2,329,378*	*2,109,691*	*1,320,411*	*789,280*	*219,687*	9.4%	*$63,586*
Mississippi Planting Range Total	*245,139*	*218,078*	*158,304*	*59,774*	*27,061*	11.0%	*$62,085*
Georgia Planting Range Total	*416,961*	*366,250*	*247,323*	*118,927*	*50,711*	12.2%	*$59,606*

	Total	Occupied			Vacant		Median
County	**Housing**	**Total**	**Owner Occupied**	**Renter Occupied**	**Vacant**	**Vacancy Rate**	**Value**
Beaufort County, South Carolina	60,509	45,532	33,363	12,169	14,977	24.8%	$168,100
St. Johns County, Florida	58,008	49,614	37,889	11,725	8,394	14.5%	$140,700
Charleston County, South Carolina	141,031	123,326	75,291	48,035	17,705	12.6%	$117,700
St. Tammany Parish, Louisiana	75,398	69,253	55,732	13,521	6,145	8.2%	$116,000
Fort Bend County, Texas	115,991	110,915	89,628	21,287	5,076	4.4%	$110,800
Flagler County, Florida	24,452	21,294	17,900	3,394	3,158	12.9%	$109,400
Baldwin County, Alabama	74,285	55,336	44,036	11,300	18,949	25.5%	$105,300
Jefferson Parish, Louisiana	187,907	176,234	112,534	63,700	11,673	6.2%	$102,800
Leon County, Florida	103,974	96,521	55,014	41,507	7,453	7.2%	$100,600
Nassau County, Florida	25,917	21,980	17,732	4,248	3,937	15.2%	$98,000
Clay County, Florida	53,748	50,243	39,120	11,123	3,505	6.5%	$97,400
Glynn County, Georgia	32,636	27,208	17,818	9,390	5,428	16.6%	$97,200
Okaloosa County, Florida	78,593	66,269	43,972	22,297	12,324	15.7%	$96,800
East Baton Rouge Parish, Louisiana	169,073	156,365	96,305	60,060	12,708	7.5%	$96,600
Santa Rosa County, Florida	49,119	43,793	35,198	8,595	5,326	10.8%	$96,300
St. Charles Parish, Louisiana	17,430	16,422	13,370	3,052	1,008	5.8%	$96,300
Montgomery County, Texas	112,770	103,296	80,750	22,546	9,474	8.4%	$95,600
Bryan County, Georgia	8,675	8,089	6,312	1,777	586	6.8%	$94,900

Attachment A-6 Potential Planting Range Housing Data Sorted by Median Value (2000) Continued

	Total Housing	Occupied			Vacant		Median Value
County		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Dorchester County, South Carolina	37,237	34,709	26,027	8,682	2,528	6.8%	$92,200
Chatham County, Georgia	99,683	89,865	54,288	35,577	9,818	9.8%	$91,500
Lafayette Parish, Louisiana	78,122	72,372	47,803	24,569	5,750	7.4%	$91,400
Ascension Parish, Louisiana	29,172	26,691	21,952	4,739	2,481	8.5%	$89,900
Alachua County, Florida	95,113	87,509	48,084	39,425	7,604	8.0%	$88,400
Brazos County, Texas	59,023	55,202	25,147	30,055	3,821	6.5%	$88,200
Orleans Parish, Louisiana	215,091	188,251	87,535	100,716	26,840	12.5%	$88,100
Effingham County, Georgia	14,169	13,151	10,871	2,280	1,018	7.2%	$87,400
Duval County, Florida	329,778	303,747	191,722	112,025	26,031	7.9%	$86,100
Lamar County, Mississippi	15,433	14,396	10,912	3,484	1,037	6.7%	$86,000
Washington County, Texas	13,241	11,322	8,327	2,995	1,919	14.5%	$85,600
Austin County, Texas	10,205	8,747	6,754	1,993	1,458	14.3%	$84,400
Harris County, Texas	1,298,130	1,205,516	667,129	538,387	92,614	7.1%	$84,200
Bay County, Florida	78,435	59,597	40,892	18,705	18,838	24.0%	$83,700
Georgetown County, South Carolina	28,282	21,659	17,606	4,053	6,623	23.4%	$83,700
St. Bernard Parish, Louisiana	26,790	25,123	18,758	6,365	1,667	6.2%	$82,900
Hancock County, Mississippi	21,072	16,897	13,457	3,440	4,175	19.8%	$82,100
Harrison County, Mississippi	79,636	71,538	44,845	26,693	8,098	10.2%	$82,000
Galveston County, Texas	111,733	94,782	62,790	31,992	16,951	15.2%	$81,900
Escambia County, Florida	124,647	111,049	74,690	36,359	13,598	10.9%	$81,700
Brazoria County, Texas	90,628	81,954	60,682	21,272	8,674	9.6%	$81,000
Wakulla County, Florida	9,820	8,450	7,116	1,334	1,370	14.0%	$79,900
Berkeley County, South Carolina	54,717	49,922	37,042	12,880	4,795	8.8%	$79,900
Lowndes County, Georgia	36,551	32,654	19,865	12,789	3,897	10.7%	$79,800
Livingston Parish, Louisiana	36,212	32,630	27,337	5,293	3,582	9.9%	$79,600
Camden County, Georgia	16,958	14,705	9,299	5,406	2,253	13.3%	$79,200
St. John the Baptist Parish, Louisiana	15,532	14,283	11,569	2,714	1,249	8.0%	$79,000
Walton County, Florida	29,083	16,548	13,072	3,476	12,535	43.1%	$77,500
Waller County, Texas	11,955	10,557	7,649	2,908	1,398	11.7%	$77,500
Mobile County, Alabama	165,101	150,179	103,402	46,777	14,922	9.0%	$76,600
Jackson County, Mississippi	51,678	47,676	35,548	12,128	4,002	7.7%	$75,400
Franklin County, Florida	7,180	4,096	3,245	851	3,084	43.0%	$74,600
Houston County, Alabama	39,571	35,834	24,893	10,941	3,737	9.4%	$74,500
West Baton Rouge Parish, Louisiana	8,370	7,663	6,036	1,627	707	8.4%	$74,400
Liberty County, Georgia	21,977	19,383	9,824	9,559	2,594	11.8%	$73,800
Tangipahoa Parish, Louisiana	40,794	36,558	26,805	9,753	4,236	10.4%	$73,000
Terrebonne Parish, Louisiana	39,928	35,997	27,193	8,804	3,931	9.8%	$72,200
Lafourche Parish, Louisiana	35,045	32,057	24,988	7,069	2,988	8.5%	$71,100
Chambers County, Texas	10,336	9,139	7,637	1,502	1,197	11.6%	$71,100
Calcasieu Parish, Louisiana	75,995	68,613	49,085	19,528	7,382	9.7%	$70,300
Pearl River County, Mississippi	20,610	18,078	14,426	3,652	2,532	12.3%	$70,200

Attachment A-6 Potential Planting Range Housing Data Sorted by Median Value (2000) Continued

	Total Housing	Occupied			Vacant		Median Value
County		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Marion County, Florida	122,663	106,755	85,171	21,584	15,908	13.0%	$70,100
Jefferson County, Florida	5,251	4,695	3,798	897	556	10.6%	$69,900
Stone County, Mississippi	5,343	4,747	3,861	886	596	11.2%	$69,900
St. James Parish, Louisiana	7,605	6,992	5,984	1,008	613	8.1%	$69,300
Plaquemines Parish, Louisiana	10,481	9,021	7,114	1,907	1,460	13.9%	$68,900
Victoria County, Texas	32,945	30,071	20,257	9,814	2,874	8.7%	$68,600
Pointe Coupee Parish, Louisiana	10,297	8,397	6,523	1,874	1,900	18.5%	$68,400
Rapides Parish, Louisiana	52,038	47,120	32,055	15,065	4,918	9.5%	$68,300
Thomas County, Georgia	18,285	16,309	11,409	4,900	1,976	10.8%	$68,100
Gulf County, Florida	7,587	4,931	3,995	936	2,656	35.0%	$67,900
Walker County, Texas	21,099	18,303	10,959	7,344	2,796	13.3%	$67,700
East Feliciana Parish, Louisiana	7,915	6,699	5,517	1,182	1,216	15.4%	$67,000
Baker County, Florida	7,592	7,043	5,723	1,320	549	7.2%	$65,500
Nacogdoches County, Texas	25,051	22,006	13,540	8,466	3,045	12.2%	$65,500
Jasper County, South Carolina	7,928	7,042	5,476	1,566	886	11.2%	$64,900
Iberia Parish, Louisiana	27,844	25,381	18,628	6,753	2,463	8.8%	$64,700
Washington County, Florida	9,503	7,931	6,492	1,439	1,572	16.5%	$64,400
Grady County, Georgia	9,991	8,797	6,449	2,348	1,194	12.0%	$64,100
Bradford County, Florida	9,605	8,497	6,709	1,788	1,108	11.5%	$64,000
Iberville Parish, Louisiana	11,953	10,674	8,249	2,425	1,279	10.7%	$64,000
Gilchrist County, Florida	5,906	5,021	4,326	695	885	15.0%	$63,600
Columbia County, Florida	23,579	20,925	16,137	4,788	2,654	11.3%	$63,300
St. Mary Parish, Louisiana	21,650	19,317	14,275	5,042	2,333	10.8%	$63,100
Colleton County, South Carolina	18,129	14,470	11,612	2,858	3,659	20.2%	$62,200
Hardin County, Texas	19,836	17,805	14,694	3,111	2,031	10.2%	$62,100
Decatur County, Georgia	11,968	10,380	7,525	2,855	1,588	13.3%	$61,800
Natchitoches Parish, Louisiana	16,890	14,263	9,200	5,063	2,627	15.6%	$61,500
Lavaca County, Texas	9,657	7,669	6,012	1,657	1,988	20.6%	$61,500
Gadsden County, Florida	17,703	15,867	12,379	3,488	1,836	10.4%	$61,200
Lafayette County, Florida	2,660	2,142	1,723	419	518	19.5%	$60,800
Leon County, Texas	8,299	6,189	5,125	1,064	2,110	25.4%	$60,800
Colorado County, Texas	9,431	7,641	5,858	1,783	1,790	19.0%	$60,200
George County, Mississippi	7,513	6,742	5,814	928	771	10.3%	$60,100
St. Martin Parish, Louisiana	20,245	17,164	14,022	3,142	3,081	15.2%	$59,400
Jackson County, Florida	19,490	16,620	12,943	3,677	2,870	14.7%	$59,300
Vermilion Parish, Louisiana	22,461	19,832	15,267	4,565	2,629	11.7%	$58,900
Assumption Parish, Louisiana	9,635	8,239	6,928	1,311	1,396	14.5%	$58,400
Jefferson County, Texas	102,080	92,880	61,253	31,627	9,200	9.0%	$58,300
Suwannee County, Florida	15,679	13,460	10,903	2,557	2,219	14.2%	$57,900
Adams County, Mississippi	15,175	13,677	9,602	4,075	1,498	9.9%	$57,900
Grimes County, Texas	9,490	7,753	6,032	1,721	1,737	18.3%	$57,100

Attachment A-6 Potential Planting Range Housing Data Sorted by Median Value (2000) Continued

	Total Housing	Occupied			Vacant		Median Value
County		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Orange County, Texas	34,781	31,642	24,436	7,206	3,139	9.0%	$57,100
Angelina County, Texas	32,435	28,685	20,775	7,910	3,750	11.6%	$57,000
Echols County, Georgia	1,482	1,264	957	307	218	14.7%	$56,700
Matagorda County, Texas	18,611	13,901	9,287	4,614	4,710	25.3%	$56,700
Wharton County, Texas	16,606	14,799	10,176	4,623	1,807	10.9%	$56,700
Jefferson Davis Parish, Louisiana	12,824	11,480	8,596	2,884	1,344	10.5%	$56,400
Vernon Parish, Louisiana	21,030	18,260	10,360	7,900	2,770	13.2%	$56,400
Wayne County, Georgia	10,827	9,324	7,129	2,195	1,503	13.9%	$56,200
Union County, Florida	3,736	3,367	2,509	858	369	9.9%	$56,000
Beauregard Parish, Louisiana	14,501	12,104	9,664	2,440	2,397	16.5%	$55,600
Colquitt County, Georgia	17,554	15,495	10,333	5,162	2,059	11.7%	$55,500
Mitchell County, Georgia	8,880	8,063	5,803	2,260	817	9.2%	$55,500
Brooks County, Georgia	7,118	6,155	4,731	1,424	963	13.5%	$55,400
Madison County, Texas	4,797	3,914	3,014	900	883	18.4%	$55,300
Levy County, Florida	16,570	13,867	11,588	2,279	2,703	16.3%	$55,100
St. Helena Parish, Louisiana	5,034	3,873	3,291	582	1,161	23.1%	$55,100
Liberty County, Texas	26,359	23,242	18,362	4,880	3,117	11.8%	$55,100
Acadia Parish, Louisiana	23,209	21,142	15,259	5,883	2,067	8.9%	$54,800
San Jacinto County, Texas	11,520	8,651	7,602	1,049	2,869	24.9%	$54,200
Putnam County, Florida	33,870	27,839	22,265	5,574	6,031	17.8%	$54,100
Taylor County, Florida	9,646	7,176	5,725	1,451	2,470	25.6%	$53,900
Berrien County, Georgia	7,100	6,261	4,733	1,528	839	11.8%	$53,900
St. Landry Parish, Louisiana	36,216	32,328	22,869	9,459	3,888	10.7%	$53,800
Long County, Georgia	4,232	3,574	2,366	1,208	658	15.5%	$53,700
McIntosh County, Georgia	5,735	4,202	3,510	692	1,533	26.7%	$53,500
Holmes County, Florida	7,998	6,921	5,645	1,276	1,077	13.5%	$53,200
Cook County, Georgia	6,558	5,882	4,408	1,474	676	10.3%	$53,200
Burleson County, Texas	8,197	6,363	5,064	1,299	1,834	22.4%	$53,100
Jasper County, Texas	16,576	13,450	10,840	2,610	3,126	18.9%	$52,900
Washington Parish, Louisiana	19,106	16,467	12,592	3,875	2,639	13.8%	$52,800
Marion County, Mississippi	10,395	9,336	7,506	1,830	1,059	10.2%	$52,800
Ware County, Georgia	15,831	13,475	9,472	4,003	2,356	14.9%	$52,500
Seminole County, Georgia	4,742	3,573	2,887	686	1,169	24.7%	$52,200
Jackson County, Texas	6,545	5,336	3,935	1,401	1,209	18.5%	$52,200
Pierce County, Georgia	6,719	5,958	4,808	1,150	761	11.3%	$52,000
Avoyelles Parish, Louisiana	16,576	14,736	10,968	3,768	1,840	11.1%	$52,000
Madison County, Florida	7,836	6,629	5,197	1,432	1,207	15.4%	$51,900
Allen Parish, Louisiana	9,157	8,102	6,160	1,942	1,055	11.5%	$51,800
Charlton County, Georgia	3,859	3,342	2,697	645	517	13.4%	$51,400
Hampton County, South Carolina	8,582	7,444	5,817	1,627	1,138	13.3%	$51,400
Calhoun County, Texas	10,238	7,442	5,416	2,026	2,796	27.3%	$51,400
Cameron Parish, Louisiana	5,336	3,592	3,061	531	1,744	32.7%	$51,000
Grant Parish, Louisiana	8,531	7,073	5,776	1,297	1,458	17.1%	$50,900
Polk County, Texas	21,177	15,119	12,343	2,776	6,058	28.6%	$50,600

Attachment A-6 Potential Planting Range Housing Data Sorted by Median Value (2000) Continued

	Total Housing	Occupied			Vacant		Median Value
County		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Lanier County, Georgia	3,011	2,593	1,979	614	418	13.9%	$50,300
Calhoun County, Florida	5,250	4,468	3,584	884	782	14.9%	$50,200
Baker County, Georgia	1,740	1,514	1,175	339	226	13.0%	$50,200
Liberty County, Florida	3,156	2,222	1,816	406	934	29.6%	$49,900
Coffee County, Georgia	15,610	13,354	9,935	3,419	2,256	14.5%	$49,800
Miller County, Georgia	2,770	2,487	1,913	574	283	10.2%	$49,000
Houston County, Texas	10,730	8,259	6,283	1,976	2,471	23.0%	$48,400
Evangeline Parish, Louisiana	14,258	12,736	8,837	3,899	1,522	10.7%	$48,300
Trinity County, Texas	8,141	5,723	4,622	1,101	2,418	29.7%	$48,300
Concordia Parish, Louisiana	9,148	7,521	5,723	1,798	1,627	17.8%	$47,200
Sabine County, Texas	7,659	4,485	3,868	617	3,174	41.4%	$47,000
Perry County, Mississippi	5,107	4,420	3,738	682	687	13.5%	$46,900
Early County, Georgia	5,338	4,695	3,401	1,294	643	12.0%	$46,600
Bacon County, Georgia	4,464	3,833	2,870	963	631	14.1%	$46,400
Tyler County, Texas	10,419	7,775	6,531	1,244	2,644	25.4%	$46,400
Hamilton County, Florida	4,966	4,161	3,218	943	805	16.2%	$45,900
Dixie County, Florida	7,362	5,205	4,500	705	2,157	29.3%	$45,100
San Augustine County, Texas	5,356	3,575	2,916	659	1,781	33.3%	$45,100
Clinch County, Georgia	2,837	2,512	1,818	694	325	11.5%	$43,700
La Salle Parish, Louisiana	6,273	5,291	4,416	875	982	15.7%	$43,300
Newton County, Texas	7,331	5,583	4,718	865	1,748	23.8%	$43,100
Tensas Parish, Louisiana	3,359	2,416	1,676	740	943	28.1%	$42,500
Claiborne County, Mississippi	4,252	3,685	2,960	725	567	13.3%	$42,200
Jefferson County, Mississippi	3,819	3,308	2,661	647	511	13.4%	$41,900
Wilkinson County, Mississippi	5,106	3,578	2,974	604	1,528	29.9%	$39,700
Brantley County, Georgia	6,490	5,436	4,723	713	1,054	16.2%	$39,400
Catahoula Parish, Louisiana	5,351	4,082	3,390	692	1,269	23.7%	$38,000
Atkinson County, Georgia	3,171	2,717	2,015	702	454	14.3%	$32,500

Attachment A-7 Potential Planting Range Housing Data Sorted by Vacancy Rate (2000)

	Total Housing	Occupied			Vacant		Median Value
State		**Total**	**Owner Occupied**	**Renter Occupied**	**Vacant**	**Vacancy Rate**	
State of Florida	**7,302,947**	**6,337,929**	**4,441,711**	**1,896,218**	**965,018**	**13.2%**	**$93,200**
State of South Carolina	**1,753,670**	**1,533,854**	**1,107,619**	**426,235**	**219,816**	**12.5%**	**$83,100**
State of Alabama	**1,963,711**	**1,737,080**	**1,258,686**	**478,394**	**226,631**	**11.5%**	**$76,700**
State of Louisiana	**1,847,181**	**1,656,053**	**1,124,995**	**531,058**	**191,128**	**10.3%**	**$77,500**
State of Mississippi	**1,161,953**	**1,046,434**	**757,151**	**289,283**	**115,519**	**9.9%**	**$64,700**
State of Texas	**8,157,575**	**7,393,354**	**4,717,294**	**2,676,060**	**764,221**	**9.4%**	**$77,800**
State of Georgia	**3,281,737**	**3,006,369**	**2,029,293**	**977,076**	**275,368**	**8.4%**	**$100,600**

	Total Housing	Occupied			Vacant		Median Value
State Planting Range		**Total**	**Owner Occupied**	**Renter Occupied**	**Vacant**	**Vacancy Rate**	
South Carolina Planting Range Total	*356,415*	*304,104*	*212,234*	*91,870*	*52,311*	14.7%	*$90,013*
Alabama Planting Range Total	*278,957*	*241,349*	*172,331*	*69,018*	*37,608*	13.5%	*$85,467*
Florida Planting Range Total	*1,415,475*	*1,236,452*	*861,992*	*374,460*	*179,023*	12.6%	*$72,064*
Georgia Planting Range Total	*416,961*	*366,250*	*247,323*	*118,927*	*50,711*	12.2%	*$59,606*
Mississippi Planting Range Total	*245,139*	*218,078*	*158,304*	*59,774*	*27,061*	11.0%	*$62,085*
Louisiana Planting Range Total	*1,479,782*	*1,332,814*	*903,402*	*429,412*	*146,968*	9.9%	*$66,637*
Texas Planting Range Total	*2,329,378*	*2,109,691*	*1,320,411*	*789,280*	*219,687*	9.4%	*$63,586*

	Total Housing	Occupied			Vacant		Median Value
County		**Total**	**Owner Occupied**	**Renter Occupied**	**Vacant**	**Vacancy Rate**	
Walton County, Florida	29,083	16,548	13,072	3,476	12,535	43.1%	$77,500
Franklin County, Florida	7,180	4,096	3,245	851	3,084	43.0%	$74,600
Sabine County, Texas	7,659	4,485	3,868	617	3,174	41.4%	$47,000
Gulf County, Florida	7,587	4,931	3,995	936	2,656	35.0%	$67,900
San Augustine County, Texas	5,356	3,575	2,916	659	1,781	33.3%	$45,100
Cameron Parish, Louisiana	5,336	3,592	3,061	531	1,744	32.7%	$51,000
Wilkinson County, Mississippi	5,106	3,578	2,974	604	1,528	29.9%	$39,700
Trinity County, Texas	8,141	5,723	4,622	1,101	2,418	29.7%	$48,300
Liberty County, Florida	3,156	2,222	1,816	406	934	29.6%	$49,900
Dixie County, Florida	7,362	5,205	4,500	705	2,157	29.3%	$45,100
Polk County, Texas	21,177	15,119	12,343	2,776	6,058	28.6%	$50,600
Tensas Parish, Louisiana	3,359	2,416	1,676	740	943	28.1%	$42,500
Calhoun County, Texas	10,238	7,442	5,416	2,026	2,796	27.3%	$51,400
McIntosh County, Georgia	5,735	4,202	3,510	692	1,533	26.7%	$53,500
Taylor County, Florida	9,646	7,176	5,725	1,451	2,470	25.6%	$53,900
Baldwin County, Alabama	74,285	55,336	44,036	11,300	18,949	25.5%	$105,300
Leon County, Texas	8,299	6,189	5,125	1,064	2,110	25.4%	$60,800
Tyler County, Texas	10,419	7,775	6,531	1,244	2,644	25.4%	$46,400
Matagorda County, Texas	18,611	13,901	9,287	4,614	4,710	25.3%	$56,700

Attachment A-7 Potential Planting Range Housing Data Sorted by Vacancy Rate (2000) Continued

	Total Housing	Occupied			Vacant		Median Value
County		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
San Jacinto County, Texas	11,520	8,651	7,602	1,049	2,869	24.9%	$54,200
Beaufort County, South Carolina	60,509	45,532	33,363	12,169	14,977	24.8%	$168,100
Seminole County, Georgia	4,742	3,573	2,887	686	1,169	24.7%	$52,200
Bay County, Florida	78,435	59,597	40,892	18,705	18,838	24.0%	$83,700
Newton County, Texas	7,331	5,583	4,718	865	1,748	23.8%	$43,100
Catahoula Parish, Louisiana	5,351	4,082	3,390	692	1,269	23.7%	$38,000
Georgetown County, South Carolina	28,282	21,659	17,606	4,053	6,623	23.4%	$83,700
St. Helena Parish, Louisiana	5,034	3,873	3,291	582	1,161	23.1%	$55,100
Houston County, Texas	10,730	8,259	6,283	1,976	2,471	23.0%	$48,400
Burleson County, Texas	8,197	6,363	5,064	1,299	1,834	22.4%	$53,100
Lavaca County, Texas	9,657	7,669	6,012	1,657	1,988	20.6%	$61,500
Colleton County, South Carolina	18,129	14,470	11,612	2,858	3,659	20.2%	$62,200
Hancock County, Mississippi	21,072	16,897	13,457	3,440	4,175	19.8%	$82,100
Lafayette County, Florida	2,660	2,142	1,723	419	518	19.5%	$60,800
Colorado County, Texas	9,431	7,641	5,858	1,783	1,790	19.0%	$60,200
Jasper County, Texas	16,576	13,450	10,840	2,610	3,126	18.9%	$52,900
Jackson County, Texas	6,545	5,336	3,935	1,401	1,209	18.5%	$52,200
Pointe Coupee Parish, Louisiana	10,297	8,397	6,523	1,874	1,900	18.5%	$68,400
Madison County, Texas	4,797	3,914	3,014	900	883	18.4%	$55,300
Grimes County, Texas	9,490	7,753	6,032	1,721	1,737	18.3%	$57,100
Putnam County, Florida	33,870	27,839	22,265	5,574	6,031	17.8%	$54,100
Concordia Parish, Louisiana	9,148	7,521	5,723	1,798	1,627	17.8%	$47,200
Grant Parish, Louisiana	8,531	7,073	5,776	1,297	1,458	17.1%	$50,900
Glynn County, Georgia	32,636	27,208	17,818	9,390	5,428	16.6%	$97,200
Washington County, Florida	9,503	7,931	6,492	1,439	1,572	16.5%	$64,400
Beauregard Parish, Louisiana	14,501	12,104	9,664	2,440	2,397	16.5%	$55,600
Levy County, Florida	16,570	13,867	11,588	2,279	2,703	16.3%	$55,100
Brantley County, Georgia	6,490	5,436	4,723	713	1,054	16.2%	$39,400
Hamilton County, Florida	4,966	4,161	3,218	943	805	16.2%	$45,900
Okaloosa County, Florida	78,593	66,269	43,972	22,297	12,324	15.7%	$96,800
La Salle Parish, Louisiana	6,273	5,291	4,416	875	982	15.7%	$43,300
Natchitoches Parish, Louisiana	16,890	14,263	9,200	5,063	2,627	15.6%	$61,500
Long County, Georgia	4,232	3,574	2,366	1,208	658	15.5%	$53,700
Madison County, Florida	7,836	6,629	5,197	1,432	1,207	15.4%	$51,900
East Feliciana Parish, Louisiana	7,915	6,699	5,517	1,182	1,216	15.4%	$67,000
St. Martin Parish, Louisiana	20,245	17,164	14,022	3,142	3,081	15.2%	$59,400
Nassau County, Florida	25,917	21,980	17,732	4,248	3,937	15.2%	$98,000
Galveston County, Texas	111,733	94,782	62,790	31,992	16,951	15.2%	$81,900
Gilchrist County, Florida	5,906	5,021	4,326	695	885	15.0%	$63,600
Calhoun County, Florida	5,250	4,468	3,584	884	782	14.9%	$50,200

Attachment A-7 Potential Planting Range Housing Data Sorted by Vacancy Rate (2000) Continued

	Total Housing	Occupied			Vacant		Median Value
County		Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	
Ware County, Georgia	15,831	13,475	9,472	4,003	2,356	14.9%	$52,500
Jackson County, Florida	19,490	16,620	12,943	3,677	2,870	14.7%	$59,300
Echols County, Georgia	1,482	1,264	957	307	218	14.7%	$56,700
Washington County, Texas	13,241	11,322	8,327	2,995	1,919	14.5%	$85,600
Assumption Parish, Louisiana	9,635	8,239	6,928	1,311	1,396	14.5%	$58,400
St. Johns County, Florida	58,008	49,614	37,889	11,725	8,394	14.5%	$140,700
Coffee County, Georgia	15,610	13,354	9,935	3,419	2,256	14.5%	$49,800
Atkinson County, Georgia	3,171	2,717	2,015	702	454	14.3%	$32,500
Austin County, Texas	10,205	8,747	6,754	1,993	1,458	14.3%	$84,400
Suwannee County, Florida	15,679	13,460	10,903	2,557	2,219	14.2%	$57,900
Bacon County, Georgia	4,464	3,833	2,870	963	631	14.1%	$46,400
Wakulla County, Florida	9,820	8,450	7,116	1,334	1,370	14.0%	$79,900
Plaquemines Parish, Louisiana	10,481	9,021	7,114	1,907	1,460	13.9%	$68,900
Lanier County, Georgia	3,011	2,593	1,979	614	418	13.9%	$50,300
Wayne County, Georgia	10,827	9,324	7,129	2,195	1,503	13.9%	$56,200
Washington Parish, Louisiana	19,106	16,467	12,592	3,875	2,639	13.8%	$52,800
Brooks County, Georgia	7,118	6,155	4,731	1,424	963	13.5%	$55,400
Holmes County, Florida	7,998	6,921	5,645	1,276	1,077	13.5%	$53,200
Perry County, Mississippi	5,107	4,420	3,738	682	687	13.5%	$46,900
Charlton County, Georgia	3,859	3,342	2,697	645	517	13.4%	$51,400
Jefferson County, Mississippi	3,819	3,308	2,661	647	511	13.4%	$41,900
Claiborne County, Mississippi	4,252	3,685	2,960	725	567	13.3%	$42,200
Camden County, Georgia	16,958	14,705	9,299	5,406	2,253	13.3%	$79,200
Decatur County, Georgia	11,968	10,380	7,525	2,855	1,588	13.3%	$61,800
Hampton County, South Carolina	8,582	7,444	5,817	1,627	1,138	13.3%	$51,400
Walker County, Texas	21,099	18,303	10,959	7,344	2,796	13.3%	$67,700
Vernon Parish, Louisiana	21,030	18,260	10,360	7,900	2,770	13.2%	$56,400
Baker County, Georgia	1,740	1,514	1,175	339	226	13.0%	$50,200
Marion County, Florida	122,663	106,755	85,171	21,584	15,908	13.0%	$70,100
Flagler County, Florida	24,452	21,294	17,900	3,394	3,158	12.9%	$109,400
Charleston County, South Carolina	141,031	123,326	75,291	48,035	17,705	12.6%	$117,700
Orleans Parish, Louisiana	215,091	188,251	87,535	100,716	26,840	12.5%	$88,100
Pearl River County, Mississippi	20,610	18,078	14,426	3,652	2,532	12.3%	$70,200
Nacogdoches County, Texas	25,051	22,006	13,540	8,466	3,045	12.2%	$65,500
Early County, Georgia	5,338	4,695	3,401	1,294	643	12.0%	$46,600
Grady County, Georgia	9,991	8,797	6,449	2,348	1,194	12.0%	$64,100
Liberty County, Texas	26,359	23,242	18,362	4,880	3,117	11.8%	$55,100
Berrien County, Georgia	7,100	6,261	4,733	1,528	839	11.8%	$53,900
Liberty County, Georgia	21,977	19,383	9,824	9,559	2,594	11.8%	$73,800
Colquitt County, Georgia	17,554	15,495	10,333	5,162	2,059	11.7%	$55,500

Attachment A-7 Potential Planting Range Housing Data Sorted by Vacancy Rate (2000) Continued

	Total	Occupied			Vacant		Median
County	Housing	Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	Value
Vermilion Parish, Louisiana	22,461	19,832	15,267	4,565	2,629	11.7%	$58,900
Waller County, Texas	11,955	10,557	7,649	2,908	1,398	11.7%	$77,500
Chambers County, Texas	10,336	9,139	7,637	1,502	1,197	11.6%	$71,100
Angelina County, Texas	32,435	28,685	20,775	7,910	3,750	11.6%	$57,000
Bradford County, Florida	9,605	8,497	6,709	1,788	1,108	11.5%	$64,000
Allen Parish, Louisiana	9,157	8,102	6,160	1,942	1,055	11.5%	$51,800
Clinch County, Georgia	2,837	2,512	1,818	694	325	11.5%	$43,700
Pierce County, Georgia	6,719	5,958	4,808	1,150	761	11.3%	$52,000
Columbia County, Florida	23,579	20,925	16,137	4,788	2,654	11.3%	$63,300
Jasper County, South Carolina	7,928	7,042	5,476	1,566	886	11.2%	$64,900
Stone County, Mississippi	5,343	4,747	3,861	886	596	11.2%	$69,900
Avoyelles Parish, Louisiana	16,576	14,736	10,968	3,768	1,840	11.1%	$52,000
Escambia County, Florida	124,647	111,049	74,690	36,359	13,598	10.9%	$81,700
Wharton County, Texas	16,606	14,799	10,176	4,623	1,807	10.9%	$56,700
Santa Rosa County, Florida	49,119	43,793	35,198	8,595	5,326	10.8%	$96,300
Thomas County, Georgia	18,285	16,309	11,409	4,900	1,976	10.8%	$68,100
St. Mary Parish, Louisiana	21,650	19,317	14,275	5,042	2,333	10.8%	$63,100
St. Landry Parish, Louisiana	36,216	32,328	22,869	9,459	3,888	10.7%	$53,800
Iberville Parish, Louisiana	11,953	10,674	8,249	2,425	1,279	10.7%	$64,000
Evangeline Parish, Louisiana	14,258	12,736	8,837	3,899	1,522	10.7%	$48,300
Lowndes County, Georgia	36,551	32,654	19,865	12,789	3,897	10.7%	$79,800
Jefferson County, Florida	5,251	4,695	3,798	897	556	10.6%	$69,900
Jefferson Davis Parish, Louisiana	12,824	11,480	8,596	2,884	1,344	10.5%	$56,400
Tangipahoa Parish, Louisiana	40,794	36,558	26,805	9,753	4,236	10.4%	$73,000
Gadsden County, Florida	17,703	15,867	12,379	3,488	1,836	10.4%	$61,200
Cook County, Georgia	6,558	5,882	4,408	1,474	676	10.3%	$53,200
George County, Mississippi	7,513	6,742	5,814	928	771	10.3%	$60,100
Hardin County, Texas	19,836	17,805	14,694	3,111	2,031	10.2%	$62,100
Miller County, Georgia	2,770	2,487	1,913	574	283	10.2%	$49,000
Marion County, Mississippi	10,395	9,336	7,506	1,830	1,059	10.2%	$52,800
Harrison County, Mississippi	79,636	71,538	44,845	26,693	8,098	10.2%	$82,000
Livingston Parish, Louisiana	36,212	32,630	27,337	5,293	3,582	9.9%	$79,600
Union County, Florida	3,736	3,367	2,509	858	369	9.9%	$56,000
Adams County, Mississippi	15,175	13,677	9,602	4,075	1,498	9.9%	$57,900
Chatham County, Georgia	99,683	89,865	54,288	35,577	9,818	9.8%	$91,500
Terrebonne Parish, Louisiana	39,928	35,997	27,193	8,804	3,931	9.8%	$72,200
Calcasieu Parish, Louisiana	75,995	68,613	49,085	19,528	7,382	9.7%	$70,300
Brazoria County, Texas	90,628	81,954	60,682	21,272	8,674	9.6%	$81,000
Rapides Parish, Louisiana	52,038	47,120	32,055	15,065	4,918	9.5%	$68,300
Houston County, Alabama	39,571	35,834	24,893	10,941	3,737	9.4%	$74,500
Mitchell County, Georgia	8,880	8,063	5,803	2,260	817	9.2%	$55,500
Mobile County, Alabama	165,101	150,179	103,402	46,777	14,922	9.0%	$76,600

Attachment A-7 Potential Planting Range Housing Data Sorted by Vacancy Rate (2000) Continued

	Total	Occupied			Vacant		Median
County	Housing	Total	Owner Occupied	Renter Occupied	Vacant	Vacancy Rate	Value
Orange County, Texas	34,781	31,642	24,436	7,206	3,139	9.0%	$57,100
Jefferson County, Texas	102,080	92,880	61,253	31,627	9,200	9.0%	$58,300
Acadia Parish, Louisiana	23,209	21,142	15,259	5,883	2,067	8.9%	$54,800
Iberia Parish, Louisiana	27,844	25,381	18,628	6,753	2,463	8.8%	$64,700
Berkeley County, South Carolina	54,717	49,922	37,042	12,880	4,795	8.8%	$79,900
Victoria County, Texas	32,945	30,071	20,257	9,814	2,874	8.7%	$68,600
Lafourche Parish, Louisiana	35,045	32,057	24,988	7,069	2,988	8.5%	$71,100
Ascension Parish, Louisiana	29,172	26,691	21,952	4,739	2,481	8.5%	$89,900
West Baton Rouge Parish, Louisiana	8,370	7,663	6,036	1,627	707	8.4%	$74,400
Montgomery County, Texas	112,770	103,296	80,750	22,546	9,474	8.4%	$95,600
St. Tammany Parish, Louisiana	75,398	69,253	55,732	13,521	6,145	8.2%	$116,000
St. James Parish, Louisiana	7,605	6,992	5,984	1,008	613	8.1%	$69,300
St. John the Baptist Parish, Louisiana	15,532	14,283	11,569	2,714	1,249	8.0%	$79,000
Alachua County, Florida	95,113	87,509	48,084	39,425	7,604	8.0%	$88,400
Duval County, Florida	329,778	303,747	191,722	112,025	26,031	7.9%	$86,100
Jackson County, Mississippi	51,678	47,676	35,548	12,128	4,002	7.7%	$75,400
East Baton Rouge Parish, Louisiana	169,073	156,365	96,305	60,060	12,708	7.5%	$96,600
Lafayette Parish, Louisiana	78,122	72,372	47,803	24,569	5,750	7.4%	$91,400
Baker County, Florida	7,592	7,043	5,723	1,320	549	7.2%	$65,500
Effingham County, Georgia	14,169	13,151	10,871	2,280	1,018	7.2%	$87,400
Leon County, Florida	103,974	96,521	55,014	41,507	7,453	7.2%	$100,600
Harris County, Texas	1,298,130	1,205,516	667,129	538,387	92,614	7.1%	$84,200
Dorchester County, South Carolina	37,237	34,709	26,027	8,682	2,528	6.8%	$92,200
Bryan County, Georgia	8,675	8,089	6,312	1,777	586	6.8%	$94,900
Lamar County, Mississippi	15,433	14,396	10,912	3,484	1,037	6.7%	$86,000
Clay County, Florida	53,748	50,243	39,120	11,123	3,505	6.5%	$97,400
Brazos County, Texas	59,023	55,202	25,147	30,055	3,821	6.5%	$88,200
St. Bernard Parish, Louisiana	26,790	25,123	18,758	6,365	1,667	6.2%	$82,900
Jefferson Parish, Louisiana	187,907	176,234	112,534	63,700	11,673	6.2%	$102,800
St. Charles Parish, Louisiana	17,430	16,422	13,370	3,052	1,008	5.8%	$96,300
Fort Bend County, Texas	115,991	110,915	89,628	21,287	5,076	4.4%	$110,800

Attachment A-8 Potential Planting Range Income

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
Baldwin County, Alabama	40,250	20,826	138,148	14,018	10.1	0	40,531	3,082	7.6	0
Houston County, Alabama	34,431	18,759	87,646	13,146	15.0	0	25,286	2,981	11.8	0
Mobile County, Alabama	33,710	17,178	392,003	72,549	18.5	1	107,338	16,720	15.6	1
Alabama Planting Range Total	*36,130*	*18,921*	*617,797*	*99,713*	*16.1*	1	*173,155*	*22,783*	*13.2*	1
State of Alabama	**34,135**	**18,189**	**4,334,919**	**698,097**	**16.1**		**1,223,185**	**153,113**	**12.5**	
Alachua County, Florida	31,426	18,465	206,224	46,939	22.8	1	48,100	5,880	12.2	0
Baker County, Florida	40,035	15,164	20,168	2,961	14.7	0	5,668	644	11.4	0
Bay County, Florida	36,092	18,700	144,747	18,882	13.0	0	40,653	3,984	9.8	0
Bradford County, Florida	33,140	14,226	21,812	3,183	14.6	0	6,234	693	11.1	0
Calhoun County, Florida	26,575	12,379	11,261	2,252	20.0	1	3,179	472	14.8	1
Clay County, Florida	48,854	20,868	139,162	9,437	6.8	0	39,731	2,018	5.1	0
Columbia County, Florida	30,881	14,598	53,485	8,027	15.0	0	14,973	1,704	11.4	0
Dixie County, Florida	26,082	13,559	12,705	2,428	19.1	1	3,698	536	14.5	1
Duval County, Florida	40,703	20,753	762,726	90,828	11.9	0	203,227	18,641	9.2	0
Escambia County, Florida	35,234	18,641	271,889	41,978	15.4	0	74,528	9,021	12.1	0
Flagler County, Florida	40,214	21,879	49,288	4,287	8.7	0	15,705	1,048	6.7	0
Franklin County, Florida	26,756	16,140	9,330	1,654	17.7	1	2,725	322	11.8	0
Gadsden County, Florida	31,248	14,499	42,705	8,509	19.9	1	11,548	1,898	16.4	1
Gilchrist County, Florida	30,328	13,985	13,054	1,844	14.1	0	3,704	404	10.9	0
Gulf County, Florida	30,276	14,449	11,915	1,988	16.7	1	3,549	485	13.7	1
Hamilton County, Florida	25,638	10,562	10,760	2,799	26.0	1	3,040	659	21.7	1
Holmes County, Florida	27,923	14,135	16,842	3,209	19.1	1	4,928	757	15.4	1
Jackson County, Florida	29,744	13,905	40,730	6,998	17.2	1	11,659	1,492	12.8	1
Jefferson County, Florida	32,998	17,006	11,905	2,040	17.1	1	3,341	444	13.3	1
Lafayette County, Florida	30,651	13,087	5,718	999	17.5	1	1,611	208	12.9	1
Leon County, Florida	37,517	21,024	225,863	41,078	18.2	1	54,796	5,164	9.4	0
Levy County, Florida	26,959	14,746	33,708	6,263	18.6	1	9,693	1,458	15.0	1
Liberty County, Florida	28,840	17,225	5,611	1,114	19.9	1	1,548	260	16.8	1

Attachment A-8 Potential Planting Range Income Continued

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
Madison County, Florida	26,533	12,511	16,994	3,919	23.1	1	4,738	896	18.9	1
Marion County, Florida	31,944	17,848	251,736	32,918	13.1	0	74,927	6,929	9.2	0
Nassau County, Florida	46,022	22,836	56,772	5,192	9.1	0	16,567	1,067	6.4	0
Okaloosa County, Florida	41,474	20,918	164,709	14,562	8.8	0	46,858	3,099	6.6	0
Putnam County, Florida	28,180	15,603	69,225	14,449	20.9	1	19,451	3,080	15.8	1
St. Johns County, Florida	50,099	28,674	120,920	9,698	8.0	0	34,266	1,750	5.1	0
Santa Rosa County, Florida	41,881	20,089	114,784	11,282	9.8	0	33,577	2,641	7.9	0
Suwannee County, Florida	29,963	14,678	34,260	6,325	18.5	1	9,785	1,444	14.8	1
Taylor County, Florida	30,032	15,281	17,923	3,229	18.0	1	5,157	750	14.5	1
Union County, Florida	34,563	12,333	9,289	1,298	14.0	0	2,655	278	10.5	0
Wakulla County, Florida	37,149	17,678	21,610	2,437	11.3	0	6,260	585	9.3	0
Walton County, Florida	32,407	18,198	38,776	5,577	14.4	0	11,300	1,312	11.6	0
Washington County, Florida	27,922	14,980	19,591	3,757	19.2	1	5,754	884	15.4	1
Florida Planting Range Total	*33,508*	*16,712*	*3,058,197*	*424,340*	*13.9*	19	*839,133*	*82,907*	*9.9*	16
State of Florida	**38,819**	**21,557**	**15,605,367**	**1,952,629**	**12.5**		**4,238,409**	**383,131**	**9.0**	
Atkinson County, Georgia	26,470	12,178	7,584	1,746	23.0	1	2,003	362	18.1	1
Bacon County, Georgia	26,910	14,289	9,870	2,335	23.7	1	2,895	584	20.2	1
Baker County, Georgia	30,338	16,969	4,071	951	23.4	1	1,092	217	19.9	1
Berrien County, Georgia	30,044	16,375	15,975	2,827	17.7	1	4,540	663	14.6	1
Brantley County, Georgia	30,361	13,713	14,485	2,266	15.6	0	4,176	507	12.1	0
Brooks County, Georgia	26,911	13,977	16,152	3,785	23.4	1	4,430	845	19.1	1
Bryan County, Georgia	48,345	19,794	23,240	2,715	11.7	0	6,563	705	10.7	0
Camden County, Georgia	41,056	16,445	41,642	4,221	10.1	0	11,462	960	8.4	0
Charlton County, Georgia	27,869	12,920	9,053	1,893	20.9	1	2,507	445	17.8	1
Chatham County, Georgia	37,752	21,152	224,398	35,043	15.6	0	59,750	7,031	11.8	0
Clinch County, Georgia	26,755	13,023	6,562	1,538	23.4	1	1,814	403	22.2	1
Coffee County, Georgia	30,710	15,530	35,828	6,859	19.1	1	9,822	1,500	15.3	1
Colquitt County, Georgia	28,539	14,457	41,396	8,205	19.8	1	11,155	1,797	16.1	1

Attachment A-8 Potential Planting Range Income Continued

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
Cook County, Georgia	27,582	13,465	15,555	3,221	20.7	1	4,315	713	16.5	1
Decatur County, Georgia	28,820	15,063	27,548	6,240	22.7	1	7,631	1,466	19.2	1
Early County, Georgia	25,629	14,936	12,037	3,094	25.7	1	3,301	732	22.2	1
Echols County, Georgia	25,851	15,727	3,699	1,060	28.7	1	938	209	22.3	1
Effingham County, Georgia	46,505	18,873	37,150	3,458	9.3	0	10,487	743	7.1	0
Glynn County, Georgia	38,765	21,707	66,813	10,120	15.1	0	18,649	2,170	11.6	0
Grady County, Georgia	28,656	14,278	23,347	4,982	21.3	1	6,549	1,092	16.7	1
Lanier County, Georgia	29,171	13,690	6,925	1,284	18.5	1	1,948	298	15.3	1
Liberty County, Georgia	33,477	13,855	56,604	8,464	15.0	0	15,332	2,075	13.5	1
Long County, Georgia	30,640	12,586	10,174	1,986	19.5	1	2,693	475	17.6	1
Lowndes County, Georgia	32,132	16,683	85,144	15,622	18.3	1	22,389	3,102	13.9	1
McIntosh County, Georgia	30,102	14,253	10,648	1,990	18.7	1	3,019	475	15.7	1
Miller County, Georgia	27,335	15,435	6,238	1,322	21.2	1	1,761	298	16.9	1
Mitchell County, Georgia	26,581	13,042	21,929	5,793	26.4	1	5,964	1,329	22.3	1
Pierce County, Georgia	29,895	14,230	15,486	2,849	18.4	1	4,431	638	14.4	1
Seminole County, Georgia	27,094	14,635	9,242	2,141	23.2	1	2,611	412	15.8	1
Thomas County, Georgia	31,115	16,211	41,578	7,231	17.4	1	11,446	1,562	13.6	1
Ware County, Georgia	28,360	14,384	33,210	6,823	20.5	1	9,325	1,482	15.9	1
Wayne County, Georgia	32,766	15,628	24,406	4,071	16.7	1	7,040	943	13.4	1
Georgia Planting Range Total	*31,017*	*15,297*	*957,989*	*166,135*	*17.3*	25	*262,038*	*36,233*	*13.8*	26
State of Georgia	**42,433**	**21,154**	**7,959,649**	**1,033,793**	**13.0**		**2,126,360**	**210,138**	**9.9**	
Acadia Parish, Louisiana	26,684	13,424	57,799	14,183	24.5	1	15,764	3,310	21.0	1
Allen Parish, Louisiana	27,777	13,101	21,218	4,225	19.9	1	6,025	1,079	17.9	1
Ascension Parish, Louisiana	44,288	17,858	75,755	9,808	12.9	0	21,002	2,254	10.7	0
Assumption Parish, Louisiana	31,168	14,008	23,184	5,062	21.8	1	6,272	1,225	19.5	1
Avoyelles Parish, Louisiana	23,851	12,146	38,303	9,939	25.9	1	10,621	2,301	21.7	1
Beauregard Parish, Louisiana	32,582	15,514	31,728	4,945	15.6	0	9,093	1,183	13.0	1
Calcasieu Parish, Louisiana	35,372	17,710	178,713	27,582	15.4	0	49,249	6,304	12.8	1

Attachment A-8 Potential Planting Range Income Continued

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
Cameron Parish, Louisiana	34,232	15,348	9,879	1,220	12.3	0	2,703	247	9.1	0
Catahoula Parish, Louisiana	22,528	12,608	10,379	2,921	28.1	1	3,041	686	22.6	1
Concordia Parish, Louisiana	22,742	11,966	19,513	5,680	29.1	1	5,467	1,327	24.3	1
East Baton Rouge Parish, Louisiana	37,224	19,790	398,888	71,276	17.9	1	103,357	13,647	13.2	1
East Feliciana Parish, Louisiana	31,631	15,428	18,915	4,352	23.0	1	5,061	927	18.3	1
Evangeline Parish, Louisiana	20,532	11,432	33,687	10,857	32.2	1	9,261	2,523	27.2	1
Grant Parish, Louisiana	29,622	14,410	18,377	3,948	21.5	1	5,222	885	16.9	1
Iberia Parish, Louisiana	31,204	14,145	71,977	16,952	23.6	1	19,121	3,861	20.2	1
Iberville Parish, Louisiana	29,039	13,272	29,895	6,909	23.1	1	8,027	1,569	19.5	1
Jefferson Parish, Louisiana	38,435	19,953	451,243	61,608	13.7	0	120,841	13,055	10.8	0
Jefferson Davis Parish, Louisiana	27,736	13,398	30,957	6,462	20.9	1	8,614	1,558	18.1	1
Lafayette Parish, Louisiana	36,518	19,371	185,805	29,216	15.7	0	49,108	5,811	11.8	0
Lafourche Parish, Louisiana	34,910	15,809	88,077	14,560	16.5	1	24,421	3,212	13.2	1
La Salle Parish, Louisiana	28,189	14,033	13,262	2,486	18.7	1	3,784	564	14.9	1
Livingston Parish, Louisiana	38,887	16,282	90,959	10,339	11.4	0	25,659	2,347	9.1	0
Natchitoches Parish, Louisiana	25,722	13,743	36,404	9,653	26.5	1	9,562	1,994	20.9	1
Orleans Parish, Louisiana	27,133	17,258	468,453	130,896	27.9	1	113,948	26,988	23.7	1
Plaquemines Parish, Louisiana	38,173	15,937	25,969	4,682	18.0	1	6,986	1,078	15.4	1
Pointe Coupee Parish, Louisiana	30,618	15,387	22,360	5,172	23.1	1	6,216	1,162	18.7	1
Rapides Parish, Louisiana	29,856	16,088	122,161	25,097	20.5	1	33,339	5,454	16.4	1
St. Bernard Parish, Louisiana	35,939	16,718	66,269	8,687	13.1	0	18,363	1,935	10.5	0
St. Charles Parish, Louisiana	45,139	19,054	47,591	5,424	11.4	0	13,182	1,223	9.3	0
St. Helena Parish, Louisiana	24,970	12,318	10,450	2,804	26.8	1	2,772	631	22.8	1
St. James Parish, Louisiana	35,277	14,381	20,915	4,328	20.7	1	5,564	1,004	18.0	1
St. John the Baptist Parish, Louisiana	39,456	15,445	42,536	7,114	16.7	1	11,346	1,576	13.9	1
St. Landry Parish, Louisiana	22,855	12,042	86,113	25,210	29.3	1	23,361	5,773	24.7	1
St. Martin Parish, Louisiana	30,701	13,619	47,615	10,261	21.5	1	12,978	2,385	18.4	1

Attachment A-8 Potential Planting Range Income Continued

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
St. Mary Parish, Louisiana	28,072	13,399	52,831	12,472	23.6	1	14,092	2,903	20.6	1
St. Tammany Parish, Louisiana	47,883	22,514	188,661	18,336	9.7	0	52,971	4,041	7.6	0
Tangipahoa Parish, Louisiana	29,412	14,461	97,474	22,119	22.7	1	25,895	4,664	18.0	1
Tensas Parish, Louisiana	19,799	12,622	6,108	2,215	36.3	1	1,658	497	30.0	1
Terrebonne Parish, Louisiana	35,235	16,051	102,709	19,607	19.1	1	27,473	4,329	15.8	1
Vermilion Parish, Louisiana	29,500	14,201	52,828	11,681	22.1	1	14,511	2,523	17.4	1
Vernon Parish, Louisiana	31,216	14,036	49,027	7,479	15.3	0	13,881	1,700	12.2	0
Washington Parish, Louisiana	24,264	12,915	42,007	10,370	24.7	1	11,666	2,268	19.4	1
West Baton Rouge Parish, Louisiana	37,117	15,773	20,953	3,564	17.0	1	5,765	759	13.2	1
Louisiana Planting Range Total	*31,476*	*15,092*	*3,507,947*	*671,701*	*19.1*	32	*937,242*	*144,762*	*15.4*	34
State of Louisiana	**32,566**	**16,912**	**4,334,094**	**851,113**	**19.6**		**1,163,191**	**183,448**	**15.8**	
Adams County, Mississippi	25,234	15,778	33,860	8,775	25.9	1	9,492	2,169	22.9	1
Claiborne County, Mississippi	22,615	11,244	10,024	3,246	32.4	1	2,549	710	27.9	1
George County, Mississippi	34,730	14,337	18,805	3,140	16.7	1	5,329	695	13.0	1
Hancock County, Mississippi	35,202	17,748	42,474	6,137	14.4	0	11,882	1,331	11.2	0
Harrison County, Mississippi	35,624	18,024	182,302	26,597	14.6	0	48,969	5,660	11.6	0
Jackson County, Mississippi	39,118	17,768	129,465	16,504	12.7	0	35,921	3,761	10.5	0
Jefferson County, Mississippi	18,447	9,709	9,069	3,265	36.0	1	2,323	754	32.5	1
Lamar County, Mississippi	37,628	18,849	38,782	5,150	13.3	0	10,717	1,043	9.7	0
Marion County, Mississippi	24,555	12,301	24,620	6,099	24.8	1	6,987	1,448	20.7	1
Pearl River County, Mississippi	30,912	15,160	47,729	8,800	18.4	1	13,726	2,124	15.5	1
Perry County, Mississippi	27,189	12,837	12,017	2,646	22.0	1	3,372	662	19.6	1
Stone County, Mississippi	30,495	14,693	12,990	2,271	17.5	1	3,651	529	14.5	1
Wilkinson County, Mississippi	18,929	10,868	9,246	3,486	37.7	1	2,535	838	33.1	1
Mississippi Planting Range Total	*29,283*	*14,563*	*571,383*	*96,116*	*16.8*	9	*157,453*	*21,724*	*13.8*	9
State of Mississippi	**31,330**	**15,853**	**2,750,677**	**548,079**	**19.9**		**752,234**	**120,039**	**16.0**	
Beaufort County, South Carolina	46,992	25,377	114,377	12,194	10.7	0	33,397	2,681	8.0	0

Attachment A-8 Potential Planting Range Income Continued

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
Berkeley County, South Carolina	39,908	16,879	136,671	16,066	11.8	0	37,892	3,664	9.7	0
Charleston County, South Carolina	37,810	21,393	300,183	49,330	16.4	1	77,744	9,643	12.4	1
Colleton County, South Carolina	29,733	14,831	37,939	8,014	21.1	1	10,598	1,829	17.3	1
Dorchester County, South Carolina	43,316	18,840	94,316	9,108	9.7	0	26,482	1,883	7.1	0
Georgetown County, South Carolina	35,312	19,805	55,263	9,439	17.1	1	15,881	2,126	13.4	1
Hampton County, South Carolina	28,771	13,129	19,629	4,277	21.8	1	5,356	954	17.8	1
Jasper County, South Carolina	30,727	14,161	19,346	3,996	20.7	1	5,117	788	15.4	1
South Carolina Planting Range Total	*36,571*	*18,052*	*777,724*	*112,424*	*14.5*	5	*212,467*	*23,568*	*11.1*	5
State of South Carolina	**37,082**	**18,795**	**3,883,329**	**547,869**	**14.1**		**1,078,736**	**115,899**	**10.7**	
Angelina County, Texas	33,806	15,876	77,567	12,241	15.8	0	21,374	2,643	12.4	1
Austin County, Texas	38,615	18,140	23,345	2,814	12.1	0	6,493	570	8.8	0
Brazoria County, Texas	48,632	20,021	230,436	23,465	10.2	0	63,513	5,130	8.1	0
Brazos County, Texas	29,104	16,212	139,110	37,417	26.9	1	30,723	4,302	14.0	1
Burleson County, Texas	33,026	16,616	16,347	2,813	17.2	1	4,608	606	13.2	1
Calhoun County, Texas	35,849	17,125	20,389	3,340	16.4	1	5,605	713	12.7	1
Chambers County, Texas	47,964	19,863	25,719	2,833	11.0	0	7,221	601	8.3	0
Colorado County, Texas	32,425	16,910	19,543	3,171	16.2	1	5,385	660	12.3	0
Fort Bend County, Texas	63,831	24,985	349,010	24,953	7.1	0	93,808	5,139	5.5	0
Galveston County, Texas	42,419	21,568	245,887	32,510	13.2	0	66,494	6,734	10.1	0
Grimes County, Texas	32,280	14,368	20,717	3,442	16.6	1	5,626	775	13.8	1
Hardin County, Texas	37,612	17,962	47,518	5,314	11.2	0	13,794	1,210	8.8	0
Harris County, Texas	42,598	21,435	3,360,536	503,234	15.0	0	840,630	101,693	12.1	0
Houston County, Texas	28,119	14,525	20,135	4,219	21.0	1	5,786	902	15.6	1
Jackson County, Texas	35,254	16,693	14,088	2,074	14.7	0	3,963	484	12.2	0
Jasper County, Texas	30,902	15,636	34,540	6,237	18.1	1	9,991	1,502	15.0	1

Attachment A-8 Potential Planting Range Income Continued

Geographic Area	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)	Total Families	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level	Percent Individuals Below Poverty Greater Than Planting Range (1 = yes, 0 = no)
Jefferson County, Texas	34,706	17,571	236,846	41,142	17.4	1	64,338	9,378	14.6	1
Lavaca County, Texas	29,132	16,398	18,739	2,480	13.2	0	5,396	551	10.2	0
Leon County, Texas	30,981	17,599	15,205	2,365	15.6	0	4,578	576	12.6	1
Liberty County, Texas	38,361	15,539	64,878	9,296	14.3	0	17,937	1,998	11.1	0
Madison County, Texas	29,418	14,056	10,059	1,588	15.8	0	2,853	351	12.3	1
Matagorda County, Texas	32,174	15,709	37,367	6,913	18.5	1	10,012	1,496	14.9	1
Montgomery County, Texas	50,864	24,544	291,519	27,376	9.4	0	80,723	5,766	7.1	0
Nacogdoches County, Texas	28,301	15,437	54,637	12,743	23.3	1	14,169	2,199	15.5	1
Newton County, Texas	28,500	13,381	14,461	2,760	19.1	1	4,133	641	15.5	1
Orange County, Texas	37,586	17,554	83,755	11,518	13.8	0	23,909	2,724	11.4	0
Polk County, Texas	30,495	15,834	37,658	6,540	17.4	1	11,059	1,470	13.3	1
Sabine County, Texas	27,198	15,821	10,313	1,643	15.9	1	3,173	373	11.8	0
San Augustine County, Texas	27,025	15,548	8,688	1,840	21.2	1	2,593	405	15.6	1
San Jacinto County, Texas	32,220	16,144	22,049	4,150	18.8	1	6,446	972	15.1	1
Trinity County, Texas	27,070	15,472	13,582	2,394	17.6	1	4,046	533	13.2	1
Tyler County, Texas	29,808	15,367	19,278	3,044	15.8	0	5,688	716	12.6	1
Victoria County, Texas	38,732	18,379	82,527	10,681	12.9	0	22,348	2,352	10.5	0
Walker County, Texas	31,468	14,508	44,904	8,253	18.4	1	11,533	1,225	10.6	0
Waller County, Texas	38,136	16,338	29,487	4,718	16.0	1	7,837	901	11.5	0
Washington County, Texas	36,760	17,384	28,597	3,690	12.9	0	8,014	786	9.8	0
Wharton County, Texas	32,208	15,388	40,519	6,703	16.5	1	10,774	1,430	13.3	1
Texas Planting Range Total	*35,232*	*17,079*	*5,809,955*	*841,914*	*14.5*	19	*1,506,573*	*170,507*	*11.3*	19
State of Texas	**39,927**	**19,617**	**20,287,300**	**3,117,609**	**15.4**		**5,283,474**	**632,676**	**12.0**	
Planting Range Total	**32,776**	**16,061**	**15,300,992**	**2,412,343**	**15.8**	**110**	**4,088,061**	**502,484**	**12.3**	**110**
State Total	**36,613**	**18,868**	**59,155,335**	**8,749,189**	**14.8**		**15,865,589**	**1,798,444**	**11.3**	

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income

State	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
State of Georgia	**42,433**	**21,154**	**7,959,649**	**1,033,793**	**13.0**	**2,126,360**	**210,138**	**9.9**
State of Texas	**39,927**	**19,617**	**20,287,300**	**3,117,609**	**15.4**	**5,283,474**	**632,676**	**12.0**
State of Florida	**38,819**	**21,557**	**15,605,367**	**1,952,629**	**12.5**	**4,238,409**	**383,131**	**9.0**
State of South Carolina	**37,082**	**18,795**	**3,883,329**	**547,869**	**14.1**	**1,078,736**	**115,899**	**10.7**
State of Alabama	**34,135**	**18,189**	**4,334,919**	**698,097**	**16.1**	**1,223,185**	**153,113**	**12.5**
State of Louisiana	**32,566**	**16,912**	**4,334,094**	**851,113**	**19.6**	**1,163,191**	**183,448**	**15.8**
State of Mississippi	**31,330**	**15,853**	**2,750,677**	**548,079**	**19.9**	**752,234**	**120,039**	**16.0**

State Planting Range	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
South Carolina Planting Range Total	*36,571*	*18,052*	*777,724*	*112,424*	*14.5*	*212,467*	*23,568*	*11.1*
Alabama Planting Range Total	*36,130*	*18,921*	*617,797*	*99,713*	*16.1*	*173,155*	*22,783*	*13.2*
Texas Planting Range Total	*35,232*	*17,079*	*5,809,955*	*841,914*	*14.5*	*1,506,573*	*170,507*	*11.3*
Florida Planting Range Total	*33,508*	*16,712*	*3,058,197*	*424,340*	*13.9*	*839,133*	*82,907*	*9.9*
Louisiana Planting Range Total	*31,476*	*15,092*	*3,507,947*	*671,701*	*19.1*	*937,242*	*144,762*	*15.4*
Georgia Planting Range Total	*31,017*	*15,297*	*957,989*	*166,135*	*17.3*	*262,038*	*36,233*	*13.8*
Mississippi Planting Range Total	*29,283*	*14,563*	*571,383*	*96,116*	*16.8*	*157,453*	*21,724*	*13.8*

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Fort Bend County, Texas	63,831	24,985	349,010	24,953	7.1	93,808	5,139	5.5
Montgomery County, Texas	50,864	24,544	291,519	27,376	9.4	80,723	5,766	7.1
St. Johns County, Florida	50,099	28,674	120,920	9,698	8.0	34,266	1,750	5.1
Clay County, Florida	48,854	20,868	139,162	9,437	6.8	39,731	2,018	5.1
Brazoria County, Texas	48,632	20,021	230,436	23,465	10.2	63,513	5,130	8.1
Bryan County, Georgia	48,345	19,794	23,240	2,715	11.7	6,563	705	10.7

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Chambers County, Texas	47,964	19,863	25,719	2,833	11.0	7,221	601	8.3
St. Tammany Parish, Louisiana	47,883	22,514	188,661	18,336	9.7	52,971	4,041	7.6
Beaufort County, South Carolina	46,992	25,377	114,377	12,194	10.7	33,397	2,681	8.0
Effingham County, Georgia	46,505	18,873	37,150	3,458	9.3	10,487	743	7.1
Nassau County, Florida	46,022	22,836	56,772	5,192	9.1	16,567	1,067	6.4
St. Charles Parish, Louisiana	45,139	19,054	47,591	5,424	11.4	13,182	1,223	9.3
Ascension Parish, Louisiana	44,288	17,858	75,755	9,808	12.9	21,002	2,254	10.7
Dorchester County, South Carolina	43,316	18,840	94,316	9,108	9.7	26,482	1,883	7.1
Harris County, Texas	42,598	21,435	3,360,536	503,234	15.0	840,630	101,693	12.1
Galveston County, Texas	42,419	21,568	245,887	32,510	13.2	66,494	6,734	10.1
Santa Rosa County, Florida	41,881	20,089	114,784	11,282	9.8	33,577	2,641	7.9
Okaloosa County, Florida	41,474	20,918	164,709	14,562	8.8	46,858	3,099	6.6
Camden County, Georgia	41,056	16,445	41,642	4,221	10.1	11,462	960	8.4
Duval County, Florida	40,703	20,753	762,726	90,828	11.9	203,227	18,641	9.2
Baldwin County, Alabama	40,250	20,826	138,148	14,018	10.1	40,531	3,082	7.6
Flagler County, Florida	40,214	21,879	49,288	4,287	8.7	15,705	1,048	6.7
Baker County, Florida	40,035	15,164	20,168	2,961	14.7	5,668	644	11.4
Berkeley County, South Carolina	39,908	16,879	136,671	16,066	11.8	37,892	3,664	9.7
St. John the Baptist Parish, Louisiana	39,456	15,445	42,536	7,114	16.7	11,346	1,576	13.9
Jackson County, Mississippi	39,118	17,768	129,465	16,504	12.7	35,921	3,761	10.5
Livingston Parish, Louisiana	38,887	16,282	90,959	10,339	11.4	25,659	2,347	9.1
Glynn County, Georgia	38,765	21,707	66,813	10,120	15.1	18,649	2,170	11.6
Victoria County, Texas	38,732	18,379	82,527	10,681	12.9	22,348	2,352	10.5
Austin County, Texas	38,615	18,140	23,345	2,814	12.1	6,493	570	8.8
Jefferson Parish, Louisiana	38,435	19,953	451,243	61,608	13.7	120,841	13,055	10.8
Liberty County, Texas	38,361	15,539	64,878	9,296	14.3	17,937	1,998	11.1
Plaquemines Parish, Louisiana	38,173	15,937	25,969	4,682	18.0	6,986	1,078	15.4
Waller County, Texas	38,136	16,338	29,487	4,718	16.0	7,837	901	11.5

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Charleston County, South Carolina	37,810	21,393	300,183	49,330	16.4	77,744	9,643	12.4
Chatham County, Georgia	37,752	21,152	224,398	35,043	15.6	59,750	7,031	11.8
Lamar County, Mississippi	37,628	18,849	38,782	5,150	13.3	10,717	1,043	9.7
Hardin County, Texas	37,612	17,962	47,518	5,314	11.2	13,794	1,210	8.8
Orange County, Texas	37,586	17,554	83,755	11,518	13.8	23,909	2,724	11.4
Leon County, Florida	37,517	21,024	225,863	41,078	18.2	54,796	5,164	9.4
East Baton Rouge Parish, Louisiana	37,224	19,790	398,888	71,276	17.9	103,357	13,647	13.2
Wakulla County, Florida	37,149	17,678	21,610	2,437	11.3	6,260	585	9.3
West Baton Rouge Parish, Louisiana	37,117	15,773	20,953	3,564	17.0	5,765	759	13.2
Washington County, Texas	36,760	17,384	28,597	3,690	12.9	8,014	786	9.8
Lafayette Parish, Louisiana	36,518	19,371	185,805	29,216	15.7	49,108	5,811	11.8
Bay County, Florida	36,092	18,700	144,747	18,882	13.0	40,653	3,984	9.8
St. Bernard Parish, Louisiana	35,939	16,718	66,269	8,687	13.1	18,363	1,935	10.5
Calhoun County, Texas	35,849	17,125	20,389	3,340	16.4	5,605	713	12.7
Harrison County, Mississippi	35,624	18,024	182,302	26,597	14.6	48,969	5,660	11.6
Calcasieu Parish, Louisiana	35,372	17,710	178,713	27,582	15.4	49,249	6,304	12.8
Georgetown County, South Carolina	35,312	19,805	55,263	9,439	17.1	15,881	2,126	13.4
St. James Parish, Louisiana	35,277	14,381	20,915	4,328	20.7	5,564	1,004	18.0
Jackson County, Texas	35,254	16,693	14,088	2,074	14.7	3,963	484	12.2
Terrebonne Parish, Louisiana	35,235	16,051	102,709	19,607	19.1	27,473	4,329	15.8
Escambia County, Florida	35,234	18,641	271,889	41,978	15.4	74,528	9,021	12.1
Hancock County, Mississippi	35,202	17,748	42,474	6,137	14.4	11,882	1,331	11.2
Lafourche Parish, Louisiana	34,910	15,809	88,077	14,560	16.5	24,421	3,212	13.2
George County, Mississippi	34,730	14,337	18,805	3,140	16.7	5,329	695	13.0
Jefferson County, Texas	34,706	17,571	236,846	41,142	17.4	64,338	9,378	14.6
Union County, Florida	34,563	12,333	9,289	1,298	14.0	2,655	278	10.5
Houston County, Alabama	34,431	18,759	87,646	13,146	15.0	25,286	2,981	11.8

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Cameron Parish, Louisiana	34,232	15,348	9,879	1,220	12.3	2,703	247	9.1
Angelina County, Texas	33,806	15,876	77,567	12,241	15.8	21,374	2,643	12.4
Mobile County, Alabama	33,710	17,178	392,003	72,549	18.5	107,338	16,720	15.6
Liberty County, Georgia	33,477	13,855	56,604	8,464	15.0	15,332	2,075	13.5
Bradford County, Florida	33,140	14,226	21,812	3,183	14.6	6,234	693	11.1
Burleson County, Texas	33,026	16,616	16,347	2,813	17.2	4,608	606	13.2
Jefferson County, Florida	32,998	17,006	11,905	2,040	17.1	3,341	444	13.3
Wayne County, Georgia	32,766	15,628	24,406	4,071	16.7	7,040	943	13.4
Beauregard Parish, Louisiana	32,582	15,514	31,728	4,945	15.6	9,093	1,183	13.0
Colorado County, Texas	32,425	16,910	19,543	3,171	16.2	5,385	660	12.3
Walton County, Florida	32,407	18,198	38,776	5,577	14.4	11,300	1,312	11.6
Grimes County, Texas	32,280	14,368	20,717	3,442	16.6	5,626	775	13.8
San Jacinto County, Texas	32,220	16,144	22,049	4,150	18.8	6,446	972	15.1
Wharton County, Texas	32,208	15,388	40,519	6,703	16.5	10,774	1,430	13.3
Matagorda County, Texas	32,174	15,709	37,367	6,913	18.5	10,012	1,496	14.9
Lowndes County, Georgia	32,132	16,683	85,144	15,622	18.3	22,389	3,102	13.9
Marion County, Florida	31,944	17,848	251,736	32,918	13.1	74,927	6,929	9.2
East Feliciana Parish, Louisiana	31,631	15,428	18,915	4,352	23.0	5,061	927	18.3
Walker County, Texas	31,468	14,508	44,904	8,253	18.4	11,533	1,225	10.6
Alachua County, Florida	31,426	18,465	206,224	46,939	22.8	48,100	5,880	12.2
Gadsden County, Florida	31,248	14,499	42,705	8,509	19.9	11,548	1,898	16.4
Vernon Parish, Louisiana	31,216	14,036	49,027	7,479	15.3	13,881	1,700	12.2
Iberia Parish, Louisiana	31,204	14,145	71,977	16,952	23.6	19,121	3,861	20.2
Assumption Parish, Louisiana	31,168	14,008	23,184	5,062	21.8	6,272	1,225	19.5
Thomas County, Georgia	31,115	16,211	41,578	7,231	17.4	11,446	1,562	13.6
Leon County, Texas	30,981	17,599	15,205	2,365	15.6	4,578	576	12.6
Pearl River County, Mississippi	30,912	15,160	47,729	8,800	18.4	13,726	2,124	15.5

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Jasper County, Texas	30,902	15,636	34,540	6,237	18.1	9,991	1,502	15.0
Columbia County, Florida	30,881	14,598	53,485	8,027	15.0	14,973	1,704	11.4
Jasper County, South Carolina	30,727	14,161	19,346	3,996	20.7	5,117	788	15.4
Coffee County, Georgia	30,710	15,530	35,828	6,859	19.1	9,822	1,500	15.3
St. Martin Parish, Louisiana	30,701	13,619	47,615	10,261	21.5	12,978	2,385	18.4
Lafayette County, Florida	30,651	13,087	5,718	999	17.5	1,611	208	12.9
Long County, Georgia	30,640	12,586	10,174	1,986	19.5	2,693	475	17.6
Pointe Coupee Parish, Louisiana	30,618	15,387	22,360	5,172	23.1	6,216	1,162	18.7
Stone County, Mississippi	30,495	14,693	12,990	2,271	17.5	3,651	529	14.5
Polk County, Texas	30,495	15,834	37,658	6,540	17.4	11,059	1,470	13.3
Brantley County, Georgia	30,361	13,713	14,485	2,266	15.6	4,176	507	12.1
Baker County, Georgia	30,338	16,969	4,071	951	23.4	1,092	217	19.9
Gilchrist County, Florida	30,328	13,985	13,054	1,844	14.1	3,704	404	10.9
Gulf County, Florida	30,276	14,449	11,915	1,988	16.7	3,549	485	13.7
McIntosh County, Georgia	30,102	14,253	10,648	1,990	18.7	3,019	475	15.7
Berrien County, Georgia	30,044	16,375	15,975	2,827	17.7	4,540	663	14.6
Taylor County, Florida	30,032	15,281	17,923	3,229	18.0	5,157	750	14.5
Suwannee County, Florida	29,963	14,678	34,260	6,325	18.5	9,785	1,444	14.8
Pierce County, Georgia	29,895	14,230	15,486	2,849	18.4	4,431	638	14.4
Rapides Parish, Louisiana	29,856	16,088	122,161	25,097	20.5	33,339	5,454	16.4
Tyler County, Texas	29,808	15,367	19,278	3,044	15.8	5,688	716	12.6
Jackson County, Florida	29,744	13,905	40,730	6,998	17.2	11,659	1,492	12.8
Colleton County, South Carolina	29,733	14,831	37,939	8,014	21.1	10,598	1,829	17.3
Grant Parish, Louisiana	29,622	14,410	18,377	3,948	21.5	5,222	885	16.9
Vermilion Parish, Louisiana	29,500	14,201	52,828	11,681	22.1	14,511	2,523	17.4
Madison County, Texas	29,418	14,056	10,059	1,588	15.8	2,853	351	12.3
Tangipahoa Parish, Louisiana	29,412	14,461	97,474	22,119	22.7	25,895	4,664	18.0
Lanier County, Georgia	29,171	13,690	6,925	1,284	18.5	1,948	298	15.3
Lavaca County, Texas	29,132	16,398	18,739	2,480	13.2	5,396	551	10.2
Brazos County, Texas	29,104	16,212	139,110	37,417	26.9	30,723	4,302	14.0

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Iberville Parish, Louisiana	29,039	13,272	29,895	6,909	23.1	8,027	1,569	19.5
Liberty County, Florida	28,840	17,225	5,611	1,114	19.9	1,548	260	16.8
Decatur County, Georgia	28,820	15,063	27,548	6,240	22.7	7,631	1,466	19.2
Hampton County, South Carolina	28,771	13,129	19,629	4,277	21.8	5,356	954	17.8
Grady County, Georgia	28,656	14,278	23,347	4,982	21.3	6,549	1,092	16.7
Colquitt County, Georgia	28,539	14,457	41,396	8,205	19.8	11,155	1,797	16.1
Newton County, Texas	28,500	13,381	14,461	2,760	19.1	4,133	641	15.5
Ware County, Georgia	28,360	14,384	33,210	6,823	20.5	9,325	1,482	15.9
Nacogdoches County, Texas	28,301	15,437	54,637	12,743	23.3	14,169	2,199	15.5
La Salle Parish, Louisiana	28,189	14,033	13,262	2,486	18.7	3,784	564	14.9
Putnam County, Florida	28,180	15,603	69,225	14,449	20.9	19,451	3,080	15.8
Houston County, Texas	28,119	14,525	20,135	4,219	21.0	5,786	902	15.6
St. Mary Parish, Louisiana	28,072	13,399	52,831	12,472	23.6	14,092	2,903	20.6
Holmes County, Florida	27,923	14,135	16,842	3,209	19.1	4,928	757	15.4
Washington County, Florida	27,922	14,980	19,591	3,757	19.2	5,754	884	15.4
Charlton County, Georgia	27,869	12,920	9,053	1,893	20.9	2,507	445	17.8
Allen Parish, Louisiana	27,777	13,101	21,218	4,225	19.9	6,025	1,079	17.9
Jefferson Davis Parish, Louisiana	27,736	13,398	30,957	6,462	20.9	8,614	1,558	18.1
Cook County, Georgia	27,582	13,465	15,555	3,221	20.7	4,315	713	16.5
Miller County, Georgia	27,335	15,435	6,238	1,322	21.2	1,761	298	16.9
Sabine County, Texas	27,198	15,821	10,313	1,643	15.9	3,173	373	11.8
Perry County, Mississippi	27,189	12,837	12,017	2,646	22.0	3,372	662	19.6
Orleans Parish, Louisiana	27,133	17,258	468,453	130,896	27.9	113,948	26,988	23.7
Seminole County, Georgia	27,094	14,635	9,242	2,141	23.2	2,611	412	15.8
Trinity County, Texas	27,070	15,472	13,582	2,394	17.6	4,046	533	13.2
San Augustine County, Texas	27,025	15,548	8,688	1,840	21.2	2,593	405	15.6
Levy County, Florida	26,959	14,746	33,708	6,263	18.6	9,693	1,458	15.0
Brooks County, Georgia	26,911	13,977	16,152	3,785	23.4	4,430	845	19.1
Bacon County, Georgia	26,910	14,289	9,870	2,335	23.7	2,895	584	20.2

Attachment A-9 Potential Planting Range Income Sorted by Median Household Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Franklin County, Florida	26,756	16,140	9,330	1,654	17.7	2,725	322	11.8
Clinch County, Georgia	26,755	13,023	6,562	1,538	23.4	1,814	403	22.2
Acadia Parish, Louisiana	26,684	13,424	57,799	14,183	24.5	15,764	3,310	21.0
Mitchell County, Georgia	26,581	13,042	21,929	5,793	26.4	5,964	1,329	22.3
Calhoun County, Florida	26,575	12,379	11,261	2,252	20.0	3,179	472	14.8
Madison County, Florida	26,533	12,511	16,994	3,919	23.1	4,738	896	18.9
Atkinson County, Georgia	26,470	12,178	7,584	1,746	23.0	2,003	362	18.1
Dixie County, Florida	26,082	13,559	12,705	2,428	19.1	3,698	536	14.5
Echols County, Georgia	25,851	15,727	3,699	1,060	28.7	938	209	22.3
Natchitoches Parish, Louisiana	25,722	13,743	36,404	9,653	26.5	9,562	1,994	20.9
Hamilton County, Florida	25,638	10,562	10,760	2,799	26.0	3,040	659	21.7
Early County, Georgia	25,629	14,936	12,037	3,094	25.7	3,301	732	22.2
Adams County, Mississippi	25,234	15,778	33,860	8,775	25.9	9,492	2,169	22.9
St. Helena Parish, Louisiana	24,970	12,318	10,450	2,804	26.8	2,772	631	22.8
Marion County, Mississippi	24,555	12,301	24,620	6,099	24.8	6,987	1,448	20.7
Washington Parish, Louisiana	24,264	12,915	42,007	10,370	24.7	11,666	2,268	19.4
Avoyelles Parish, Louisiana	23,851	12,146	38,303	9,939	25.9	10,621	2,301	21.7
St. Landry Parish, Louisiana	22,855	12,042	86,113	25,210	29.3	23,361	5,773	24.7
Concordia Parish, Louisiana	22,742	11,966	19,513	5,680	29.1	5,467	1,327	24.3
Claiborne County, Mississippi	22,615	11,244	10,024	3,246	32.4	2,549	710	27.9
Catahoula Parish, Louisiana	22,528	12,608	10,379	2,921	28.1	3,041	686	22.6
Evangeline Parish, Louisiana	20,532	11,432	33,687	10,857	32.2	9,261	2,523	27.2
Tensas Parish, Louisiana	19,799	12,622	6,108	2,215	36.3	1,658	497	30.0
Wilkinson County, Mississippi	18,929	10,868	9,246	3,486	37.7	2,535	838	33.1
Jefferson County, Mississippi	18,447	9,709	9,069	3,265	36.0	2,323	754	32.5

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income

State	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
State of Florida	**38,819**	**21,557**	**15,605,367**	**1,952,629**	**12.5**	**4,238,409**	**383,131**	**9.0**
State of Georgia	**42,433**	**21,154**	**7,959,649**	**1,033,793**	**13.0**	**2,126,360**	**210,138**	**9.9**
State of Texas	**39,927**	**19,617**	**20,287,300**	**3,117,609**	**15.4**	**5,283,474**	**632,676**	**12.0**
State of South Carolina	**37,082**	**18,795**	**3,883,329**	**547,869**	**14.1**	**1,078,736**	**115,899**	**10.7**
State of Alabama	**34,135**	**18,189**	**4,334,919**	**698,097**	**16.1**	**1,223,185**	**153,113**	**12.5**
State of Louisiana	**32,566**	**16,912**	**4,334,094**	**851,113**	**19.6**	**1,163,191**	**183,448**	**15.8**
State of Mississippi	**31,330**	**15,853**	**2,750,677**	**548,079**	**19.9**	**752,234**	**120,039**	**16.0**

State Planting Range	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Alabama Planting Range Total	*36,130*	*18,921*	*617,797*	*99,713*	*16.1*	*173,155*	*22,783*	*13.2*
South Carolina Planting Range Total	*36,571*	*18,052*	*777,724*	*112,424*	*14.5*	*212,467*	*23,568*	*11.1*
Texas Planting Range Total	*35,232*	*17,079*	*5,809,955*	*841,914*	*14.5*	*1,506,573*	*170,507*	*11.3*
Florida Planting Range Total	*33,508*	*16,712*	*3,058,197*	*424,340*	*13.9*	*839,133*	*82,907*	*9.9*
Georgia Planting Range Total	*31,017*	*15,297*	*957,989*	*166,135*	*17.3*	*262,038*	*36,233*	*13.8*
Louisiana Planting Range Total	*31,476*	*15,092*	*3,507,947*	*671,701*	*19.1*	*937,242*	*144,762*	*15.4*
Mississippi Planting Range Total	*29,283*	*14,563*	*571,383*	*96,116*	*16.8*	*157,453*	*21,724*	*13.8*

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
St. Johns County, Florida	50,099	28,674	120,920	9,698	8.0	34,266	1,750	5.1
Beaufort County, South Carolina	46,992	25,377	114,377	12,194	10.7	33,397	2,681	8.0
Fort Bend County, Texas	63,831	24,985	349,010	24,953	7.1	93,808	5,139	5.5
Montgomery County, Texas	50,864	24,544	291,519	27,376	9.4	80,723	5,766	7.1
Nassau County, Florida	46,022	22,836	56,772	5,192	9.1	16,567	1,067	6.4

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
St. Tammany Parish, Louisiana	47,883	22,514	188,661	18,336	9.7	52,971	4,041	7.6
Flagler County, Florida	40,214	21,879	49,288	4,287	8.7	15,705	1,048	6.7
Glynn County, Georgia	38,765	21,707	66,813	10,120	15.1	18,649	2,170	11.6
Galveston County, Texas	42,419	21,568	245,887	32,510	13.2	66,494	6,734	10.1
Harris County, Texas	42,598	21,435	3,360,536	503,234	15.0	840,630	101,693	12.1
Charleston County, South Carolina	37,810	21,393	300,183	49,330	16.4	77,744	9,643	12.4
Chatham County, Georgia	37,752	21,152	224,398	35,043	15.6	59,750	7,031	11.8
Leon County, Florida	37,517	21,024	225,863	41,078	18.2	54,796	5,164	9.4
Okaloosa County, Florida	41,474	20,918	164,709	14,562	8.8	46,858	3,099	6.6
Clay County, Florida	48,854	20,868	139,162	9,437	6.8	39,731	2,018	5.1
Baldwin County, Alabama	40,250	20,826	138,148	14,018	10.1	40,531	3,082	7.6
Duval County, Florida	40,703	20,753	762,726	90,828	11.9	203,227	18,641	9.2
Santa Rosa County, Florida	41,881	20,089	114,784	11,282	9.8	33,577	2,641	7.9
Brazoria County, Texas	48,632	20,021	230,436	23,465	10.2	63,513	5,130	8.1
Jefferson Parish, Louisiana	38,435	19,953	451,243	61,608	13.7	120,841	13,055	10.8
Chambers County, Texas	47,964	19,863	25,719	2,833	11.0	7,221	601	8.3
Georgetown County, South Carolina	35,312	19,805	55,263	9,439	17.1	15,881	2,126	13.4
Bryan County, Georgia	48,345	19,794	23,240	2,715	11.7	6,563	705	10.7
East Baton Rouge Parish, Louisiana	37,224	19,790	398,888	71,276	17.9	103,357	13,647	13.2
Lafayette Parish, Louisiana	36,518	19,371	185,805	29,216	15.7	49,108	5,811	11.8
St. Charles Parish, Louisiana	45,139	19,054	47,591	5,424	11.4	13,182	1,223	9.3
Effingham County, Georgia	46,505	18,873	37,150	3,458	9.3	10,487	743	7.1
Lamar County, Mississippi	37,628	18,849	38,782	5,150	13.3	10,717	1,043	9.7
Dorchester County, South Carolina	43,316	18,840	94,316	9,108	9.7	26,482	1,883	7.1
Houston County, Alabama	34,431	18,759	87,646	13,146	15.0	25,286	2,981	11.8
Bay County, Florida	36,092	18,700	144,747	18,882	13.0	40,653	3,984	9.8
Escambia County, Florida	35,234	18,641	271,889	41,978	15.4	74,528	9,021	12.1
Alachua County, Florida	31,426	18,465	206,224	46,939	22.8	48,100	5,880	12.2

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Victoria County, Texas	38,732	18,379	82,527	10,681	12.9	22,348	2,352	10.5
Walton County, Florida	32,407	18,198	38,776	5,577	14.4	11,300	1,312	11.6
Austin County, Texas	38,615	18,140	23,345	2,814	12.1	6,493	570	8.8
Harrison County, Mississippi	35,624	18,024	182,302	26,597	14.6	48,969	5,660	11.6
Hardin County, Texas	37,612	17,962	47,518	5,314	11.2	13,794	1,210	8.8
Ascension Parish, Louisiana	44,288	17,858	75,755	9,808	12.9	21,002	2,254	10.7
Marion County, Florida	31,944	17,848	251,736	32,918	13.1	74,927	6,929	9.2
Jackson County, Mississippi	39,118	17,768	129,465	16,504	12.7	35,921	3,761	10.5
Hancock County, Mississippi	35,202	17,748	42,474	6,137	14.4	11,882	1,331	11.2
Calcasieu Parish, Louisiana	35,372	17,710	178,713	27,582	15.4	49,249	6,304	12.8
Wakulla County, Florida	37,149	17,678	21,610	2,437	11.3	6,260	585	9.3
Leon County, Texas	30,981	17,599	15,205	2,365	15.6	4,578	576	12.6
Jefferson County, Texas	34,706	17,571	236,846	41,142	17.4	64,338	9,378	14.6
Orange County, Texas	37,586	17,554	83,755	11,518	13.8	23,909	2,724	11.4
Washington County, Texas	36,760	17,384	28,597	3,690	12.9	8,014	786	9.8
Orleans Parish, Louisiana	27,133	17,258	468,453	130,896	27.9	113,948	26,988	23.7
Liberty County, Florida	28,840	17,225	5,611	1,114	19.9	1,548	260	16.8
Mobile County, Alabama	33,710	17,178	392,003	72,549	18.5	107,338	16,720	15.6
Calhoun County, Texas	35,849	17,125	20,389	3,340	16.4	5,605	713	12.7
Jefferson County, Florida	32,998	17,006	11,905	2,040	17.1	3,341	444	13.3
Baker County, Georgia	30,338	16,969	4,071	951	23.4	1,092	217	19.9
Colorado County, Texas	32,425	16,910	19,543	3,171	16.2	5,385	660	12.3
Berkeley County, South Carolina	39,908	16,879	136,671	16,066	11.8	37,892	3,664	9.7
St. Bernard Parish, Louisiana	35,939	16,718	66,269	8,687	13.1	18,363	1,935	10.5
Jackson County, Texas	35,254	16,693	14,088	2,074	14.7	3,963	484	12.2
Lowndes County, Georgia	32,132	16,683	85,144	15,622	18.3	22,389	3,102	13.9
Burleson County, Texas	33,026	16,616	16,347	2,813	17.2	4,608	606	13.2
Camden County, Georgia	41,056	16,445	41,642	4,221	10.1	11,462	960	8.4
Lavaca County, Texas	29,132	16,398	18,739	2,480	13.2	5,396	551	10.2

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Berrien County, Georgia	30,044	16,375	15,975	2,827	17.7	4,540	663	14.6
Waller County, Texas	38,136	16,338	29,487	4,718	16.0	7,837	901	11.5
Livingston Parish, Louisiana	38,887	16,282	90,959	10,339	11.4	25,659	2,347	9.1
Brazos County, Texas	29,104	16,212	139,110	37,417	26.9	30,723	4,302	14.0
Thomas County, Georgia	31,115	16,211	41,578	7,231	17.4	11,446	1,562	13.6
San Jacinto County, Texas	32,220	16,144	22,049	4,150	18.8	6,446	972	15.1
Franklin County, Florida	26,756	16,140	9,330	1,654	17.7	2,725	322	11.8
Rapides Parish, Louisiana	29,856	16,088	122,161	25,097	20.5	33,339	5,454	16.4
Terrebonne Parish, Louisiana	35,235	16,051	102,709	19,607	19.1	27,473	4,329	15.8
Plaquemines Parish, Louisiana	38,173	15,937	25,969	4,682	18.0	6,986	1,078	15.4
Angelina County, Texas	33,806	15,876	77,567	12,241	15.8	21,374	2,643	12.4
Polk County, Texas	30,495	15,834	37,658	6,540	17.4	11,059	1,470	13.3
Sabine County, Texas	27,198	15,821	10,313	1,643	15.9	3,173	373	11.8
Lafourche Parish, Louisiana	34,910	15,809	88,077	14,560	16.5	24,421	3,212	13.2
Adams County, Mississippi	25,234	15,778	33,860	8,775	25.9	9,492	2,169	22.9
West Baton Rouge Parish, Louisiana	37,117	15,773	20,953	3,564	17.0	5,765	759	13.2
Echols County, Georgia	25,851	15,727	3,699	1,060	28.7	938	209	22.3
Matagorda County, Texas	32,174	15,709	37,367	6,913	18.5	10,012	1,496	14.9
Jasper County, Texas	30,902	15,636	34,540	6,237	18.1	9,991	1,502	15.0
Wayne County, Georgia	32,766	15,628	24,406	4,071	16.7	7,040	943	13.4
Putnam County, Florida	28,180	15,603	69,225	14,449	20.9	19,451	3,080	15.8
San Augustine County, Texas	27,025	15,548	8,688	1,840	21.2	2,593	405	15.6
Liberty County, Texas	38,361	15,539	64,878	9,296	14.3	17,937	1,998	11.1
Coffee County, Georgia	30,710	15,530	35,828	6,859	19.1	9,822	1,500	15.3
Beauregard Parish, Louisiana	32,582	15,514	31,728	4,945	15.6	9,093	1,183	13.0
Trinity County, Texas	27,070	15,472	13,582	2,394	17.6	4,046	533	13.2
St. John the Baptist Parish, Louisiana	39,456	15,445	42,536	7,114	16.7	11,346	1,576	13.9

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Nacogdoches County, Texas	28,301	15,437	54,637	12,743	23.3	14,169	2,199	15.5
Miller County, Georgia	27,335	15,435	6,238	1,322	21.2	1,761	298	16.9
East Feliciana Parish, Louisiana	31,631	15,428	18,915	4,352	23.0	5,061	927	18.3
Wharton County, Texas	32,208	15,388	40,519	6,703	16.5	10,774	1,430	13.3
Pointe Coupee Parish, Louisiana	30,618	15,387	22,360	5,172	23.1	6,216	1,162	18.7
Tyler County, Texas	29,808	15,367	19,278	3,044	15.8	5,688	716	12.6
Cameron Parish, Louisiana	34,232	15,348	9,879	1,220	12.3	2,703	247	9.1
Taylor County, Florida	30,032	15,281	17,923	3,229	18.0	5,157	750	14.5
Baker County, Florida	40,035	15,164	20,168	2,961	14.7	5,668	644	11.4
Pearl River County, Mississippi	30,912	15,160	47,729	8,800	18.4	13,726	2,124	15.5
Decatur County, Georgia	28,820	15,063	27,548	6,240	22.7	7,631	1,466	19.2
Washington County, Florida	27,922	14,980	19,591	3,757	19.2	5,754	884	15.4
Early County, Georgia	25,629	14,936	12,037	3,094	25.7	3,301	732	22.2
Colleton County, South Carolina	29,733	14,831	37,939	8,014	21.1	10,598	1,829	17.3
Levy County, Florida	26,959	14,746	33,708	6,263	18.6	9,693	1,458	15.0
Stone County, Mississippi	30,495	14,693	12,990	2,271	17.5	3,651	529	14.5
Suwannee County, Florida	29,963	14,678	34,260	6,325	18.5	9,785	1,444	14.8
Seminole County, Georgia	27,094	14,635	9,242	2,141	23.2	2,611	412	15.8
Columbia County, Florida	30,881	14,598	53,485	8,027	15.0	14,973	1,704	11.4
Houston County, Texas	28,119	14,525	20,135	4,219	21.0	5,786	902	15.6
Walker County, Texas	31,468	14,508	44,904	8,253	18.4	11,533	1,225	10.6
Gadsden County, Florida	31,248	14,499	42,705	8,509	19.9	11,548	1,898	16.4
Tangipahoa Parish, Louisiana	29,412	14,461	97,474	22,119	22.7	25,895	4,664	18.0
Colquitt County, Georgia	28,539	14,457	41,396	8,205	19.8	11,155	1,797	16.1
Gulf County, Florida	30,276	14,449	11,915	1,988	16.7	3,549	485	13.7
Grant Parish, Louisiana	29,622	14,410	18,377	3,948	21.5	5,222	885	16.9
Ware County, Georgia	28,360	14,384	33,210	6,823	20.5	9,325	1,482	15.9
St. James Parish, Louisiana	35,277	14,381	20,915	4,328	20.7	5,564	1,004	18.0
Grimes County, Texas	32,280	14,368	20,717	3,442	16.6	5,626	775	13.8

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
George County, Mississippi	34,730	14,337	18,805	3,140	16.7	5,329	695	13.0
Bacon County, Georgia	26,910	14,289	9,870	2,335	23.7	2,895	584	20.2
Grady County, Georgia	28,656	14,278	23,347	4,982	21.3	6,549	1,092	16.7
McIntosh County, Georgia	30,102	14,253	10,648	1,990	18.7	3,019	475	15.7
Pierce County, Georgia	29,895	14,230	15,486	2,849	18.4	4,431	638	14.4
Bradford County, Florida	33,140	14,226	21,812	3,183	14.6	6,234	693	11.1
Vermilion Parish, Louisiana	29,500	14,201	52,828	11,681	22.1	14,511	2,523	17.4
Jasper County, South Carolina	30,727	14,161	19,346	3,996	20.7	5,117	788	15.4
Iberia Parish, Louisiana	31,204	14,145	71,977	16,952	23.6	19,121	3,861	20.2
Holmes County, Florida	27,923	14,135	16,842	3,209	19.1	4,928	757	15.4
Madison County, Texas	29,418	14,056	10,059	1,588	15.8	2,853	351	12.3
Vernon Parish, Louisiana	31,216	14,036	49,027	7,479	15.3	13,881	1,700	12.2
La Salle Parish, Louisiana	28,189	14,033	13,262	2,486	18.7	3,784	564	14.9
Assumption Parish, Louisiana	31,168	14,008	23,184	5,062	21.8	6,272	1,225	19.5
Gilchrist County, Florida	30,328	13,985	13,054	1,844	14.1	3,704	404	10.9
Brooks County, Georgia	26,911	13,977	16,152	3,785	23.4	4,430	845	19.1
Jackson County, Florida	29,744	13,905	40,730	6,998	17.2	11,659	1,492	12.8
Liberty County, Georgia	33,477	13,855	56,604	8,464	15.0	15,332	2,075	13.5
Natchitoches Parish, Louisiana	25,722	13,743	36,404	9,653	26.5	9,562	1,994	20.9
Brantley County, Georgia	30,361	13,713	14,485	2,266	15.6	4,176	507	12.1
Lanier County, Georgia	29,171	13,690	6,925	1,284	18.5	1,948	298	15.3
St. Martin Parish, Louisiana	30,701	13,619	47,615	10,261	21.5	12,978	2,385	18.4
Dixie County, Florida	26,082	13,559	12,705	2,428	19.1	3,698	536	14.5
Cook County, Georgia	27,582	13,465	15,555	3,221	20.7	4,315	713	16.5
Acadia Parish, Louisiana	26,684	13,424	57,799	14,183	24.5	15,764	3,310	21.0
St. Mary Parish, Louisiana	28,072	13,399	52,831	12,472	23.6	14,092	2,903	20.6
Jefferson Davis Parish, Louisiana	27,736	13,398	30,957	6,462	20.9	8,614	1,558	18.1

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Newton County, Texas	28,500	13,381	14,461	2,760	19.1	4,133	641	15.5
Iberville Parish, Louisiana	29,039	13,272	29,895	6,909	23.1	8,027	1,569	19.5
Hampton County, South Carolina	28,771	13,129	19,629	4,277	21.8	5,356	954	17.8
Allen Parish, Louisiana	27,777	13,101	21,218	4,225	19.9	6,025	1,079	17.9
Lafayette County, Florida	30,651	13,087	5,718	999	17.5	1,611	208	12.9
Mitchell County, Georgia	26,581	13,042	21,929	5,793	26.4	5,964	1,329	22.3
Clinch County, Georgia	26,755	13,023	6,562	1,538	23.4	1,814	403	22.2
Charlton County, Georgia	27,869	12,920	9,053	1,893	20.9	2,507	445	17.8
Washington Parish, Louisiana	24,264	12,915	42,007	10,370	24.7	11,666	2,268	19.4
Perry County, Mississippi	27,189	12,837	12,017	2,646	22.0	3,372	662	19.6
Tensas Parish, Louisiana	19,799	12,622	6,108	2,215	36.3	1,658	497	30.0
Catahoula Parish, Louisiana	22,528	12,608	10,379	2,921	28.1	3,041	686	22.6
Long County, Georgia	30,640	12,586	10,174	1,986	19.5	2,693	475	17.6
Madison County, Florida	26,533	12,511	16,994	3,919	23.1	4,738	896	18.9
Calhoun County, Florida	26,575	12,379	11,261	2,252	20.0	3,179	472	14.8
Union County, Florida	34,563	12,333	9,289	1,298	14.0	2,655	278	10.5
St. Helena Parish, Louisiana	24,970	12,318	10,450	2,804	26.8	2,772	631	22.8
Marion County, Mississippi	24,555	12,301	24,620	6,099	24.8	6,987	1,448	20.7
Atkinson County, Georgia	26,470	12,178	7,584	1,746	23.0	2,003	362	18.1
Avoyelles Parish, Louisiana	23,851	12,146	38,303	9,939	25.9	10,621	2,301	21.7
St. Landry Parish, Louisiana	22,855	12,042	86,113	25,210	29.3	23,361	5,773	24.7
Concordia Parish, Louisiana	22,742	11,966	19,513	5,680	29.1	5,467	1,327	24.3
Evangeline Parish, Louisiana	20,532	11,432	33,687	10,857	32.2	9,261	2,523	27.2
Claiborne County, Mississippi	22,615	11,244	10,024	3,246	32.4	2,549	710	27.9
Wilkinson County, Mississippi	18,929	10,868	9,246	3,486	37.7	2,535	838	33.1
Hamilton County, Florida	25,638	10,562	10,760	2,799	26.0	3,040	659	21.7

Attachment A-10 Potential Planting Range Income Sorted by Per Capita Income Continued

County	Median Household Income (dollars) 1999	Per Capita Income (dollars) 1999	Total Individuals	Number of Individuals Below Poverty Level	Percentage of Individuals Below Poverty Level	Families Below Poverty Level	Number of Families Below Poverty Level	Percentage of Families Below Poverty Level
Jefferson County, Mississippi	18,447	9,709	9,069	3,265	36.0	2,323	754	32.5

Appendix G: Silviculture of Freeze Tolerant Eucalyptus

Why Grow FTE?

The genus *Eucalyptus*, with more than 700 species, has some of the fastest growing trees in the world. The native range of eucalypts is primarily Australia with a few species also native to Indonesia and Papua New Guinea. Testing of different *Eucalyptus* species became important in the mid 1800's in many parts of the world as a source of wood for mining timbers, railroad ties and fuel. Today there are around 20 *Eucalyptus* species that are widely planted outside their native range.

Purpose grown plantations of eucalypts are a reality in almost 100 countries. The reasons are rapid growth rate, resistance to disease and insects as well as highly desirable wood properties for multiple forest processing industries. In parts of the southeastern US, eucalypts have the potential to substantially increase forest productivity for a wide variety of end uses. The United States Department of Energy has identified *Eucalyptus* as being an important woody biomass feedstock. Eucalypts offers multiple advantages as a biomass crop including high productivity on short rotations, potential for planting on marginal lands, multiple crops from a single planting (coppicing ability), high bulk density, excellent fiber properties and high carbon storage.

FTE is a fast growing *Eucalyptus* hybrid species with sufficient freeze tolerance for USDA Hardiness Zone 8b. The FTE hybrid was developed by adding freeze tolerance to a cross of *Eucalyptus grandis* and *Eucalyptus urophylla*.

Best plantation growth will be realized with timely and adequate silvicultural management as described below. One of the key success elements is an early start in the process. Management should follow state Best Management Practices (BMPs). Actual yields will vary due to climate, site and management inputs.

Site Selection. Late winter or early spring to allow a fall planting. Preference should be given to sites formerly in pine or hardwood plantations.

Seedlings. Orders should be placed no later than December 15 for spring planting, March 15 for summer planting and May 15 for fall planting...

Spacing. Pulpwood 600 TPA (Trees Per Acre). Bioenergy 1200 TPA.

Soils. Moderately well drained soils with some degree of clay content for water retention. Avoid excessively well drained or poorly drained sites.

Site Preparation. Chemical site preparation will be dependent on post-harvest vegetation growth, but generally will include a summer broadcast application of glyphosate or similar product at a rate of 8 - 10qts/acre, 15 gallons water/acre and a surfactant following all herbicide label instructions. Mechanical site preparation should consist of bedding or subsoiling. Eucalypts require both chemical and mechanical site preparation for best growth. Old-field sites will need to be subsoiled.

Planting. 100% containerized. Fall planting is preferred, mid-September to early November depending on adequate soil moisture and historical date of first frost. Spring planting can be successful as long as care is taken to plant after the last frost. Hand planting is the norm but mechanical planting is possible depending on equipment and contractor experience with container stock.

Fertilization. Near the date of planting, broadcast application of 150-200 lbs/acre of Triple Super Phosphate (TSP) on Phosphorus-deficient sites. After crown closure at age 2-3 years, broadcast application of 150-200 lbs/acre urea. Weed control must be adequate before any nitrogen application.

Weed control. Complete weed control in the 1st year. One practical means to accomplish this is a direct spray of glyphosate. Eucalypts have been labeled for the use of Oust, which has been shown to be safe on eucalypts at 0.5 to 1.5 oz/acre. In the second year, a directed-spray of glyphosate may be required. Note that site preparation pine tank mixes will result in eucalypt mortality or stunted growth. All label instructions for herbicides should be followed.

Suggested Rotation Length and Yields:

Bioenergy
3 year rotation 22-27 tons/acre/year

Pulpwood
7 year rotation, MAI 17-22 tons/acre/year.

For more information contact ArborGen Inc. (eucalyptus@arborgen.com)

Petition 11-019-01p

Supplement 1. Submitted by ArborGen August 17, 2011

Attachment 1: Procedure for Monitoring for Plant Pests and Diseases in ArborGen's Transgenic *Eucalyptus* Field Trials.

Prepared 8/11/2011 and submitted to BRS as supplementary information to Appendix C of pending Petition 11-019-01p

Introduction:
The primary focus of data collection in most forestry tree trials is typically growth and form, usually with only infrequent monitoring for pests and diseases as an incidental or secondary component to assessment of other traits. In those cases where specific resistance to a known and established disease or pest is being assessed, for example, across a collection of genotypes expected to express a range of resistance, experiments may be set up specifically for that purpose. Alternatively, for some diseases greenhouse or laboratory assays have been developed (e.g. fusiform rust in southern yellow pines). ArborGen's process to assess pests and diseases in our transgenic *Eucalyptus* trials is to use a general survey approach. This approach takes into account the expectation that for the vast majority of cases, no pests or diseases are likely to be observed. We also considered that there is no *a-priori* expectation that the introduced genes would cause a difference in the incidence of pests and diseases between lines of the transgenic trees versus non-transgenic trees. Therefore, a survey approach was used to assess whether there were any notable pests or diseases present across the broad range of trials.

Monitoring Process:
At nearly all sites the tests are monitored by ArborGen employees (at a few sites monitoring is performed by experienced local forest managers who have been trained by ArborGen employees). These ArborGen employees have extensive experience in the establishment, management and maintenance of field trials of forest tree species. Each employee typically has at least 10 years of experience with field trials of forest trees (with some up to 20+ years experience). Employees are provided with training and reference information about specific pests and diseases of concern for *Eucalyptus* and are specifically required to make observations for these pests and diseases: *Eucalyptus* psyllid (*Blastopsylla occidentalis*), Red gum psyllid (*Glycaspis brimblecombei*), *Cryphonectria* canker, *Botryosphaeria* canker, *Eucalyptus* (guava) rust (*Puccinia psidii*), and Blue gum chalcid *(Leptocybe invasa*). In addition, the employee is asked to note the presence of grasshoppers as well as any other pests or diseases observed. In the event that a pest or disease is observed but is not known to the field employee, ArborGen's in-house *Eucalyptus* experts, familiar with growing *Eucalyptus* both within and outside of the US, are available for consultation to aid in identification.

All tests are monitored approximately every six weeks, much more frequently than is typical for most forest tree field trials. During each monitoring session, the employee will walk through the trial looking at each individual tree for evidence of pests and diseases. As an example, the employee may begin the inspection at the first tree in row #1, proceeding down the row and then on to row #2, then row #3 etc until the entire test is complete. Thus, for example, in a test containing 100 trees, all 100 trees would be visually inspected. The same process is repeated at the next scheduled monitoring, thus over the course of an estimated ~10 inspections during a given year, in the above example ~1,000 observations (10 occasions x

100 trees each time) would be made. If, through this process a pest or disease is noted, then the employee is required to estimate of the approximate percentage of the test affected (either 0-25%, 25%-50%. 5-%-75%, or 75%-100%). They are required to record any notable difference in frequency or damage on transgenic trees vs. nontransgenic trees.

A more intensive assessment would be warranted if there is significant pest or disease damage that appears to be line specific, for example, extensive defoliation (as distinct from defoliation through winter freeze damage). Under these circumstances, data on individual trees may be collected, including the extent of damage on each tree and duration of infection or infestation. [Note there has been no significant damage reported in any of these trials, therefore no such detailed observations have been necessary.]

All field monitoring observations are recorded on Field Monitoring Forms which are submitted to ArborGen's Regulatory Department where they are reviewed, scanned, and filed electronically on ArborGen computer servers. The monitoring information contained in the ArborGen Field Monitoring Form is collated in a Field Monitoring Database, and this information was summarized in Appendix C of the submitted Petition for Deregulation. This Database also serves as the source for information on pests and diseases which is included in Annual reports submitted to APHIS-BRS.

Attachment 2A: Details of Pests and Diseases Noted in Appendix C of Submitted Petition for Deregulation

DISEASES:

Trial ID	Trial Location	Observation Date	Disease Observed	Details
AR 162a	Baldwin County, Alabama	11/14/2006	rust	on ~10% of leaf area; frequency in transgenics same as control
AR 162b		11/14/2006	rust	on ~10% of leaf area; frequency in transgenics same as control
		8/9/2007	*Alternaria*	2-5% severity; seen on mostly lower branches; no difference between controls and transgenics noted
AR 202		11/14/2006	rust	on ~10% of leaf area; frequency in transgenics same as control
AR 162b	Highlands County, Florida	3/25/2008	not specified	disease noted but not specified

INSECT PESTS:

Trial ID	Trial Location	Observation Date	Pest Observed	Details
AR 162a	Baldwin County, Alabama	8/10/2010	sharpshooters	on 25-50% of trees; no difference between transgenic and nontransgenic trees noted
AR 162b				
AR 162d				
AR 162f				
AR 202				
AR 202a				
AR 162f	Gadsden County, Florida	9/24/2010	sharpshooters	on 25-50% of trees; no difference between transgenic and nontransgenic trees noted
AR 162b	Highlands County, Florida	5/22/2007	psyllids	on 20% of the trees; little to no damage observed; no difference between transgenic and non-transgenic trees noted
		6/14/2010	grasshoppers	on less than or equal to 25% of trees; same frequency for transgenics and controls
		9/15/2010		on less than or equal to 25% of trees; same frequency for transgenics and controls
AR 162f	Marion County, Florida	7/14/2010	grasshoppers	noted in test but no damage observed
		8/12/2010		on less than or equal to 25% of trees; frequency on transgenics same as controls; do not appear to be feeding on foliage
		10/11/2010		on 75-100% of test; frequency on transgenics same as controls; little to no damage observed
AR 162f	Taylor County, Florida (site 1)	10/14/2008	grasshoppers	on ~2% of leaves with some insect feeding
AR 162i	Taylor County, Florida (site 2)	9/28/2009	grasshoppers	damage on ~25% of trees- believe was caused by grasshoppers; feeding on inner bark/cambium, caused some limbs to break
AR 162f	Evans County, Georgia	8/9/2010	sharpshooters	no additional comments
AR 162d	Pearl River County, Mississippi	12/11/2007	leaf miners; grasshoppers	leaf miners less than 5%; grasshopper damage less than 5%
AR 162f		8/5/2010	grasshoppers	noted in test but no damage observed
AR 162i	Jasper County, Texas	8/10/2010	grasshoppers	on less than or equal to 25% of trees

Attachment 2B: Summary of Number of Trees in Each Trial, Number of Times Each Trial Was Observed, and Number of Times a Pest or Disease Was Observed.

Trial ID	Trial Location	Date Planted	Date Terminated	Number of Trees Planted[a]	Number of Times Trees in Test Observed[b]	Number of Times Pests/ Diseases Observed
AR 162a	Baldwin County, Alabama	11/8/2005	N.A.	540	45	2
AR 162b		7/11/2006	N.A.	720	41	3
AR 202		8/8/2006	N.A.	320	37	2
AR 202a		6/27/2007	N.A.	320	24	1
AR 162d		7/31/2007	N.A.	890	29	1
AR 162f		7/16/2008	N.A.	400	19	1
AR 162d	Escambia County, Alabama	7/31/2007	N.A.	140	22	0
AR 162f		7/15/2008	N.A.	100	16	0
AR 162e	Bay County, Florida	10/23/2007	6/26/2008	200	4	0
AR 162f		7/15/2008	7/20/2009	190	9	0
AR 162f	Gadsden County, Florida	7/16/2008	N.A.	100	17	1
AR 162e	Glades County, Florida	10/10/2007	9/1/2009	965	17	0
AR 162f		10/16/2008	9/1/2009	70	4	0
AR 162b	Highlands County, Florida	7/18-19/06	N.A.	720	35	4
AR 162f	Marion County, Florida	8/26/2008	N.A.	445	17	3
AR 162f	Taylor County, Florida (site 1)	9/17/2008	N.A.	1425	17	1
AR 162f	Taylor County, Florida (site 2)	7/17/2008	N.A.	400	19	0*
AR 162i		9/17/2008	N.A.	150	16	1
AR 162f	Evans County, Georgia	8/26/2008	N.A.	60	22	1
AR 162b	Saint Landry's Parish, Louisiana	7/13/2006	6/24/2009	646	34	0
AR 162d		8/1/2007	6/25/2009	140	11	0
AR 162f		7/29/2008	N.A.	100	17	0
AR 162d	Marshall County, Mississippi	10/30/2007	8/5/2008	140	6	0
AR 162d	Pearl River County, Mississippi	10/31/2007	N.A.	765	26	1
AR 162f		7/29/2008	N.A.	525	15	1
AR 162b	Bamberg County, South Carolina	7/5/2006	7/23/2009	120	29	0
AR 162d		7/18/2007	7/23/2009	150	10	0
AR 202		8/4/2006	7/23/2009	1440	27	0
AR 162f		8/8/2008	N.A.	60	9	0
AR 162b	Berkeley County, South Carolina	7/5/2006	7/14/2008	120	25	0
AR 162d		7/20/2007	6/22/2009	140	18	0
AR 162b	Charleston County, South Carolina	7/6/2006	7/22/2009	120	36	0
AR 162d		7/19/2007	7/22/2009	150	14	0
AR 202		8/15/2006	7/22/2009	1440	24	0
AR 162d	Marlboro County, South Carolina	8/24/2007	7/22/2009	140	15	0
AR 162i	Jasper County, Texas	8/27/2008	N.A.	320	17	1
			Totals	14671	743	24

* Previously noted in App C as one occurrence of pest/disease but later identified as a typographical error.

[a] Note that over time the number of trees in a test may have been reduced due to harvesting of samples or termination of subsets of trees.

[b] For tests listed here, at each monitoring time-point all trees in the test were inspected (see description of field monitoring process attached). Thus, for example, a field test of 100 trees inspected on10 different occasions, reflects cumulative observations on 1,000 trees.

Petition 11-019-01p

Supplement 2. Submitted by ArborGen October 24, 2011

RECEIVED
By APHIS BRS, Oct 24, 2011

ArborGen®

October 24, 2011

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RE: FOLLOW-UP INFORMATION FOR PETITION #11-019-01p

Dear Lee,

This letter is a follow-up to our discussion on the Plant Pest Risk and Weediness sections of the submitted Petition # 11-019-01p. As requested, we are providing the following additional information in support of the Petition.

IFAS Weed Risk Assessment of Eucalyptus Hybrid

In the petition, we concluded that FTE translines are highly unlikely to spread beyond a managed plantation. Our conclusion was based on the data that suggest very low amounts of viable seed production in the translines and EH1 control trees compared to open pollinated *Eucalyptus* trees, documented poor seedling establishment under conditions present in a typical managed field planting together with extremely poor germination and survival of *Eucalyptus* seed in competitive conditions in unmanaged areas, and lack of any seeded volunteers in the field trials allowed to flower in the southeastern US.

As discussed in the “Weediness of Planted *Eucalyptus*” section (II.F) of the petition, several commercially important *Eucalyptus* species grown in Florida have been evaluated according to the Institute of Food and Agricultural Sciences (IFAS) Assessment of the Status of Non-Native plants in Florida’s Natural Areas. Based on an assessments using the modified Australian Weed Risk Assessment model, *E. grandis*, one of the parents of the EH1 hybrid, was categorized by IFAS as ‘predicted to be invasive’. Recently, IFAS has completed an analysis on *E. urograndis* (http://plants.ifas.ufl.edu/assessment/pdfs/wra/Eucalyptus%20urograndis_WRA.pdf) (together with several other *Eucalyptus* species). Based on this analysis, the *E. urograndis* hybrid received a score of 3 and a recommendation to accept this as a non-invasive species.

During our call we also indicated our understanding that the Division of Plant Industry (DPI), Florida Department of Agriculture and Consumer Services (FDACS) is analyzing proposals to grant exemption status to certain Eucalyptus species being assessed for biomass production in Florida under the state’s Biomass Planting Rule (Florida Statute 581.083(4) and FL Rule 5B-57.011). DPI is a regulatory agency of FDACS which works to detect, intercept and control plant pests that threaten Florida's native and commercially grown plants and agricultural resources (http://www.freshfromflorida.com/pi/).

It is our understanding that the exemption process for biomass production is fairly informal. Individuals or groups seeking an exemption submit a candidate species to the DPI for consideration. If the DPI determines that a weed assessment is needed, a request is made to IFAS to perform their weed risk assessment. As noted above, this step has been completed for *E. urograndis* with a low weed risk score. Prior to officially being proposed to be added to the exemption list in the Rule the proposal must undergo legal review. We understand that the *E. urograndis* analysis was submitted for legal review quite some time ago, but recognize that this can sometimes take several months or longer and we have no indication on a timeframe for this to be completed. However, based on the IFAS weed risk assessment we believe that there will likely be a decision in the near future to list this species as exempt in the Biomass Planting Rule.

Please also find attached a PDF of the recent publication (da Silva et al., 2011) we discussed that concludes that *E. urograndis* (*E. urophylla* × *E. grandis*), the hybrid used as a base variety for our translines does not spread beyond plantations. These data further support our conclusion in the petition that the freeze tolerant *Eucalyptus* lines are unlikely to spread beyond the managed plantation and thus are not expected to be invasive in any way.

No significant planting of FTE translines 427 or 435 is expected in California and Oregon

While it is possible that FTE lines could be planted in California and Oregon, for example in USDA hardiness zone 8b in those states, this is not likely to create a plant pest risk for the following reasons:

1) In the plant pest analyses section of the petition, we provided a discussion of the potential pests and diseases of *Eucalyptus* that may be present outside of Florida including California and other states. Field trial data of FTE lines in the southeast indicate that the translines are not more susceptible to pests or diseases than the non-transgenic controls. Therefore, there is no evidence that should FTE lines be planted in California or Oregon they would create any new or different pest concerns over and above any concerns for *Eucalyptus* already planted in those states.

2) The potential for any significant planting of FTE lines in California and Oregon is very unlikely. In contrast to forestry operations in the U.S. south, the target deployment region for FTE and where hardwoods account for around 35% of the total harvest, on the Pacific coast the vast majority of wood harvested are softwoods (Smith et al., 2004). In 2001, of the approximately 10 billion cubic feet harvested in the south, about 3.6 billion of this was hardwoods. For the Pacific coast region (including Alaska and Hawaii) of the ~2.5 billion cubic feet harvested less than 120 million of this was hardwoods (see Table 35 of Smith et al., 2004). An important driver in the forestry industry in the Pacific coast region is sawlogs, which account for 67% of the total harvest and consists almost entirely of softwoods (97% , see Table 39 of Smith et al., 2004). Pulpwood in the US south makes up ~40% of the total harvest and is a key market for FTE, but makes up just 2.5% of the total harvest in the Pacific coast region and again almost all (94%) is made up of softwoods. In fact, Smith et al (see Table 39) do not indicate <u>any</u> hardwood harvested for pulp in the Pacific southwest (representing California and Hawaii). Based on this understanding of the forest industry in the Pacific coast region, we do not anticipate that there would be significant demand for planting FTE lines 427 and 435 in that region

We hope that this additional information is helpful in APHIS's review of the petition. Please feel free contact me at (843) 851 4597 or by e-mail at Lxpears@arborgen.com.

Sincerely,

Les Pearson
Director of Regulatory Affairs.

cc: Narender Nehra

Attachments:

1) da Silva et al 2011.pdf
2) Smith et al Forest resources of US 2002.pdf

Forest Resources of the United States, 2002

W. BRAD SMITH, PATRICK D. MILES, JOHN S. VISSAGE, AND SCOTT A. PUGH

A Technical Document Supporting
the USDA Forest Service 2005 Update of the RPA Assessment

U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

THE AUTHORS:

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Patrick D. Miles is a Research Forester with the Forest Inventory and Analysis Unit, North Central Research Station, U.S. Department of Agriculture, Forest Service, St. Paul, MN.

John S. Vissage is a Research Forester with the Forest Inventory and Analysis Unit, North Central Research Station, U.S. Department of Agriculture, Forest Service, St. Paul, MN.

Scott A. Pugh is an Information Technology Specialist with the Forest Inventory and Analysis Unit, North Central Research Station, U.S. Department of Agriculture, Forest Service, Houghton, MI.

IMPORTANT NOTE:
The reader is cautioned that all tables in this report carry the nominal date of 2002. The actual data presented, however, represents the best data available at the end of the 2001 field season for each State. Table A-3 in Appendix A displays the actual date of data collection for each State by data category. For example, a new inventory of North Carolina was completed after the October 2001 cutoff date for data for this report. As a result, the data in this report for North Carolina were based on information collected in 1990 and may not accurately reflect what appears in the 2002 North Carolina State inventory report.

Published by:

North Central Research Station
Forest Service - U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108
2004

Web site: www.ncrs.fs.fed.us

Forest Resources of the United States, 2002

W. Brad Smith, Patrick D. Miles, John S. Vissage, and Scott A. Pugh

ACKNOWLEDGMENTS

The development of this report has been a team effort, involving the work and contributions of many people.

We greatly appreciate the help of the staffs of the Forest Inventory and Analysis Research Work Units at the Forest Service Research Stations and the Forest Management staffs in the regional offices of the National Forest System who compiled the basic resource data for entry into the 2002 RPA National Database. The following people made significant contributions and were responsible for coordinating and submitting resource data and analytical input: Carol Alerich, Gary Boyack, Dave Darr, Dave Ellen, Jorge Negron, Bruce Hiserote, Tom Frieswyk, Jeff Hogg, Charles Keegan, Dennis May, Mel Mehl, Burt Mead, Kevin Dobbelbower, Eric Wharton, Sue Willits, Ralph Warbington, Sharon Woudenberg, Ray Sheffield, Joe Glover, and Tony Johnson.

We also appreciate the efforts of the following people in reviewing the resource data: Doug Powell, Doug MacCleery, Mike Higgs, and Al Abee.

CONTENTS

Introduction

Forest resource growth, harvests, and land use conversion can change inventories within States, among regions, and even among countries, and can significantly influence the future performance of resources. This could affect the State, regional, and national economies that depend on the affected resources, as well as the resource environments. Periodic surveys provide information needed to assess the current status and performance of resources, and to estimate their future condition. As required by the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), P.L. 93-378, 88 Stat. 4765, as amended, this report updates information on the Nation's forest resource.

This report updates resource statistics published by Smith *et al.* (2001). For brevity and balance in presenting reporting periods in tabular outputs, RPA Assessment data for 1963, 1970, and 1992 have been omitted from this report. To provide a context for evaluating and interpreting changes in the forest resource, data for 1953, 1963 (some tables), 1977, 1987, and 1997 are included. A forest type map produced from satellite imagery displaying the area and location of forest land in the United States is available on the Internet at http://www.nationalatlas.gov. A compact disk (CD) is provided in a pocket at the back of this publication that contains the data used for this report and an interactive computer tool for accessing and displaying the data in tables and maps. A user manual with tutorials is provided on the CD.

Geographic Context of the United States

The main landmass of the United States, situated in mid-North America (fig. 1), has a central plain with hills and low mountains to the east and rugged mountains and wide valleys to the west. Alaska, on Canada's western border, is dominated by Pacific and Arctic mountains, central plateau, and Arctic slope. Hawaii, comprised of tops of a chain of submerged volcanic mountains, lies 1,600 miles west of the mainland in the north Pacific.

Original forests were abundant throughout the Eastern U.S., mountainous regions of the interior and coastal west, Hawaii, and non-polar regions of Alaska. Today, the forests of the United States cover 749 million acres, are split almost evenly east and west of the central plain, and contain over 800 species of trees of which 82 are non-native. About one-third of the pre-European settlement forest has been cleared, primarily for agriculture during the 19th century. Although there have been significant regional changes, the total area of forest land has been fairly stable for nearly 100 years.

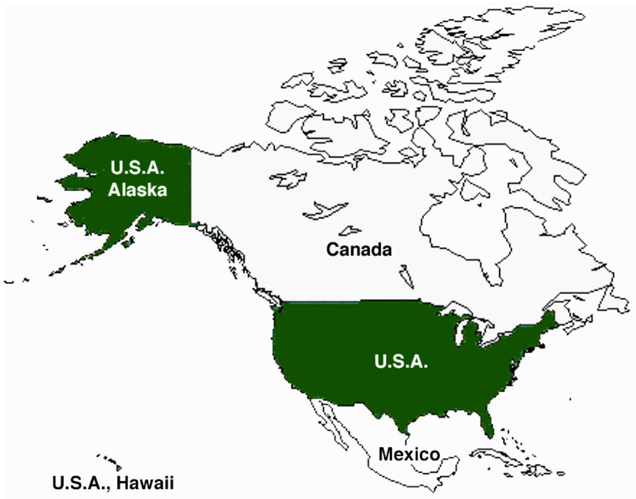

Figure 1—*Geographic location of the United States in North America.*

A forest type map based on types described by Eyre (1980) was produced from satellite imagery and is available to display the spatial extent and location of forest land in the United States. This map may be found online at http://www.nationalatlas.gov/fortypem.html, and further information about the mapping process can be found in Zhu and Evans (1992).

For this report, the United States is divided into four major regions: North, South, Rocky Mountain, and Pacific Coast as shown in figure 2. These major regions are divided into subregions for further geographic reference. Due to a lack of historic field data, Alaska is frequently considered a separate region in these highlights.

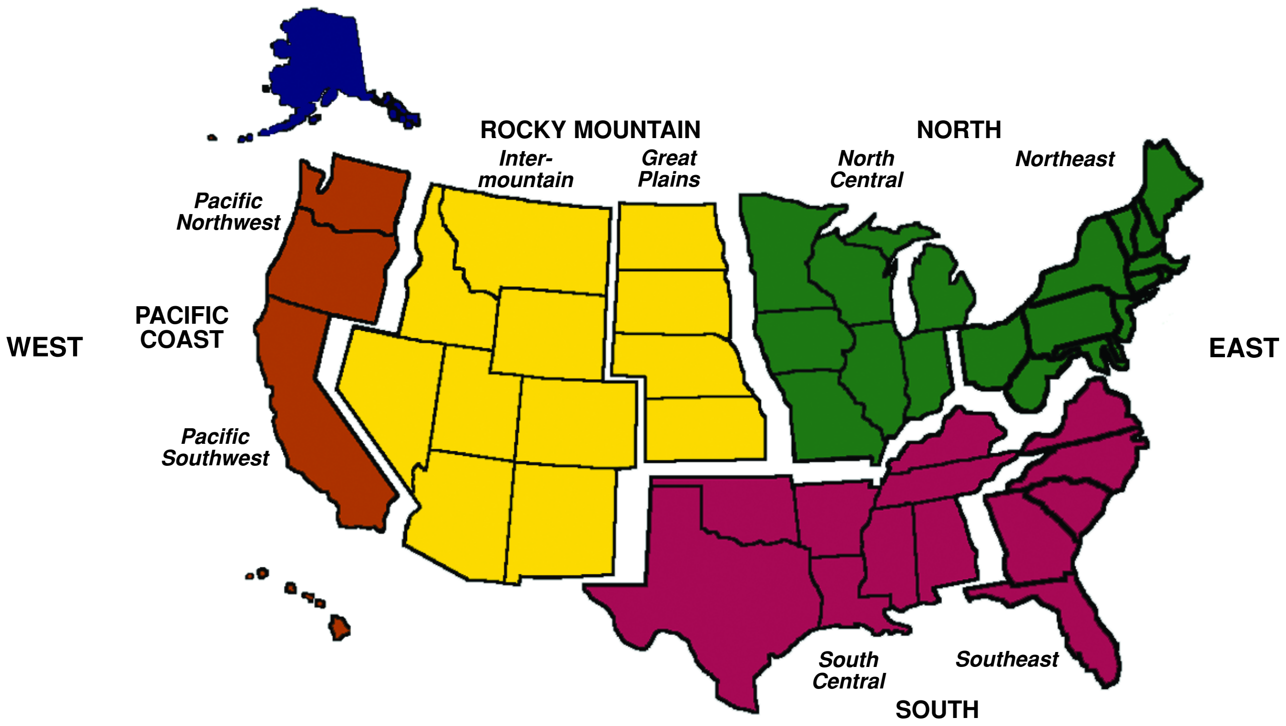

Figure 2—*Forest Resource Reporting Regions and Subregions of the United States.*

Highlights

Information compiled for this Assessment Update indicates that the forest resources of the U.S. have continued improving in general condition and quality, as measured by increased average size and volume of trees. This trend has been evident since the 1960s and before. However, if quality is measured as a function of optimum stand density—that is, optimum number of trees per acre for stands of a given age—then the overall quality of many stands has deteriorated.

The following are some highlights from the new information:

Forest Land Area

- Forest land area increased from 747 to 749 million acres (0.3 percent) between 1997 and 2002, continuing a slight upward trend in area beginning in the late 1980s.

- About 33 percent of the 2.3 billion acres of land area in the U.S. is forest today (fig. 3) as compared to about one-half in 1630 (1.0 billion acres). Some 300 million acres of forest land have been converted to other uses since 1630, predominantly agricultural uses in the East.

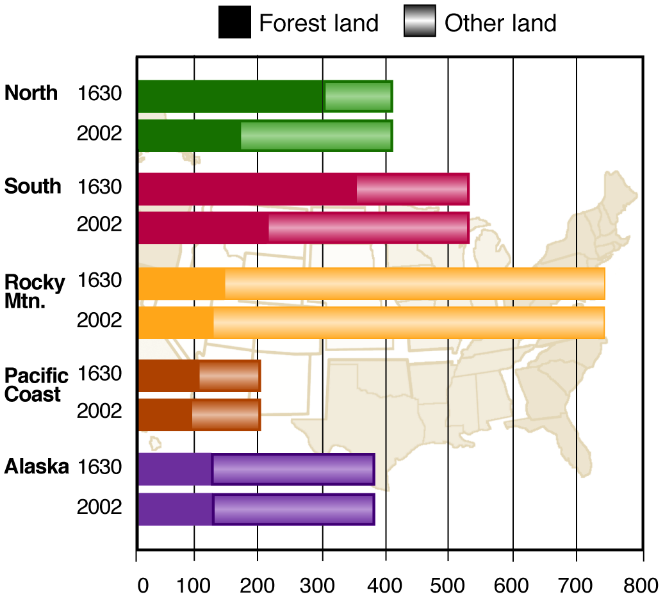

Figure 3—*Land and forest area distribution in the U.S., 1630 and 2002.*

- Nearly two-thirds of the net loss of forests to other uses occurred between 1850 and 1900. By 1920, the clearing of forests for agriculture had largely subsided (fig. 4).

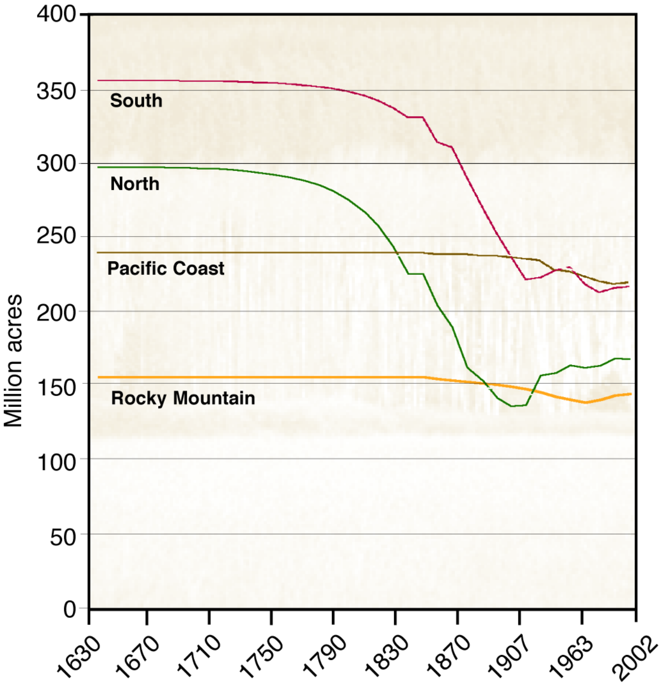

Figure 4—*Forest area of the United States by major region, 1630-2002.*

- Fifty-seven percent of all forest land is privately owned (fig. 5). Public forest land is dominant in the western U.S. and private forest land is dominant in the East.

- Land transfers deriving from the Alaska Native Claims Settlement Act of 1971 and updating of forestland survey data continue. This assessment includes updated estimates for approximately 185 million acres in Alaska. Current FIA plots indicate that private land owners control a minimum of 18.887 million acres of forestland in Alaska. Actual ownership of non-industrial private forestland in Alaska is believed to be as much as 35 million acres.

- About 77 million acres of forest land (10 percent of all U.S. forest land) is reserved from commercial timber harvest in wilderness, parks, and other legally reserved classifications (fig. 6). This is more than double the area of reserved forest in 1953 with major increases occurring in the West. The sharp increase in the Pacific Coast region since 1997 is due to reclassification of lands in Alaska transferred from the Bureau of Land Management to the Park Service and Fish and Wildlife Service.

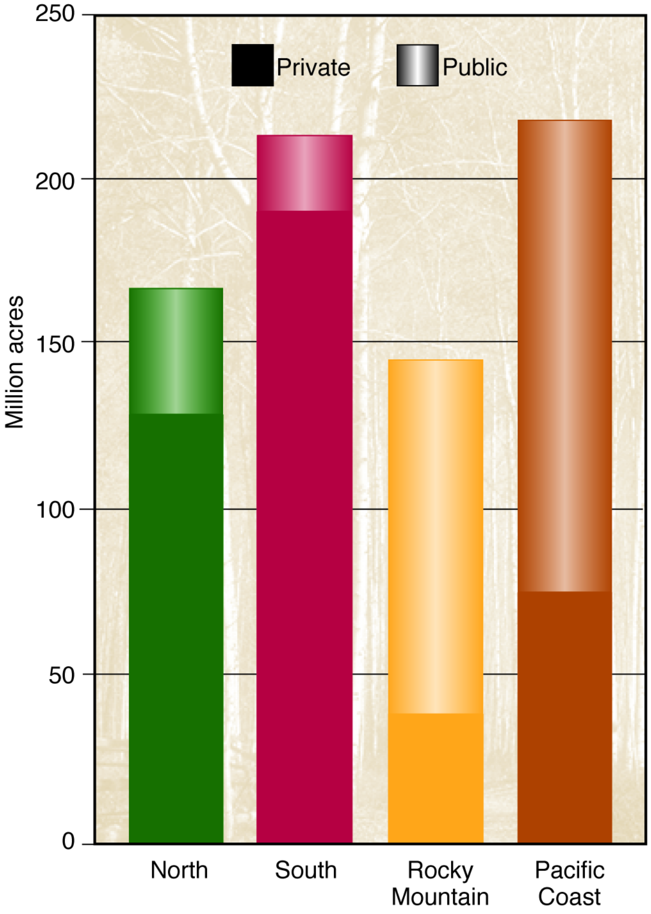

Figure 5—*Distribution of forest land by major region and ownership group.*

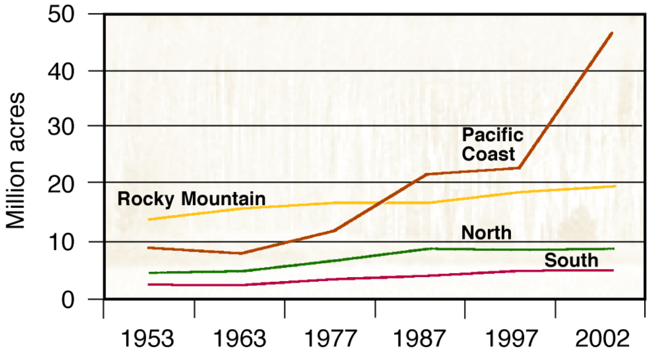

Figure 6—*Trends in reserved forest land by major region, 1953-2002.*

Timberland Area

- About 504 million acres of forest land (two-thirds of all forest land) is classed as timberland—forest land capable of producing in excess of 20 cubic feet per acre per year and not legally withdrawn from timber production—94 percent of eastern forests are classed as timberland, 80 percent of the Pacific Northwest, about 50 percent of the interior West and Southwest, and 10 percent of Alaska.

- Since 1953, the area of timberland had a net loss of about 1 percent, or about 5 million acres. Over the last 5 decades, losses have come primarily from withdrawals of public timberland as wilderness or other reserved forests that do not permit timber harvest, and conversion of timberland to nonforest land use. Most increases have come from reclassification of marginally productive forests and reversion of abandoned lands.

Timber Inventories

- Growing-stock volume on U.S. timberland increased from 616 to 856 billion cubic feet (39 percent) between 1953 and 2002 (fig. 7). Between those years, average growing-stock volume rose by 96 percent in the North, 80 percent in the South, and 42 percent in the Rocky Mountain region. Volume declined in the Pacific Coast region. The loss of timberland in the Pacific Coast region is the result of harvesting in older, higher volume stands since 1953 and set asides of large areas of older stands in reserved forests (which reclassifies trees in these areas as non-growing stock). The rate of loss has subsided in recent years as harvesting has been sharply curtailed and total volume for the region has begun to stabilize.

- Some 57 percent of the volume of growing stock is softwoods, with the remaining 43 percent is in hardwoods. However, 90 percent of the hardwood timber is in the Eastern United

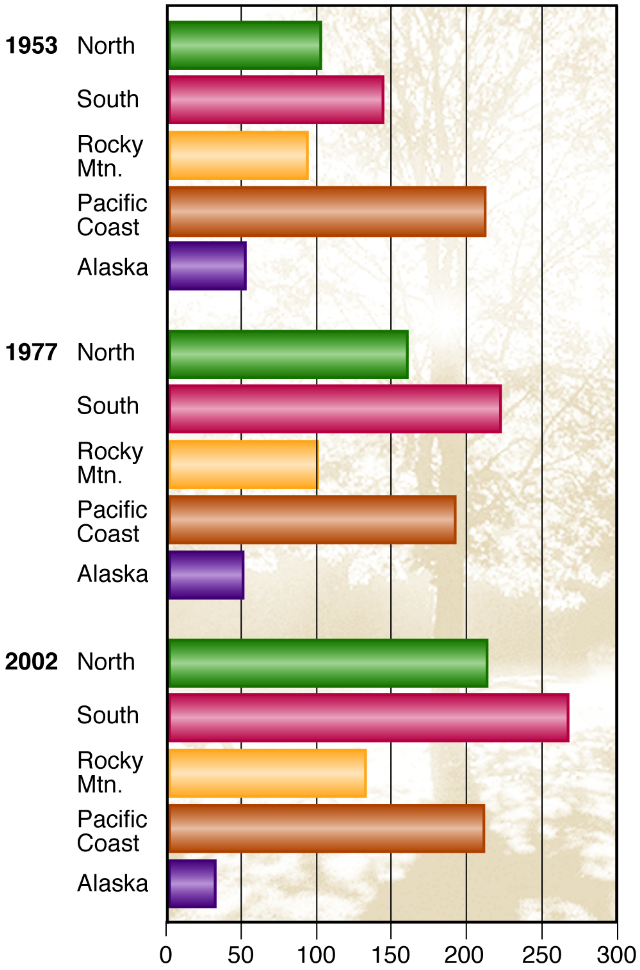

Figure 7—*Trends in growing-stock volume on timberland by region, 1953-2002.*

States. About 68 percent of the softwood timber is in the Western United States and 22 percent is in the South.

- Because hardwood growth greatly exceeds harvest, the quantity of larger hardwood trees generally continues to increase. However, highgrading, or removing only the largest and best trees, may create shortagesof high quality trees in some localities.

- The net growing-stock volume of U.S. hardwoods increased by 37 percent between 1977 and 2002 and by 98 percent between 1953 and 2002. This rapid increase has subsided in recent years as changing technology has increased demand for hardwood species in product manufacture.

- The volume of hardwoods in diameter classes greater than 20 inches has doubled since 1953, from 26 to 66 billion cubic feet in 2002 (fig. 8).

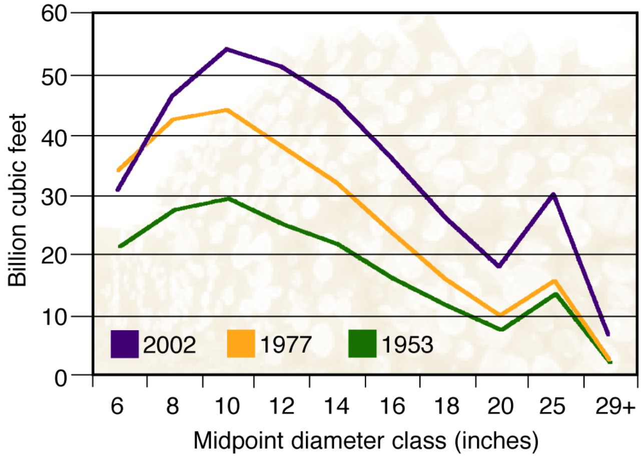

Figure 8—*Distribution of hardwood growing stock on timberland by diameter class, 1953, 1977, and 2002.*

- The net volume of U.S. softwoods increased from 432 billion to 492 billion cubic feet (14 percent) between 1953 and 2002. Volumes are higher in all diameter classes below 25 inches (fig. 9). Lower volumes in larger trees since 1953 are the result of harvesting of large trees and the increased area set aside as reserved forest (which reclassifies trees in these areas as non-growing stock).

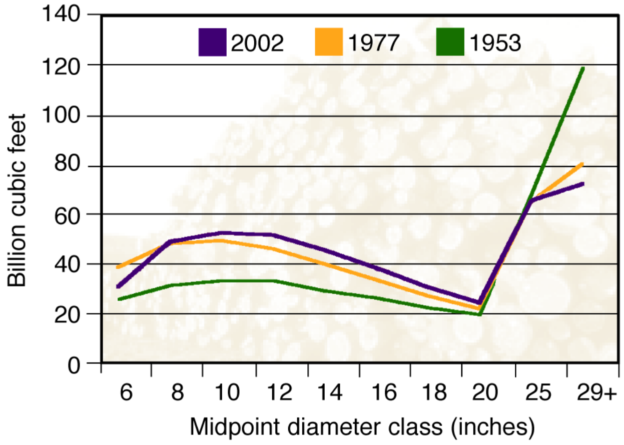

Figure 9—*Distribution of softwood growing stock on timberland by diameter class, 1953, 1977, and 2002.*

- The slower increase in standing volume for softwoods versus hardwoods is the result of stronger historic demand for softwood species in wood product manufacture.

- For the first time since 1953, declines were observed for softwood inventory on private lands and hardwood inventory on forest industry lands in the South.

- For the South as a whole, the volume of standing softwood inventory increased by 3 percent between 1997 and 2002, reversing a decline of 0.7 percent between 1987 and 1997.

Mortality

- Timber mortality increased between 1976 and 2001 in all regions of the country, on all ownerships, and for both hardwoods and softwoods (fig. 10). Nationally, the volume of mortality was up 54 percent from 1976 to 2001, from 4.1 billion cubic feet to 6.3 billion cubic feet—0.74 percent of the growing-stock inventory in 2001 compared to 0.56 percent in 1976. Softwood mortality rose by 46 percent between 1976 and 2001 and hardwood mortality rose by 66 percent. Although these increases are significant, there is no evidence to suggest that they are beyond the range of normal variability as the rate has fluctuated up and down since the first national statistics were reported in 1953. Continued monitoring will be critical in providing more information.

- Timber mortality rates in the South increased between 1976 and 2001—36 percent for hardwoods and 37 percent for softwoods (fig. 11). Recent insect outbreaks in the South and West as well as hurricane impacts in the South were significant factors in sharply rising mortality rates. Regional mortality patterns reflect the impact of these events.

Growth and Harvest

The relationship of growth and removals is a coarse-filter measure that approximates the notion of sustainable production: If the Nation is growing more wood than it is cutting it implies that levels of wood production and standing volume are sustainable. Growth is assumed to be a measure of sustainable output. However, the relationship conveys no information about quality, forest types, size, and other attributes of growth and harvest.

- Data for the Nation as a whole indicate that growth has exceeded removals for both softwoods and hardwoods since the first national statistics were reported for 1952. In 2001, for the Nation, net growth exceeded removals by 33 percent (fig. 12). That is, the Nation's forest inventory accrued more volume than it lost by mortality and harvest by nearly one-third. Recent declines in harvesting on public lands in the West have significantly deviated from historic growth/removals patterns and have placed more pressure on eastern forests that are predominantly in private ownership.

- In the 1920s, timber growth nationally was about half the rate of harvest. By the 1940s, improving forest growth rates and modestly declining harvest rates resulted in timber growth and harvest coming into approximate balance. By 1952, timber growth nationally exceeded harvest by 17 percent. Since the 1950s, timber growth has consistently exceeded harvest.

- Net timber growth exceeded harvest by 54 percent in 1976, 36 percent in 1986, and 33 percent in 2001. Net growth rates have not been increasing as rapidly as in the past, while harvest levels have remained relatively stable since 1986. Additional resource demands have been met by increased imports.

- In 2001, growth exceeded removals in all regions of the country: in the North by 49 percent, in the South by 12 percent, in the Rocky Mountains by 74 percent, and in the Pacific Coast region by 47 percent. For the

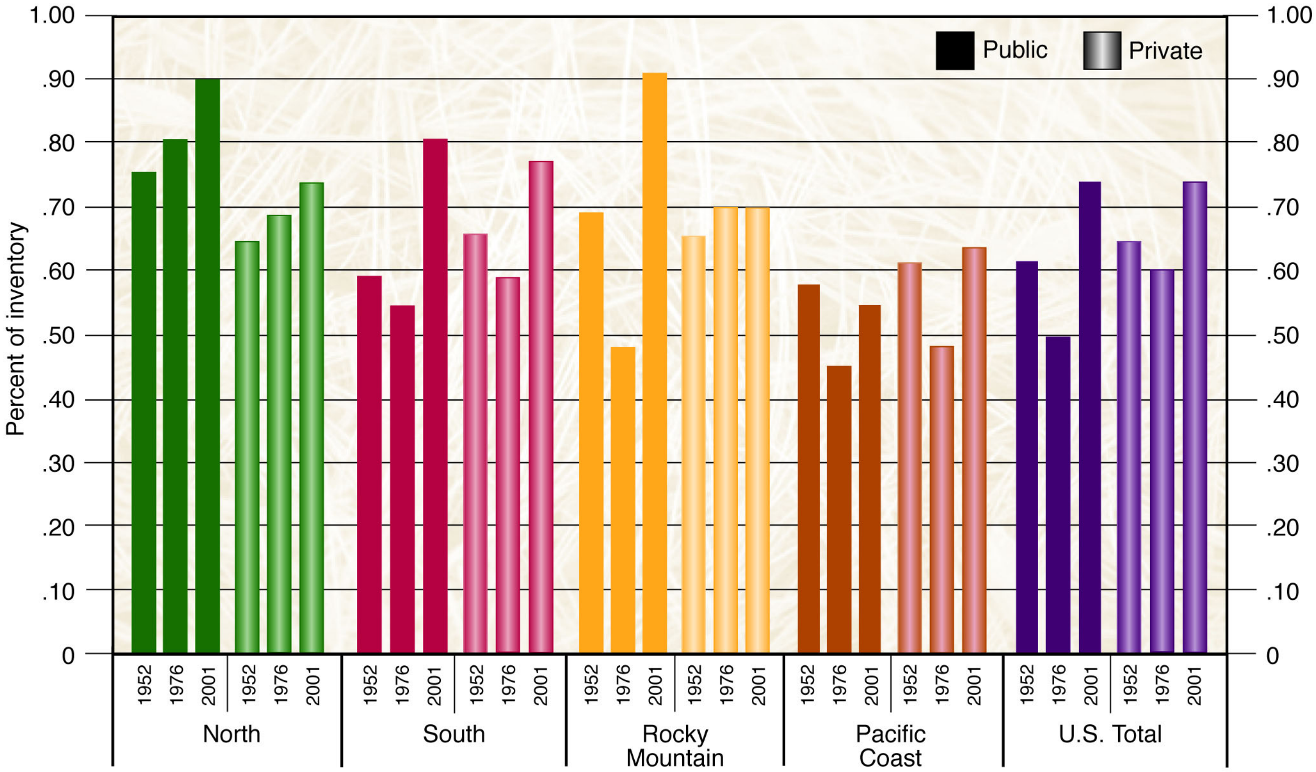

Figure 10—*Mortality as a percent of growing-stock volume on timberland by major owner group, 1952-2001.*

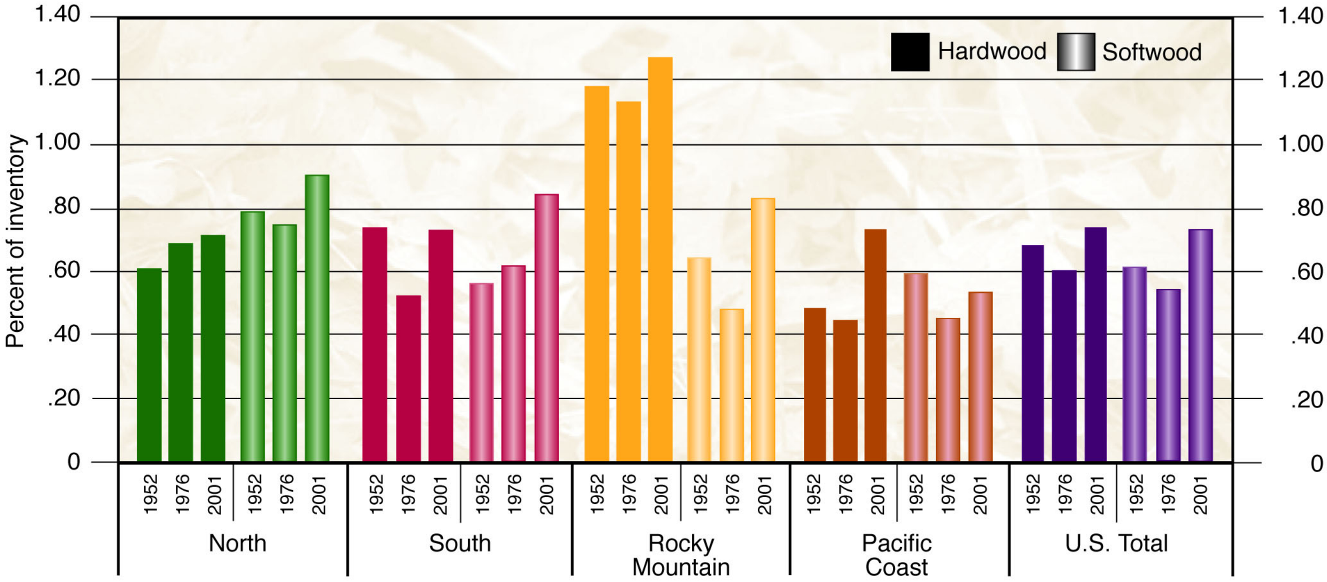

Figure 11—*Mortality as a percent of growing-stock volume on timberland by species group and region, 1952-2001.*

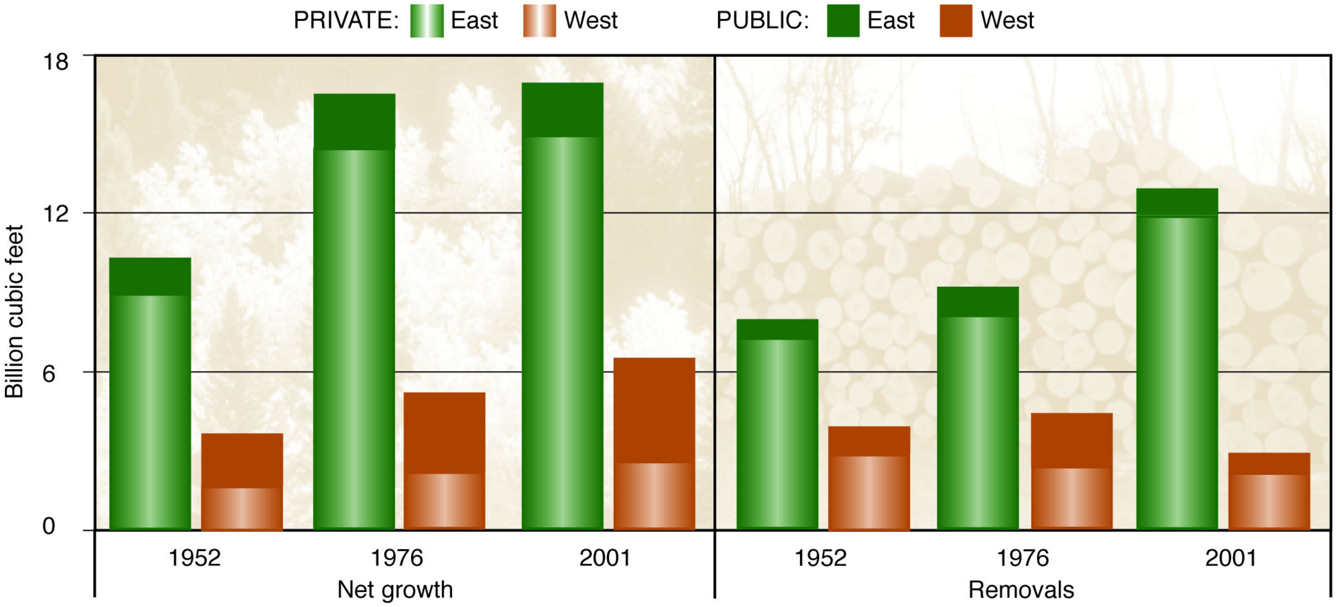

Figure 12—*Growing-stock growth and removals by major region, 1952-2001.*

United States, hardwood growth exceeded removals by 42 percent, and softwoods by 26 percent.

- Total timber growth increased by about 72 percent between 1952 and 2001.
- In the South, softwood removals were approximately equal to growth in 2001.

Trends in Removals

- Timber harvests have remained stable since 1986 but have risen by 13 percent since 1976. In 2001, growing-stock removals totaled 16 billion cubic feet.
- In 2001, about 64 percent of the volume of timber removals was softwoods and 36 percent was hardwoods, compared with 69 and 31 percent, respectively, in 1986. This reflects a trend toward rising hardwood removals in response to new product technologies using hardwoods.
- The South accounted for 63 percent of growing-stock removals in 2001, up from 51 percent in 1986.
- The predominant use of growing stock continues to be for lumber and plywood manufactured predominantly from saw logs and veneer logs. Saw logs accounted for 49 percent of growing-stock volume harvested in 2001, veneer logs—9 percent, and pulpwood—35 percent. The remaining 7 percent was used for fuelwood and other products. Pulp and composite product demand continues to rise, increasing by 25 percent since 1986 (fig. 13).

Ownership and Harvest

- Seventy-one percent of timberland is privately owned (including forest industry), but these lands accounted for 92 percent of growing-stock removals in 2001.
- Non-industrial private ownerships made up 58 percent (291 million acres) of U.S. timberland and accounted for 63 percent of the volume of growing-stock removals in 2001. Timber harvest on non-industrial private forest lands increased by about 46 percent between 1986 and 2001 as a large share of harvesting shifted from the Pacific Northwest to the South (fig. 14).

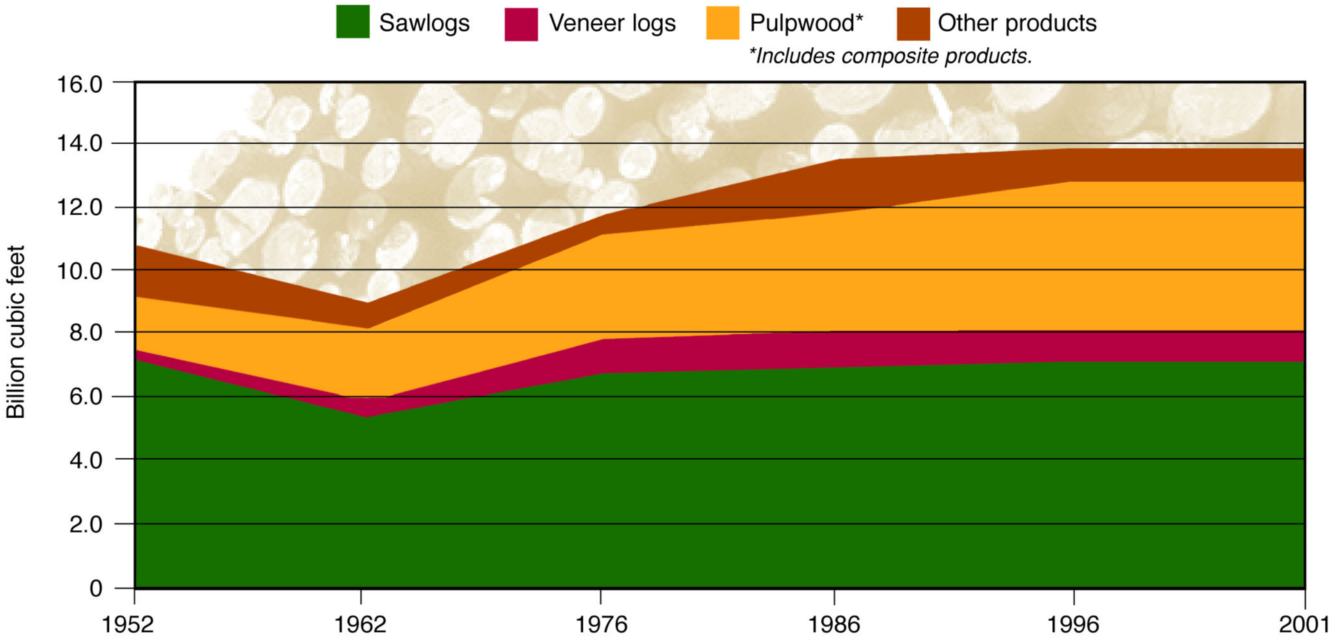

Figure 13.—*Trends in growing stock harvested for timber products output, 1952-2002.*

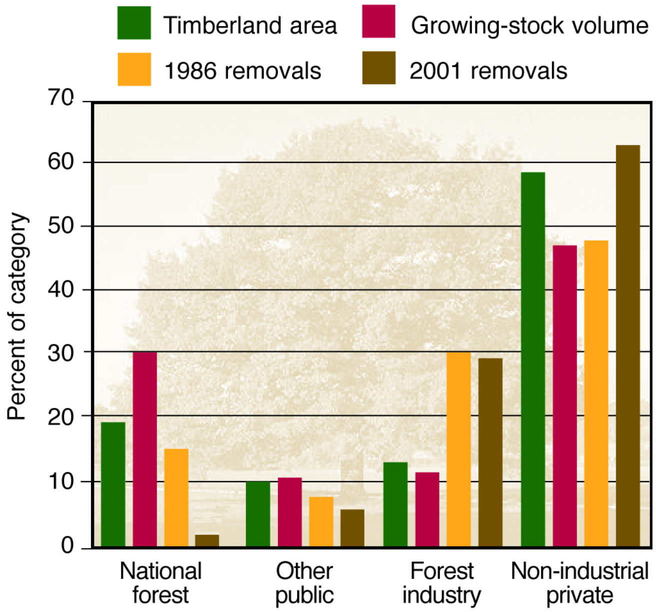

Figure 14—*Proportion of timberland area, growing-stock volume, and harvest volume by ownership group, 2001.*

- Industrial private forests accounted for 13 percent of U.S. timberland (66 million acres). Although these forests contain only 12 percent of the growing-stock volume, in 2001 they accounted for 29 percent of the volume of growing stock harvested.

- Public forests comprise 29 percent (148 million acres) of U.S. timberland. National forests are the largest Federal ownership, making up 19 percent of U.S. timberland but accounting for only 2 percent of timber harvest in 2001. National forest timber harvest levels declined by 84 percent between 1986 and 2001, after rising by 92 percent between 1952 and 1986.

- Other public forests made up 10 percent of U.S. timberland and accounted for 6 percent of growing-stock removals in 2001 as harvesting on public forests continued to decline. Harvest on other public forest lands declined by 14 percent between 1986 and 2001.

Board Foot Tables

This document does not contain board foot tables. However, recognizing an important client base for these tables to compare historic data for certain products or geographic regions, these tables may be downloaded from the FIA Web site at http://www.fia.fs.fed.us/rpa.

Additional Analysis

Additional analysis of the 2002 data may be found in the 2003 National Report on Sustainable Forests (http://www.fs.fed.us/research/sustain/data.htm). Most of the data for Criterion 2, derived primarily from the RPA data in this report, were provided by Forest Inventory and Analysis (http://www.fia.fs.fed.us).

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Glossary

Annual mortality—The average annual volume of sound wood in growing-stock trees that died from natural causes during the period between inventories.

Annual removals—The net volume of growing-stock trees removed from the inventory during a specified year by harvesting, cultural operations such as timber stand improvement, or land clearing.

Bureau of Land Management (BLM)—An ownership class of Federal lands administered by the Bureau of Land Management, U.S. Department of the Interior.

Coarse materials—Wood residues suitable for chipping, such as slabs, edgings, and trimmings.

Commercial species—Tree species suitable for industrial wood products.

County and municipal—An ownership class of public lands owned by counties or local public agencies, or lands leased by these governmental units for more than 50 years.

Cull tree—A live tree, 5.0 inches in diameter at breast height (d.b.h.) or larger, that is unmerchantable for saw logs now or prospectively because of rot, roughness, or species. (See definitions for rotten and rough trees.)

Diameter class—A classification of trees based on diameter outside bark measured at breast height (4-1/2 feet above ground). D.b.h. is the common abbreviation for diameter at breast height. With 2-inch diameter classes, the 6-inch class, for example, includes trees 5.0 through 6.9 inches d.b.h.

Federal—An ownership class of public lands owned by the U.S. Government.

Fiber products—Products derived from wood and bark residues, such as pulp, composition board products, and wood chips for export.

Fine materials—Wood residues not suitable for chipping, such as planer shavings and sawdust.

Forest industry—An ownership class of private lands owned by companies or individuals operating wood-using plants.

Forest land—Land at least 10 percent stocked by forest trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. Forest land includes transition zones, such as areas between heavily forested and nonforested lands that are at least 10 percent stocked with forest trees and forest areas adjacent to urban and built-up lands. Also included are pinyon-juniper and chaparral areas in the West and afforested areas. The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of trees must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if less than 120 feet wide.

Forest type—A classification of forest land based on the species presently forming a plurality of the live-tree stocking.

Forest type group—A combination of forest types that share closely associated species or site requirements and are generally combined for brevity of reporting.

Major eastern forest type groups:

White-red-jack pine—Forests in which eastern white pine, red pine, or jack pine, singly or in combination, comprise a plurality of the stocking. Common associates include hemlock, aspen, birch, and maple.

Spruce-fir—Forests in which spruce or true firs, singly or in combination, comprise a plurality of the stocking. Common associates include white cedar, tamarack, maple, birch, and hemlock.

Longleaf-slash pine—Forests in which longleaf or slash pine, singly or in combination, comprise a plurality of the stocking. Common associates include other southern pines, oak, and gum.

Loblolly-shortleaf pine—Forests in which loblolly pine, shortleaf pine, or southern yellow pines, except longleaf or slash pine, singly or in combination, comprise a plurality of the stocking. Common associates include oak, hickory, and gum.

Oak-pine—Forests in which hardwoods (usually upland oaks) comprise a plurality of the stocking, but in which pine or eastern redcedar comprises 25-50 percent of the stocking. Common associates include gum, hickory, and yellow-poplar.

Oak-hickory—Forests in which upland oaks or hickory, singly or in combination, comprise a plurality of the stocking except where pines comprise 25-50 percent, in which case the stand is classified as oak-pine. Common associates include yellow-poplar, elm, maple, and black walnut.

Oak-gum-cypress—Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination, comprise a plurality of the stocking except where pines comprise 25-50 percent, in which case the stand is classified as oak-pine. Common associates include cottonwood, willow, ash, elm, hackberry, and maple.

Elm-ash-cottonwood—Forests in which elm, ash, or cottonwood, singly or in combination, comprise a plurality of the stocking. Common associates include willow, sycamore, beech, and maple.

Maple-beech-birch—Forests in which maple, beech, or yellow birch, singly or in combination, comprise a plurality of the stocking. Common associates include hemlock, elm, basswood, and white pine.

Aspen-birch—Forests in which aspen, balsam poplar, paper birch, or gray birch, singly or in combination, comprise a plurality of the stocking. Common associates include maple and balsam fir.

Major western forest type groups:

Douglas-fir—Forests in which Douglas-fir comprises a plurality of the stocking. Common associates include western hemlock, western redcedar, the true firs, redwood, ponderosa pine, and larch.

Hemlock-Sitka spruce—Forests in which western hemlock and/or Sitka spruce comprise a plurality of the stocking. Common associates include Douglas-fir, silver fir, and western redcedar.

Redwood—Forests in which redwood comprises a plurality of the stocking. Common associates include Douglas-fir, grand fir, and tanoak.

Ponderosa pine—Forests in which ponderosa pine comprises a plurality of the stocking. Common associates include Jeffrey pine, sugar pine, limber pine, Arizona pine, Apache pine, Chihuahua pine, Douglas-fir, incense-cedar, and white fir.

Western white pine—Forests in which western white pine comprises a plurality of the stocking. Common associates include western redcedar, larch, white fir, Douglas-fir, lodgepole pine, and Engelmann spruce.

Lodgepole pine—Forests in which lodgepole pine comprises a plurality of the stocking. Common associates include alpine fir, western white pine, Engelmann spruce, aspen, and larch.

Larch—Forests in which western larch comprises a plurality of the stocking. Common associates include Douglas-fir, grand fir, western redcedar, and western white pine.

Fir-spruce—Forests in which true firs, Engelmann spruce, or Colorado blue spruce, singly or in combination, comprise a plurality of the stocking. Common associates include mountain hemlock and lodgepole pine.

Western hardwoods—Forests in which aspen, red alder, or other western hardwoods, singly or in combination, comprise a plurality of the stocking.

Chaparral—Forests of heavily branched, dwarfed trees or shrubs, usually evergreen, the crown canopy of which at maturity covers more than 50 percent of the ground and whose primary value is watershed protection.

The more common chaparral constituents are species of *Quercus, Cercocarpus, Garrya, Ceanothus, Arctostaphylos,* and *Adenostoma*. Types dominated by such shrubs as *Artemisia, Chrysothamnus, Purshia, Gutierrezia,* or semidesert species are not commonly considered chaparral.

Pinyon-juniper—Forests in which pinyon or juniper, or both, comprise a plurality of the stocking.

Other softwoods—Forests in which other softwood species not mentioned above comprise a plurality of the stocking. These are primarily black spruce forests in interior Alaska.

Fuelwood—Wood used for conversion to some form of energy, primarily in residential use.

Growing stock—A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality or vigor. Cull trees are excluded. When associated with volume, includes only trees 5.0 inches d.b.h. and larger.

Hardwood—A dicotyledonous tree, usually broad-leaved and deciduous.

Industrial wood—All commercial roundwood products except fuelwood.

Land area—The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river flood plains; streams, sloughs, estuaries, and canals less than 200 feet wide; and lakes, reservoirs, and ponds less than 4.5 acres in area.

Live cull—A classification that includes live cull trees. When associated with volume, it is the net volume in live cull trees that are 5.0 inches d.b.h. and larger.

Logging residues—The unused portions of growing-stock and non-growing-stock trees cut or killed by logging and left in the woods (footnote on table 40).

Lowland forest types—Generally refers to the elm-ash-cottonwood and oak-gum-cypress forest types.

National forest—An ownership class of Federal lands, designated by Executive order or statute as national forests or purchase units, and other lands under the administration of the Forest Service including experimental areas and Bankhead-Jones Title III lands.

Native American land—(a) Lands held in trust by the United States or individual States for Native American tribes or individual Native Americans; (b) Lands owned in fee by Native American tribes whether subject to Federal or State restrictions against alienation or not.

Net annual growth—The average annual net increase in the volume of trees during the period between inventories. Components include the increment in net volume of trees at the beginning of the specific year surviving to its end, plus the net volume of trees reaching the minimum size class during the year, minus the volume of trees that died during the year, and minus the net volume of trees that became cull trees during the year.

Net volume in cubic feet—The gross volume in cubic feet less deductions for rot, roughness, and poor form. Volume is computed for the central stem from a 1-foot stump to a minimum 4.0-inch top diameter outside bark, or to the point where the central stem breaks into limbs.

Noncommercial species—Tree species of typically small size, poor form, or inferior quality, which normally do not develop into trees suitable for industrial wood products.

Nonforest land—Land that has never supported forests and lands formerly forested where use of timber management is precluded by development for other uses. (Note: Includes area used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 4.5-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide, and clearings, etc., must be more than 1 acre in area, to qualify as nonforest land.)

Nonindustrial private—An ownership class of private lands where the owner does not operate wood-using plants.

Nonstocked areas—Timberland less than 10 percent stocked with all live trees.

Other Federal—An ownership class of Federal lands other than those administered by the Forest Service or the Bureau of Land Management. This category includes the National Park Service, Fish and Wildlife Service, Departments of Defense and Energy, and miscellaneous Federal ownerships.

Other forest land—Forest land other than timberland and reserved forest land. It includes available forest land, which is incapable of annually producing 20 cubic feet per acre of industrial wood under natural conditions because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness.

Other land—Nonforest land less the area in streams, sloughs, estuaries, and canals between 120 and 200 feet wide and lakes, reservoirs, and ponds between 1 and 4.5 acres in area.

Other private—An ownership class of private lands that are not owned by forest industry or farmers.

Other products—A miscellaneous category of roundwood products that includes such items as cooperage, pilings, poles, posts, shakes, shingles, board mills, charcoal, and export logs.

Other public—An ownership class that includes all public lands except national forests. This category generally includes State, county, and municipal ownerships.

Other red oaks—A group of species in the genus *Quercus* that includes scarlet oak, northern pin oak, southern red oak, bear oak, shingle oak, laurel oak, blackjack oak, water oak, pin oak, willow oak, and black oak.

Other removals—Unutilized wood volume from cut or otherwise killed growing stock, from cultural operations such as precommercial thinnings, or from timberland clearing. Does not include volume removed from inventory through reclassification of timberland to productive reserved forest land.

Other sources—Sources of roundwood products that are not growing stock. These include salvable dead trees, rough and rotten trees, trees of noncommercial species, trees less than 5.0 inches d.b.h., tops, and roundwood harvested from nonforest land (for example, fence rows).

Other white oaks—A group of species in the genus *Quercus* that includes overcup oak, chestnut oak, and post oak.

Ownership—The property owned by one ownership unit, including all parcels of land in the United States.

Ownership unit—A classification of ownership encompassing all types of legal entities having an ownership interest in land, regardless of the number of people involved. A unit may be an individual; a combination of persons; a legal entity such as a corporation, partnership, club, or trust; or a public agency. An ownership unit has control of a parcel or group of parcels of land.

Poletimber trees—Live trees at least 5.0 inches in d.b.h. but smaller than sawtimber trees.

Primary wood-using mill—A mill that converts roundwood products into other wood products. Common examples are sawmills that convert saw logs into lumber and pulpmills that convert pulpwood into wood pulp.

Productivity class—A classification of forest land in terms of potential annual cubic-foot volume growth per acre at culmination of mean annual increment in fully stocked natural stands.

Pulpwood—Roundwood, whole-tree chips, or wood residues that are used for the production of wood pulp.

Reserved forest land—Forest land withdrawn from timber utilization through statute, administrative regulation, or designation without regard to productive status.

Residues—Bark and woody materials that are generated in primary wood-using mills when roundwood products are converted to other products. Examples are slabs, edgings, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and pulp screenings. Includes bark residues and wood residues (both coarse and fine materials) but excludes logging residues.

Rotten tree—A live tree of commercial species that does not contain a saw log now or prospectively primarily because of rot (that is, when rot accounts for more than 50 percent of the total cull volume).

Rough tree—(a) A live tree of commercial species that does not contain a saw log now or prospectively primarily because of roughness (that is, when sound cull due to such factors as poor form, splits, or cracks accounts for more than 50 percent of the total cull volume) or (b) a live tree of noncommercial species.

Roundwood products—Logs, bolts, and other round timber generated from harvesting trees for industrial or consumer use.

Rural-urban continuum—A classification of U.S. counties by urban characteristic as described by Butler and Beale (1993). Classes are generically defined as follows:

Major metro
Major metro-Central: Central counties of metropolitan areas of 1 million population or more
Major metro-Fringe: Fringe counties of metropolitan areas of 1 million population or more
Intermediate and small metro
Intermediate metro: Counties in metropolitan areas of 250,000 - 1,000,000 population
Small metro: Counties in metropolitan areas of less than 250,000 population
Large town
Large town metro: Urban population of 20,000 or more, adjacent to a metropolitan area
Large town nonmetro: Urban population of 20,000 or more, not adjacent to a metropolitan area
Small town
Small town metro: Urban population of 2,500 - 19,999, adjacent to a metropolitan area
Small town nonmetro: Urban population of 2,500 - 19,999, not adjacent to a metropolitan area
Rural
Rural metro: Completely rural (no places with a population of 2,500 or more) adjacent to a metropolitan area
Rural nonmetro: Completely rural (no places with a population of 2,500 or more) not adjacent to a metropolitan area

Salvable dead tree—A downed or standing dead tree that is considered currently or potentially merchantable by regional standards.

Saplings—Live trees 1.0 inch through 4.9 inches d.b.h.

Saw log—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, and with a minimum diameter inside bark of 6 inches for softwoods and 8 inches for hardwoods, or meeting other combinations of size and defect specified by regional standards.

Seedlings—Live trees less than 1.0 inch d.b.h. and at least 1 foot in height.

Select red oaks—A group of species in the genus *Quercus* that includes cherrybark oak, northern red oak, and Shumard oak.

Select white oaks—A group of species in the genus *Quercus* that includes white oak, swamp white oak, bur oak, swamp chestnut oak, and chinkapin oak.

Softwood—A coniferous tree, usually evergreen, having needles or scale-like leaves.

Sound dead—The net volume in salvable dead trees.

Stand-size class—A classification of forest land based on the size class of all live trees in the area. The classes include:

> **Nonstocked stands**—Forest land that is stocked with less than 10 percent of full stocking with all live trees. Examples are recently cut-over areas or recently reverted agricultural fields.
>
> **Seedling-sapling stands**—Forest land that is stocked with at least 10 percent of full stocking with all live trees with half or more of such stocking in seedlings or saplings or both.
>
> **Poletimber stands**—Forest land that is stocked with at least 10 percent of full stocking with all live trees with half or more of such stocking in poletimber or sawtimber trees or both, and in which the stocking of poletimber exceeds that of sawtimber.
>
> **Sawtimber stands**—Forest land that is stocked with at least 10 percent of full stocking with all live trees with half or more of such stocking in poletimber or sawtimber trees or both, and in which the stocking of sawtimber is at least equal to that of poletimber.

State—An ownership class of public lands owned by States or lands leased by States for more than 50 years.

Stocking—The degree of occupancy of land by trees, measured by basal area or number of trees by size and spacing, or both, compared to a stocking standard; that is, the basal area or number of trees, or both, required to fully utilize the growth potential of the land.

Timberland—Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

Tops—The wood of a tree above the merchantable height (or above the point on the stem 4.0 inches diameter outside bark [d.o.b.]). It includes the usable material in the uppermost stem.

Unreserved forest land—Forest land that is not withdrawn from harvest by statute or administrative regulation. Includes forest lands that are not capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands.

Veneer log—A roundwood product from which veneer is sliced or sawn and that usually meets certain standards of minimum diameter and length and maximum defect.

Weight—The weight of wood and bark, oven-dry basis (approximately 12 percent moisture content).

Xerophytic plants—Plants growing where soil moisture conditions are very dry most of the time.

Appendix A: Procedures for the Update

Timing of Inventory Data

The tables in this report are dated 2002 for area and volume and 2001 for growth, mortality, and removals. These dates are used as nominal dates for national reporting. The actual inventory for a particular State is the most recent inventory available and may not have been collected in 1996-2000. Until recently, forest inventory in the United States has been a cyclic process with new inventories conducted in each State every 10-12 years. When national statistics are compiled, these data are updated to the extent possible. Tables in this appendix describe when the inventories actually occurred and whether they have been updated for this report. Future assessments will have more current data as new data will be collected in every State every year. For more information on the new FIA procedures, refer to the FIA Strategic Plan found in the “Library” section at http://fia.fs.fed.us.

Adjustments to Historic Inventory Data

Historic data presented in this report for previous national assessments may be adjusted from those found in the original publications. Generally, this is due to changes in data classifications, regional reporting boundaries, or occasionally when data are deemed to be inaccurate due to errors in reporting.

The Database

In 1987, the first national database was developed for the assessment. It was a summary database that placed all inventory data in a common format at the State/owner level of resolution. In 1992, the summary database was made available online. For 2002, the national standard FIA Database (FIADB) was used as a basis for a county-level summary database.

The complete RPA logical database for 2002 is composed of three physical databases. The first is the FIADB national standard database with data available for all forest lands except interior Alaska and Hawaii. These areas were compiled in summary format from modeled inventory data. The second database is the national timber products output (TPO) database composed of data from surveys of primary wood-using facilities (sawmills, pulpmills, veneer mills, chip mills, etc.) as well as residential fuelwood and post producers (Smith 1991 and May 1998). This database provides county-level removals data for the United States. The third database is the national summary database that draws upon each of the other physical databases as well as “value-added” data from the Bureau of the Census such as total county land area, county latitude and longitude envelope, and population. The national summary database is available via the Internet and can provide data at the county level for most of the United States. The exceptions to this general rule are areas of interior Alaska where data are stored in aggregate.

For more information on these databases, log on to http://fia.fs.fed.us. Further information on data collection procedures is available from the USDA Forest Service Research Stations and Regions listed in tables A-1 and A-2.

Appendix Table A-1—Addresses of USDA Forest Service Research Stations with responsibilities for forest inventories in the United States and their area of responsibility[a]

Address	Areas of responsibility
Northeastern Research Station 11 Campus Boulevard Newtown Square, PA 19073	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and West Virginia
North Central Research Station 1992 Folwell Avenue St. Paul, MN 55108	Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin
Southern Research Station 200 Weaver Blvd. P.O. Box 2680 Asheville, NC 28802	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, Puerto Rico, and the Virgin Islands
Pacific Northwest Research Station P.O. Box 3890 Portland, OR 97208	Alaska, California, Hawaii, Oregon, Washington, and Pacific Trust Islands
Rocky Mountain Research Station Natural Resources Research Center 2150 Centre Avenue, Building A Fort Collins, CO 80526-2098	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming

[a] For additional information, visit the Forest Inventory and Analysis Web site: www.fia.fs.fed.us.

Appendix Table A-2—Addresses of National Forest System regional offices in the United States

Address	Region	Location of National Forests
Forest Service, USDA **Northern Region** Federal Building P.O. Box 7669 Missoula, MT 59807	Region 1	Montana, northern Idaho, North Dakota, and northwestern South Dakota
Forest Service, USDA **Rocky Mountain Region** 11177 West 8th Avenue P.O. Box 25127 Lakewood, CO 80225	Region 2	Colorado, Kansas, Nebraska, South Dakota, and eastern Wyoming
Forest Service, USDA **Southwestern Region** Federal Building 517 Gold Avenue S.W. Albuquerque, NM 87102	Region 3	Arizona and New Mexico
Forest Service, USDA **Intermountain Region** Federal Building 324 25th Street Ogden, UT 84401	Region 4	Southern Idaho, Nevada, Utah, and western Wyoming
Forest Service, USDA **Pacific Southwest Region** 1323 Club Drive Vallejo, CA 94592	Region 5	California
Forest Service, USDA **Pacific Northwest Region** 333 S.W. 1st Avenue P.O. Box 3623 Portland, OR 97208	Region 6	Oregon and Washington
Forest Service, USDA **Southern Region** 1720 Peachtree Road, N.W. Atlanta, GA 30309	Region 8	Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, Tennessee, Texas, Virginia, West Virginia, and Puerto Rico
Forest Service, USDA **Eastern Region** 626 East Wisconsin Avenue Milwaukee, WI 53202	Region 9	Connecticut, Delaware, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, and Wisconsin
Forest Service, USDA **Alaska Region** P.O. Box 21628 Juneau, AK 99802-1628	Region 10	Alaska

For additional information, contact the Internet sites for the regional offices through the USDA Forest Service home page: http://www.fs.fed.us. Timber inventories are managed by the forest management staff in each regional office.

The inventories reported in this document were not actually conducted in 2001-2002, but rather data were collected periodically. A full accounting of the inventory status for national forests, States (non-national forest), and timber products output data found in this report is provided in this appendix.

Appendix Table A-3—Dates of source data for RPA inventory and removals statistics

	Forest inventory data		Timber products output (removals) data			
Region/State	**Non-NFS lands**	**NFS lands**	**Pulpwood**	**Saw logs/ Veneer**	**Fuelwood**	**Other products**
Northeast:						
Connecticut	1998		1996	1984*u*	1984	1984*u*
Delaware	1999		1996	1985*u*	1985	1985*u*
Maine	1995	1995	1996	1995	1995	1995
Maryland	1999	1999	1996	1985*u*	1985	1985*u*
Massachusetts	1998	1998	1996	1984*u*	1984	1984*u*
New Hampshire	1997	1997	1996	1996	1996	1996
New Jersey	1999		1996	1986*u*	1986	1986*u*
New York	1993	1993	1996	1993*u*	1993	1993*u*
Pennsylvania	1989	1989	1996	1988*u*	1988	1988*u*
Rhode Island	1998		1996	1984*u*	1984	1984*u*
Vermont	1997	1997	1996	1996	1996	1996
West Virginia	1989	1989	1996	1994*u*	1994	1994*u*
North Central:						
Illinois	1998	1998	1999	1996	1983*u*	1996
Indiana	1998	1998	1999	1995	1996	1995
Iowa	1990		1999	1994	1995	1994
Michigan	1993	1993	1999	1996	1992	1996
Minnesota	1990	1990	1999	1997	1996*u*	1997
Missouri	1989	1989	1999	1997	1996*u*	1997
Ohio	1993	1993	1996	1989*u*	1989	1989*u*
Wisconsin	1996	1996	1999	1996	1994	1996
Southeast:						
Florida	1995	1995	1999	1999	1999*u*	1999
Georgia	1997	1997	1999	1999	1999*u*	1999
North Carolina	1990	1990	1999	1999	1999*u*	1999
South Carolina	2000	2000	1999	1999	1999*u*	1999
Virginia	1992	1992	1999	1999	1999*u*	1999
South Central:						
Alabama	2000	2000	1999	1999	1999*u*	1999
Arkansas	1995	1995	1999	1999	1999*u*	1999
Kentucky	1988	1988	1999	1999	1999*u*	1999
Louisiana	1991	1991	1999	1999	1999*u*	1999
Mississippi	1994	1994	1999	1999	1999*u*	1999
Oklahoma	1993	1993	1999	1999	1999*u*	1999
Tennessee	1999	1999	1999	1999	1999*u*	1999
Texas	1992	1992	1999	1999	1999*u*	1999

(continued on next page)

Appendix Table A-3 (continued)

Region/State	Forest inventory data		Timber products output (removals) data			
	Non-NFS lands	NFS lands	Pulpwood	Saw logs/ Veneer	Fuelwood	Other products
Great Plains:						
Kansas	1994		1999	1998	1994	1993
Nebraska	1994	1994	1999	1993	1994	1993
North Dakota	1995	1995	1999	1998	1994	1998
South Dakota	1995	1986*u*	1999	1993	1994	1999
Intermountain:						
Arizona	1999	1999	1995	1995	1984	1995
Colorado	1983	1981-88*u*	1996	1996	1982	1996
Idaho	1991	1990-95*u*	1995	1995	1990	1995
Montana	1989	1995	1993*u*	1993*u*	1989	1993*u*
Nevada	1989*u*	1987*u*	1996	1996	1996	1996
New Mexico	1999	1999	1995	1995	1986	1995
Utah	1995	1995	1992	1992	1992	1992
Wyoming	1984	1985-93*u*	1996	1996	1983*u*	1996
Pacific Northwest:						
Alaska	1977-94	1998	1995	1995	1982*u*	1995
Oregon	1992	1994-96	1994	1994	1994	1994
Washington	1991	1995	1996	1996	1996	1996
Pacific Southwest:						
California	1994	1995	1994	1994	1994	1994
Hawaii	1985		1995	1995	1995	1995

u = source data updated to 2001 for reporting.

Appendix B: Metric Equivalents for Various Units of Measure

1 acre = 0.404686 hectares

1,000 acres = 404.686 hectares

1 board foot = 0.00348 cubic meters

1 cubic foot = 0.028317 cubic meters

1,000 cubic feet = 28.317 cubic meters

1 inch = 2.54 centimeters or 0.0254 meters

1 foot = 30.48 centimeters or 0.3048 meters

1 mile = 1.609 kilometers

1 square foot = 0.0929 square meters

1 square foot per acre basal area = 0.229568 square meters per hectare

1 ton = 0.90718 metric tons

Breast height = 1.37 meters above ground level

Appendix C: Accuracy of the Data

All of the data for the national assessment of forests are collected under the guidance of the USDA Forest Service and compiled by the agency's Forest Inventory and Analysis (FIA) program. All data are collected by the FIA program in cooperation with State forestry agencies or National Forest System (NFS) regions.

Inventories conducted by FIA are designed to meet the following statistical guidelines for accuracy within one standard deviation at the 67 percent level for each State:

+/- 3-5 percent per million acres of timberland
+/- 10 percent per million acres of all other forest land
+/- 5 percent per billion cubic feet of growing-stock volume
+/- 10 percent per billion cubic feet of growing-stock growth
+/- 15 percent per billion cubic feet of growing-stock mortality
+/- 15 percent per billion cubic feet of growing-stock removals

Since these guidelines are applied at the State level, the accuracy of data for any national or multi-State totals for these categories will be greater.

Inventories conducted historically on NFS lands would have similar accuracy estimates in the Eastern United States and Alaska where FIA conducted these inventories. In other NFS regions, regional inventory data were converted to emulate FIA classifications and thus specific accuracy estimates are difficult to derive. Overall, historic NFS data are presumed to have similar error characteristics except where errors of omission may have occurred.

Appendix D: Common and Scientific Names of Major Tree Species

Common name	Scientific name
Eastern Softwoods:	
True firs	*Abies* Mill.
Balsam fir	*A. balsamea* (L.) Mill.
Fraser fir	*A. fraseri* (Pursh) Poir.
Eastern redcedar	*Juniperus virginiana* L.
Tamarack	*Larix laricina* (Du Roi) K. Koch
Spruce	*Picea* A. Dietr.
Jack pine	*Pinus banksiana* Lamb.
Shortleaf pine	*P. echinata* Mill.
Slash pine	*P. elliottii* Engelm.
Longleaf pine	*P. palustris* Mill.
Red pine	*P. resinosa* Ait.
Eastern white pine	*P. strobus* L.
Loblolly pine	*P. taeda* L.
Baldcypress	*Taxodium* Rich.
Northern white-cedar	*Thuja occidentalis* L.
Eastern hemlock	*Tsuga canadensis* (L.) Carr.
Eastern Hardwoods:	
Maple	*Acer* L.
Red (soft) maple	*A. rubrum* L.
Sugar (hard) maple	*A. saccharum* Marsh.
Birch	*Betula* L.
Yellow birch	*B. alleghaniensis* Britton
Paper birch	*B. papyrifera* Marsh.
Gray birch	*B. populifolia* Marsh.
Hackberry	*Celtis occidentalis* L.
American beech	*Fagus grandifolia* Ehrh.
Ash	*Fraxinus* L.
Black walnut	*Juglans nigra* L.
Sweetgum	*Liquidambar styraciflua* L.
Yellow-poplar	*Liriodendron tulipifera* L.
Tupelo, gum	*Nyssa* L.
Black tupelo	*N. sylvatica* Marsh. var. *sylvatica*
Sycamore	*Platanus occidentalis* L.
Aspen	*Populus* L.
Balsam poplar	*P. balsamifera* L.
Eastern cottonwood	*P. deltoides* Bartr. ex Marsh.
Black cherry	*Prunus serotina* Ehrh.
Oak	*Quercus* L.
White oak	*Q. alba* L.
Swamp white oak	*Q. bicolor* Willd.
Scarlet oak	*Q. coccinea* Muenchh.
Northern pin oak	*Q. ellipsoidalis* E. J. Hill
Southern red oak	*Q. falcata* Michx.
Cherrybark oak	*Q. falcata* var. *pagodifolia* Ell.
Bear oak	*Q. ilicifolia* Wangenh.
Shingle oak	*Q. imbricaria* Michx.
Overcup oak	*Q. lyrata* Walt.
Bur oak	*Q. macrocarpa* Michx.
Blackjack oak	*Q. marilandica* Muenchh.
Swamp chestnut oak	*Q. michauxii* Nutt.
Chinkapin oak	*Q. muehlenbergii* Engelm.
Water oak	*Q. nigra* L.
Pin oak	*Q. palustris* Muenchh.
Willow oak	*Q. phellos* L.
Chestnut oak	*Q. prinus* L.
Northern red oak	*Q. rubra* L.
Shumard oak	*Q. shumardii* Buckl.
Post oak	*Q. stellata* Wangenh. var. *stellata*
Black oak	*Q. velutina* Lam.
Willow	*Salix* L.
Basswood	*Tilia* L.
Elm	*Ulmus* L.
Western Softwoods:	
True firs	*Abies* Mill.
Pacific silver fir	*A. amabilis* Dougl. ex Forbes
White fir	*A. concolor* (Gord. & Glend.) Lindl. ex Hildebr.
Grand fir	*A. grandis* (Dougl. ex D. Don) Lindl.
Subalpine fir	*A. lasiocarpa* (Hook.) Nutt.
Juniper	*Juniperus* L.
Incense-cedar	*Libocedrus decurrens* Torr.
Engelmann spruce	*Picea engelmannii* Parry ex Engelm.
Blue spruce	*P. pungens* Engelm.
Sitka spruce	*P. sitchensis* (Bong.) Carr.
Lodgepole pine	*Pinus contorta* Dougl. ex Loud.
Pinyon pine	*P. edulis* Engelm.
Apache pine	*P. engelmannii* Carr.
Limber pine	*P. flexilis* James
Jeffrey pine	*P. jeffreyi* Grev. & Balf.
Sugar pine	*P. lambertiana* Dougl.
Chihuahua pine	*P. leiophylla* var. *chihuahuana* (Engelm.) Shaw
Western white pine	*P. monticola* Dougl. ex D. Don
Ponderosa pine	*P. ponderosa* Dougl. ex Laws.
Arizona pine	*P. ponderosa* var. *arizonica* (Engelm.) Shaw
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Redwood	*Sequoia sempervirens* (D. Don) Endl.
Western redcedar	*Thuja plicata* Donn ex D. Don
Western hemlock	*Tsuga heterophylla* (Raf.) Sarg.
Mountain hemlock	*T. mertensiana* (Bong.) Carr.
Western Hardwoods:	
Red alder	*Alnus rubra* Bong.
Tanoak	*Lithocarpus densiflorus* (Hook & Arn.) Rehd.
Cottonwood	*Populus* L.
Oak	*Quercus* L.

Source: Little 1979.

List of Tables

Table 40.— Roundwood products, logging residues, and other removals from growing stock and other sources by species group, region, and subregion, 2001

Table 41.— Weight of bark and wood residue from primary wood-using mills by type of material, species group, region, subregion, and type of use, 2001

Table 1—Land area in the United States by major class, region, subregion, and State, 2002

		Land class				
		Forest land				
Region, subregion, and State	Total land area	Total forest land	Timberland	Reserved[a]	Other[b]	Other land
			Thousand acres			
North:						
Northeast:						
Connecticut	3,101	1,859	1,696	14	149	1,242
Delaware	1,251	383	376	0	7	868
Maine	19,753	17,699	16,952	380	368	2,054
Maryland	6,295	2,566	2,372	180	14	3,729
Massachusetts	5,016	3,126	2,631	127	369	1,890
New Hampshire	5,740	4,818	4,503	157	158	922
New Jersey	4,748	2,132	1,876	160	96	2,616
New York	30,223	18,432	15,389	2,920	123	11,791
Pennsylvania	28,685	16,905	15,853	833	219	11,780
Rhode Island	668	385	340	10	36	283
Vermont	5,920	4,618	4,482	114	21	1,302
West Virginia	15,415	12,108	11,900	181	27	3,307
Total	126,815	85,031	78,370	5,076	1,587	41,784
North Central:						
Illinois	35,580	4,331	4,087	244	0	31,249
Indiana	22,957	4,501	4,342	159	0	18,456
Iowa	35,760	2,050	1,944	88	19	33,710
Michigan	36,359	19,281	18,616	575	90	17,078
Minnesota	50,955	16,680	14,723	1,118	840	34,275
Missouri	44,095	13,992	13,365	317	311	30,103
Ohio	26,210	7,855	7,568	140	147	18,355
Wisconsin	34,761	15,963	15,701	201	61	18,798
Total	286,677	84,653	80,346	2,842	1,468	202,024
North total:	413,492	169,684	158,716	7,918	3,055	243,808
South:						
Southeast:						
Florida	34,520	16,285	14,636	1,121	528	18,235
Georgia	37,068	24,405	23,802	595	7	12,663
North Carolina	31,180	19,302	18,664	598	40	11,878
South Carolina	19,272	12,495	12,301	194	0	6,777
Virginia	25,343	16,074	15,371	686	16	9,269
Total	147,383	88,561	84,774	3,194	591	58,822
South Central:						
Alabama	32,481	22,987	22,922	65	0	9,494
Arkansas	33,328	18,771	18,373	231	167	14,557
Kentucky	25,428	12,684	12,347	305	32	12,744
Louisiana	27,883	13,812	13,722	90	0	14,071
Mississippi	30,025	18,580	18,572	8	0	11,445
Oklahoma	43,955	7,665	6,234	45	1,386	36,290
Tennessee	26,381	14,396	13,956	440	0	11,985
Texas	167,626	17,149	11,774	125	5,250	150,477
Total	387,107	126,044	117,900	1,309	6,835	261,063
South total:	534,490	214,605	202,674	4,503	7,426	319,885

Table 1—(continued).

		Land class				
		Forest land				
Region, subregion, and State	Total land area	Total forest land	Timberland	Reserved[a]	Other[b]	Other land
			Thousand acres			
Rocky Mountain:						
Great Plains:						
Kansas	52,367	1,545	1,491	18	37	50,822
Nebraska	49,201	947	898	32	18	48,254
North Dakota	44,156	672	441	0	231	43,484
South Dakota	48,574	1,619	1,511	23	85	46,955
Total	194,298	4,783	4,341	73	371	189,515
Intermountain:						
Arizona	72,732	19,427	3,527	1,819	14,082	53,305
Colorado	66,387	21,637	11,607	2,712	7,318	44,750
Idaho	52,960	21,646	16,824	3,708	1,115	31,314
Montana	93,157	23,293	19,185	3,682	426	69,864
Nevada	70,276	10,204	363	568	9,273	60,072
New Mexico	77,674	16,682	4,359	1,704	10,619	60,992
Utah	52,587	15,676	4,683	771	10,223	36,911
Wyoming	62,147	10,995	5,739	3,916	1,340	51,152
Total	547,920	139,560	66,287	18,880	54,396	408,360
Rocky Mountain total:	742,218	144,343	70,628	18,953	54,767	597,875
Pacific Coast:						
Alaska:						
Alaska	365,041	126,869	11,865	33,068	81,936	238,172
Total	365,041	126,869	11,865	33,068	81,936	238,172
Pacific Northwest:						
Oregon	61,442	29,651	23,831	2,482	3,337	31,791
Washington	42,612	21,790	17,347	3,483	960	20,822
Total	104,054	51,441	41,178	5,965	4,297	52,613
Pacific Southwest:						
California	99,824	40,233	17,781	6,453	15,998	59,591
Hawaii	4,111	1,748	700	196	853	2,363
Total	103,935	41,981	18,481	6,649	16,851	61,954
Pacific Coast total:	573,030	220,291	71,524	45,682	103,084	352,739
United States:	2,263,230	748,923	503,542	77,056	168,332	1,514,307

[a] For 2002, reserved forest includes lands previously classified as unproductive reserved and tabulated under the other forest category.

[b] For 2002, other forest no longer includes lands classified as unproductive reserved. This area, amounting to about 12 million acres in 1987, is now included in the reserved forest category.

Note: Data may not add to totals because of rounding.

Table 2—Forest land area in the United States by ownership, region, subregion, and State, 2002

		Public							Private[a]		
			Federal								
Region, subregion, and State	All owner-ships	Total public	Total Federal	National forest	Bureau of Land Man-agement	Other	State	County and muni-cipal	Total private	Forest industry	Non-industrial private
					Thousand acres						
North:											
Northeast:											
Connecticut	1,859	315	7	0	0	7	168	139	1,545	0	1,545
Delaware	383	32	0	0	0	0	32	0	351	26	325
Maine	17,699	970	116	40	0	76	738	116	16,730	7,449	9,281
Maryland	2,566	609	72	0	0	72	424	113	1,957	88	1,869
Massachusetts	3,126	743	74	0	0	74	424	245	2,383	14	2,369
New Hampshire	4,818	1,088	740	717	0	22	224	125	3,730	463	3,267
New Jersey	2,132	810	106	0	0	106	531	173	1,322	0	1,322
New York	18,432	3,977	163	5	0	157	3,486	328	14,455	1,225	13,230
Pennsylvania	16,905	4,403	587	460	0	127	3,529	287	12,502	613	11,889
Rhode Island	385	95	3	0	0	3	77	15	290	0	290
Vermont	4,618	754	369	337	0	32	313	72	3,864	253	3,612
West Virginia	12,108	1,520	1,164	1,002	0	163	311	44	10,588	887	9,701
Total	85,032	15,315	3,400	2,561	0	839	10,258	1,657	69,716	11,017	58,700
North Central:											
Illinois	4,331	680	342	270	0	72	192	146	3,651	11	3,639
Indiana	4,501	770	425	191	0	234	323	22	3,730	17	3,713
Iowa	2,050	244	74	0	0	74	127	42	1,807	0	1,807
Michigan	19,281	7,143	2,934	2,683	0	250	3,946	264	12,138	1,520	10,618
Minnesota	16,680	9,393	2,956	2,625	29	302	3,773	2,664	7,288	759	6,528
Missouri	13,992	2,366	1,775	1,428	0	347	523	69	11,626	222	11,403
Ohio	7,855	690	241	216	0	25	294	156	7,165	174	6,990
Wisconsin	15,963	4,767	1,643	1,421	0	222	823	2,300	11,196	1,105	10,091
Total	84,653	26,053	10,389	8,834	29	1,526	10,001	5,663	58,600	3,811	54,789
North total:	169,685	41,368	13,789	11,395	29	2,365	20,259	7,320	128,317	14,827	113,489
South:											
Southeast:											
Florida	16,285	3,893	2,378	1,126	9	1,243	1,403	111	12,392	4,016	8,377
Georgia	24,405	2,356	1,907	855	0	1,052	336	113	22,048	4,381	17,667
North Carolina	19,302	2,502	1,977	1,218	0	759	440	85	16,800	2,252	14,548
South Carolina	12,495	1,418	953	596	0	357	380	85	11,076	1,994	9,082
Virginia	16,074	2,593	2,226	1,626	0	600	267	99	13,481	1,537	11,944
Total	88,560	12,761	9,442	5,422	9	4,012	2,826	493	75,798	14,180	61,618
South Central:											
Alabama	22,987	1,291	928	647	0	281	241	122	21,696	3,740	17,956
Arkansas	18,771	3,532	3,062	2,483	0	580	402	67	15,239	4,497	10,742
Kentucky	12,684	1,316	1,103	645	0	458	213	0	11,368	205	11,164
Louisiana	13,812	1,335	828	588	0	239	300	207	12,477	3,898	8,578
Mississippi	18,580	1,943	1,534	1,098	0	435	310	100	16,636	3,238	13,399
Oklahoma	7,665	665	499	245	0	255	139	27	7,000	1,047	5,952
Tennessee	14,396	2,005	1,371	623	0	748	565	69	12,390	1,391	11,000
Texas	17,149	909	794	608	0	186	68	47	16,240	3,720	12,521
Total	126,043	12,996	10,119	6,936	0	3,182	2,239	639	113,047	21,735	91,311
South total:	214,603	25,758	19,561	12,358	9	7,194	5,065	1,132	188,845	35,916	152,929

Table 2—(continued).

		Public							Private[a]		
			Federal								
Region, subregion, and State	All ownerships	Total public	Total Federal	National forest	Bureau of Land Management	Other	State	County and municipal	Total private	Forest industry	Nonindustrial private
					Thousand acres						
Rocky Mountain:											
Great Plains:											
Kansas	1,545	109	65	0	0	65	32	13	1,436	0	1,436
Nebraska	947	133	57	47	0	10	66	10	814	0	814
North Dakota	672	231	197	181	2	14	34	0	442	0	442
South Dakota	1,619	1,060	1,004	979	6	19	55	1	559	0	559
Total	4,784	1,533	1,323	1,206	8	109	186	24	3,251	0	3,251
Intermountain:											
Arizona	19,427	11,417	10,192	8,223	1,304	666	1,185	40	8,010	0	8,010
Colorado	21,637	15,672	15,075	10,561	4,108	407	518	79	5,965	0	5,965
Idaho	21,646	18,257	17,129	16,157	893	79	1,103	25	3,389	1,284	2,106
Montana	23,293	17,240	16,512	14,587	804	1,121	721	7	6,053	1,618	4,435
Nevada	10,204	9,624	9,608	3,231	6,249	128	16	0	580	25	555
New Mexico	16,682	10,351	9,522	8,092	1,120	309	825	3	6,331	0	6,331
Utah	15,676	12,932	11,913	5,605	6,073	235	1,005	14	2,744	0	2,744
Wyoming	10,995	9,109	8,832	5,858	1,004	1,970	277	0	1,886	0	1,886
Total	139,560	104,601	98,783	72,314	21,555	4,913	5,650	168	34,959	2,926	32,032
Rocky Mountain total:	144,344	106,134	100,106	73,520	21,563	5,022	5,837	192	38,209	2,926	35,283
Pacific Coast:											
Alaska:											
Alaska[b]	126,869	90,994	63,423	10,455	16,954	36,014	27,469	101	35,875	0	35,875
Total	126,869	90,994	63,423	10,455	16,954	36,014	27,469	101	35,875	0	35,875
Pacific Northwest:											
Oregon	29,651	18,875	17,741	14,293	3,260	187	913	222	10,775	5,305	5,471
Washington	21,790	11,959	9,422	7,919	50	1,453	2,294	243	9,831	4,338	5,493
Total	51,441	30,835	27,162	22,212	3,311	1,639	3,208	465	20,606	9,643	10,963
Pacific Southwest:											
California	40,233	23,479	22,371	18,515	2,208	1,647	729	380	16,754	3,068	13,685
Hawaii	1,748	593	12	0	0	12	573	8	1,155	0	1,155
Total	41,981	24,073	22,383	18,515	2,208	1,659	1,302	388	17,909	3,068	14,840
Pacific Coast total:	220,291	145,901	112,968	51,183	22,472	39,313	31,979	954	74,390	12,711	61,679
United States:	748,922	319,161	246,425	148,456	44,074	53,895	63,140	9,597	429,761	66,380	363,381

[a] Native American lands are included exclusively in the nonindustrial private owner group for 1997 only. For 1987 and earlier years, these lands may be included in the other public owner group.

[b] Per the Alaska Natives Claims Settlement Act of 1971, approximately 35 million forested acres expected upon update of all ownership data for Alaska.

Note: Data may not add to totals because of rounding.

Table 3—Forest area in the United States[a] by region, subregion, and State, 2002, 1997, 1987, 1977, 1953, 1938, 1907, and 1630

Region, subregion, and State	2002	1997	1987[b]	1977[c]	1963[d]	1953[e]	1938[f]	1907[g]	1630[h]
					Thousand acres				
North:									
Northeast:									
Connecticut	1,859	1,863	1,815	1,861	1,910	1,990	1,809	1,600	2,930
Delaware	383	389	398	392	392	454	423	350	1,130
Maine	17,699	17,711	17,713	17,718	17,425	17,088	16,036	14,900	18,180
Maryland	2,566	2,701	2,632	2,653	2,920	2,920	2,595	2,200	5,730
Massachusetts	3,126	3,264	3,097	2,952	3,070	3,288	3,283	2,000	4,630
New Hampshire	4,818	4,955	5,021	5,014	5,019	4,848	4,664	3,500	5,490
New Jersey	2,132	1,991	1,985	1,928	2,371	2,098	2,157	2,000	4,330
New York	18,432	18,581	18,775	18,380	15,865	14,450	13,321	12,000	27,450
Pennsylvania	16,905	16,905	16,997	16,826	16,486	14,805	13,945	9,200	27,260
Rhode Island	385	409	399	404	434	434	360	250	650
Vermont	4,618	4,607	4,509	4,512	4,230	3,860	3,549	2,500	5,550
West Virginia	12,108	12,108	11,942	11,669	11,469	10,327	10,074	9,100	14,610
Total	85,031	85,484	85,283	84,309	81,591	76,562	72,216	59,600	117,940
North Central:									
Illinois	4,331	4,294	4,266	4,151	4,144	3,890	3,600	2,500	13,805
Indiana	4,501	4,501	4,439	3,943	4,018	4,103	3,580	4,000	19,520
Iowa	2,050	2,050	1,562	1,561	2,620	2,600	2,550	2,500	5,340
Michigan	19,281	19,335	18,220	18,691	19,699	19,592	19,073	15,500	33,110
Minnesota	16,680	16,796	16,583	16,709	17,403	17,826	19,615	15,500	31,500
Missouri	13,992	14,047	12,523	12,876	15,296	15,177	16,200	18,300	26,390
Ohio	7,855	7,855	7,309	7,037	6,091	5,500	5,110	4,800	23,470
Wisconsin	15,963	15,963	15,319	14,908	14,885	15,559	16,946	16,000	26,520
Total	84,653	84,842	80,221	79,876	84,156	84,247	86,674	79,100	179,655
North total:	169,684	170,326	165,504	164,185	165,747	160,809	158,890	138,700	297,595
South:									
Southeast:									
Florida	16,285	16,254	16,721	17,040	19,050	20,817	21,740	24,128	29,840
Georgia	24,405	24,413	24,187	24,556	26,365	24,057	21,433	22,300	35,700
North Carolina	19,302	19,298	19,281	19,913	20,662	20,113	18,400	19,600	29,630
South Carolina	12,495	12,651	12,257	12,569	12,250	11,943	10,704	12,000	17,570
Virginia	16,074	16,047	16,108	16,387	16,412	16,032	14,832	14,000	24,480
Total	88,561	88,662	88,554	90,465	94,739	92,962	87,109	92,028	137,220
South Central:									
Alabama	22,987	21,964	21,725	21,525	21,770	20,771	18,878	20,000	29,540
Arkansas	18,771	18,790	16,987	16,852	20,051	19,681	20,963	24,200	31,940
Kentucky	12,684	12,684	12,256	12,161	11,791	11,647	11,546	10,000	23,140
Louisiana	13,812	13,783	13,883	14,348	16,176	16,230	16,211	16,500	26,160
Mississippi	18,580	18,595	16,693	16,716	17,076	16,890	16,253	17,500	26,700
Oklahoma	7,665	7,665	7,283	8,513	9,235	10,329	10,415	10,500	13,330
Tennessee	14,396	13,603	13,258	13,184	13,629	12,808	13,000	15,000	24,010
Texas	17,149	18,354	20,505	23,279	23,954	24,708	26,949	30,000	41,980
Total	126,044	125,438	122,590	126,578	133,682	133,064	134,215	143,700	216,800
South total:	214,605	214,100	211,144	217,043	228,421	226,026	221,324	235,728	354,020

Table 3—(continued).

Region, subregion, and State	2002	1997	1987[b]	1977[c]	1963[d]	1953[e]	1938[f]	1907[g]	1630[h]
					Thousand acres				
Rocky Mountain:									
Great Plains:									
Kansas	1,545	1,545	1,358	1,344	1,351	1,668	2,408	2,648	1,570
Nebraska	947	947	722	1,029	1,162	903	1,188	1,472	1,470
North Dakota	672	674	460	422	439	473	495	384	450
South Dakota	1,619	1,632	1,690	1,702	1,837	2,169	2,080	2,200	2,480
Total	4,783	4,798	4,230	4,497	4,789	5,213	6,171	6,704	5,970
Intermountain:									
Arizona	19,427	19,926	19,384	18,494	19,902	19,212	20,106	21,000	21,570
Colorado	21,637	21,270	21,338	22,271	22,583	22,000	21,720	21,440	21,440
Idaho	21,646	21,937	21,818	21,727	21,815	21,025	21,713	22,400	24,130
Montana	23,293	23,232	21,910	22,559	22,048	22,330	22,415	22,500	23,320
Nevada	10,204	9,928	8,928	7,683	9,000	9,500	10,750	12,000	12,000
New Mexico	16,682	15,505	15,826	15,360	15,487	15,550	15,334	15,168	15,680
Utah	15,676	15,705	16,234	15,557	14,955	16,219	16,310	16,400	17,890
Wyoming	10,995	10,944	9,966	10,028	9,777	10,513	10,757	11,000	12,490
Total	139,560	138,447	135,404	133,679	135,567	136,349	139,105	141,908	148,520
Rocky Mountain total:	144,343	143,244	139,634	138,176	140,356	141,562	145,276	148,612	154,490
Pacific Coast:									
Alaska:									
Alaska	126,869	127,380	129,045	129,100	129,100	129,100	129,100	129,100	129,100
Total	126,869	127,380	129,045	129,100	129,100	129,100	129,100	129,100	129,100
Pacific Northwest:									
Oregon	29,651	29,720	28,773	29,810	30,739	30,261	30,381	30,500	30,590
Washington	21,790	21,892	22,521	23,181	23,050	23,868	24,684	25,500	25,670
Total	51,441	51,612	51,294	52,991	53,789	54,129	55,065	56,000	56,260
Pacific Southwest:									
California	40,233	38,547	39,381	40,152	42,541	42,541	48,159	49,000	51,970
Hawaii	1,748	1,748	1,748	1,986	1,982	2,000	2,000	2,000	2,000
Total	41,981	40,296	41,129	42,138	44,523	44,541	50,159	51,000	53,970
Pacific Coast total:	220,291	219,288	221,468	224,229	227,412	227,770	234,324	236,100	239,330
United States:	748,923	746,958	737,750	743,633	761,936	756,167	759,814	759,140	1,045,435

[a] Estimates for 1938 include forest area for regions that would become the States of Alaska and Hawaii. Estimates for 1907 include forest area for regions that would become the States of Alaska, Arizona, Hawaii, and New Mexico. Estimates for 1630 represent the forest area in North America for regions that would become the 50 States within the current United States.

[b] Data for 1987 based on Waddell *et al.* (1989).

[c] Data for 1977 based on USDA Forest Service (1982).

[d] Data for 1963 based on USDA Forest Service (1965).

[e] Data for 1953 based on USDA Forest Service (1958).

[f] Data for 1938 based on U.S. Congress (1938).

[g] Data for 1907 based on Kellogg (1909).

[h] Data for 1630 were also from Kellogg (1909) as an estimate of the original forest area based on the current estimate of forest and historic land clearing information. These data are provided here for general reference purposes only to convey the relative extent of the forest estate, in what is now the United States, at the time of European settlement.

Table 4—Forest land area in the United States by productivity class, region, subregion, and State, 2002

		Productivity class[a]					
Region, subregion, and State	Total	120 + cu. ft.	85-119 cu. ft.	50-84 cu. ft.	20-49 cu. ft.	0-19 cu. ft.	Reserved forest land
				Thousand acres			
North:							
Northeast:							
Connecticut	1,859	61	110	549	977	149	14
Delaware	383	24	39	128	184	7	0
Maine	17,699	241	1,825	6,066	8,821	368	380
Maryland	2,566	191	416	890	875	14	180
Massachusetts	3,126	232	318	1,045	1,035	369	126
New Hampshire	4,818	54	478	1,356	2,615	158	157
New Jersey	2,132	26	137	475	1,238	96	160
New York	18,432	815	1,592	3,754	9,228	123	2,920
Pennsylvania	16,905	716	1,471	3,838	9,828	219	833
Rhode Island	385	4	30	103	202	36	10
Vermont	4,618	88	535	1,056	2,803	21	114
West Virginia	12,108	971	2,718	3,839	4,373	27	181
Total	85,032	3,424	9,669	23,098	42,180	1,586	5,075
North Central:							
Illinois	4,331	754	1,303	1,340	690	0	244
Indiana	4,501	1,082	1,641	1,203	416	0	159
Iowa	2,050	82	573	911	377	19	88
Michigan	19,281	960	4,388	7,710	5,558	90	575
Minnesota	16,680	266	2,948	5,355	6,154	840	1,117
Missouri	13,992	124	554	6,395	6,291	311	317
Ohio	7,855	387	583	1,495	5,103	147	140
Wisconsin	15,963	1,014	4,022	7,013	3,652	61	201
Total	84,653	4,669	16,011	31,423	28,240	1,468	2,842
North total:	169,685	8,093	25,680	54,521	70,420	3,054	7,916
South:							
Southeast:							
Florida	16,285	206	1,942	8,694	3,793	528	1,121
Georgia	24,405	983	6,093	14,970	1,756	7	595
North Carolina	19,302	1,106	5,613	9,690	2,255	40	598
South Carolina	12,495	902	3,229	5,842	2,327	0	194
Virginia	16,074	563	3,294	9,501	2,013	16	686
Total	88,560	3,761	20,171	48,697	12,145	592	3,194
South Central:							
Alabama	22,987	4,941	9,115	7,470	1,396	0	65
Arkansas	18,771	3,452	5,060	7,112	2,749	167	231
Kentucky	12,684	1,102	2,065	3,876	5,305	32	305
Louisiana	13,812	6,374	4,498	2,552	299	0	90
Mississippi	18,580	7,900	7,347	3,033	291	0	8
Oklahoma	7,665	258	636	2,715	2,624	1,386	45
Tennessee	14,396	2,279	4,283	5,755	1,639	0	440
Texas	17,149	3,722	4,769	2,707	576	5,250	125
Total	126,043	30,027	37,774	35,220	14,878	6,834	1,309
South total:	214,603	33,788	57,945	83,917	27,023	7,427	4,503

Table 4—(continued).

		Productivity class[a]					
Region, subregion, and State	Total	120 + cu. ft.	85-119 cu. ft.	50-84 cu. ft.	20-49 cu. ft.	0-19 cu. ft.	Reserved forest land
				Thousand acres			
Rocky Mountain:							
Great Plains:							
Kansas	1,545	62	256	558	615	37	18
Nebraska	947	23	173	269	432	18	32
North Dakota	672	0	19	98	325	231	0
South Dakota	1,619	1	16	246	1,247	85	23
Total	4,784	87	463	1,172	2,619	370	73
Intermountain:							
Arizona	19,427	0	27	945	2,554	14,082	1,818
Colorado	21,637	7	366	3,054	8,180	7,318	2,711
Idaho	21,646	2,648	4,977	5,394	3,805	1,115	3,708
Montana	23,293	453	2,133	7,093	9,505	426	3,682
Nevada	10,204	29	21	115	198	9,273	568
New Mexico	16,682	0	35	1,253	3,071	10,619	1,704
Utah	15,676	7	210	1,389	3,078	10,223	770
Wyoming	10,995	0	100	1,201	4,438	1,340	3,916
Total	139,560	3,145	7,868	20,443	34,831	54,396	18,877
Rocky Mountain total:	144,344	3,231	8,332	21,615	37,449	54,766	18,950
Pacific Coast:							
Alaska:							
Alaska	126,869	356	660	1,650	9,198	81,936	33,068
Total	126,869	356	660	1,650	9,198	81,936	33,068
Pacific Northwest:							
Oregon	29,651	10,843	4,925	5,037	3,026	3,337	2,482
Washington	21,790	9,879	3,009	2,757	1,701	960	3,483
Total	51,441	20,723	7,934	7,794	4,727	4,297	5,965
Pacific Southwest:							
California	40,233	6,417	3,873	4,775	2,717	15,998	6,453
Hawaii	1,748	700	0	0	0	853	196
Total	41,981	7,116	3,873	4,775	2,717	16,851	6,649
Pacific Coast total:	220,291	28,195	12,467	14,220	16,642	103,085	45,682
United States:	748,922	73,308	104,424	174,274	151,535	168,331	77,051

[a] Productivity classes are displayed as cubic feet per acre per year.

Note: Data may not add to totals because of rounding.

Table 5—Forest land area in the Western United States by forest type group, subregion, productivity class, and ownership group, 2002

	Forest type group												
Subregion and productivity class[a]	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
Thousand acres													
All ownership groups													
Great Plains:													
120 +	87	0	2	0	0	0	0	0	0	3	82	0	0
85 to 119	463	0	38	0	0	0	0	0	0	21	404	0	0
50 to 84	1,172	0	170	0	0	0	0	0	0	49	945	0	7
20 to 49	2,619	0	1,065	0	0	0	0	0	0	82	1,432	0	39
Other forest	370	0	3	0	0	0	0	0	0	3	9	6	348
Reserved	73	0	29	0	0	0	0	0	0	1	27	0	16
Total	4,784	0	1,307	0	0	0	0	0	0	160	2,900	6	410
Intermountain:													
120 +	3,145	1,343	308	64	841	341	61	130	0	6	51	0	0
85 to 119	7,868	2,664	505	31	2,855	630	341	559	0	5	263	0	14
50 to 84	20,443	6,197	2,641	29	6,175	518	372	2,456	0	111	1,846	0	97
20 to 49	34,831	7,219	10,525	0	4,539	23	119	6,410	0	1,559	4,086	70	281
Other forest	54,396	122	280	0	217	0	15	451	0	2,285	6,113	43,721	1,191
Reserved	18,877	2,595	1,709	0	4,611	68	103	4,690	0	1,053	1,055	2,428	567
Total	139,560	20,141	15,968	124	19,239	1,580	1,011	14,696	0	5,019	13,414	46,219	2,150
Alaska[b]:													
120 +	356	0	0	0	0	336	0	0	0	0	20	0	0
85 to 119	660	0	0	0	6	637	0	0	0	0	17	0	0
50 to 84	1,650	0	0	0	104	1,451	0	6	0	6	82	0	1
20 to 49	9,198	0	0	0	3,538	1,823	0	34	0	149	3,543	0	112
Other forest	81,936	0	0	0	30,681	2,581	0	294	0	44,103	4,272	0	4
Reserved	33,068	0	0	0	11,412	3,622	0	28	0	16,587	1,352	0	68
Total	126,869	0	0	0	45,741	10,449	0	361	0	60,845	9,287	0	185
Pacific Northwest:													
120 +	20,723	10,208	292	11	2,042	4,057	76	476	6	7	3,223	22	302
85 to 119	7,934	3,005	1,387	14	1,201	538	112	696	0	8	799	69	107
50 to 84	7,794	2,518	2,493	4	830	355	80	797	0	26	434	134	122
20 to 49	4,727	1,230	2,079	22	204	77	14	477	0	23	253	192	156
Other forest	4,297	327	766	2	12	26	0	19	0	11	714	2,216	204
Reserved	5,965	1,268	202	37	1,421	2,152	55	246	0	308	173	76	26
Total	51,441	18,555	7,219	90	5,711	7,206	338	2,710	6	383	5,597	2,709	918
Pacific Southwest:													
120 +	7,116	383	1,243	0	511	13	0	22	654	2,353	1,519	2	415
85 to 119	3,873	213	933	2	407	1	0	42	76	1,060	1,046	0	93
50 to 84	4,775	143	1,789	17	305	18	0	200	0	748	1,275	1	281
20 to 49	2,717	29	881	21	132	16	0	179	0	502	621	4	332
Other forest	16,851	5	1,501	16	5	0	0	7	0	373	11,864	2,404	676
Reserved	6,649	132	628	96	791	93	0	542	186	1,190	2,232	393	366
Total	41,981	904	6,975	152	2,150	141	0	992	916	6,226	18,558	2,805	2,162
West total:													
120 +	31,426	11,934	1,845	75	3,395	4,747	137	628	660	2,369	4,896	24	718
85 to 119	20,798	5,882	2,862	46	4,469	1,806	454	1,296	76	1,094	2,530	69	214
50 to 84	35,835	8,858	7,093	49	7,414	2,343	452	3,459	0	941	4,582	136	508
20 to 49	54,092	8,477	14,550	43	8,413	1,939	133	7,100	0	2,316	9,936	266	919
Other forest	157,851	454	2,550	18	30,915	2,608	15	771	0	46,776	22,973	48,348	2,423
Reserved	64,632	3,995	2,568	133	18,235	5,935	157	5,506	186	19,138	4,839	2,897	1,042
Total	364,634	39,599	31,469	365	72,841	19,377	1,349	18,759	921	72,633	49,756	51,739	5,825

Table 5—(continued).

	Forest type group												
Subregion and productivity class[a]	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
						Thousand acres							
						National forest							
Great Plains:													
120 +	0	0	0	0	0	0	0	0	0	0	0	0	0
85 to 119	24	0	17	0	0	0	0	0	0	6	0	0	0
50 to 84	148	0	107	0	0	0	0	0	0	35	6	0	0
20 to 49	848	0	759	0	0	0	0	0	0	12	64	0	13
Other forest	175	0	0	0	0	0	0	0	0	0	1	6	167
Reserved	11	0	11	0	0	0	0	0	0	0	0	0	0
Total	1,206	0	895	0	0	0	0	0	0	53	72	6	181
Intermountain:													
120 +	1,749	823	174	32	442	173	37	62	0	6	0	0	0
85 to 119	5,042	1,746	248	25	1,973	322	247	417	0	5	45	0	14
50 to 84	13,276	3,883	1,188	29	4,883	353	198	1,835	0	38	794	0	74
20 to 49	22,872	4,424	4,888	0	3,926	23	83	5,477	0	1,193	2,528	70	261
Other forest	15,550	70	119	0	156	0	15	431	0	1,426	2,265	10,265	803
Reserved	13,826	2,012	1,283	0	4,238	68	34	2,659	0	1,014	800	1,398	320
Total	72,314	12,958	7,899	86	15,617	939	614	10,881	0	3,683	6,432	11,734	1,471
Alaska[b]:													
120 +	256	0	0	0	0	244	0	0	0	0	12	0	0
85 to 119	519	0	0	0	6	508	0	0	0	0	6	0	0
50 to 84	1,140	0	0	0	104	1,026	0	6	0	0	3	0	1
20 to 49	1,857	0	0	0	418	1,384	0	22	0	0	33	0	0
Other forest	2,680	0	0	0	709	1,688	0	255	0	8	17	0	4
Reserved	4,003	0	0	0	917	3,005	0	28	0	0	33	0	20
Total	10,455	0	0	0	2,154	7,855	0	310	0	8	103	0	25
Pacific Northwest:													
120 +	8,230	3,726	240	11	1,725	1,557	68	455	0	7	395	15	32
85 to 119	4,404	1,232	1,114	4	910	329	53	583	0	8	133	26	11
50 to 84	4,194	907	1,809	4	440	218	48	516	0	19	64	111	57
20 to 49	1,083	149	477	22	36	17	0	166	0	23	26	163	6
Other forest	261	27	28	2	0	8	0	12	0	7	8	143	26
Reserved	4,040	867	143	35	1,167	1,304	16	213	0	47	146	76	26
Total	22,212	6,908	3,812	77	4,278	3,433	185	1,945	0	111	771	534	158
Pacific Southwest:													
120 +	3,249	127	101	0	428	6	0	8	0	2,289	272	0	19
85 to 119	2,020	69	165	2	318	1	0	35	0	1,051	333	0	47
50 to 84	2,924	60	850	14	223	18	0	177	0	748	611	0	223
20 to 49	1,723	16	249	21	123	16	0	164	0	498	334	0	303
Other forest	4,381	5	88	16	5	0	0	7	0	207	2,388	1,168	497
Reserved	4,217	91	218	96	433	86	0	355	11	1,152	1,231	176	366
Total	18,513	368	1,671	149	1,529	127	0	746	11	5,945	5,168	1,344	1,455
West total:													
120 +	13,484	4,676	514	43	2,595	1,980	105	524	0	2,302	678	15	51
85 to 119	12,008	3,047	1,544	30	3,207	1,160	300	1,034	0	1,070	516	26	72
50 to 84	21,682	4,851	3,954	47	5,651	1,615	245	2,534	0	840	1,479	111	355
20 to 49	28,384	4,589	6,373	43	4,502	1,440	83	5,829	0	1,726	2,984	233	583
Other forest	23,046	102	235	18	869	1,695	15	704	0	1,649	4,679	11,583	1,496
Reserved	26,097	2,970	1,655	131	6,754	4,463	50	3,255	11	2,214	2,210	1,651	732
Total	124,701	20,234	14,276	313	23,579	12,353	799	13,881	11	9,801	12,546	13,619	3,290

Table 5—(continued).

	Forest type group												
Subregion and productivity class[a]	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
						Thousand acres							
						Other public							
Great Plains:													
120 +	12	0	0	0	0	0	0	0	0	0	12	0	0
85 to 119	27	0	5	0	0	0	0	0	0	0	22	0	0
50 to 84	87	0	11	0	0	0	0	0	0	0	72	0	4
20 to 49	131	0	43	0	0	0	0	0	0	6	77	0	5
Other forest	15	0	0	0	0	0	0	0	0	0	1	0	14
Reserved	55	0	13	0	0	0	0	0	0	1	25	0	16
Total	327	0	72	0	0	0	0	0	0	7	210	0	38
Intermountain:													
120 +	432	137	35	6	168	54	6	15	0	0	11	0	0
85 to 119	759	282	48	0	253	109	23	14	0	0	30	0	0
50 to 84	1,638	674	138	0	325	57	35	182	0	22	204	0	0
20 to 49	3,222	1,038	1,082	0	213	0	2	418	0	166	302	0	0
Other forest	21,347	30	60	0	54	0	0	11	0	189	1,052	19,856	96
Reserved	4,888	544	419	0	359	0	69	2,031	0	38	236	945	247
Total	32,287	2,705	1,782	6	1,374	221	136	2,670	0	415	1,836	20,801	342
Alaska[b]:													
120 +	60	0	0	0	0	55	0	0	0	0	6	0	0
85 to 119	100	0	0	0	0	88	0	0	0	0	12	0	0
50 to 84	239	0	0	0	0	159	0	0	0	0	79	0	0
20 to 49	4,922	0	0	0	1,951	129	0	0	0	57	2,718	0	67
Other forest	46,158	0	0	0	7,618	290	0	15	0	34,873	3,361	0	0
Reserved	29,059	0	0	0	10,489	617	0	0	0	16,587	1,319	0	48
Total	80,538	0	0	0	20,058	1,338	0	15	0	51,517	7,495	0	114
Pacific Northwest:													
120 +	3,225	1,913	0	0	71	585	0	0	0	0	622	7	28
85 to 119	812	512	65	0	52	57	18	13	0	0	88	0	6
50 to 84	824	481	71	0	43	35	11	38	0	7	133	7	0
20 to 49	732	284	213	0	6	11	0	64	0	0	116	7	32
Other forest	1,244	94	137	0	0	0	0	0	0	3	111	864	35
Reserved	1,785	392	51	3	248	797	4	7	0	259	24	0	0
Total	8,623	3,675	536	3	420	1,485	33	122	0	269	1,094	885	100
Pacific Southwest:													
120 +	474	10	45	0	0	0	0	0	79	18	149	0	173
85 to 119	115	0	57	0	10	0	0	0	1	0	47	0	0
50 to 84	77	7	19	0	0	0	0	1	0	0	49	0	0
20 to 49	55	0	36	0	0	0	0	1	0	0	11	3	4
Other forest	2,450	0	81	0	0	0	0	0	0	55	1,545	741	29
Reserved	2,388	39	407	0	358	7	0	187	173	35	966	217	0
Total	5,559	57	645	0	368	7	0	189	253	108	2,767	961	206
West total:													
120 +	4,204	2,060	80	6	240	694	6	15	79	18	800	7	201
85 to 119	1,813	794	175	0	316	255	41	27	1	0	199	0	6
50 to 84	2,864	1,162	239	0	368	252	46	221	0	29	537	7	4
20 to 49	9,063	1,322	1,374	0	2,170	140	2	483	0	229	3,225	9	108
Other forest	71,215	124	278	0	7,672	290	0	26	0	35,121	6,070	21,461	173
Reserved	38,175	975	890	3	11,454	1,421	73	2,225	173	16,919	2,571	1,162	310
Total	127,334	6,437	3,035	9	22,220	3,051	169	2,996	253	52,316	13,402	22,647	800

Table 5—(continued).

	Forest type group												
Subregion and productivity class[a]	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
	Thousand acres												
	Forest industry												
Great Plains:													
120 +	0	0	0	0	0	0	0	0	0	0	0	0	0
85 to 119	0	0	0	0	0	0	0	0	0	0	0	0	0
50 to 84	0	0	0	0	0	0	0	0	0	0	0	0	0
20 to 49	0	0	0	0	0	0	0	0	0	0	0	0	0
Other forest	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Intermountain:													
120 +	399	142	4	13	150	64	12	14	0	0	0	0	0
85 to 119	802	252	17	0	347	128	32	27	0	0	0	0	0
50 to 84	1,211	493	137	0	225	95	90	157	0	5	8	0	0
20 to 49	515	325	27	0	63	0	8	86	0	5	0	0	0
Other forest	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,926	1,213	185	13	786	286	141	283	0	10	8	0	0
Alaska[b]:													
120 +	0	0	0	0	0	0	0	0	0	0	0	0	0
85 to 119	0	0	0	0	0	0	0	0	0	0	0	0	0
50 to 84	0	0	0	0	0	0	0	0	0	0	0	0	0
20 to 49	0	0	0	0	0	0	0	0	0	0	0	0	0
Other forest	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Pacific Northwest:													
120 +	5,664	3,130	0	0	119	1,368	5	7	0	0	895	0	140
85 to 119	1,212	711	41	0	146	96	19	0	0	0	130	36	33
50 to 84	1,136	418	273	0	228	55	0	78	0	0	48	16	21
20 to 49	1,162	243	558	0	111	15	0	173	0	0	0	16	45
Other forest	469	53	164	0	0	12	0	7	0	0	91	101	41
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	9,643	4,554	1,036	0	604	1,546	25	265	0	0	1,164	168	280
Pacific Southwest:													
120 +	1,509	128	560	0	51	0	0	5	356	8	370	0	31
85 to 119	726	52	352	0	43	0	0	7	37	0	225	0	9
50 to 84	516	8	300	2	41	0	0	0	0	0	160	0	6
20 to 49	181	8	111	0	10	0	0	0	0	4	49	0	0
Other forest	136	0	15	0	0	0	0	0	0	6	93	11	10
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3,068	196	1,338	2	144	0	0	12	394	19	897	11	56
West total:													
120 +	7,572	3,399	564	13	321	1,432	17	25	356	8	1,265	0	171
85 to 119	2,739	1,016	410	0	535	223	51	34	37	0	355	36	42
50 to 84	2,863	919	710	2	494	150	90	235	0	5	216	16	26
20 to 49	1,858	576	697	0	184	15	8	260	0	9	49	16	45
Other forest	605	53	179	0	0	12	0	7	0	6	184	112	52
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	15,637	5,962	2,559	15	1,534	1,832	166	560	394	29	2,069	179	337

Table 5—(continued).

Subregion and productivity class[a]	Forest type group												
	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
	Thousand acres												
	Nonindustrial private												
Great Plains:													
120 +	75	0	2	0	0	0	0	0	0	3	70	0	0
85 to 119	413	0	15	0	0	0	0	0	0	15	382	0	0
50 to 84	938	0	52	0	0	0	0	0	0	14	867	0	4
20 to 49	1,639	0	263	0	0	0	0	0	0	64	1,291	0	20
Other forest	180	0	3	0	0	0	0	0	0	3	6	0	167
Reserved	6	0	5	0	0	0	0	0	0	0	2	0	0
Total	3,251	0	341	0	0	0	0	0	0	100	2,619	0	192
Intermountain:													
120 +	565	241	95	13	80	50	6	40	0	0	40	0	0
85 to 119	1,266	384	193	6	283	72	40	101	0	0	188	0	0
50 to 84	4,318	1,147	1,177	0	741	13	48	282	0	47	839	0	23
20 to 49	8,221	1,431	4,527	0	337	0	26	429	0	194	1,256	0	20
Other forest	17,499	22	102	0	7	0	0	9	0	670	2,796	13,600	293
Reserved	164	39	7	0	14	0	0	0	0	0	19	84	0
Total	32,032	3,265	6,101	19	1,462	134	120	861	0	911	5,138	13,684	336
Alaska[b]:													
120 +	40	0	0	0	0	37	0	0	0	0	3	0	0
85 to 119	41	0	0	0	0	41	0	0	0	0	0	0	0
50 to 84	271	0	0	0	0	266	0	0	0	6	0	0	0
20 to 49	2,419	0	0	0	1,169	310	0	12	0	92	792	0	45
Other forest	33,098	0	0	0	22,354	603	0	25	0	9,222	894	0	0
Reserved	6	0	0	0	6	0	0	0	0	0	0	0	0
Total	35,875	0	0	0	23,528	1,256	0	36	0	9,320	1,689	0	45
Pacific Northwest:													
120 +	3,603	1,439	53	0	127	547	3	14	6	0	1,312	0	103
85 to 119	1,507	550	166	10	92	55	22	100	0	0	449	7	56
50 to 84	1,641	712	340	0	119	47	22	165	0	0	190	0	45
20 to 49	1,750	554	830	0	51	35	14	74	0	0	111	7	73
Other forest	2,323	153	437	0	12	7	0	0	0	0	504	1,108	102
Reserved	140	9	8	0	7	52	34	26	0	2	3	0	0
Total	10,963	3,418	1,834	10	409	743	95	379	6	2	2,567	1,121	379
Pacific Southwest:													
120 +	1,884	118	537	0	33	7	0	10	219	37	729	2	192
85 to 119	1,012	92	359	0	36	0	0	0	38	9	442	0	38
50 to 84	1,258	67	621	0	41	0	0	22	0	0	455	1	52
20 to 49	758	6	485	0	0	0	0	14	0	1	227	1	24
Other forest	9,884	0	1,317	0	0	0	0	0	0	104	7,839	484	140
Reserved	44	2	3	0	0	0	0	0	1	3	35	0	0
Total	14,840	284	3,322	0	110	7	0	46	258	154	9,726	489	445
West total:													
120 +	6,166	1,799	687	13	240	641	9	64	224	40	2,153	2	295
85 to 119	4,238	1,025	733	16	411	168	62	201	38	24	1,460	7	94
50 to 84	8,426	1,927	2,191	0	901	326	71	469	0	67	2,351	1	123
20 to 49	14,787	1,991	6,106	0	1,557	344	41	528	0	352	3,677	8	183
Other forest	62,984	175	1,859	0	22,373	610	0	34	0	10,000	12,039	15,192	702
Reserved	360	50	22	0	27	52	34	26	1	5	59	84	0
Total	96,962	6,967	11,598	29	25,509	2,141	216	1,322	263	10,487	21,739	15,294	1,398

[a] Productivity classes are displayed as cubic feet per acre per year.

[b] Per the Alaska Natives Claims Settlement Act of 1971, approximately 35 million forested acres expected upon update of all ownership data for Alaska.

Note: Data may not add to totals because of rounding.

Table 6—Forest land area in the Eastern United States by forest type group, subregion, productivity class, and ownership group, 2002

		Forest type group												
Subregion and productivity class[a]	All forest types	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked	Unknown[b]
							Thousand acres							
							All ownership groups							
Northeast:														
120 +	3,424	337	308	0	75	123	1,016	29	333	1,135	61	0	7	0
85 to 119	9,669	1,128	1,225	0	168	298	3,403	55	194	2,595	599	0	5	0
50 to 84	23,098	2,205	2,896	0	277	787	7,030	82	438	7,917	1,467	0	0	0
20 to 49	42,180	2,295	3,151	0	754	1,081	12,663	154	1,312	18,943	1,743	0	84	0
Other forest	1,586	87	320	0	88	50	312	29	310	258	75	0	58	0
Reserved	5,075	409	434	0	99	101	1,261	7	141	2,453	165	0	5	0
Total	85,032	6,461	8,334	0	1,460	2,439	25,684	356	2,727	33,302	4,109	0	159	0
North Central:														
120 +	4,669	767	456	0	71	106	987	41	650	1,133	447	0	10	0
85 to 119	16,011	1,123	925	0	42	86	3,163	66	1,670	4,480	4,397	0	59	0
50 to 84	31,423	1,229	1,515	0	46	402	11,498	31	2,159	8,440	6,032	0	70	0
20 to 49	28,240	1,114	4,680	0	537	599	9,657	161	3,391	5,833	2,094	0	174	0
Other forest	1,468	12	754	0	12	92	264	13	83	52	51	0	135	0
Reserved	2,842	235	475	0	11	52	678	17	169	485	695	0	23	0
Total	84,653	4,480	8,806	0	719	1,337	26,247	330	8,124	20,423	13,717	0	471	0
Southeast:														
120 +	3,761	318	0	209	1,555	566	758	327	14	6	0	0	7	0
85 to 119	20,171	53	0	2,042	6,531	2,498	6,014	2,532	361	112	0	0	28	0
50 to 84	48,697	148	2	6,416	12,718	5,986	15,382	7,448	385	195	0	0	17	0
20 to 49	12,145	22	9	1,653	2,109	1,972	4,063	2,218	76	22	0	2	0	0
Other forest	592	0	0	105	18	34	24	410	0	0	0	0	0	0
Reserved	3,194	111	33	355	364	306	1,141	864	0	18	0	0	0	0
Total	88,560	652	44	10,780	23,296	11,363	27,382	13,800	836	353	0	2	53	0
South Central:														
120 +	30,027	74	0	611	9,529	4,814	7,963	6,242	649	72	0	0	72	0
85 to 119	37,774	23	0	1,072	11,317	6,294	12,802	5,535	489	116	0	0	127	0
50 to 84	35,220	28	0	1,162	6,394	5,403	17,491	4,006	398	186	0	0	151	0
20 to 49	14,878	17	0	179	1,053	1,626	10,407	895	331	342	0	0	27	0
Other forest	6,834	0	0	45	81	472	4,386	143	21	0	0	1,672	12	0
Reserved	1,309	18	0	15	197	169	788	70	3	48	0	0	1	0
Total	126,043	161	0	3,086	28,572	18,778	53,838	16,890	1,891	765	0	1,672	389	0
East total:														
120 +	41,881	1,495	764	820	11,231	5,609	10,725	6,640	1,647	2,346	508	0	96	0
85 to 119	83,625	2,327	2,150	3,114	18,058	9,176	25,382	8,188	2,714	7,302	4,996	0	219	0
50 to 84	138,438	3,611	4,413	7,578	19,436	12,578	51,401	11,567	3,380	16,738	7,499	0	238	0
20 to 49	97,443	3,449	7,840	1,833	4,453	5,277	36,789	3,428	5,110	25,141	3,837	2	285	0
Other forest	10,481	99	1,074	151	198	648	4,986	595	414	311	126	1,672	205	0
Reserved	12,419	773	942	370	671	627	3,869	958	313	3,005	860	0	29	0
Total	384,288	11,754	17,183	13,866	54,047	33,916	133,151	31,375	13,578	54,843	17,826	1,674	1,072	0

Table 6—(continued).

		Forest type group												
Subregion and productivity class[a]	All forest types	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked	Un-known[b]
							Thousand acres							
							National forest							
Northeast:														
120 +	43	5	0	0	0	0	10	0	0	27	0	0	0	0
85 to 119	156	11	26	0	6	0	58	0	0	56	0	0	0	0
50 to 84	560	20	28	0	7	18	159	0	0	311	18	0	0	0
20 to 49	1,405	11	91	0	21	7	318	0	0	901	56	0	0	0
Other forest	61	0	56	0	0	0	5	0	0	0	0	0	0	0
Reserved	337	45	42	0	0	0	41	0	0	181	28	0	0	0
Total	2,561	92	242	0	34	25	591	0	0	1,475	102	0	0	0
North Central:														
120 +	396	154	65	0	19	13	68	0	5	36	36	0	0	0
85 to 119	1,487	266	199	0	12	5	122	3	27	305	548	0	0	0
50 to 84	3,180	273	268	0	0	97	953	0	46	861	678	0	4	0
20 to 49	2,612	223	657	0	141	70	584	0	200	417	311	0	10	0
Other forest	88	0	35	0	0	16	18	0	1	0	1	0	16	0
Reserved	1,070	164	216	0	11	8	100	0	14	96	461	0	2	0
Total	8,834	1,080	1,439	0	183	209	1,844	3	293	1,714	2,035	0	32	0
Southeast:														
120 +	286	51	0	5	34	40	122	28	0	6	0	0	0	0
85 to 119	795	2	0	74	257	58	343	30	3	27	0	0	0	0
50 to 84	2,338	38	2	275	390	253	1,215	126	0	38	0	0	0	0
20 to 49	1,290	4	4	168	206	179	635	89	0	4	0	0	0	0
Other forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserved	712	24	16	49	99	104	365	42	0	14	0	0	0	0
Total	5,422	119	22	571	986	635	2,681	316	3	89	0	0	0	0
South Central:														
120 +	1,521	30	0	97	586	400	272	129	0	7	0	0	0	0
85 to 119	1,548	5	0	141	662	311	348	63	0	19	0	0	0	0
50 to 84	2,650	9	0	168	743	508	1,185	22	0	14	0	0	0	0
20 to 49	817	8	0	21	85	93	592	2	0	17	0	0	0	0
Other forest	11	0	0	0	0	0	11	0	0	0	0	0	0	0
Reserved	389	7	0	6	66	94	157	36	0	24	0	0	0	0
Total	6,936	58	0	432	2,143	1,406	2,564	252	0	81	0	0	0	0
East total:														
120 +	2,246	241	65	101	640	453	471	157	5	76	36	0	0	0
85 to 119	3,987	284	225	215	937	375	871	96	30	406	548	0	0	0
50 to 84	8,728	340	298	443	1,141	876	3,512	149	46	1,224	696	0	4	0
20 to 49	6,124	246	752	189	453	349	2,129	91	200	1,339	366	0	10	0
Other forest	159	0	91	0	0	16	33	0	1	0	1	0	16	0
Reserved	2,509	239	273	55	176	206	663	78	14	314	489	0	2	0
Total	23,753	1,350	1,704	1,003	3,346	2,275	7,681	571	297	3,359	2,137	0	32	0

Table 6—(continued).

		Forest type group											
Subregion and productivity class[a]	**All forest types**	**White-red-jack pine**	**Spruce-fir**	**Longleaf-slash pine**	**Loblolly-shortleaf pine**	**Oak-pine**	**Oak-hickory**	**Oak-gum-cypress**	**Elm-ash-cottonwood**	**Maple-beech-birch**	**Aspen-birch**	**Other forest types**	**Non-stocked**	**Un-known[b]**
						Thousand acres								
						Other public								
Northeast:														
120 +	237	39	58	0	7	5	43	0	28	49	7	0	0	0
85 to 119	663	129	31	0	28	30	218	7	18	172	31	0	0	0
50 to 84	1,968	170	206	0	39	67	732	18	50	589	97	0	0	0
20 to 49	5,053	234	101	0	270	169	2,207	28	145	1,765	135	0	0	0
Other forest	259	10	20	0	58	1	51	19	51	43	6	0	0	0
Reserved	4,574	346	385	0	87	93	1,195	7	130	2,200	125	0	5	0
Total	12,754	927	801	0	488	365	4,446	80	423	4,817	401	0	5	0
North Central:														
120 +	654	153	138	0	6	13	54	3	72	82	132	0	1	0
85 to 119	2,802	321	273	0	3	3	294	6	207	393	1,292	0	11	0
50 to 84	5,583	420	474	0	0	21	1,034	7	293	1,295	2,016	0	22	0
20 to 49	5,748	503	2,148	0	29	15	758	23	744	737	723	0	66	0
Other forest	763	0	621	0	0	0	14	13	31	2	25	0	57	0
Reserved	1,669	49	253	0	0	41	559	17	146	364	219	0	21	0
Total	17,219	1,446	3,907	0	38	94	2,714	69	1,493	2,874	4,407	0	179	0
Southeast:														
120 +	167	3	0	42	74	23	10	15	1	0	0	0	0	0
85 to 119	879	4	0	190	267	86	138	172	19	2	0	0	0	0
50 to 84	2,500	6	0	567	520	215	487	687	19	0	0	0	0	0
20 to 49	1,353	8	0	353	215	298	240	233	1	2	0	2	0	0
Other forest	4	0	0	0	0	0	4	0	0	0	0	0	0	0
Reserved	2,436	87	17	306	266	202	775	778	0	4	0	0	0	0
Total	7,340	108	17	1,460	1,342	824	1,654	1,884	40	10	0	2	0	0
South Central:														
120 +	1,386	4	0	22	288	175	261	538	90	0	0	0	8	0
85 to 119	1,571	1	0	26	269	197	436	554	62	0	0	0	27	0
50 to 84	1,495	0	0	82	110	203	696	345	53	0	0	0	5	0
20 to 49	630	0	0	9	44	93	364	107	3	9	0	0	0	0
Other forest	58	0	0	0	13	0	41	0	4	0	0	0	0	0
Reserved	920	12	0	9	131	75	632	34	3	24	0	0	1	0
Total	6,060	17	0	149	855	743	2,431	1,578	214	33	0	0	41	0
East total:														
120 +	2,444	199	196	64	375	216	368	555	191	131	138	0	10	0
85 to 119	5,915	455	304	217	567	315	1,086	739	305	567	1,322	0	38	0
50 to 84	11,546	596	680	649	669	506	2,949	1,057	416	1,884	2,113	0	27	0
20 to 49	12,784	745	2,249	363	558	576	3,570	391	893	2,513	859	2	66	0
Other forest	1,084	10	641	0	71	1	110	33	86	45	31	0	57	0
Reserved	9,600	494	655	315	484	412	3,161	836	278	2,593	344	0	27	0
Total	43,373	2,498	4,725	1,608	2,723	2,027	11,244	3,610	2,169	7,733	4,808	2	226	0

Table 6—(continued).

Subregion and productivity class[a]	All forest types	Forest type group												
		White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked	Un-known[b]
							Thousand acres							
							Forest industry							
Northeast:														
120 +	220	18	39	0	13	12	48	0	12	71	7	0	0	0
85 to 119	1,080	41	362	0	10	12	173	7	6	406	62	0	0	0
50 to 84	3,688	139	1,512	0	43	6	315	2	39	1,280	352	0	0	0
20 to 49	5,868	150	1,409	0	25	52	330	0	23	3,435	431	0	14	0
Other forest	161	0	108	0	0	0	0	0	15	7	11	0	21	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	11,017	349	3,430	0	91	81	866	9	95	5,199	862	0	34	0
North Central:														
120 +	125	15	46	0	0	0	19	0	2	21	24	0	0	0
85 to 119	692	79	103	0	0	2	26	0	17	183	279	0	4	0
50 to 84	1,498	101	150	0	4	14	181	0	45	674	328	0	1	0
20 to 49	1,478	71	409	0	13	16	194	0	136	526	112	0	1	0
Other forest	18	0	11	0	0	0	1	0	1	0	1	0	3	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3,811	265	719	0	17	31	422	0	201	1,403	744	0	9	0
Southeast:														
120 +	526	12	0	46	358	50	25	26	3	0	0	0	7	0
85 to 119	3,428	0	0	659	1,648	297	324	419	65	1	0	0	16	0
50 to 84	8,551	5	0	2,122	3,338	664	838	1,525	58	1	0	0	0	0
20 to 49	1,674	0	0	314	402	202	160	584	13	0	0	0	0	0
Other forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	14,180	16	0	3,140	5,747	1,212	1,347	2,553	139	2	0	0	24	0
South Central:														
120 +	6,746	8	0	218	3,086	924	1,112	1,292	80	0	0	0	24	0
85 to 119	8,584	0	0	361	4,279	1,504	1,494	896	30	0	0	0	20	0
50 to 84	5,722	3	0	271	2,458	1,030	1,389	510	31	7	0	0	24	0
20 to 49	684	0	0	16	178	82	325	71	8	6	0	0	0	0
Other forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	21,735	11	0	866	10,001	3,540	4,319	2,768	149	12	0	0	68	0
East total:														
120 +	7,617	53	84	264	3,458	985	1,204	1,318	96	92	31	0	32	0
85 to 119	13,784	120	465	1,020	5,937	1,815	2,018	1,321	118	590	341	0	40	0
50 to 84	19,458	248	1,662	2,393	5,843	1,714	2,723	2,037	173	1,962	680	0	25	0
20 to 49	9,704	220	1,819	330	618	351	1,009	654	181	3,966	543	0	14	0
Other forest	179	0	119	0	0	0	1	0	16	7	12	0	24	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	50,743	641	4,149	4,006	15,856	4,865	6,955	5,330	583	6,616	1,606	0	135	0

Table 6—(continued).

Subregion and productivity class[a]	All forest types	Forest type group												
		White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked	Un-known[b]
							Thousand acres							
							Nonindustrial private							
Northeast:														
120 +	2,925	274	211	0	54	106	915	29	293	988	48	0	7	0
85 to 119	7,770	946	806	0	124	256	2,953	41	170	1,961	507	0	5	0
50 to 84	16,882	1,876	1,150	0	188	696	5,824	62	348	5,737	1,000	0	0	0
20 to 49	29,854	1,901	1,549	0	438	853	9,809	126	1,144	12,843	1,121	0	70	0
Other forest	1,106	78	136	0	30	49	256	9	244	209	58	0	37	0
Reserved	164	18	7	0	12	7	24	0	11	73	12	0	0	0
Total	58,700	5,093	3,860	0	846	1,967	19,782	267	2,210	21,810	2,744	0	119	0
North Central:														
120 +	3,493	445	207	0	46	80	847	38	572	994	255	0	9	0
85 to 119	11,030	458	351	0	27	76	2,721	57	1,420	3,600	2,278	0	44	0
50 to 84	21,162	435	623	0	42	270	9,329	25	1,775	5,610	3,010	0	44	0
20 to 49	18,403	317	1,466	0	355	498	8,119	138	2,311	4,153	949	0	97	0
Other forest	599	12	87	0	12	76	231	0	50	50	23	0	58	0
Reserved	102	22	7	0	0	2	20	0	10	25	15	0	0	0
Total	54,789	1,689	2,741	0	481	1,003	21,267	258	6,137	14,433	6,530	0	251	0
Southeast:														
120 +	2,781	252	0	116	1,089	454	601	258	11	0	0	0	0	0
85 to 119	15,069	47	0	1,119	4,358	2,057	5,208	1,912	274	83	0	0	12	0
50 to 84	35,307	100	0	3,451	8,470	4,853	12,843	5,110	308	155	0	0	17	0
20 to 49	7,827	10	5	818	1,286	1,293	3,027	1,312	61	15	0	0	0	0
Other forest	588	0	0	105	18	34	19	410	0	0	0	0	0	0
Reserved	45	0	0	0	0	0	1	44	0	0	0	0	0	0
Total	61,618	409	5	5,610	15,221	8,691	21,700	9,047	654	253	0	0	29	0
South Central:														
120 +	20,374	31	0	274	5,569	3,316	6,319	4,284	479	65	0	0	39	0
85 to 119	26,071	18	0	544	6,108	4,281	10,524	4,022	397	97	0	0	80	0
50 to 84	25,354	17	0	641	3,083	3,663	14,221	3,128	314	166	0	0	121	0
20 to 49	12,747	10	0	133	746	1,358	9,126	715	321	311	0	0	27	0
Other forest	6,765	0	0	45	67	472	4,334	143	17	0	0	1,672	12	0
Reserved	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	91,311	75	0	1,639	15,572	13,090	44,523	12,292	1,528	639	0	1,672	280	0
East total:														
120 +	29,574	1,002	419	390	6,758	3,955	8,682	4,610	1,354	2,047	303	0	55	0
85 to 119	59,940	1,468	1,157	1,663	10,617	6,671	21,406	6,031	2,261	5,740	2,785	0	141	0
50 to 84	98,705	2,427	1,773	4,093	11,783	9,482	42,217	8,325	2,745	11,668	4,010	0	182	0
20 to 49	68,831	2,238	3,020	952	2,824	4,001	30,081	2,292	3,836	17,322	2,069	0	195	0
Other forest	9,058	90	223	151	127	632	4,841	562	311	259	81	1,672	108	0
Reserved	311	40	14	0	12	9	45	44	21	98	27	0	0	0
Total	266,419	7,266	6,606	7,248	32,121	24,750	107,272	21,864	10,529	37,134	9,275	1,672	680	0

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[a] Productivity classes are displayed as cubic feet per acre per year.

[b] Poorly stocked reserved and other forest lands have insufficient data to determine a forest type.

Note: Data may not add to totals because of rounding.

Table 7—Forest land area in the Eastern and Western United States by rural-urban continuum class and forest type group, 2002

		Predominant county population continuum class				
Forest type group	Total	Major metro	Intermediate-small metro	Large town	Small town	Rural
			Thousand acres			
East:						
White-red-jack pine	11,754	1,712	2,443	531	4,894	2,175
Spruce-fir	17,183	221	2,202	2,364	9,715	2,682
Longleaf-slash pine	13,866	2,915	1,519	386	6,259	2,785
Loblolly-shortleaf pine	54,047	9,055	5,835	1,879	26,082	11,196
Oak-pine	33,916	6,534	3,801	1,102	15,274	7,204
Oak-hickory	133,151	26,320	15,941	3,213	56,882	30,795
Oak-gum-cypress	31,375	6,339	4,377	974	14,435	5,250
Elm-ash-cottonwood	13,578	3,381	2,002	567	5,692	1,935
Maple-beech-birch	54,843	8,721	8,026	4,187	25,247	8,662
Aspen-birch	17,826	580	2,792	1,011	8,853	4,589
Other forest types	1,676	647	74	9	511	434
Nonstocked	1,072	176	196	37	466	197
East total:	384,288	66,603	49,209	16,261	174,309	77,905
West:						
Douglas-fir	39,599	4,542	6,520	4,168	15,308	9,062
Ponderosa pine	31,469	2,416	3,304	5,109	13,309	7,331
Western white pine	365	51	43	4	245	23
Fir-spruce	72,841	1,627	2,199	3,005	14,393	51,616
Hemlock-Sitka spruce	19,377	1,570	1,909	1,439	6,185	8,275
Larch	1,349	4	42	314	665	325
Lodgepole pine	18,759	585	756	2,864	9,897	4,657
Redwood	921	221	287	349	63	0
Other softwoods	72,633	1,576	1,437	861	6,486	62,272
Western hardwoods	49,756	12,324	6,119	4,045	13,632	13,636
Pinyon-juniper	51,739	5,118	4,362	9,718	23,201	9,340
Nonstocked	5,825	1,082	915	956	2,098	773
West total:	364,635	31,117	27,894	32,831	105,482	167,310
United States:	748,922	97,720	77,103	49,092	279,791	245,216

Note: Data may not add to totals because of rounding.

Table 8—Area of planted and natural forest land in the Eastern and Western United States by forest type group and major ownership group, 2002

	All owners			National forest			Other public		
Forest type group[a]	Total	Planted	Natural	Total	Planted	Natural	Total	Planted	Natural
				Thousand acres					
North:									
White-red-jack pine	10,941	2,663	8,278	1,173	543	630	2,373	675	1,698
Spruce-fir	17,140	460	16,679	1,682	67	1,614	4,708	108	4,600
Longleaf-slash pine	0	0	0	0	0	0	0	0	0
Loblolly-shortleaf pine	2,179	273	1,906	217	61	156	526	27	499
Oak-pine	3,776	228	3,547	234	38	196	460	33	426
Oak-hickory	51,931	283	51,648	2,435	18	2,418	7,159	45	7,114
Oak-gum-cypress	686	7	679	3	3	0	148	2	146
Elm-ash-cottonwood	10,851	85	10,766	293	0	293	1,915	15	1,901
Maple-beech-birch	53,725	252	53,473	3,189	19	3,170	7,691	43	7,648
Aspen-birch	17,826	60	17,766	2,137	2	2,134	4,808	3	4,805
Other forest types	0	0	0	0	0	0	0	0	0
Nonstocked	630	13	617	32	0	32	185	1	183
North total:	169,685	4,326	165,359	11,395	752	10,643	29,973	953	29,021
South:									
White-red-jack pine	813	98	715	177	2	175	125	2	123
Spruce-fir	44	0	44	22	0	22	17	0	17
Longleaf-slash pine	13,866	7,683	6,183	1,003	266	736	1,608	367	1,241
Loblolly-shortleaf pine	51,868	23,928	27,940	3,129	731	2,398	2,197	378	1,819
Oak-pine	30,140	4,242	25,898	2,041	179	1,862	1,567	74	1,493
Oak-hickory	81,220	1,369	79,851	5,245	95	5,150	4,085	35	4,049
Oak-gum-cypress	30,690	170	30,519	568	0	568	3,462	14	3,448
Elm-ash-cottonwood	2,727	63	2,664	3	0	3	254	0	254
Maple-beech-birch	1,118	8	1,110	170	0	170	42	0	42
Aspen-birch	0	0	0	0	0	0	0	0	0
Other forest types	1,675	0	1,675	0	0	0	2	0	2
Nonstocked	442	40	402	0	0	0	41	8	33
South total:	214,603	37,602	177,001	12,358	1,274	11,084	13,400	878	12,522
West[c]:									
Douglas-fir	39,599	7,402[c]	32,197	20,234	[c]	[c]	6,437	[c]	[c]
Ponderosa pine	31,469	2,328[c]	29,141	14,276	[c]	[c]	3,035	[c]	[c]
Western white pine	365	45[c]	320	313	[c]	[c]	9	[c]	[c]
Fir-spruce	72,841	1,216[c]	71,625	23,579	[c]	[c]	22,220	[c]	[c]
Hemlock-Sitka spruce	19,377	194[c]	19,183	12,353	[c]	[c]	3,051	[c]	[c]
Larch	1,349	859[c]	490	799	[c]	[c]	169	[c]	[c]
Lodgepole pine	18,759	988[c]	17,771	13,881	[c]	[c]	2,996	[c]	[c]
Redwood	921	0[c]	921	11	[c]	[c]	253	[c]	[c]
Other softwoods	72,633	195[c]	72,438	9,801	[c]	[c]	52,316	[c]	[c]
Western hardwoods	49,756	397[c]	49,359	12,546	[c]	[c]	13,402	[c]	[c]
Pinyon-juniper	51,739	0[c]	51,739	13,619	[c]	[c]	22,647	[c]	[c]
Nonstocked	5,825	0[c]	5,825	3,290	[c]	[c]	800	[c]	[c]
West total:	364,635	13,624[c]	351,011	124,701	[c]	[c]	127,334	[c]	[c]
United States:	748,922	55,551[c]	693,371	148,454	[c]	[c]	170,707	[c]	[c]

Table 8—(continued).

Forest type group[a]	Forest industry			Nonindustrial private[b]		
	Total	Planted	Natural	Total	Planted	Natural
	Thousand acres					
North:						
White-red-jack pine	613	210	403	6,782	1,235	5,547
Spruce-fir	4,149	85	4,064	6,601	200	6,401
Longleaf-slash pine	0	0	0	0	0	0
Loblolly-shortleaf pine	108	37	71	1,327	148	1,179
Oak-pine	113	10	102	2,970	146	2,823
Oak-hickory	1,288	25	1,263	41,049	196	40,853
Oak-gum-cypress	9	0	9	525	2	524
Elm-ash-cottonwood	296	0	296	8,347	70	8,277
Maple-beech-birch	6,602	32	6,570	36,243	158	36,085
Aspen-birch	1,606	8	1,598	9,275	46	9,229
Other forest types	0	0	0	0	0	0
Nonstocked	43	3	40	371	9	362
North total:	14,827	410	14,417	113,489	2,211	111,278
South:						
White-red-jack pine	27	12	16	483	82	401
Spruce-fir	0	0	0	5	0	5
Longleaf-slash pine	4,006	3,362	645	7,248	3,688	3,560
Loblolly-shortleaf pine	15,748	11,380	4,368	30,794	11,438	19,356
Oak-pine	4,752	1,770	2,982	21,781	2,219	19,561
Oak-hickory	5,667	536	5,131	66,224	703	65,520
Oak-gum-cypress	5,321	60	5,262	21,339	97	21,242
Elm-ash-cottonwood	288	24	264	2,182	39	2,143
Maple-beech-birch	14	0	14	892	8	884
Aspen-birch	0	0	0	0	0	0
Other forest types	0	0	0	1,674	0	1,674
Nonstocked	92	12	80	309	20	289
South total:	35,916	17,155	18,761	152,929	18,295	134,634
West[c]:						
Douglas-fir	5,962	[c]	[c]	6,967	[c]	[c]
Ponderosa pine	2,559	[c]	[c]	11,598	[c]	[c]
Western white pine	15	[c]	[c]	29	[c]	[c]
Fir-spruce	1,534	[c]	[c]	25,509	[c]	[c]
Hemlock-Sitka spruce	1,832	[c]	[c]	2,141	[c]	[c]
Larch	166	[c]	[c]	216	[c]	[c]
Lodgepole pine	560	[c]	[c]	1,322	[c]	[c]
Redwood	394	[c]	[c]	263	[c]	[c]
Other softwoods	29	[c]	[c]	10,487	[c]	[c]
Western hardwoods	2,069	[c]	[c]	21,739	[c]	[c]
Pinyon-juniper	179	[c]	[c]	15,294	[c]	[c]
Chaparral	0	[c]	[c]	0	[c]	[c]
Nonstocked	337	[c]	[c]	1,398	[c]	[c]
West total:	15,637	[c]	[c]	96,962	[c]	[c]
United States:	66,380	[c]	[c]	363,381	[c]	[c]

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[a] Forest type reflects the current dominant species by plurality of stocking and may not reflect the actual species planted at the time of stand origin.

[b] Per the Alaska Natives Claims Settlement Act of 1971, approximately 35 million forested acres expected upon update of all ownership data for Alaska.

[c] Approximately 13.6 million acres of forest in the West are planted, primarily to augment natural regeneration after a harvest and ensure adequate stocking of desired species. The species planted are usually native, making these stands difficult to detect during field sampling. Additionally, there are thousands of acres of more traditional "plantations" such as those found in the East that are not currently identified during field sampling.

Note: Data may not add to totals because of rounding.

Table 9—Forest land area in the United States by average d.b.h. class and forest type group, 2002

Forest type group	Total	Average d.b.h. class (inches) 1.0-4.9	5.0-9.9	10.0+	Un-determined[a]
		Thousand acres			
East:					
White-red-jack pine	11,754	1,525	2,717	7,214	298
Spruce-fir	17,183	6,054	6,140	4,543	447
Longleaf-slash pine	13,866	5,028	4,098	4,370	369
Loblolly-shortleaf pine	54,047	17,811	15,953	20,032	252
Oak-pine	33,916	12,371	8,019	12,866	661
Oak-hickory	133,151	29,080	34,875	65,036	4,160
Oak-gum-cypress	31,375	6,182	6,187	17,825	1,181
Elm-ash-cottonwood	13,578	3,329	3,874	6,353	22
Maple-beech-birch	54,843	8,509	17,154	27,475	1,705
Aspen-birch	17,826	6,689	7,039	4,088	10
Other forest types	1,674	0	2	0	1,672
Nonstocked	1,072	1,043	6	19	4
East total:	384,286	97,621	106,064	169,822	10,780
West:					
Douglas-fir	39,599	6,632	3,761	27,432	1,775
Ponderosa pine	31,469	3,861	2,565	22,171	2,871
Western white pine	365	137	57	169	3
Fir-spruce	72,841	15,964	5,595	23,620	27,662
Hemlock-Sitka spruce	19,377	2,340	877	10,707	5,454
Larch	1,349	246	253	742	108
Lodgepole pine	18,759	3,133	5,197	6,718	3,712
Redwood	921	34	41	672	174
Other softwoods	72,633	2,827	1,212	9,027	59,567
Western hardwoods	49,756	10,043	13,265	11,316	15,132
Pinyon-juniper	51,739	4,296	17,178	26,210	4,056
Nonstocked	5,825	5,504	8	0	313
West total:	364,635	55,016	50,007	138,784	120,828
United States:	748,920	152,637	156,071	308,605	131,607

[a] Undetermined stands are predominantly in reserved and low productivity forests that currently do not have field data to establish average d.b.h.

Note: Data may not add to totals because of rounding.

Table 10—Timberland area in the United States by ownership, region, subregion, and State, 2002, 1997, 1987, 1977, and 1953

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All owner-ships	Total public	Total Federal	National forest	Bureau of Land Manage-ment	Other	State	County and muni-cipal	Total private	Forest industry	Non-industrial private
							Thousand acres					
North:												
Northeast:												
Connecticut	2002	1,696	280	7	0	0	7	166	107	1,416	0	1,416
	1997	1,815	249	10	0	0	10	163	77	1,565	0	1,565
	1987	1,776	246	16	0	0	16	156	74	1,530	0	1,530
	1977	1,806	147	2	0	0	2	120	24	1,659	0	1,659
	1953	1,973	155	1	0	0	1	122	32	1,818	3	1,815
Delaware	2002	376	25	0	0	0	0	25	0	351	26	325
	1997	376	13	0	0	0	0	13	0	363	31	332
	1987	388	14	0	0	0	0	14	0	374	30	344
	1977	384	14	1	0	0	1	13	0	370	30	341
	1953	392	13	1	0	0	1	10	2	379	21	358
Maine	2002	16,952	631	53	34	0	20	469	109	16,321	7,298	9,022
	1997	16,952	629	51	32	0	20	469	109	16,323	7,298	9,024
	1987	17,174	495	76	46	0	30	331	88	16,679	8,286	8,393
	1977	16,864	541	73	38	0	36	354	114	16,323	8,083	8,240
	1953	16,609	182	90	39	0	51	41	51	16,427	6,617	9,810
Maryland	2002	2,372	422	26	0	0	26	310	86	1,950	88	1,862
	1997	2,423	281	22	0	0	22	236	23	2,143	137	2,006
	1987	2,462	280	22	0	0	22	236	22	2,182	133	2,049
	1977	2,523	243	25	0	0	25	185	33	2,280	139	2,141
	1953	2,855	214	54	0	0	54	128	32	2,641	57	2,584
Massachusetts	2002	2,631	554	35	0	0	35	344	175	2,077	14	2,063
	1997	2,965	480	48	0	0	48	275	157	2,486	71	2,415
	1987	3,010	474	40	0	0	40	292	142	2,536	81	2,455
	1977	2,798	365	10	0	0	10	240	116	2,432	30	2,402
	1953	3,259	399	29	0	0	29	280	90	2,860	259	2,601
New Hampshire	2002	4,503	881	542	520	0	22	215	123	3,622	458	3,164
	1997	4,551	793	440	417	0	22	228	125	3,758	513	3,246
	1987	4,803	788	536	506	0	30	133	119	4,015	662	3,353
	1977	4,692	580	472	459	0	13	79	29	4,112	947	3,165
	1953	4,819	682	585	580	0	5	45	52	4,137	771	3,366
New Jersey	2002	1,876	588	54	0	0	54	475	59	1,288	0	1,288
	1997	1,864	500	49	0	0	49	351	100	1,364	0	1,364
	1987	1,914	533	246	0	0	246	224	63	1,381	0	1,381
	1977	1,857	319	28	0	0	28	246	45	1,538	16	1,522
	1953	2,050	181	1	0	0	1	130	50	1,869	4	1,865
New York	2002	15,389	1,148	82	5	0	77	851	214	14,241	1,219	13,022
	1997	15,406	1,154	86	9	0	77	852	215	14,252	1,220	13,032
	1987	15,798	1,215	123	6	0	117	899	193	14,583	1,116	13,467
	1977	15,405	979	95	6	0	89	721	163	14,426	1,034	13,392
	1953	11,952	895	98	0	0	98	714	83	11,057	1,172	9,885
Pennsylvania	2002	15,853	3,519	498	446	0	51	2,788	233	12,334	613	11,721
	1997	15,853	3,519	498	446	0	51	2,788	233	12,334	613	11,721
	1987	15,918	3,487	543	478	0	65	2,731	213	12,431	879	11,552
	1977	15,924	3,471	503	485	0	18	2,796	173	12,453	964	11,489
	1953	14,574	3,229	492	454	0	38	2,580	157	11,345	442	10,903

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All owner-ships	Total public	Total Federal	National forest	Bureau of Land Manage-ment	Other	State	County and muni-cipal	Total private	Forest industry	Non-industrial private
						Thousand acres						
Rhode Island	2002	340	81	3	0	0	3	67	10	259	0	259
	1997	356	69	5	0	0	5	64	0	287	0	287
	1987	368	78	3	0	0	3	68	7	290	0	290
	1977	395	32	0	0	0	0	20	12	363	0	363
	1953	430	26	0	0	0	0	13	13	404	0	404
Vermont	2002	4,482	633	286	255	0	32	275	72	3,850	253	3,597
	1997	4,461	593	251	221	0	31	271	70	3,868	227	3,642
	1987	4,424	660	251	251	0	0	330	79	3,764	352	3,412
	1977	4,430	422	213	209	0	4	168	41	4,008	666	3,342
	1953	3,846	297	199	191	0	8	79	19	3,549	528	3,021
West Virginia	2002	11,900	1,324	1,033	904	0	128	253	38	10,576	887	9,689
	1997	11,900	1,324	1,033	904	0	128	253	38	10,576	887	9,689
	1987	11,799	1,320	1,070	916	0	154	250	0	10,479	1,036	9,443
	1977	11,484	1,121	892	853	0	39	229	0	10,363	880	9,483
	1953	10,276	982	895	881	0	14	83	4	9,294	270	9,024
Northeast total:	2002	78,371	10,085	2,621	2,164	0	456	6,239	1,225	68,286	10,855	57,430
	1997	78,923	9,603	2,491	2,029	0	462	5,966	1,146	69,320	10,996	58,324
	1987	79,834	9,590	2,926	2,203	0	723	5,665	1,000	70,244	12,575	57,669
	1977	78,561	8,233	2,312	2,049	0	263	5,171	750	70,328	12,789	57,539
	1953	73,035	7,255	2,445	2,145	0	300	4,225	585	65,780	10,144	55,636
North Central:												
Illinois	2002	4,087	440	312	249	0	64	82	46	3,647	11	3,635
	1997	4,058	417	321	254	0	66	55	42	3,641	13	3,628
	1987	4,030	389	292	226	0	66	55	42	3,641	13	3,628
	1977	4,033	330	273	211	0	62	22	35	3,703	15	3,688
	1953	3,830	226	216	184	0	32	10	0	3,604	10	3,594
Indiana	2002	4,342	623	373	170	0	203	238	12	3,719	17	3,701
	1997	4,342	624	373	170	0	203	238	13	3,719	17	3,701
	1987	4,296	535	329	166	0	163	177	29	3,761	18	3,743
	1977	3,815	410	239	162	0	77	170	1	3,405	27	3,378
	1953	4,015	283	172	112	0	60	109	2	3,732	9	3,723
Iowa	2002	1,944	156	44	0	0	44	74	38	1,788	0	1,788
	1997	1,944	156	44	0	0	44	74	38	1,788	0	1,788
	1987	1,460	102	43	0	0	43	52	7	1,358	0	1,358
	1977	1,460	111	55	0	0	55	51	5	1,350	17	1,333
	1953	2,595	36	12	3	0	9	22	2	2,559	0	2,559
Michigan	2002	18,616	6,577	2,592	2,542	0	50	3,728	256	12,039	1,514	10,525
	1997	18,667	6,628	2,643	2,593	0	50	3,728	256	12,039	1,514	10,525
	1987	17,364	6,288	2,520	2,475	0	45	3,581	187	11,076	1,966	9,110
	1977	18,199	6,360	2,489	2,435	8	45	3,763	109	11,839	2,137	9,702
	1953	19,121	6,288	2,509	2,410	9	90	3,695	85	12,832	1,548	11,284
Minnesota	2002	14,723	7,584	2,019	1,821	26	172	3,062	2,503	7,139	751	6,388
	1997	14,819	7,680	2,115	1,917	26	172	3,063	2,503	7,139	751	6,388
	1987	13,572	6,814	1,826	1,670	44	112	2,654	2,334	6,758	788	5,970
	1977	13,695	6,862	1,870	1,715	10	145	2,651	2,342	6,834	772	6,062
	1953	16,580	8,407	2,338	2,195	49	94	2,450	3,619	8,173	578	7,595

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All ownerships	Total public	Total Federal	National forest	Bureau of Land Management	Other	State	County and municipal	Total private	Forest industry	Nonindustrial private
						Thousand acres						
Missouri	2002	13,365	2,006	1,561	1,315	0	246	403	42	11,359	222	11,137
	1997	13,411	2,052	1,608	1,361	0	246	403	42	11,359	222	11,137
	1987	11,995	1,657	1,390	1,303	0	87	242	25	10,338	231	10,107
	1977	12,289	1,532	1,313	1,246	0	67	187	32	10,757	362	10,394
	1953	14,300	1,617	1,461	1,339	1	121	156	0	12,683	460	12,223
Ohio	2002	7,568	531	220	216	0	4	227	84	7,036	174	6,862
	1997	7,568	531	220	216	0	4	227	84	7,036	174	6,862
	1987	7,141	423	171	171	0	0	173	79	6,718	186	6,532
	1977	6,916	411	168	159	0	9	202	42	6,505	186	6,319
	1953	5,450	297	88	88	0	0	168	41	5,153	30	5,123
Wisconsin	2002	15,701	4,546	1,520	1,363	0	157	744	2,282	11,155	1,102	10,053
	1997	15,701	4,546	1,520	1,363	0	157	744	2,282	11,155	1,102	10,053
	1987	14,726	4,167	1,419	1,242	0	177	569	2,179	10,559	1,159	9,400
	1977	14,478	4,318	1,383	1,266	0	117	568	2,366	10,161	1,148	9,012
	1953	15,349	4,720	1,624	1,357	5	262	444	2,652	10,629	942	9,687
North Central total:	2002	80,344	22,462	8,641	7,676	26	940	8,557	5,264	57,881	3,793	54,088
	1997	80,510	22,633	8,843	7,874	26	942	8,530	5,260	57,877	3,795	54,082
	1987	74,584	20,375	7,990	7,253	44	693	7,503	4,882	54,209	4,361	49,848
	1977	74,885	20,333	7,790	7,194	18	578	7,613	4,931	54,552	4,664	49,887
	1953	81,240	21,875	8,420	7,688	64	668	7,054	6,401	59,365	3,577	55,788
North total:	2002	158,715	32,547	11,262	9,840	26	1,396	14,796	6,489	126,167	14,649	111,519
	1997	159,433	32,237	11,334	9,904	26	1,404	14,497	6,406	127,197	14,791	112,406
	1987	154,418	29,965	10,916	9,456	44	1,416	13,168	5,882	124,453	16,936	107,517
	1977	153,446	28,566	10,102	9,243	18	841	12,784	5,681	124,880	17,453	107,426
	1953	154,275	29,130	10,865	9,833	64	968	11,279	6,986	125,145	13,721	111,424
South:												
Southeast:												
Florida	2002	14,636	2,817	1,601	1,015	0	586	1,138	78	11,819	4,016	7,803
	1997	14,605	2,786	1,570	984	0	586	1,138	78	11,819	4,016	7,803
	1987	14,983	2,434	1,561	990	0	571	814	59	12,549	4,770	7,779
	1977	15,843	2,151	1,579	1,005	0	574	532	40	13,692	4,658	9,034
	1953	18,135	2,215	1,777	1,035	14	728	382	56	15,920	4,369	11,551
Georgia	2002	23,802	1,757	1,386	703	0	683	260	111	22,045	4,381	17,664
	1997	23,796	1,751	1,380	711	0	669	260	111	22,045	4,381	17,664
	1987	23,660	1,609	1,421	790	0	631	118	70	22,051	4,983	17,068
	1977	24,106	1,589	1,453	813	0	640	100	36	22,517	4,629	17,888
	1953	23,969	1,685	1,560	644	0	916	102	23	22,284	4,246	18,038
North Carolina	2002	18,664	1,904	1,473	1,036	0	437	346	84	16,760	2,252	14,508
	1997	18,639	1,878	1,448	1,011	0	437	346	84	16,760	2,252	14,508
	1987	18,749	1,861	1,440	1,025	0	415	339	82	16,888	2,337	14,551
	1977	19,435	1,717	1,319	1,029	0	290	320	78	17,718	2,140	15,578
	1953	19,582	1,540	1,251	1,020	0	232	253	36	18,043	2,584	15,459
South Carolina	2002	12,301	1,224	880	564	0	316	280	64	11,076	1,994	9,082
	1997	12,419	1,078	867	524	0	343	177	33	11,341	2,322	9,019
	1987	12,179	1,173	913	577	0	336	233	27	11,006	2,626	8,380
	1977	12,496	1,085	895	573	0	322	167	23	11,411	2,215	9,196
	1953	11,884	955	802	563	0	239	128	25	10,929	1,650	9,279

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All ownerships	Total public	Total Federal	National forest	Bureau of Land Management	Other	State	County and municipal	Total private	Forest industry	Nonindustrial private
						Thousand acres						
Virginia	2002	15,371	1,906	1,612	1,392	0	221	211	83	13,465	1,537	11,927
	1997	15,345	1,880	1,586	1,365	0	221	211	83	13,465	1,537	11,927
	1987	15,570	1,993	1,707	1,486	0	221	209	77	13,577	1,834	11,743
	1977	15,939	1,921	1,669	1,424	0	245	183	69	14,018	1,670	12,348
	1953	15,497	1,493	1,355	1,198	0	157	86	52	14,004	1,095	12,909
Southeast total:	2002	84,774	9,609	6,953	4,710	0	2,244	2,236	419	75,165	14,180	60,985
	1997	84,803	9,373	6,851	4,594	0	2,257	2,133	389	75,430	14,508	60,922
	1987	85,141	9,070	7,042	4,868	0	2,174	1,713	315	76,071	16,550	59,521
	1977	87,818	8,462	6,914	4,843	0	2,071	1,303	246	79,356	15,312	64,044
	1953	89,067	7,887	6,745	4,459	14	2,272	951	192	81,180	13,944	67,236
South Central:												
Alabama	2002	22,922	1,226	863	601	0	263	241	122	21,696	3,740	17,956
	1997	21,911	1,130	823	573	0	250	212	95	20,781	4,796	15,985
	1987	21,659	1,161	951	689	5	257	147	63	20,498	4,464	16,034
	1977	21,498	1,091	860	659	0	201	172	59	20,407	4,330	16,077
	1953	20,756	968	791	616	10	165	150	27	19,788	3,138	16,650
Arkansas	2002	18,373	3,277	2,816	2,353	0	463	394	67	15,096	4,497	10,599
	1997	18,392	3,275	2,813	2,350	0	463	394	67	15,118	4,498	10,620
	1987	16,673	3,011	2,659	2,329	0	330	311	41	13,662	4,240	9,422
	1977	16,793	2,918	2,658	2,350	1	307	240	20	13,875	4,156	9,719
	1953	19,627	2,916	2,799	2,292	122	385	115	2	16,711	4,157	12,554
Kentucky	2002	12,347	1,004	863	628	0	235	141	0	11,344	205	11,139
	1997	12,347	1,004	863	628	0	235	141	0	11,344	205	11,139
	1987	11,909	890	856	583	0	273	34	0	11,019	205	10,814
	1977	11,902	895	819	589	0	230	76	1	11,007	255	10,752
	1953	11,497	725	672	455	0	217	53	0	10,772	308	10,464
Louisiana	2002	13,722	1,245	737	507	0	230	300	207	12,477	3,898	8,578
	1997	13,693	1,214	707	477	0	230	300	207	12,479	3,899	8,579
	1987	13,872	1,331	833	621	0	212	330	168	12,541	3,603	8,938
	1977	14,292	1,024	715	581	1	133	299	10	13,268	3,773	9,495
	1953	16,039	848	666	535	4	127	177	5	15,191	3,166	12,025
Mississippi	2002	18,572	1,935	1,525	1,091	0	435	310	100	16,636	3,238	13,399
	1997	18,587	1,936	1,526	1,091	0	435	311	100	16,651	3,241	13,411
	1987	16,674	1,720	1,488	1,240	0	248	100	132	14,954	2,864	12,090
	1977	16,504	1,663	1,202	1,121	1	80	95	366	14,841	2,995	11,846
	1953	16,853	1,709	1,235	1,036	4	195	54	420	15,144	2,461	12,683
Oklahoma	2002	6,234	582	443	223	0	220	118	21	5,651	1,047	4,604
	1997	6,234	574	435	214	0	221	118	21	5,659	1,049	4,610
	1987	6,087	586	464	243	0	221	115	7	5,501	1,046	4,455
	1977	5,536	448	342	219	0	123	91	15	5,088	1,009	4,079
	1953	5,075	494	309	213	7	89	185	0	4,581	889	3,692
Tennessee	2002	13,956	1,565	978	557	0	422	519	69	12,390	1,391	11,000
	1997	13,265	1,509	1,027	556	0	471	422	59	11,757	1,122	10,635
	1987	12,840	1,360	958	581	6	371	373	29	11,480	1,220	10,260
	1977	12,862	1,161	856	558	0	298	283	22	11,701	1,212	10,489
	1953	12,551	1,114	806	564	0	242	298	10	11,437	713	10,724

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All owner-ships	Total public	Total Federal	National forest	Bureau of Land Manage-ment	Other	State	County and muni-cipal	Total private	Forest industry	Non-industrial private
						Thousand acres						
Texas	2002	11,774	783	669	577	0	92	68	47	10,990	3,720	7,271
	1997	11,766	776	661	569	0	92	68	47	10,990	3,720	7,271
	1987	12,414	795	708	610	0	98	75	12	11,619	3,796	7,823
	1977	12,426	773	717	576	0	141	49	7	11,653	3,818	7,835
	1953	13,081	782	745	654	0	91	35	2	12,299	3,019	9,280
South Central total:	2002	117,899	11,618	8,895	6,536	0	2,359	2,090	633	106,281	21,735	84,546
	1997	116,196	11,417	8,855	6,457	0	2,397	1,966	597	104,778	22,529	82,249
	1987	112,128	10,854	8,917	6,896	11	2,010	1,485	452	101,274	21,438	79,836
	1977	111,812	9,973	8,169	6,653	3	1,513	1,305	500	101,839	21,548	80,291
	1953	115,479	9,556	8,023	6,365	147	1,511	1,067	466	105,923	17,851	88,072
South total:	2002	202,673	21,226	15,848	11,245	0	4,603	4,326	1,052	181,447	35,916	145,531
	1997	200,999	20,791	15,706	11,052	0	4,654	4,099	986	180,208	37,037	143,171
	1987	197,269	19,924	15,959	11,764	11	4,184	3,198	767	177,345	37,988	139,357
	1977	199,630	18,435	15,083	11,496	3	3,584	2,608	746	181,195	36,860	144,335
	1953	204,546	17,443	14,768	10,824	161	3,783	2,018	658	187,103	31,795	155,308
Rocky Mountain:												
Great Plains:												
Kansas	2002	1,491	92	53	0	0	53	32	8	1,399	0	1,399
	1997	1,491	92	53	0	0	53	32	8	1,399	0	1,399
	1987	1,207	46	37	0	0	37	7	2	1,161	0	1,161
	1977	1,187	37	27	0	0	27	8	2	1,151	0	1,151
	1953	1,208	27	27	0	0	27	0	0	1,181	0	1,181
Nebraska	2002	898	108	48	47	0	2	50	10	790	0	790
	1997	898	108	48	47	0	2	50	10	790	0	790
	1987	537	55	29	29	0	0	22	4	482	0	482
	1977	593	54	43	29	0	14	10	1	539	0	539
	1953	734	56	45	28	0	17	11	1	678	0	678
North Dakota	2002	441	54	28	14	0	14	26	0	387	0	387
	1997	442	55	28	14	0	14	26	0	387	0	387
	1987	338	36	12	0	0	12	22	2	302	0	302
	1977	405	63	53	0	0	53	10	0	342	0	342
	1953	451	68	57	0	1	57	11	0	383	0	383
South Dakota	2002	1,511	1,023	967	960	0	8	54	1	488	0	488
	1997	1,487	1,001	946	938	0	8	54	1	485	0	485
	1987	1,447	1,005	915	914	0	1	87	3	442	21	421
	1977	1,467	1,038	965	953	6	6	70	3	429	16	413
	1953	1,621	1,037	970	951	7	11	67	0	585	17	568
Great Plains total:	2002	4,341	1,277	1,097	1,020	0	76	162	18	3,064	0	3,064
	1997	4,317	1,256	1,076	999	0	76	162	18	3,062	0	3,062
	1987	3,529	1,142	993	943	0	50	138	11	2,387	21	2,366
	1977	3,652	1,190	1,087	982	6	99	98	5	2,462	16	2,446
	1953	4,014	1,188	1,099	979	8	112	88	1	2,827	17	2,809
Intermountain:												
Arizona	2002	3,527	2,450	2,438	2,405	0	33	12	0	1,077	0	1,077
	1997	4,073	2,775	2,763	2,720	20	23	12	0	1,297	0	1,297
	1987	3,789	2,527	2,515	2,471	20	24	12	0	1,262	0	1,262
	1977	3,896	2,513	2,480	2,462	18	0	32	2	1,382	0	1,382
	1953	3,621	2,304	2,271	2,269	2	0	32	2	1,317	0	1,317

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All ownerships	Total public	Total Federal	National forest	Bureau of Land Management	Other	State	County and municipal	Total private	Forest industry	Nonindustrial private
						Thousand acres						
Colorado	2002	11,607	8,383	8,020	6,937	1,069	14	311	52	3,224	0	3,224
	1997	11,555	8,331	7,968	6,885	1,069	14	311	52	3,224	0	3,224
	1987	11,740	8,464	8,144	7,062	1,074	8	274	46	3,276	0	3,276
	1977	11,315	8,166	7,933	7,506	422	5	189	45	3,148	15	3,134
	1953	12,283	9,038	8,802	8,382	416	5	190	45	3,245	15	3,231
Idaho	2002	16,824	13,602	12,596	12,055	512	29	980	25	3,222	1,284	1,938
	1997	17,123	13,901	12,896	12,354	512	29	980	25	3,222	1,284	1,938
	1987	14,534	11,397	10,310	9,705	558	47	1,036	51	3,137	1,198	1,939
	1977	13,541	10,450	9,570	9,153	409	8	861	19	3,091	947	2,144
	1953	15,540	12,445	11,558	11,046	505	8	867	19	3,095	954	2,142
Montana	2002	19,185	13,228	12,506	11,623	783	100	715	7	5,957	1,618	4,339
	1997	19,164	13,207	12,485	11,602	783	100	715	7	5,957	1,618	4,340
	1987	14,737	9,382	8,742	8,300	431	11	638	2	5,355	1,703	3,652
	1977	14,359	9,169	8,635	8,162	420	53	530	5	5,190	1,055	4,135
	1953	16,753	11,529	10,992	10,456	482	54	533	5	5,224	1,063	4,161
Nevada	2002	363	281	265	251	5	8	16	0	82	25	57
	1997	169	86	70	57	5	8	16	0	82	25	57
	1987	221	109	106	99	6	1	3	0	112	0	112
	1977	134	66	61	61	0	0	3	1	69	8	60
	1953	142	73	68	68	0	0	3	1	69	8	61
New Mexico	2002	4,359	2,948	2,829	2,802	27	0	119	0	1,411	0	1,411
	1997	4,833	2,875	2,778	2,733	44	0	84	13	1,958	0	1,958
	1987	5,180	3,005	2,893	2,863	30	0	112	0	2,175	5	2,170
	1977	5,538	3,037	2,867	2,818	39	9	171	0	2,500	0	2,500
	1953	5,627	3,067	2,895	2,809	77	9	172	0	2,559	138	2,421
Utah	2002	4,683	3,805	3,586	3,248	338	0	212	7	878	0	878
	1997	4,700	3,822	3,603	3,265	338	0	212	7	878	0	878
	1987	3,078	2,481	2,314	2,108	175	31	150	17	597	0	597
	1977	3,405	2,670	2,431	2,277	154	0	239	0	735	0	735
	1953	3,882	3,058	2,817	2,662	155	0	241	0	824	0	824
Wyoming	2002	5,739	4,295	4,093	3,618	474	0	203	0	1,444	0	1,444
	1997	5,085	3,641	3,438	2,964	474	0	203	0	1,444	0	1,444
	1987	4,332	2,888	2,685	2,211	474	0	203	0	1,444	37	1,407
	1977	4,334	3,355	3,245	3,045	200	0	111	0	979	54	925
	1953	4,738	3,752	3,641	3,244	397	0	112	0	986	55	932
Intermountain total:	2002	66,287	48,991	46,332	42,939	3,208	185	2,569	90	17,296	2,926	14,370
	1997	66,701	48,638	46,001	42,580	3,245	175	2,534	103	18,063	2,926	15,137
	1987	57,611	40,253	37,709	34,819	2,768	122	2,428	116	17,358	2,943	14,415
	1977	56,521	39,427	37,220	35,483	1,663	74	2,136	71	17,094	2,079	15,014
	1953	62,585	45,267	43,044	40,935	2,033	75	2,152	72	17,318	2,233	15,086
Rocky Mountain total:	2002	70,628	50,268	47,428	43,959	3,208	261	2,730	109	20,360	2,926	17,434
	1997	71,018	49,893	47,076	43,579	3,246	252	2,696	121	21,125	2,926	18,199
	1987	61,140	41,395	38,702	35,762	2,768	172	2,566	127	19,745	2,964	16,781
	1977	60,173	40,617	38,307	36,465	1,669	173	2,234	76	19,556	2,095	17,460
	1953	66,599	46,455	44,143	41,914	2,041	187	2,240	73	20,145	2,250	17,895

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All owner-ships	Total public	Total Federal	National forest	Bureau of Land Manage-ment	Other	State	County and muni-cipal	Total private	Forest industry	Non-industrial private
						Thousand acres						
Pacific Coast:												
Alaska:												
Alaska	2002	11,865	9,094	4,750	3,772	805	173	4,282	62	2,771	0	2,771
	1997	12,395	8,605	4,306	3,780	407	119	4,279	20	3,790	0	3,790
	1987	15,763	9,578	4,936	4,476	336	124	4,622	20	6,185	0	6,185
	1977	19,722	19,164	15,751	6,529	9,096	126	3,396	17	558	0	558
	1953	20,342	20,086	20,007	6,873	13,008	126	75	4	257	0	257
Alaska total:	2002	11,865	9,094	4,750	3,772	805	173	4,282	62	2,771	0	2,771
	1997	12,395	8,605	4,306	3,780	407	119	4,279	20	3,790	0	3,790
	1987	15,763	9,578	4,936	4,476	336	124	4,622	20	6,185	0	6,185
	1977	19,722	19,164	15,751	6,529	9,096	126	3,396	17	558	0	558
	1953	20,342	20,086	20,007	6,873	13,008	126	75	4	257	0	257
Pacific Northwest:												
Oregon	2002	23,831	15,125	14,194	11,978	2,213	3	811	120	8,706	5,022	3,684
	1997	23,749	15,123	14,217	11,999	2,213	6	815	91	8,626	5,012	3,613
	1987	22,801	14,107	13,178	10,868	2,304	6	827	102	8,694	5,114	3,580
	1977	24,211	14,743	13,817	11,633	2,178	6	820	106	9,468	5,522	3,946
	1953	25,688	14,706	13,654	11,296	2,350	8	797	255	10,982	4,661	6,321
Washington	2002	17,347	8,379	6,104	5,933	36	134	2,076	200	8,968	4,152	4,816
	1997	17,418	8,464	6,209	6,036	33	139	2,035	220	8,954	4,109	4,845
	1987	17,514	7,941	5,691	5,524	37	130	2,025	225	9,573	4,588	4,985
	1977	17,922	7,648	5,382	5,167	47	168	2,084	182	10,274	4,319	5,955
	1953	19,188	8,191	5,882	5,595	174	113	2,095	214	10,997	4,385	6,612
Pacific Northwest total:	2002	41,178	23,505	20,297	17,911	2,249	138	2,887	320	17,674	9,174	8,500
	1997	41,167	23,587	20,426	18,035	2,246	145	2,850	310	17,580	9,121	8,458
	1987	40,315	22,048	18,869	16,392	2,341	136	2,852	327	18,267	9,702	8,565
	1977	42,133	22,391	19,199	16,800	2,225	174	2,904	288	19,742	9,841	9,901
	1953	44,876	22,897	19,536	16,891	2,524	121	2,892	469	21,979	9,046	12,933
Pacific Southwest:												
California	2002	17,781	10,298	10,130	9,916	204	11	146	22	7,483	2,932	4,551
	1997	17,952	10,516	10,319	10,086	218	15	159	38	7,437	2,982	4,455
	1987	16,712	9,158	9,051	8,742	300	9	95	12	7,554	2,757	4,797
	1977	16,303	8,540	8,434	8,168	226	40	79	27	7,763	2,687	5,076
	1953	17,127	8,931	8,730	8,372	318	40	193	8	8,196	2,167	6,029
Hawaii	2002	700	338	0	0	0	0	336	2	362	0	362
	1997	700	338	0	0	0	0	336	2	362	0	362
	1987	700	338	0	0	0	0	336	2	362	0	362
	1977	948	454	12	0	0	12	442	0	494	0	494
	1953	1,089	496	9	0	0	9	487	0	593	0	593
Pacific Southwest total:	2002	18,481	10,637	10,130	9,916	204	11	483	23	7,845	2,932	4,912
	1997	18,652	10,854	10,319	10,086	218	15	495	40	7,798	2,982	4,816
	1987	17,412	9,496	9,051	8,742	300	9	431	14	7,916	2,757	5,159
	1977	17,251	8,994	8,446	8,168	226	52	521	27	8,257	2,687	5,570
	1953	18,216	9,427	8,739	8,372	318	49	680	8	8,789	2,167	6,622

Table 10—(continued).

			Public							Private[a]		
				Federal								
Region, subregion, and State	Year	All ownerships	Total public	Total Federal	National forest	Bureau of Land Management	Other	State	County and municipal	Total private	Forest industry	Nonindustrial private
						Thousand acres						
Pacific Coast total:	2002	71,524	43,235	35,178	31,599	3,258	322	7,652	405	28,290	12,106	16,183
	1997	72,214	43,046	35,052	31,901	2,871	279	7,624	370	29,168	12,103	17,064
	1987	73,490	41,122	32,856	29,610	2,977	269	7,905	361	32,368	12,459	19,909
	1977	79,106	50,549	43,396	31,497	11,547	352	6,821	332	28,557	12,528	16,029
	1953	83,434	52,140	48,282	32,136	15,850	296	3,647	481	31,025	11,213	19,812
United States:	2002	503,540	147,276	109,717	96,643	6,492	6,582	29,505	8,055	356,264	65,596	290,667
	1997	503,664	145,967	109,168	96,435	6,143	6,590	28,915	7,883	357,698	66,858	290,840
	1987	486,317	132,406	98,433	86,592	5,800	6,041	26,837	7,137	353,911	70,347	283,564
	1977	492,355	138,169	106,887	88,701	13,237	4,949	24,447	6,835	354,186	68,937	285,249
	1953	508,854	145,436	118,056	94,707	18,116	5,234	19,183	8,197	363,419	58,979	304,440

[a] Native American lands have been exclusively in the nonindustrial private owner group since 1997. For 1987 and earlier years, these lands may be included in the other public owner group.

Note: Data may not add to totals because of rounding.

Table 11—Timberland area in the United States by ownership group, region, subregion, and State, 2002

		Ownership group			
Region, subregion, and State	All ownerships	National forest	Other public	Forest industry	Non-industrial private
	Thousand acres				
North:					
Northeast:					
Connecticut	1,696	0	280	0	1,416
Delaware	376	0	25	26	325
Maine	16,952	34	598	7,298	9,022
Maryland	2,372	0	422	88	1,862
Massachusetts	2,631	0	554	14	2,063
New Hampshire	4,503	520	361	458	3,164
New Jersey	1,876	0	588	0	1,288
New York	15,389	5	1,142	1,219	13,022
Pennsylvania	15,853	446	3,072	613	11,721
Rhode Island	340	0	81	0	259
Vermont	4,482	255	378	253	3,597
West Virginia	11,900	904	420	887	9,689
Total	78,370	2,164	7,921	10,856	57,428
North Central:					
Illinois	4,087	249	191	11	3,635
Indiana	4,342	170	453	17	3,701
Iowa	1,944	0	156	0	1,788
Michigan	18,616	2,542	4,034	1,514	10,525
Minnesota	14,723	1,821	5,763	751	6,388
Missouri	13,365	1,315	691	222	11,137
Ohio	7,568	216	316	174	6,862
Wisconsin	15,701	1,363	3,183	1,102	10,053
Total	80,346	7,676	14,787	3,791	54,089
North total:	158,716	9,840	22,708	14,647	111,517
South:					
Southeast:					
Florida	14,636	1,015	1,802	4,016	7,803
Georgia	23,802	703	1,055	4,381	17,664
North Carolina	18,664	1,036	868	2,252	14,508
South Carolina	12,301	564	660	1,994	9,082
Virginia	15,371	1,392	515	1,537	11,927
Total	84,774	4,710	4,900	14,180	60,984
South Central:					
Alabama	22,922	601	625	3,740	17,956
Arkansas	18,373	2,353	924	4,497	10,599
Kentucky	12,347	628	376	205	11,139
Louisiana	13,722	507	738	3,898	8,578
Mississippi	18,572	1,091	844	3,238	13,399
Oklahoma	6,234	223	359	1,047	4,604
Tennessee	13,956	557	1,009	1,391	11,000
Texas	11,774	577	207	3,720	7,271
Total	117,900	6,537	5,082	21,736	84,546
South total:	202,674	11,247	9,982	35,916	145,530
Rocky Mountain:					
Great Plains:					
Kansas	1,491	0	92	0	1,399
Nebraska	898	47	61	0	790
North Dakota	441	14	41	0	387
South Dakota	1,511	960	63	0	488
Total	4,341	1,021	257	0	3,064
Intermountain:					
Arizona	3,527	2,405	44	0	1,077
Colorado	11,607	6,937	1,446	0	3,224
Idaho	16,824	12,055	1,547	1,284	1,938
Montana	19,185	11,623	1,605	1,618	4,339
Nevada	363	251	30	25	57
New Mexico	4,359	2,802	146	0	1,411
Utah	4,683	3,248	557	0	878
Wyoming	5,739	3,618	677	0	1,444
Total	66,287	42,939	6,052	2,927	14,368
Rocky Mountain total:	70,628	43,960	6,309	2,927	17,432
Pacific Coast:					
Alaska:					
Alaska	11,865	3,772	5,321	0	2,771
Total	11,865	3,772	5,321	0	2,771
Pacific Northwest:					
Oregon	23,831	11,978	3,147	5,022	3,684
Washington	17,347	5,933	2,446	4,152	4,816
Total	41,178	17,911	5,593	9,174	8,500
Pacific Southwest:					
California	17,781	9,916	383	2,932	4,551
Hawaii	700	0	338	0	362
Total	18,481	9,916	721	2,932	4,913
Pacific Coast total:	71,524	31,599	11,635	12,106	16,184
United States:	503,542	96,646	50,634	65,596	290,663

Note: Data may not add to totals because of rounding.

Table 12—Timberland area in the Eastern United States by forest type group, subregion, and stand-age class, 2002

		Forest type group											
Subregion and stand-age class	All forest types	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked
(Years)						*Thousand acres*							
Northeast:													
0 to 19	3,222	85	512	0	82	29	488	7	111	1,402	464	0	42
20 to 39	8,951	621	943	0	272	248	2,003	49	681	3,270	829	0	36
40 to 59	13,457	1,138	817	0	338	551	5,009	40	501	4,283	779	0	0
60 to 79	18,672	1,313	1,391	0	251	659	6,702	69	369	7,300	619	0	0
80 to 99	12,794	917	984	0	109	249	4,733	59	192	5,208	342	0	0
100 to 149	5,453	447	978	0	41	111	1,627	4	83	2,074	88	0	0
150 to 199	173	7	112	0	0	0	0	0	0	47	7	0	0
200 and older	20	0	20	0	0	0	0	0	0	0	0	0	0
Uneven aged	15,630	1,438	1,823	0	182	441	3,550	92	339	7,005	741	0	18
Total	78,371	5,965	7,580	0	1,273	2,289	24,112	320	2,277	30,590	3,869	0	96
North Central:													
0 to 19	9,946	786	652	0	84	163	1,926	6	819	1,997	3,283	0	229
20 to 39	14,337	1,296	1,583	0	197	267	3,367	69	1,737	2,966	2,822	0	33
40 to 59	20,723	1,225	1,825	0	233	372	6,103	88	2,198	4,911	3,746	0	22
60 to 79	17,014	495	1,575	0	100	228	5,981	58	1,607	4,556	2,399	0	15
80 to 99	8,868	255	918	0	49	98	4,008	44	635	2,339	517	0	6
100 to 149	5,990	141	904	0	8	36	2,366	12	436	1,927	157	0	4
150 to 199	302	5	106	0	0	0	76	0	17	94	5	0	0
200 and older	28	5	8	0	0	0	0	0	5	6	4	0	0
Uneven aged	3,135	23	6	0	26	31	1,477	23	415	1,091	37	0	5
Total	80,344	4,233	7,576	0	697	1,193	25,305	299	7,871	19,886	12,971	0	313
Southeast:													
0 to 19	30,363	82	0	5,244	11,765	4,254	6,091	2,652	211	11	0	2	53
20 to 39	16,478	133	0	2,684	5,892	1,991	3,809	1,787	171	12	0	0	0
40 to 59	18,290	124	7	1,514	3,808	2,619	6,686	3,231	229	72	0	0	0
60 to 79	13,127	138	4	745	1,200	1,584	6,288	2,862	154	152	0	0	0
80 to 99	4,521	30	0	118	208	439	2,323	1,294	59	50	0	0	0
100 to 149	1,904	29	0	15	41	121	984	665	12	38	0	0	0
150 to 199	87	5	0	0	0	11	36	35	0	0	0	0	0
200 and older	4	0	0	0	0	4	0	0	0	0	0	0	0
Uneven aged	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	84,774	541	11	10,319	22,913	11,022	26,217	12,525	836	334	0	2	53
South Central:													
0 to 19	36,914	11	0	1,671	15,936	5,923	10,307	2,300	413	6	0	0	347
20 to 39	30,055	30	0	727	8,348	6,399	10,596	3,436	417	88	0	0	15
40 to 59	28,276	36	0	406	3,207	4,342	13,446	6,220	467	148	0	0	3
60 to 79	13,842	42	0	191	606	1,065	7,506	4,012	264	147	0	0	9
80 to 99	3,226	8	0	19	64	214	2,415	331	80	94	0	0	2
100 to 149	1,176	10	0	12	12	33	989	89	6	25	0	0	0
150 to 199	1	0	0	0	0	1	0	0	0	0	0	0	0
200 and older	0	0	0	0	0	0	0	0	0	0	0	0	0
Uneven aged	4,408	7	0	0	121	159	3,404	288	221	208	0	0	0
Total	117,899	143	0	3,025	28,294	18,137	48,663	16,677	1,867	717	0	0	376

Table 12—(continued).

		Forest type group											
Subregion and stand-age class	All forest types	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked
(Years)						*Thousand acres*							
East total:													
0 to 19	80,445	963	1,163	6,915	27,868	10,368	18,812	4,966	1,554	3,416	3,747	2	671
20 to 39	69,821	2,080	2,526	3,411	14,707	8,904	19,775	5,340	3,006	6,336	3,651	0	83
40 to 59	80,746	2,524	2,648	1,920	7,586	7,884	31,244	9,579	3,395	9,414	4,525	0	25
60 to 79	62,655	1,988	2,970	935	2,158	3,535	26,477	7,001	2,393	12,155	3,018	0	24
80 to 99	29,409	1,210	1,902	136	429	1,000	13,479	1,728	966	7,691	859	0	8
100 to 149	14,524	627	1,882	27	101	301	5,966	770	537	4,063	245	0	4
150 to 199	563	16	218	0	0	12	112	35	17	141	12	0	0
200 and older	52	5	28	0	0	4	0	0	5	6	4	0	0
Uneven aged	23,173	1,468	1,829	0	329	631	8,431	404	976	8,303	779	0	23
Total	361,388	10,882	15,167	13,345	53,178	32,640	124,297	29,822	12,850	51,527	16,840	2	838

Note: Data may not add to totals because of rounding.

Table 13—Timberland area in the Western United States by forest type group, subregion, and stand-age class, 2002

		Forest type group											
Subregion and stand-age class (Years)	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
						Thousand acres							
Great Plains:													
0 to 19	452	0	133	0	0	0	0	0	0	10	284	0	25
20 to 39	898	0	47	0	0	0	0	0	0	50	798	0	3
40 to 59	952	0	88	0	0	0	0	0	0	27	834	0	4
60 to 79	880	0	257	0	0	0	0	0	0	20	598	0	5
80 to 99	708	0	408	0	0	0	0	0	0	13	279	0	8
100 to 149	372	0	272	0	0	0	0	0	0	35	63	0	3
150 to 199	72	0	64	0	0	0	0	0	0	0	9	0	0
200 and older	7	0	6	0	0	0	0	0	0	1	0	0	0
Uneven aged	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,341	0	1,275	0	0	0	0	0	0	156	2,864	0	46
Intermountain:													
0 to 19	7,249	1,769	1,816	37	1,292	110	123	730	0	183	726	70	392
20 to 39	2,588	477	380	29	736	48	80	330	0	83	424	0	0
40 to 59	4,856	1,312	937	38	819	204	86	645	0	73	745	0	0
60 to 79	12,590	3,167	3,160	3	1,789	272	235	1,955	0	162	1,845	0	0
80 to 99	15,175	3,940	3,811	12	2,655	401	177	2,319	0	133	1,726	0	0
100 to 149	15,673	4,217	2,957	4	4,307	317	116	2,575	0	450	730	0	0
150 to 199	5,766	1,710	718	0	1,963	131	65	799	0	341	40	0	0
200 and older	2,390	831	200	0	851	30	10	202	0	256	10	0	0
Uneven aged	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	66,287	17,424	13,979	124	14,411	1,512	893	9,555	0	1,681	6,246	70	392
Alaska:													
0 to 19	425	0	0	0	63	182	0	0	0	0	164	0	16
20 to 39	974	0	0	0	135	82	0	0	0	3	715	0	39
40 to 59	1,095	0	0	0	279	34	0	0	0	79	700	0	4
60 to 79	907	0	0	0	332	38	0	4	0	18	515	0	0
80 to 99	1,509	0	0	0	540	310	0	0	0	7	652	0	0
100 to 149	1,838	0	0	0	1,031	369	0	0	0	38	367	0	33
150 to 199	1,395	0	0	0	447	489	0	6	0	3	450	0	0
200 and older	3,217	0	0	0	724	2,444	0	29	0	0	6	0	14
Uneven aged	507	0	0	0	97	299	0	1	0	8	94	0	8
Total	11,865	0	0	0	3,648	4,247	0	39	0	155	3,663	0	113
Pacific Northwest:													
0 to 19	7,060	3,192	619	10	420	850	16	430	0	2	796	111	613
20 to 39	5,478	2,619	271	9	191	914	9	160	0	10	1,260	15	18
40 to 59	6,203	2,833	716	6	190	848	29	364	6	0	1,170	15	28
60 to 79	5,514	2,224	1,230	0	463	442	89	390	0	4	618	46	7
80 to 99	4,841	1,789	1,237	4	596	320	52	413	0	18	352	59	2
100 to 149	6,863	2,557	1,412	15	1,268	595	51	505	0	9	304	127	20
150 to 199	2,914	990	545	4	652	440	28	122	0	17	90	26	0
200 and older	2,305	756	220	4	497	619	9	61	0	4	118	18	0
Uneven aged	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	41,178	16,960	6,251	51	4,277	5,027	284	2,445	6	64	4,710	417	687

Table 13—(continued).

		Forest type group											
Subregion and stand-age class (Years)	**All forest types**	**Douglas-fir**	**Ponderosa pine**	**Western white pine**	**Fir-spruce**	**Hemlock-Sitka spruce**	**Larch**	**Lodgepole pine**	**Redwood**	**Other softwoods**	**Western hardwoods**	**Pinyon-juniper**	**Nonstocked**
						Thousand acres							
Pacific Southwest:													
0 to 19	2,311	99	265	0	41	0	0	11	43	159	569	4	1,121
20 to 39	1,310	148	326	0	4	1	0	2	177	114	537	0	0
40 to 59	1,929	78	596	8	81	7	0	22	197	214	727	0	0
60 to 79	2,594	52	878	7	212	0	0	40	141	474	787	2	0
80 to 99	2,955	117	1,262	0	212	0	0	49	59	565	691	0	0
100 to 149	3,588	70	1,100	9	337	1	0	154	50	1,307	558	1	0
150 to 199	1,754	66	167	10	282	21	0	69	8	830	302	0	0
200 and older	2,040	137	252	5	187	18	0	97	54	1,000	291	0	0
Uneven aged	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	18,481	767	4,846	39	1,355	48	0	443	730	4,663	4,461	7	1,121
West total:													
0 to 19	17,496	5,061	2,833	47	1,816	1,142	140	1,170	43	355	2,538	185	2,167
20 to 39	11,247	3,244	1,024	39	1,067	1,045	89	493	177	260	3,735	15	59
40 to 59	15,036	4,223	2,337	52	1,368	1,093	114	1,030	203	392	4,175	15	35
60 to 79	22,483	5,444	5,526	10	2,796	752	324	2,389	141	677	4,364	48	11
80 to 99	25,187	5,846	6,718	16	4,002	1,030	229	2,782	59	736	3,700	59	9
100 to 149	28,334	6,843	5,741	27	6,943	1,281	168	3,234	50	1,840	2,023	129	56
150 to 199	11,902	2,766	1,493	13	3,343	1,081	93	995	8	1,192	891	26	0
200 and older	9,959	1,724	678	9	2,259	3,111	20	388	54	1,260	425	18	14
Uneven aged	507	0	0	0	97	299	0	1	0	8	94	0	8
Total	142,152	35,151	26,350	214	23,691	10,834	1,177	12,483	735	6,719	21,944	494	2,359

Note: Data may not add to totals because of rounding.

Table 14—Timberland area in the United States by forest type group, subregion, and stand-size class, 2002

		Forest type group											
Subregion and stand-size class	All forest types	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch	Other forest types	Non-stocked
							Thousand acres						
Northeast:													
Nonstocked	141	0	0	0	10	0	29	0	3	3	0	0	96
Seedling-sapling	11,979	332	2,076	0	248	235	2,471	77	585	4,425	1,530	0	0
Poletimber	25,392	995	3,016	0	498	884	7,337	83	760	10,024	1,794	0	0
Sawtimber	40,860	4,639	2,487	0	517	1,170	14,275	160	929	16,138	545	0	0
Total	78,371	5,965	7,580	0	1,273	2,289	24,112	320	2,277	30,590	3,869	0	96
North Central:													
Nonstocked	312	0	0	0	0	0	0	0	0	0	0	0	312
Seedling-sapling	19,038	1,001	3,079	0	158	276	4,100	7	1,754	3,718	4,944	0	1
Poletimber	25,174	1,460	2,729	0	190	391	6,787	67	2,377	6,346	4,827	0	0
Sawtimber	35,820	1,773	1,769	0	348	526	14,418	226	3,740	9,822	3,199	0	0
Total	80,344	4,233	7,576	0	697	1,193	25,305	299	7,871	19,886	12,971	0	313
Southeast:													
Nonstocked	1,142	5	0	349	178	83	206	247	22	0	0	0	53
Seedling-sapling	24,893	51	4	3,665	7,634	4,381	6,219	2,749	180	10	0	0	0
Poletimber	23,539	73	5	3,307	7,715	2,559	6,542	3,110	180	46	0	2	0
Sawtimber	35,200	412	2	2,998	7,386	3,999	13,250	6,420	455	278	0	0	0
Total	84,774	541	11	10,319	22,913	11,022	26,217	12,525	836	334	0	2	53
South Central:													
Nonstocked	376	0	0	0	0	0	0	0	0	0	0	0	376
Seedling-sapling	36,568	29	0	970	9,398	7,236	15,300	3,016	516	104	0	0	0
Poletimber	28,037	5	0	750	7,391	3,997	12,435	2,901	364	194	0	0	0
Sawtimber	52,918	109	0	1,305	11,506	6,903	20,928	10,761	987	419	0	0	0
Total	117,899	143	0	3,025	28,294	18,137	48,663	16,677	1,867	717	0	0	376
East total:													
Nonstocked	1,971	5	0	349	187	83	235	247	24	3	0	0	837
Seedling-sapling	92,478	1,412	5,159	4,635	17,439	12,128	28,090	5,848	3,035	8,256	6,474	0	1
Poletimber	102,142	2,533	5,750	4,057	15,794	7,831	33,101	6,161	3,680	16,611	6,621	2	0
Sawtimber	164,798	6,932	4,258	4,304	19,757	12,598	62,870	17,566	6,111	26,656	3,745	0	0
Total	361,388	10,882	15,167	13,345	53,178	32,640	124,297	29,822	12,850	51,527	16,840	2	838

Table 14—(continued).

		Forest type group											
Subregion and stand-size class	All forest types	Douglas-fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwoods	Western hardwoods	Pinyon-juniper	Nonstocked
						Thousand acres							
Great Plains:													
Nonstocked	46	0	0	0	0	0	0	0	0	0	0	0	46
Seedling-sapling	881	0	204	0	0	0	0	0	0	65	612	0	0
Poletimber	1,168	0	218	0	0	0	0	0	0	39	912	0	0
Sawtimber	2,245	0	853	0	0	0	0	0	0	51	1,340	0	0
Total	4,341	0	1,275	0	0	0	0	0	0	156	2,864	0	46
Intermountain:													
Nonstocked	2,864	719	1,032	7	311	37	8	107	0	115	136	0	392
Seedling-sapling	7,151	1,622	979	47	1,820	128	188	1,182	0	158	1,026	0	0
Poletimber	12,132	1,660	1,121	36	1,477	153	186	3,861	0	294	3,275	70	0
Sawtimber	44,140	13,423	10,847	34	10,803	1,194	512	4,404	0	1,114	1,808	0	0
Total	66,287	17,424	13,979	124	14,411	1,512	893	9,555	0	1,681	6,246	70	392
Alaska:													
Nonstocked	234	0	0	0	23	91	0	0	0	6	1	0	113
Seedling-sapling	2,550	0	0	0	948	406	0	6	0	78	1,112	0	0
Poletimber	3,135	0	0	0	1,048	74	0	14	0	68	1,932	0	0
Sawtimber	5,945	0	0	0	1,629	3,676	0	19	0	3	618	0	0
Total	11,865	0	0	0	3,648	4,247	0	39	0	155	3,663	0	113
Pacific Northwest:													
Nonstocked	1,059	81	199	0	20	8	2	28	0	0	15	28	679
Seedling-sapling	8,910	3,753	785	37	961	1,178	35	1,072	0	21	1,009	58	0
Poletimber	5,442	1,788	642	4	274	490	61	668	0	8	1,447	52	8
Sawtimber	25,768	11,338	4,625	11	3,023	3,352	186	677	6	34	2,239	278	0
Total	41,178	16,960	6,251	51	4,277	5,027	284	2,445	6	64	4,710	417	687
Pacific Southwest:													
Nonstocked	1,140	0	6	0	6	0	0	3	0	3	0	0	1,121
Seedling-sapling	1,360	115	325	8	73	1	0	28	34	238	535	4	0
Poletimber	1,598	68	356	5	14	0	0	21	41	157	936	0	0
Sawtimber	14,384	584	4,159	26	1,262	47	0	390	655	4,265	2,991	3	0
Total	18,481	767	4,846	39	1,355	48	0	443	730	4,663	4,461	7	1,121
West total:													
Nonstocked	5,343	800	1,237	7	359	135	10	138	0	124	152	28	2,352
Seedling-sapling	20,851	5,489	2,292	91	3,802	1,713	224	2,288	34	561	4,295	62	0
Poletimber	23,476	3,516	2,337	45	2,813	717	246	4,565	41	566	8,501	122	8
Sawtimber	92,482	25,345	20,484	71	16,717	8,269	697	5,491	661	5,468	8,996	281	0
Total	142,152	35,151	26,350	214	23,691	10,834	1,177	12,483	735	6,719	21,944	494	2,359

Note: Data may not add to totals because of rounding.

Table 15—Area of timberland in the United States by stand-size class, region, and subregion, 2002, 1997, 1987, 1977, and 1953

Region and subregion	Year	Total	Sawtimber	Poletimber	Seedling/ sapling	Nonstocked
				Thousand acres		
North:						
Northeast	2002	78,370	40,860	25,392	11,978	142
	1997	78,923	40,513	26,022	12,285	104
	1987	79,835	41,299	27,588	10,676	271
	1977	78,561	33,801	21,614	21,071	2,075
	1953	73,035	27,639	30,287	12,631	2,478
North Central	2002	80,346	35,820	25,174	19,038	314
	1997	80,510	35,545	25,025	19,640	300
	1987	74,585	26,017	28,018	19,022	1,528
	1977	74,885	21,971	29,774	20,811	2,329
	1953	81,240	15,414	26,712	26,524	12,590
North total:	2002	158,716	76,680	50,566	31,016	456
	1997	159,433	76,058	51,047	31,925	403
	1987	154,419	67,316	55,606	29,698	1,799
	1977	153,446	55,772	51,388	41,882	4,404
	1953	154,275	43,053	56,999	39,155	15,068
South:						
Southeast	2002	84,774	35,202	23,539	24,893	1,142
	1997	84,803	35,742	22,385	25,511	1,165
	1987	85,141	36,415	25,189	20,273	3,264
	1977	87,818	32,878	28,619	22,162	4,159
	1953	89,067	25,669	29,709	21,804	11,885
South Central	2002	117,900	52,917	28,036	36,568	375
	1997	116,196	52,801	30,018	33,111	266
	1987	112,127	48,622	34,688	28,677	140
	1977	111,812	43,789	32,611	34,331	1,081
	1953	115,479	39,736	53,172	18,051	4,520
South total:	2002	202,674	88,119	51,575	61,461	1,517
	1997	200,999	88,543	52,403	58,622	1,431
	1987	197,268	85,037	59,877	48,950	3,404
	1977	199,630	76,667	61,230	56,493	5,240
	1953	204,546	65,405	82,881	39,855	16,405
East total:	2002	361,390	164,799	102,141	92,477	1,973
	1997	360,432	164,601	103,450	90,547	1,834
	1987	351,687	152,342	115,495	78,648	5,202
	1977	353,076	132,439	112,618	98,375	9,644
	1953	358,821	108,458	139,880	79,010	31,473

Table 15—(continued).

Region and subregion	Year	Total	Sawtimber	Poletimber	Seedling/ sapling	Nonstocked
				Thousand acres		
Rocky Mountain:						
Great Plains	2002	4,341	2,245	1,169	882	46
	1997	4,317	2,250	1,254	761	53
	1987	3,529	1,993	758	675	102
	1977	3,652	2,003	756	396	497
	1953	4,014	1,341	1,302	850	521
Intermountain	2002	66,287	44,140	12,132	7,150	2,863
	1997	66,701	45,416	12,078	6,543	2,664
	1987	57,610	40,526	9,453	6,308	1,324
	1977	56,521	35,880	12,197	5,873	2,571
	1953	62,585	29,613	19,412	8,823	4,737
Rocky Mountain total:	2002	70,628	46,385	13,301	8,032	2,909
	1997	71,018	47,666	13,332	7,304	2,717
	1987	61,139	42,519	10,211	6,983	1,426
	1977	60,173	37,883	12,953	6,269	3,068
	1953	66,599	30,954	20,714	9,673	5,258
Pacific Coast:						
Alaska	2002	11,865	5,945	3,135	2,550	234
	1997	12,395	7,282	2,764	2,186	163
	1987	15,763	10,155	3,018	2,423	168
	1977	19,720	14,592	2,487	2,492	149
	1953	20,342	19,499	357	357	129
Pacific Northwest	2002	41,178	25,768	5,441	8,909	1,058
	1997	41,167	25,744	5,421	8,955	1,047
	1987	40,315	24,093	7,672	7,403	1,147
	1977	42,133	26,230	7,196	6,711	1,996
	1953	44,876	28,367	8,418	5,428	2,663
Pacific Southwest	2002	18,481	14,383	1,598	1,359	1,139
	1997	18,652	13,387	2,203	1,291	1,772
	1987	17,412	13,747	1,597	1,956	112
	1977	17,251	12,066	1,440	1,995	1,750
	1953	18,216	14,213	1,319	97	2,587
Pacific Coast total:	2002	71,524	46,096	10,174	12,818	2,431
	1997	72,214	46,413	10,387	12,431	2,982
	1987	73,490	47,994	12,286	11,782	1,427
	1977	79,104	52,888	11,123	11,198	3,895
	1953	83,434	62,079	10,094	5,882	5,379
West total:	2002	142,152	92,481	23,475	20,850	5,340
	1997	143,232	94,079	23,719	19,735	5,699
	1987	134,629	90,513	22,498	18,765	2,853
	1977	139,277	90,771	24,076	17,467	6,963
	1953	150,033	93,033	30,808	15,555	10,637
United States:	2002	503,542	257,280	125,616	113,327	7,313
	1997	503,664	258,680	127,169	110,283	7,533
	1987	486,316	242,855	137,993	97,413	8,055
	1977	492,353	223,210	136,694	115,842	16,607
	1953	508,854	201,491	170,688	94,565	42,110

Note: Data may not add to totals because of rounding.

Table 16—Timberland area in the United States by major geographic region and forest type group, 2002, 1997, 1987, 1977, and 1953

Region	Year	All eastern types	White-red-jack pine	Spruce-fir	Longleaf-slash pine	Loblolly-shortleaf pine	Oak-pine	Oak-hickory	Oak-gum-cypress	Elm-ash–cottonwood	Maple-beech–birch	Aspen-birch	Non-stocked
							Thousand acres						
North	2002	158,715	10,198	15,156	0	1,971	3,482	49,416	620	10,148	50,476	16,840	409
	1997	159,433	10,512	15,185	0	2,263	3,595	49,678	770	10,000	50,210	16,818	404
	1987	154,418	13,030	16,421	0	2,294	3,457	45,945	778	11,009	42,263	17,346	1,876
	1977	153,446	11,362	17,468	0	2,468	3,115	42,262	518	18,050	34,300	19,149	4,754
	1953	154,275	8,940	18,887	0	3,569	1,022	46,455	1,212	19,673	23,248	24,637	6,633
South	2002	202,673	683	11	13,345	51,207	29,159	74,881	29,203	2,703	1,051	0	429
	1997	200,999	645	11	13,129	49,719	29,809	74,315	28,495	2,299	1,146	0	1,431
	1987	197,269	519	18	15,640	46,694	28,043	71,239	27,596	3,036	884	0	3,599
	1977	199,630	407	8	16,725	47,433	31,453	66,307	26,116	4,171	1,776	0	5,234
	1953	204,546	329	12	26,926	51,792	23,970	54,872	34,498	4,051	750	0	7,346
East total:	2002	361,388	10,882	15,167	13,345	53,178	32,640	124,297	29,822	12,850	51,527	16,840	838
	1997	360,432	11,157	15,196	13,129	51,982	33,404	123,992	29,265	12,299	51,356	16,818	1,835
	1987	351,687	13,789	16,752	15,407	48,335	31,148	116,997	27,977	14,210	43,939	17,676	5,457
	1977	353,076	11,769	17,476	16,725	49,901	34,568	108,569	26,635	22,222	36,076	19,149	9,988
	1953	358,821	9,269	18,899	26,926	55,360	24,992	101,326	35,710	23,724	23,998	24,637	13,979

Region	Year	All western types	Douglas-fir	Ponderosa-Jeffrey pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Red-wood	Other Western softwood types	Western hardwood types	Pinyon-juniper	Non-stocked
							Thousand acres							
Rocky Mountain	2002	70,628	17,424	15,254	124	14,411	1,512	893	9,555	0	1,837	9,110	70	438
	1997	71,018	17,645	15,752	131	14,236	1,510	873	9,696	0	1,906	8,796	365	108
	1987	61,140	14,119	14,555	276	11,684	1,580	1,856	9,973	0	319	5,105	1,673	1,576
	1977	60,173	12,729	15,285	333	10,545	1,298	1,822	10,225	0	528	4,745	2,663	2,556
	1953	66,599	11,923	18,800	2,670	7,529	99	2,677	13,326	0	0	5,600	3,973	3,241
Pacific West	2002	59,660	17,727	11,096	90	5,633	5,076	284	2,889	736	4,727	9,171	424	1,808
	1997	59,819	18,889	13,553	147	7,214	5,084	288	2,573	738	1,610	8,248	273	1,203
	1987	57,727	19,768	11,236	14	10,438	4,034	873	2,233	1,129	319	6,849	834	814
	1977	59,384	18,666	11,969	126	8,197	4,819	683	2,917	662	0	7,566	3,780	3,782
	1953	63,092	20,646	16,281	2,797	4,441	4,881	888	2,703	1,283	0	4,773	4,398	4,370
Alaska	2002	11,865	0	0	0	3,648	4,247	0	40	0	155	3,663	0	113
	1997	12,395	0	0	0	3,107	4,818	0	0	0	155	4,165	0	150
	1987	15,763	0	0	0	5,661	5,560	0	0	0	181	4,358	4	4
	1977	19,722	0	0	0	2,715	12,063	0	0	0	0	4,857	87	49
	1953	20,342	0	0	0	0	19,438	0	0	0	0	0	904	190
West total:	2002	142,152	35,151	26,350	214	23,691	10,834	1,177	12,483	735	6,719	21,944	494	2,359
	1997	143,232	36,534	29,305	278	24,557	11,411	1,161	12,269	738	3,671	21,210	638	1,460
	1987	134,630	33,887	25,791	290	27,783	11,174	2,729	12,205	1,129	819	16,312	2,511	2,394
	1977	139,279	31,395	27,253	459	21,457	18,180	2,504	13,142	662	528	17,168	6,529	6,387
	1953	150,033	32,570	35,081	5,467	11,970	24,419	3,565	16,030	1,283	0	10,373	9,275	7,800

Table 17—Net volume of timber on timberland in the United States by class of timber, species group, region, subregion, and State, 2002

	All timber			Growing stock			Live cull			Sound dead		
Region, subregion, and State	Total	Soft- woods	Hard- woods	Total	Soft- woods	Hard- woods	Total	Soft- woods	Hard- woods	Total	Soft- woods	Hard- woods
	Million cubic feet											
North:												
Northeast:												
Connecticut	3,403	518	2,885	3,192	470	2,721	191	42	149	20	6	15
Delaware	738	118	621	695	115	581	38	2	36	5	1	4
Maine	22,307	12,304	10,002	20,891	11,682	9,209	1,067	401	665	349	221	128
Maryland	5,254	816	4,439	5,092	801	4,291	141	7	135	21	8	13
Massachusetts	6,140	2,235	3,904	5,732	2,097	3,635	364	120	243	44	18	26
New Hampshire	9,652	4,028	5,624	9,015	3,799	5,216	521	169	352	116	60	56
New Jersey	2,967	629	2,339	2,819	582	2,238	117	28	89	31	19	12
New York	23,035	5,612	17,424	21,831	5,399	16,432	1,086	170	917	118	43	75
Pennsylvania	25,771	2,389	23,382	24,903	2,329	22,574	748	41	707	120	19	101
Rhode Island	536	118	418	496	112	384	39	5	33	1	1	1
Vermont	9,494	3,066	6,428	8,696	2,841	5,855	661	151	510	137	74	63
West Virginia	21,195	1,280	19,915	20,309	1,250	19,059	834	14	820	52	16	36
Total	130,492	33,113	97,381	123,671	31,477	92,195	5,807	1,150	4,656	1,014	486	530
North Central:												
Illinois	6,771	178	6,592	5,943	169	5,774	758	7	750	70	2	68
Indiana	7,866	303	7,563	6,900	278	6,623	908	19	889	58	6	51
Iowa	2,577	37	2,541	1,669	18	1,651	872	19	854	36	0	36
Michigan	29,540	8,158	21,382	26,661	7,576	19,085	2,642	501	2,141	237	81	156
Minnesota	17,307	4,956	12,352	15,147	4,652	10,495	1,928	246	1,682	232	58	175
Missouri	13,880	937	12,943	8,965	856	8,109	4,846	76	4,770	69	5	64
Ohio	10,568	410	10,158	10,159	401	9,758	354	4	350	55	5	50
Wisconsin	21,304	4,791	16,511	18,513	4,452	14,061	2,266	203	2,062	525	136	388
Total	109,813	19,770	90,042	93,957	18,402	75,556	14,574	1,075	13,498	1,282	293	988
North total:	240,305	52,883	187,423	217,628	49,879	167,751	20,381	2,225	18,154	2,296	779	1,518
South:												
Southeast:												
Florida	17,026	9,533	7,493	15,366	9,424	5,942	1,649	101	1,548	11	8	3
Georgia	33,663	15,319	18,344	31,704	15,224	16,480	1,957	94	1,863	2	1	1
North Carolina	34,752	12,648	22,104	32,742	12,530	20,212	1,939	77	1,862	71	41	30
South Carolina	19,418	9,194	10,224	17,702	8,931	8,771	1,716	263	1,453	0	0	0
Virginia	28,653	6,736	21,917	26,487	6,648	19,838	2,126	75	2,051	40	13	28
Total	133,512	53,430	80,082	124,001	52,757	71,243	9,387	610	8,777	124	63	62
South Central:												
Alabama	31,150	13,279	17,871	27,847	12,683	15,164	3,279	582	2,697	24	14	10
Arkansas	23,988	9,631	14,357	21,686	9,342	12,344	2,098	200	1,898	204	89	115
Kentucky	16,621	1,254	15,369	15,956	1,213	14,743	621	25	597	44	16	29
Louisiana	20,768	10,137	10,631	18,844	9,928	8,916	1,894	194	1,700	30	15	15
Mississippi	22,753	9,425	13,327	20,611	9,208	11,402	2,038	154	1,884	104	63	41
Oklahoma	4,893	1,465	3,428	3,624	1,421	2,203	1,253	39	1,214	16	5	11
Tennessee	26,308	3,963	22,346	22,456	3,586	18,870	3,830	369	3,462	22	8	14
Texas	14,289	8,057	6,232	12,939	7,879	5,060	1,290	130	1,160	60	48	12
Total	160,770	57,211	103,561	143,963	55,260	88,702	16,303	1,693	14,612	504	258	247
South total:	294,282	110,641	183,643	267,964	108,017	159,945	25,690	2,303	23,389	628	321	309

Table 17—(continued).

Region, subregion, and State	All timber			Growing stock			Live cull			Sound dead		
	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
	Million cubic feet											
Rocky Mountain:												
Great Plains:												
Kansas	1,998	22	1,977	1,254	17	1,238	704	5	699	40	0	40
Nebraska	1,329	261	1,069	856	212	645	449	42	407	24	7	17
North Dakota	504	5	498	330	3	326	147	2	145	27	0	27
South Dakota	2,043	1,763	280	1,819	1,648	171	136	31	105	88	84	4
Total	5,874	2,051	3,824	4,259	1,880	2,380	1,436	80	1,356	179	91	88
Intermountain:												
Arizona	7,243	6,582	660	6,193	5,914	279	608	243	365	442	425	16
Colorado	23,050	18,710	4,341	20,943	16,933	4,011	236	154	82	1,871	1,623	248
Idaho	44,070	43,177	894	40,050	39,276	774	657	589	69	3,363	3,312	51
Montana	38,682	38,094	589	35,167	34,607	561	472	449	23	3,043	3,038	5
Nevada	595	526	69	543	484	59	22	14	8	30	28	2
New Mexico	8,023	7,180	843	7,013	6,385	628	456	262	194	554	533	21
Utah	8,701	6,879	1,823	7,336	5,687	1,649	411	296	116	954	896	58
Wyoming	12,380	11,822	558	10,154	9,673	481	200	140	60	2,026	2,009	17
Total	142,744	132,970	9,777	127,399	118,959	8,442	3,062	2,147	917	12,283	11,864	418
Rocky Mountain total:	148,618	135,021	13,601	131,658	120,839	10,822	4,498	2,227	2,273	12,462	11,955	506
Pacific Coast:												
Alaska:												
Alaska	34,268	31,192	3,076	31,998	29,125	2,873	1,151	977	174	1,119	1,090	29
Total	34,268	31,192	3,076	31,998	29,125	2,873	1,151	977	174	1,119	1,090	29
Pacific Northwest:												
Oregon	87,682	80,569	7,112	83,212	76,694	6,518	934	395	538	3,536	3,480	56
Washington	67,557	60,854	6,702	65,413	58,891	6,522	262	94	167	1,882	1,869	13
Total	155,239	141,423	13,814	148,625	135,585	13,040	1,194	489	705	5,418	5,349	69
Pacific Southwest:												
California	59,521	49,074	10,446	57,902	48,351	9,550	1,441	548	893	178	175	3
Hawaii	333	4	329	280	4	276	41	0	41	12	0	12
Total	59,854	49,078	10,775	58,182	48,355	9,826	1,482	548	934	190	175	15
Pacific Coast total:	249,361	221,693	27,665	238,805	213,065	25,739	3,827	2,014	1,813	6,727	6,614	113
United States:	932,566	520,238	412,332	856,055	491,800	364,257	54,396	8,769	45,629	22,113	19,669	2,446

Note: Data may not add to totals because of rounding.

Table 18—Net volume of softwood growing stock on timberland in the United States by ownership group, region, subregion, and State, 2002, 1997, 1987, 1977, and 1953

Region, subregion, and State	All owners					National forest					Other public[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
								Million cubic feet							
North:															
Northeast:															
Connecticut	470	442	414	425	158	0	0	0	0	0	67	42	69	50	16
Delaware	115	169	173	168	236	0	0	0	0	0	4	7	8	9	5
Maine	11,682	11,682	14,510	16,060	10,093	48	48	24	22	15	508	508	527	265	112
Maryland	801	816	805	793	717	0	0	0	0	0	113	79	78	82	28
Massachusetts	2,097	1,608	1,689	1,439	631	0	0	0	0	0	420	223	270	263	78
New Hampshire	3,799	3,819	3,408	3,526	2,208	384	332	360	276	253	343	357	227	59	62
New Jersey	582	523	563	252	250	0	0	0	0	0	253	221	256	58	26
New York	5,399	5,400	4,935	3,524	2,748	5	6	1	0	0	733	734	648	442	344
Pennsylvania	2,329	2,329	1,983	1,778	1,229	63	63	68	60	38	390	390	230	213	147
Rhode Island	112	44	59	108	15	0	0	0	0	0	53	12	26	4	1
Vermont	2,841	2,863	2,010	1,826	1,251	71	66	45	39	35	154	152	130	92	38
West Virginia	1,250	1,250	1,060	1,092	492	267	267	180	239	118	73	73	27	18	28
Total	31,477	30,945	31,609	30,991	20,028	838	782	678	636	459	3,111	2,797	2,496	1,555	885
North Central:															
Illinois	169	117	118	81	17	50	47	47	35	5	30	25	25	15	0
Indiana	278	278	201	88	27	29	29	22	14	3	34	34	17	20	14
Iowa	18	18	7	6	4	0	0	0	0	0	0	0	0	0	0
Michigan	7,576	7,600	6,558	5,201	2,370	1,480	1,504	1,337	954	271	2,031	2,031	1,745	1,307	534
Minnesota	4,652	4,703	4,086	3,477	2,698	979	1,030	919	871	780	2,072	2,072	1,875	1,565	1,115
Missouri	856	863	601	392	264	304	311	273	177	134	68	68	22	12	5
Ohio	401	401	326	274	96	29	29	20	16	7	46	46	26	25	9
Wisconsin	4,452	4,450	4,112	3,340	1,549	628	627	652	475	136	994	994	1,130	784	485
Total	18,402	18,431	16,009	12,859	7,025	3,499	3,578	3,270	2,542	1,336	5,275	5,272	4,840	3,728	2,162
North total:	49,879	49,376	47,618	43,850	27,053	4,337	4,360	3,948	3,178	1,795	8,386	8,070	7,336	5,283	3,047
South:															
Southeast:															
Florida	9,424	9,424	9,305	8,750	5,384	995	995	873	912	549	1,542	1,542	1,155	752	312
Georgia	15,224	15,224	15,870	16,096	10,751	506	506	377	468	366	1,202	1,202	969	856	656
North Carolina	12,530	12,530	12,286	11,526	9,097	546	546	523	496	337	745	745	579	404	273
South Carolina	8,931	8,034	8,835	8,708	4,800	562	582	744	758	582	729	604	585	462	112
Virginia	6,648	6,648	6,323	5,928	5,516	362	362	331	312	240	359	359	351	296	231
Total	52,757	51,861	52,619	51,008	35,548	2,971	2,991	2,848	2,946	2,074	4,577	4,452	3,639	2,770	1,584
South Central:															
Alabama	12,683	11,101	11,328	11,469	5,875	631	562	659	561	278	451	270	229	216	98
Arkansas	9,342	9,342	8,586	7,973	4,640	1,895	1,895	1,677	1,520	886	284	284	224	155	41
Kentucky	1,213	1,213	1,110	916	493	158	158	164	153	139	35	35	4	4	63
Louisiana	9,928	9,928	10,552	9,342	4,253	732	732	775	724	268	351	351	277	206	83
Mississippi	9,208	9,208	9,746	8,930	3,674	1,374	1,374	1,474	1,253	579	508	508	268	376	342
Oklahoma	1,421	1,421	998	1,011	541	228	228	169	127	73	73	73	58	50	2
Tennessee	3,586	2,893	2,710	2,203	1,227	337	303	346	274	220	349	302	241	189	102
Texas	7,879	7,879	7,964	8,356	4,211	1,143	1,143	1,202	1,058	680	128	128	157	144	49
Total	55,260	52,985	52,994	50,200	24,914	6,498	6,396	6,466	5,670	3,123	2,179	1,951	1,458	1,340	780
South total:	108,017	104,846	105,613	101,208	60,462	9,469	9,387	9,314	8,616	5,197	6,756	6,403	5,097	4,110	2,364

Table 18—(continued).

Region, subregion, and State	All owners					National forest					Other public[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
								Million cubic feet							
Rocky Mountain:															
Great Plains:															
Kansas	17	17	6	1	0	0	0	0	0	0	1	1	0	0	0
Nebraska	212	212	177	148	73	54	54	31	28	19	22	22	17	13	4
North Dakota	3	3	3	0	0	1	1	0	0	0	0	0	0	0	0
South Dakota	1,648	1,331	1,726	1,650	1,236	1,391	1,090	1,270	1,345	1,046	49	47	118	100	51
Total	1,880	1,563	1,912	1,799	1,309	1,446	1,145	1,301	1,373	1,065	72	70	135	113	55
Intermountain:															
Arizona	5,914	5,609	5,980	4,763	4,600	4,062	3,931	4,176	3,208	2,888	63	47	1,753	1,449	1,596
Colorado	16,933	16,163	16,226	12,624	10,926	12,561	11,792	11,811	9,486	8,205	1,362	1,362	1,365	713	618
Idaho	39,276	38,472	32,088	31,662	28,677	30,384	29,580	23,440	21,589	18,894	3,353	3,353	3,480	3,267	2,992
Montana	34,607	34,254	27,611	27,691	27,367	25,501	25,148	18,595	18,090	17,444	2,318	2,318	2,458	2,543	2,335
Nevada	484	306	390	250	235	305	127	206	86	79	56	56	12	9	9
New Mexico	6,385	5,029	5,628	5,797	5,514	4,337	3,126	3,730	2,872	2,578	181	124	676	1,347	1,352
Utah	5,687	5,708	3,913	3,562	3,657	4,554	4,575	3,031	2,808	2,785	374	374	345	412	476
Wyoming	9,673	7,578	6,550	6,963	5,261	7,665	5,570	4,542	5,569	4,075	724	724	870	576	490
Total	118,959	113,119	98,386	93,312	86,237	89,369	83,849	69,531	63,708	56,948	8,431	8,357	10,959	10,316	9,868
Rocky Mountain total:	120,839	114,682	100,298	95,111	87,546	90,815	84,993	70,832	65,081	58,013	8,503	8,427	11,094	10,429	9,923
Pacific Coast:															
Alaska:															
Alaska	29,125	29,810	37,051	48,277	49,149	19,757	18,733	24,068	35,414	38,850	5,190	5,090	5,880	12,200	10,081
Total	29,125	29,810	37,051	48,277	49,149	19,757	18,733	24,068	35,414	38,850	5,190	5,090	5,880	12,200	10,081
Pacific Northwest:															
Oregon	76,694	76,770	70,554	74,735	87,580	47,918	47,993	42,102	44,904	45,488	12,057	12,058	12,805	12,709	15,272
Washington	58,891	59,199	60,130	57,800	61,994	27,022	27,321	23,497	22,833	25,504	9,724	9,723	13,798	13,200	12,605
Total	135,585	135,969	130,684	132,535	149,574	74,940	75,314	65,599	67,737	70,992	21,781	21,781	26,603	25,909	27,877
Pacific Southwest:															
California	48,351	49,167	46,307	45,975	58,006	28,723	29,539	27,213	28,073	29,590	1,320	1,320	1,245	1,108	1,892
Hawaii	4	4	4	4	4	0	0	0	0	0	3	3	3	3	3
Total	48,355	49,172	46,311	45,979	58,010	28,723	29,539	27,213	28,073	29,590	1,323	1,323	1,248	1,111	1,895
Pacific Coast total:	213,065	214,950	214,046	226,791	256,733	123,420	123,586	116,880	131,224	139,432	28,294	28,194	33,731	39,220	39,853
United States:	491,800	483,855	467,575	466,960	431,794	228,041	222,326	200,974	208,099	204,437	51,939	51,093	57,258	59,042	55,187

Table 18—(continued).

Region, subregion, and State	Forest Industry					Nonindustrial private[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
						Million cubic feet				
North:										
Northeast:										
Connecticut	0	0	0	0	0	403	399	345	375	142
Delaware	24	18	18	28	14	87	144	147	131	217
Maine	4,771	4,771	7,849	9,120	4,194	6,356	6,356	6,110	6,653	5,772
Maryland	59	80	79	91	64	629	657	648	620	625
Massachusetts	10	86	64	24	52	1,668	1,299	1,355	1,152	501
New Hampshire	253	269	433	800	371	2,818	2,862	2,388	2,391	1,522
New Jersey	0	0	0	0	1	329	302	307	194	223
New York	355	355	403	382	298	4,307	4,304	3,883	2,700	2,106
Pennsylvania	82	82	91	71	49	1,794	1,794	1,594	1,434	995
Rhode Island	0	0	0	0	0	59	32	33	104	14
Vermont	99	73	128	212	184	2,517	2,572	1,707	1,483	994
West Virginia	69	69	126	96	19	842	842	727	739	327
Total	5,722	5,803	9,191	10,824	5,246	21,809	21,563	19,244	17,976	13,438
North Central:										
Illinois	0	0	0	1	1	89	46	46	30	11
Indiana	0	0	0	1	0	214	214	162	53	10
Iowa	0	0	0	0	0	18	18	7	6	4
Michigan	764	764	885	808	563	3,301	3,301	2,591	2,132	1,002
Minnesota	302	302	336	265	232	1,298	1,298	956	776	571
Missouri	36	36	21	21	7	448	448	285	182	118
Ohio	24	24	2	4	4	301	301	278	229	76
Wisconsin	300	300	409	590	110	2,529	2,529	1,921	1,491	818
Total	1,426	1,426	1,653	1,690	917	8,198	8,155	6,246	4,899	2,610
North total:	7,148	7,229	10,844	12,514	6,163	30,007	29,718	25,490	22,875	16,048
South:										
Southeast:										
Florida	2,311	2,311	2,687	2,789	1,689	4,576	4,576	4,590	4,297	2,834
Georgia	3,227	3,227	3,443	2,836	2,031	10,289	10,289	11,081	11,936	7,698
North Carolina	1,884	1,884	1,646	1,157	1,546	9,356	9,356	9,538	9,469	6,941
South Carolina	1,737	1,672	1,774	1,417	700	5,903	5,175	5,732	6,071	3,406
Virginia	1,136	1,136	1,167	943	837	4,791	4,791	4,474	4,377	4,208
Total	10,295	10,231	10,717	9,142	6,803	34,915	34,187	35,415	36,150	25,087
South Central:										
Alabama	2,355	2,999	2,802	2,883	1,634	9,247	7,271	7,638	7,809	3,865
Arkansas	3,472	3,472	3,191	3,120	2,372	3,691	3,691	3,494	3,178	1,341
Kentucky	12	12	6	6	10	1,008	1,008	936	753	281
Louisiana	2,855	2,855	2,779	2,725	1,952	5,990	5,990	6,721	5,687	1,950
Mississippi	1,892	1,892	1,822	1,726	1,454	5,436	5,436	6,182	5,575	1,299
Oklahoma	574	574	350	517	359	546	546	421	317	107
Tennessee	558	302	289	232	74	2,342	1,985	1,834	1,508	831
Texas	2,126	2,126	2,276	3,221	1,883	4,481	4,481	4,329	3,933	1,599
Total	13,844	14,231	13,515	14,430	9,738	32,741	30,408	31,555	28,760	11,273
South total:	24,139	24,462	24,232	23,572	16,541	67,656	64,594	66,970	64,910	36,360

Table 18—(continued).

Region, subregion, and State	Forest Industry					Nonindustrial private[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
						Million cubic feet				
Rocky Mountain:										
Great Plains:										
Kansas	0	0	0	0	0	16	16	6	1	0
Nebraska	0	0	0	0	0	135	135	129	107	50
North Dakota	0	0	0	0	0	2	2	3	0	0
South Dakota	0	0	12	19	8	208	194	326	186	131
Total	0	0	12	19	8	361	348	464	294	181
Intermountain:										
Arizona	0	0	0	0	0	1,790	1,631	51	106	116
Colorado	0	0	0	21	19	3,010	3,010	3,050	2,404	2,084
Idaho	2,593	2,593	2,312	2,913	3,438	2,947	2,947	2,856	3,893	3,353
Montana	2,157	2,157	2,963	2,097	3,104	4,632	4,632	3,595	4,961	4,484
Nevada	23	23	0	16	15	100	100	172	139	132
New Mexico	0	0	3	0	113	1,866	1,779	1,219	1,578	1,471
Utah	0	0	0	0	0	759	759	537	342	396
Wyoming	0	0	53	61	52	1,284	1,284	1,085	757	644
Total	4,773	4,773	5,331	5,108	6,741	16,388	16,141	12,565	14,180	12,680
Rocky Mountain total:	4,773	4,773	5,343	5,127	6,749	16,749	16,489	13,029	14,474	12,861
Pacific Coast:										
Alaska:										
Alaska	0	0	0	0	0	4,177	5,987	7,103	663	218
Total	0	0	0	0	0	4,177	5,987	7,103	663	218
Pacific Northwest:										
Oregon	9,673	9,673	10,011	12,110	19,060	7,046	7,046	5,636	5,012	7,760
Washington	11,532	11,532	14,404	13,717	17,640	10,613	10,611	8,431	8,050	6,245
Total	21,205	21,205	24,415	25,827	36,700	17,659	17,657	14,067	13,062	14,005
Pacific Southwest:										
California	8,592	8,592	7,918	7,457	11,268	9,716	9,716	9,931	9,337	15,256
Hawaii	0	0	0	0	0	1	1	1	1	1
Total	8,592	8,592	7,918	7,457	11,268	9,717	9,717	9,932	9,338	15,257
Pacific Coast total:	29,797	29,797	32,333	33,284	47,968	31,553	33,361	31,102	23,063	29,480
United States:	65,857	66,262	72,752	74,497	77,421	145,965	144,162	136,591	125,322	94,749

[a] Native American lands have been exclusively in the nonindustrial private owner group since 1997. For 1987 and earlier years, these lands may be included in the other public owner group.

Note: Data may not add to totals because of rounding.

Table 19—Net volume of growing stock on timberland in the Eastern United States by species, region, and subregion, 2002, 1997, 1987, 1977, and 1963

		Softwoods									
Region and subregion (year)	Total all species	Total soft-woods	Longleaf and slash pines	Loblolly and shortleaf pines	Other yellow pines	White and red pines	Jack pine	Spruce and balsam fir	Eastern hemlock	Cypress	Other soft-woods
					Million cubic feet						
North:											
Northeast											
2002	123,667	31,476	0	658	1,653	9,823	14	9,178	7,164	6	2,980
1997	121,179	30,945	0	652	1,717	9,460	14	9,184	6,949	3	2,965
1987	112,133	31,609	0	658	1,573	7,977	0	12,977	5,878	0	2,547
1977	98,311	30,991	0	656	1,368	7,123	0	14,895	5,006	0	1,943
1963	76,869	24,034	0	701	1,119	4,958	46	11,042	4,113	0	2,056
North Central											
2002	93,957	18,402	0	734	374	5,608	1,547	4,557	1,079	21	4,481
1997	93,072	18,431	0	737	373	5,597	1,550	4,579	1,082	22	4,491
1987	77,905	16,009	0	561	158	4,396	1,646	4,711	876	31	3,630
1977	64,697	12,859	0	402	214	2,411	1,851	4,038	1,260	31	2,652
1963	51,419	9,627	0	307	110	1,794	1,520	2,954	1,040	15	1,888
North total:											
2002	217,625	49,878	0	1,393	2,027	15,431	1,561	13,735	8,244	27	7,461
1997	214,251	49,376	0	1,390	2,090	15,058	1,564	13,763	8,031	25	7,456
1987	190,038	47,618	0	1,219	1,731	12,373	1,646	17,688	6,753	31	6,178
1977	163,008	43,850	0	1,058	1,582	9,534	1,851	18,934	6,265	31	4,596
1963	128,288	33,661	0	1,008	1,229	6,752	1,566	13,995	5,153	15	3,944
South:											
Southeast											
2002	124,001	52,758	10,888	28,242	6,799	1,725	0	24	402	4,205	473
1997	122,985	51,861	11,044	27,248	6,855	1,733	0	24	413	4,066	478
1987	120,773	52,619	12,598	26,441	6,989	1,457	0	24	396	4,306	408
1977	111,699	51,008	12,284	25,910	6,897	1,068	0	25	324	4,101	400
1963	87,172	40,174	9,477	21,877	4,121	480	0	33	242	3,677	267
South Central											
2002	143,964	55,260	4,799	43,639	2,646	411	0	0	285	2,421	1,061
1997	133,377	52,985	4,886	41,517	2,774	281	0	0	213	2,317	997
1987	123,868	52,994	5,039	42,006	2,670	207	0	1	115	2,225	732
1977	111,674	50,200	5,114	40,108	2,375	185	0	0	67	1,829	522
1963	86,900	34,913	3,806	27,874	1,341	146	0	0	182	1,332	231
South total:											
2002	267,965	108,018	15,687	71,881	9,445	2,136	0	24	686	6,626	1,533
1997	256,361	104,846	15,931	68,765	9,629	2,014	0	24	626	6,382	1,475
1987	244,641	105,613	17,638	68,447	9,659	1,663	0	25	511	6,530	1,140
1977	223,373	101,208	17,398	66,018	9,272	1,253	0	25	391	5,929	922
1963	174,072	75,087	13,284	49,751	5,462	626	0	33	424	5,009	498
East total:											
2002	485,590	157,896	15,687	73,274	11,472	17,567	1,561	13,759	8,930	6,653	8,994
1997	470,612	154,222	15,931	70,154	11,719	17,072	1,564	13,787	8,657	6,408	8,931
1987	434,679	153,231	17,638	69,666	11,390	14,037	1,646	17,713	7,264	6,561	7,317
1977	386,381	145,058	17,398	67,076	10,854	10,787	1,851	18,958	6,657	5,960	5,518
1963	302,360	108,748	13,284	50,759	6,691	7,378	1,566	14,028	5,577	5,023	4,442

Table 19—(continued).

	Hardwoods									
Region and subregion (year)	Total hard-woods	Select white oaks	Select red oaks	Other white oaks	Other red oaks	Hickory	Yellow birch	Hard maple	Soft maple	Beech
	Million cubic feet									
North:										
Northeast										
2002	92,191	4,521	8,605	4,227	5,124	2,927	3,129	11,659	17,265	5,542
1997	90,234	4,437	8,625	4,271	4,932	2,846	3,062	11,533	16,741	5,466
1987	80,524	4,384	8,137	4,928	5,405	2,791	2,987	10,104	13,544	4,685
1977	67,320	4,721	7,616	4,589	4,890	2,563	2,452	7,755	10,645	3,807
1963	52,835	3,402	6,536	3,709	2,550	1,810	3,791	5,883	6,515	3,973
North Central										
2002	75,555	7,643	6,038	1,476	5,832	3,694	783	8,388	7,832	1,125
1997	74,640	7,550	5,983	1,474	5,682	3,572	786	8,369	7,662	1,122
1987	61,896	6,001	4,774	1,528	5,077	2,912	674	6,335	5,542	854
1977	51,838	5,277	4,006	1,365	4,579	2,605	807	4,814	3,302	896
1963	41,792	3,730	3,373	405	2,340	1,449	872	4,025	2,572	835
North total:										
2002	167,746	12,165	14,643	5,703	10,956	6,621	3,912	20,047	25,097	6,667
1997	164,874	11,987	14,608	5,745	10,615	6,417	3,848	19,902	24,403	6,588
1987	142,420	10,385	12,911	6,456	10,482	5,703	3,661	16,439	19,086	5,538
1977	119,158	9,121	12,186	5,788	7,991	4,401	3,719	12,972	14,985	5,278
1963	94,627	6,093	11,705	6,642	4,567	3,241	6,790	10,536	11,668	7,115
South:										
Southeast										
2002	71,244	7,177	3,157	5,919	12,367	3,642	83	464	5,565	1,016
1997	71,124	7,167	3,126	6,008	12,307	3,593	83	467	5,712	1,000
1987	68,154	6,639	3,074	5,563	11,826	3,641	62	402	5,221	942
1977	60,691	6,152	2,650	5,009	10,841	3,680	61	299	3,845	805
1963	46,998	4,753	1,966	3,886	7,837	3,314	39	158	2,555	561
South Central										
2002	88,703	10,102	5,000	8,010	17,194	8,257	14	1,595	2,699	1,579
1997	80,392	9,194	4,620	7,186	15,900	7,625	5	1,411	2,283	1,458
1987	70,874	7,974	3,969	6,722	15,062	7,254	6	933	1,719	1,193
1977	61,474	6,623	3,071	6,362	12,584	6,816	0	758	1,319	1,054
1963	51,987	5,262	2,053	5,607	9,652	5,799	11	428	898	1,116
South total:										
2002	159,947	17,279	8,157	13,930	29,561	11,899	97	2,059	8,264	2,594
1997	151,516	16,361	7,746	13,194	28,207	11,218	87	1,878	7,996	2,458
1987	139,028	14,613	7,043	12,285	26,889	10,895	68	1,335	6,940	2,135
1977	122,165	12,769	5,715	11,353	23,402	10,451	62	1,051	5,201	1,856
1963	98,985	10,015	4,021	9,467	17,469	9,069	51	580	3,492	1,667
East total:										
2002	327,693	29,444	22,800	19,632	40,517	18,520	4,008	22,107	33,362	9,262
1997	316,390	28,348	22,354	18,939	38,821	17,635	3,936	21,780	32,399	9,047
1987	281,448	24,998	19,955	18,741	37,370	16,598	3,730	17,774	26,026	7,673
1977	241,323	22,230	17,227	17,679	32,904	15,442	3,409	12,806	19,176	6,781
1963	193,612	17,154	13,364	16,832	25,683	13,941	4,815	8,117	12,657	7,123

Table 19—(continued).

Region and subregion (year)	Hardwoods								
	Sweet-gum	Tupelo and black gum	Ash	Bass-wood	Yellow poplar	Cotton-wood and aspen	Black walnut	Black cherry[a]	Other hard-woods
	Million cubic feet								
North:									
Northeast									
2002	670	595	4,762	1,489	5,039	3,651	282	4,795	7,908
1997	556	588	4,748	1,476	4,740	3,611	295	4,683	7,623
1987	486	491	3,656	1,162	2,925	3,219	211	3,738	7,671
1977	418	409	2,656	1,073	2,630	2,145	192	3,000	5,760
1963	460	333	1,898	1,221	1,968	1,719	154	0	6,915
North Central									
2002	178	194	4,842	3,104	1,716	12,095	843	1,657	8,114
1997	148	199	4,798	3,098	1,686	12,061	804	1,639	8,007
1987	122	79	3,657	2,476	1,073	10,521	612	1,144	8,516
1977	153	89	2,818	1,861	641	9,669	459	530	7,967
1963	168	63	2,127	1,505	441	8,807	340	0	8,740
North total:									
2002	848	789	9,604	4,593	6,755	15,746	1,125	6,453	16,023
1997	704	787	9,546	4,574	6,426	15,672	1,099	6,322	15,631
1987	608	570	7,313	3,639	3,998	13,740	823	4,881	16,187
1977	653	541	5,158	2,700	3,516	10,938	551	3,530	15,129
1963	824	596	3,400	2,187	3,524	3,079	275	0	12,385
South:									
Southeast									
2002	7,760	7,155	1,728	330	9,531	86	194	320	4,749
1997	7,573	7,248	1,752	334	9,538	92	197	311	4,618
1987	7,487	7,854	1,735	314	8,392	107	181	222	4,491
1977	6,850	7,462	1,492	259	6,732	117	138	155	4,143
1963	5,582	7,106	1,348	247	3,845	53	160	0	3,588
South Central									
2002	9,780	4,362	3,024	322	6,462	641	414	544	8,706
1997	9,058	4,106	2,689	275	5,283	621	362	452	7,862
1987	8,244	3,962	2,219	257	3,845	580	281	0	6,653
1977	6,826	3,921	1,967	246	2,847	504	271	195	6,110
1963	6,059	4,057	1,757	277	1,823	469	296	0	6,423
South total:									
2002	17,540	11,516	4,752	652	15,993	727	608	864	13,455
1997	16,631	11,354	4,441	609	14,821	713	559	763	12,480
1987	15,732	11,816	3,954	571	12,237	687	462	222	11,144
1977	13,678	11,436	3,452	506	9,637	616	407	349	10,225
1963	11,644	11,240	3,100	524	5,718	514	453	0	9,960
East total:									
2002	18,388	12,305	14,356	5,245	22,748	16,472	1,733	7,317	29,478
1997	17,336	12,141	13,987	5,183	21,247	16,384	1,658	7,085	28,111
1987	16,339	12,387	11,267	4,210	16,235	14,427	1,286	5,103	27,331
1977	15,623	13,058	8,428	2,981	13,752	10,501	942	3,555	24,829
1963	15,565	14,886	6,369	2,204	9,826	2,815	775	0	21,485

[a] Separate black cherry data not available for 1963, included in other hardwoods category.

Note: Data may not add to totals because of rounding.

Table 20—Net volume of growing stock on timberland in the Western United States by species, subregion, and State, 2002

		Softwoods								
Subregion and State	**All species**	**Total soft-woods**	**Douglas-fir**	**Ponderosa and Jeffrey pines**	**True fir**	**Western hemlock**	**Sugar pine**	**Western white pine**	**Redwood**	**Sitka spruce**
					Million cubic feet					
Great Plains:										
Kansas	1,254	17	0	0	0	0	0	0	0	0
Nebraska	856	212	0	0	0	0	0	0	0	0
North Dakota	330	3	0	0	0	0	0	0	0	0
South Dakota	1,819	1,648	0	1,278	0	0	0	0	0	0
Total	4,259	1,880	0	1,278	0	0	0	0	0	0
Intermountain:										
Arizona	6,193	5,914	612	4,580	321	0	0	0	0	0
Colorado	20,943	16,933	2,173	2,113	2,642	0	0	0	0	0
Idaho	40,050	39,276	12,427	2,603	9,374	896	0	447	0	0
Montana	35,167	34,607	10,706	2,843	3,540	195	0	108	0	0
Nevada	543	484	28	141	182	0	0	8	0	0
New Mexico	7,013	6,385	1,538	2,934	971	0	0	0	0	0
Utah	7,336	5,687	1,429	453	1,481	0	0	0	0	0
Wyoming	10,153	9,673	1,424	1,159	1,369	0	0	0	0	0
Total	127,399	118,957	30,336	16,827	19,879	1,091	0	562	0	0
Alaska:										
Alaska	31,998	29,124	0	0	6	11,224	0	0	0	8,641
Total	31,998	29,124	0	0	6	11,224	0	0	0	8,641
Pacific Northwest:										
Oregon	83,222	76,701	44,050	8,154	8,856	6,384	681	244	32	274
Washington	65,412	58,890	25,405	3,409	7,405	13,388	0	129	0	54
Total	148,635	135,591	69,454	11,563	16,261	19,772	681	372	32	328
Pacific Southwest:										
California	57,902	48,351	14,491	8,962	12,687	31	2,691	293	4,599	0
Hawaii	280	4	0	0	0	0	0	0	0	0
Total	58,182	48,355	14,491	8,962	12,687	31	2,691	293	4,599	0
West total:	370,472	333,907	114,281	38,630	48,832	32,118	3,373	1,227	4,631	8,969

Table 20—(continued).

	Softwoods - continued						Hardwoods				
Subregion and State	Englemann and other spruces	Western larch	Incense-cedar	Lodgepole pine	Western red-cedar[a]	Other soft-woods	Total hard-woods	Cottonwood and aspen	Red alder	Oak	Other hard-woods
						Million cubic feet					
Great Plains:											
Kansas	0	0	0	0	0	17	1,238	0	0	0	1,238
Nebraska	0	0	0	0	0	212	645	0	0	0	645
North Dakota	0	0	0	0	0	3	327	0	0	0	327
South Dakota	92	0	0	0	0	278	171	14	0	1	155
Total	92	0	0	0	0	510	2,380	14	0	1	2,364
Intermountain:											
Arizona	313	0	0	0	0	88	279	279	0	0	0
Colorado	5,995	0	0	3,891	0	119	4,011	4,011	0	0	0
Idaho	2,559	1,490	0	5,780	2,365	1,335	774	600	0	0	174
Montana	3,494	2,258	0	9,786	336	1,341	561	486	0	0	75
Nevada	42	0	4	57	0	21	59	59	0	0	0
New Mexico	713	0	0	0	0	229	628	628	0	0	0
Utah	1,527	0	0	706	0	91	1,649	1,649	0	0	0
Wyoming	1,981	0	0	3,003	0	737	481	477	0	1	2
Total	16,623	3,748	4	23,224	2,701	3,961	8,442	8,190	0	1	251
Alaska:											
Alaska	4,287	3	0	81	1,213	3,671	2,873	843	73	0	1,957
Total	4,287	3	0	81	1,213	3,671	2,873	843	73	0	1,957
Pacific Northwest:											
Oregon	1,252	785	723	2,227	1,502	1,537	6,521	94	3,182	451	2,794
Washington	1,565	1,451	0	1,774	3,531	780	6,523	645	4,353	28	1,496
Total	2,817	2,236	723	4,001	5,034	2,317	13,044	739	7,536	479	4,289
Pacific Southwest:											
California	37	0	2,884	1,195	1	481	9,550	71	230	4,932	4,318
Hawaii	0	0	0	0	0	4	276	0	0	0	276
Total	37	0	2,884	1,195	1	485	9,826	71	230	4,932	4,594
West total:	23,856	5,987	3,611	28,501	8,949	10,943	36,565	9,857	7,839	5,414	13,456

[a] Western redcedar volume may be included in other western softwood volume. Western redcedar volume in Oregon for national forest lands includes some incense-cedar.

Note: Data may not add to totals because of rounding. Total volume by State in this table may differ slightly from volume by State in other tables because of rounding.

Table 21—Net volume of softwood growing stock on timberland in the Eastern United States by species, subregion, and State, 2002

Subregion and State	Total	Longleaf and slash pines	Loblolly and shortleaf pines	Other yellow pines	White and red pines	Jack pine	Spruce and balsam fir	Eastern hemlock	Cypress	Other soft-woods
					Million cubic feet					
Northeast:										
Connecticut	470	0	0	3	220	0	4	225	0	18
Delaware	115	0	102	12	0	0	0	0	0	0
Maine	11,682	0	0	25	2,132	2	6,131	1,286	0	2,105
Maryland	801	0	527	161	74	0	0	12	6	21
Massachusetts	2,097	0	0	62	1,360	0	63	598	0	14
New Hampshire	3,799	0	0	34	1,895	0	1,017	833	0	22
New Jersey	582	0	11	403	12	0	0	12	0	143
New York	5,399	0	0	128	2,262	11	673	1,865	0	460
Pennsylvania	2,329	0	1	282	763	1	21	1,199	0	62
Rhode Island	112	0	0	8	91	0	1	1	0	11
Vermont	2,841	0	0	1	777	0	1,109	836	0	119
West Virginia	1,250	0	17	535	238	0	159	297	0	4
Total	31,476	0	658	1,653	9,823	14	9,178	7,164	6	2,980
North Central:										
Illinois	169	0	68	4	68	2	1	0	8	17
Indiana	278	0	39	95	85	5	0	0	4	50
Iowa	18	0	0	0	0	0	0	0	0	18
Michigan	7,576	0	0	87	2,498	604	1,682	662	0	2,044
Minnesota	4,652	0	0	3	849	554	2,008	0	0	1,238
Missouri	856	0	618	2	14	0	0	0	9	212
Ohio	401	0	8	175	178	0	1	16	0	22
Wisconsin	4,452	0	0	7	1,917	382	865	402	0	880
Total	18,402	0	734	374	5,608	1,547	4,557	1,079	21	4,481
Southeast:										
Florida	9,424	5,362	933	680	0	0	0	0	2,329	121
Georgia	15,224	4,210	8,997	856	305	0	0	16	800	40
North Carolina	12,530	601	7,831	2,572	717	0	20	217	436	136
South Carolina	8,931	715	7,011	486	41	0	0	4	590	84
Virginia	6,648	0	3,471	2,204	663	0	4	165	50	92
Total	52,758	10,888	28,242	6,799	1,725	0	24	402	4,205	473
South Central:										
Alabama	12,683	1,865	9,769	706	2	0	0	9	221	111
Arkansas	9,342	0	8,865	0	0	0	0	0	247	229
Kentucky	1,213	0	271	603	23	0	0	65	3	248
Louisiana	9,928	1,227	7,107	92	0	0	0	0	1,497	5
Mississippi	9,208	1,367	7,385	159	0	0	0	0	215	82
Oklahoma	1,421	0	1,369	0	0	0	0	0	3	48
Tennessee	3,586	0	1,493	1,085	386	0	0	211	124	287
Texas	7,879	339	7,380	0	0	0	0	0	109	50
Total	55,260	4,799	43,639	2,646	411	0	0	285	2,421	1,061
East total:	157,896	15,687	73,274	11,472	17,567	1,561	13,759	8,930	6,653	8,994

Note: Data may not add to totals because of rounding. Volume by State in this table may differ slightly from volume by State in other tables because of rounding.

Table 22—Net volume of hardwood growing stock on timberland in the Eastern United States by species, subregion, and State, 2002

Subregion and State	Total	Select white oaks	Select red oaks	Other white oaks	Other red oaks	Hickory	Yellow birch	Hard maple	Soft maple	Beech
					Million cubic feet					
Northeast:										
Connecticut	2,721	179	509	43	350	155	51	120	697	62
Delaware	580	78	7	4	108	3	0	0	164	11
Maine	9,209	17	499	0	20	1	940	1,584	2,328	929
Maryland	4,290	487	188	194	571	159	7	77	641	103
Massachusetts	3,635	137	623	12	369	48	125	239	1,062	165
New Hampshire	5,216	72	761	3	92	30	468	763	1,308	467
New Jersey	2,236	186	199	144	300	74	7	60	368	43
New York	16,432	270	1,250	268	210	444	580	3,534	3,555	1,280
Pennsylvania	22,574	1,279	2,515	1,635	1,195	612	244	2,193	4,475	1,122
Rhode Island	385	36	72	5	112	6	6	2	97	7
Vermont	5,855	23	289	16	3	45	503	1,993	1,045	482
West Virginia	19,059	1,756	1,692	1,903	1,794	1,351	197	1,095	1,525	871
Total	92,191	4,521	8,605	4,227	5,124	2,927	3,129	11,659	17,265	5,542
North Central:										
Illinois	5,774	985	375	138	908	647	0	207	520	15
Indiana	6,623	784	389	141	622	709	0	665	347	162
Iowa	1,651	336	189	2	90	139	0	47	163	0
Michigan	19,085	820	1,606	1	399	158	498	4,044	3,456	478
Minnesota	10,495	648	819	0	37	26	22	404	345	0
Missouri	8,109	2,210	373	880	2,447	883	0	67	123	1
Ohio	9,758	933	557	314	670	912	2	799	971	422
Wisconsin	14,061	927	1,731	0	660	219	261	2,155	1,907	48
Total	75,555	7,643	6,038	1,476	5,832	3,694	783	8,388	7,832	1,125
Southeast:										
Florida	5,942	30	2	443	1,374	122	0	13	445	7
Georgia	16,480	1,458	384	1,164	3,966	853	0	21	937	75
North Carolina	20,212	2,065	1,032	1,499	2,541	961	68	173	2,159	355
South Carolina	8,771	743	257	244	1,795	445	0	5	486	54
Virginia	19,838	2,880	1,484	2,570	2,692	1,262	15	251	1,538	523
Total	71,244	7,177	3,157	5,919	12,367	3,642	83	464	5,565	1,016
South Central:										
Alabama	15,164	1,368	605	1,017	3,458	1,279	0	64	348	151
Arkansas	12,344	2,154	1,106	1,281	2,628	1,253	0	63	135	65
Kentucky	14,743	1,982	777	1,288	1,919	1,771	2	814	753	665
Louisiana	8,916	411	365	450	1,990	563	0	7	244	149
Mississippi	11,402	975	749	559	2,716	786	0	13	195	130
Oklahoma	2,203	158	170	509	382	288	0	3	29	0
Tennessee	18,870	2,742	989	2,252	2,602	2,098	12	627	938	383
Texas	5,060	311	238	655	1,499	219	0	5	57	37
Total	88,703	10,102	5,000	8,010	17,194	8,257	14	1,595	2,699	1,579
East total:	327,693	29,444	22,800	19,632	40,517	18,520	4,008	22,107	33,362	9,262

Table 22—(continued).

Subregion and State	Sweetgum	Tupelo and black gum	Ash	Bass-wood	Yellow-poplar	Cotton-wood and aspen	Black walnut	Black cherry	Other hard-woods
					Million cubic feet				
Northeast:									
Connecticut	0	8	136	3	41	23	0	54	290
Delaware	88	30	8	0	46	2	1	7	22
Maine	0	0	402	34	0	1,225	0	34	1,195
Maryland	441	125	101	27	750	13	15	132	258
Massachusetts	0	11	210	9	7	97	0	194	328
New Hampshire	0	0	291	19	0	254	0	59	628
New Jersey	126	64	183	7	232	15	10	28	190
New York	0	10	1,416	468	61	1,047	27	1,075	936
Pennsylvania	8	151	1,138	320	816	665	100	2,391	1,715
Rhode Island	0	8	11	0	4	4	0	2	12
Vermont	0	0	402	41	0	260	0	118	633
West Virginia	7	189	464	562	3,082	45	129	701	1,699
Total	670	595	4,762	1,489	5,039	3,651	282	4,795	7,908
North Central:									
Illinois	75	22	312	71	82	234	158	107	919
Indiana	85	52	494	70	747	219	174	152	811
Iowa	0	0	56	106	0	170	64	19	270
Michigan	0	6	1,153	904	39	3,687	54	496	1,287
Minnesota	0	0	889	693	0	4,749	14	16	1,832
Missouri	8	46	146	14	4	155	147	19	586
Ohio	11	68	803	153	845	298	182	648	1,171
Wisconsin	0	0	989	1,093	0	2,582	48	200	1,239
Total	178	194	4,842	3,104	1,716	12,095	843	1,657	8,114
Southeast:									
Florida	563	1,484	339	13	83	0	0	21	1,002
Georgia	2,408	1,932	313	14	1,981	7	21	98	847
North Carolina	2,051	1,937	488	130	3,271	28	49	85	1,320
South Carolina	1,814	1,342	247	0	723	48	9	36	523
Virginia	924	459	341	172	3,472	2	115	80	1,058
Total	7,760	7,155	1,728	330	9,531	86	194	320	4,749
South Central:									
Alabama	2,388	1,221	356	53	1,436	30	11	82	1,297
Arkansas	1,510	464	347	20	11	143	31	59	1,073
Kentucky	217	240	570	124	1,961	74	183	103	1,299
Louisiana	1,664	1,090	426	6	62	132	2	20	1,338
Mississippi	2,009	733	370	18	575	108	10	91	1,365
Oklahoma	37	19	125	1	0	90	32	4	358
Tennessee	850	346	670	98	2,417	38	140	179	1,491
Texas	1,105	248	161	2	0	27	5	6	484
Total	9,780	4,362	3,024	322	6,462	641	414	544	8,706
East total:	18,388	12,305	14,356	5,245	22,748	16,472	1,733	7,317	29,478

Note: Data may not add to totals because of rounding. Volume by State in this table may differ from volume by State in other tables because of rounding.

Table 23—Net volume of hardwood growing stock on timberland in the United States by ownership group, region, subregion, and State, 2002, 1997, 1987, 1977, and 1953

	All owners					National forest					Other public[a]				
Region, subregion, and State	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
							Million cubic feet								
North:															
Northeast:															
Connecticut	2,721	2,313	2,293	2,237	1,146	0	0	0	0	0	489	370	343	190	121
Delaware	581	471	469	457	219	0	0	0	0	0	48	40	17	18	4
Maine	9,209	9,209	7,938	6,543	5,378	45	45	27	46	18	367	367	253	87	51
Maryland	4,291	3,695	3,685	2,699	2,053	0	0	0	0	0	778	432	437	260	142
Massachusetts	3,635	3,254	3,040	2,454	1,240	0	0	0	0	0	826	597	504	326	164
New Hampshire	5,216	5,220	4,471	3,760	1,757	787	597	727	623	483	404	426	226	128	38
New Jersey	2,238	1,855	1,332	1,282	917	0	0	0	0	0	525	382	315	182	47
New York	16,432	16,427	15,154	9,732	7,775	12	18	6	0	0	1,325	1,327	1,245	647	517
Pennsylvania	22,574	22,574	22,763	21,625	11,716	983	983	1,184	1,184	444	4,766	4,766	4,645	4,175	2,262
Rhode Island	384	350	369	305	146	0	0	0	0	0	85	56	84	17	11
Vermont	5,855	5,812	4,233	3,164	2,228	417	339	331	155	152	599	590	507	157	109
West Virginia	19,059	19,054	14,777	13,062	8,622	1,715	1,715	1,799	1,741	886	806	806	534	291	337
Total	92,195	90,234	80,524	67,320	43,197	3,959	3,696	4,074	3,749	1,983	11,018	10,158	9,110	6,478	3,803
North Central:															
Illinois	5,774	4,717	4,717	4,185	2,387	368	257	257	198	69	356	250	250	174	36
Indiana	6,623	6,623	5,015	3,671	2,876	280	280	217	156	50	717	717	511	250	186
Iowa	1,651	1,651	1,244	1,032	1,357	0	0	0	0	1	164	164	145	118	19
Michigan	19,085	19,134	14,414	13,103	7,610	2,051	2,100	1,689	1,392	578	3,332	3,332	2,587	2,524	1,419
Minnesota	10,495	10,564	9,645	7,978	4,253	1,124	1,193	1,045	1,000	570	3,619	3,619	3,543	2,899	1,434
Missouri	8,109	8,135	7,334	5,631	5,450	847	872	899	665	578	437	437	265	153	109
Ohio	9,758	9,758	7,227	6,121	3,153	302	302	202	190	72	531	531	321	312	187
Wisconsin	14,061	14,059	12,300	10,117	6,412	1,277	1,277	1,161	882	564	2,382	2,381	2,490	1,913	1,193
Total	75,556	74,640	61,896	51,838	33,498	6,249	6,281	5,470	4,483	2,482	11,538	11,430	10,112	8,343	4,583
North total:	167,751	164,874	142,420	119,158	76,695	10,208	9,977	9,544	8,232	4,465	22,556	21,588	19,222	14,821	8,386
South:															
Southeast:															
Florida	5,942	5,942	5,665	4,700	3,517	269	269	214	187	103	1,065	1,065	741	238	76
Georgia	16,480	16,480	14,917	13,322	8,600	922	922	874	841	611	927	927	588	443	250
North Carolina	20,212	20,212	19,778	17,705	12,323	1,913	1,913	1,929	1,462	936	767	767	574	382	197
South Carolina	8,771	8,651	8,898	8,089	5,412	372	369	407	385	195	561	362	336	278	76
Virginia	19,838	19,838	18,896	16,875	11,681	2,300	2,300	2,079	1,804	939	942	942	767	651	246
Total	71,243	71,124	68,154	60,691	41,533	5,776	5,773	5,503	4,679	2,784	4,262	4,062	3,006	1,992	845
South Central:															
Alabama	15,164	11,974	10,484	9,489	6,477	534	369	326	259	147	686	464	330	203	83
Arkansas	12,344	12,344	10,655	9,048	9,469	1,942	1,942	1,529	1,247	656	1,156	1,156	639	475	360
Kentucky	14,743	14,739	13,500	11,052	5,858	883	883	799	627	314	501	501	393	351	181
Louisiana	8,916	8,916	8,440	7,813	6,756	293	293	290	214	89	674	674	617	306	114
Mississippi	11,402	11,402	10,069	8,305	6,370	760	760	662	502	144	804	804	363	366	199
Oklahoma	2,203	2,203	1,221	1,051	840	66	66	80	75	43	152	152	130	97	31
Tennessee	18,870	13,753	11,582	9,798	7,023	985	701	626	503	276	1,637	1,087	716	510	378
Texas	5,060	5,060	4,923	4,918	3,682	236	236	190	149	116	118	118	119	93	19
Total	88,702	80,392	70,874	61,474	46,475	5,699	5,249	4,502	3,576	1,785	5,728	4,956	3,307	2,401	1,365
South total:	159,945	151,515	139,028	122,165	88,008	11,475	11,022	10,005	8,255	4,569	9,990	9,018	6,313	4,393	2,210

Table 23—(continued).

	All owners					National forest					Other public[a]				
Region, subregion, and State	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
								Million cubic feet							
Rocky Mountain:															
Great Plains:															
Kansas	1,238	1,238	847	584	477	0	0	0	0	0	67	67	46	24	16
Nebraska	645	643	312	304	285	0	0	1	1	0	55	53	16	13	7
North Dakota	326	327	239	257	257	1	1	0	0	0	32	32	39	79	79
South Dakota	171	161	70	128	79	17	9	9	9	2	7	7	11	22	13
Total	2,380	2,368	1,468	1,273	1,098	18	10	10	10	2	161	159	112	138	115
Intermountain:															
Arizona	279	368	336	220	174	128	164	151	133	103	0	0	185	48	39
Colorado	4,011	3,865	3,222	2,413	1,787	2,677	2,531	1,876	1,638	1,147	285	285	304	150	124
Idaho	774	784	503	223	213	258	268	152	67	77	116	116	149	49	42
Montana	561	561	405	287	248	107	108	40	46	28	37	37	33	62	55
Nevada	59	33	29	13	12	53	27	27	13	12	5	5	1	0	0
New Mexico	628	549	496	599	457	464	371	308	240	178	17	16	41	32	25
Utah	1,649	1,655	881	878	898	1,140	1,146	572	444	546	127	127	68	145	118
Wyoming	481	433	341	232	187	216	169	76	81	61	79	79	81	58	48
Total	8,442	8,251	6,213	4,865	3,976	5,043	4,783	3,202	2,662	2,152	666	664	862	544	451
Rocky Mountain total:	10,822	10,618	7,681	6,138	5,074	5,061	4,793	3,212	2,672	2,154	827	823	974	682	566
Pacific Coast:															
Alaska:															
Alaska	2,873	3,145	4,209	4,222	4,189	99	176	146	237	248	2,260	1,930	1,751	3,864	3,902
Total	2,873	3,145	4,209	4,222	4,189	99	176	146	237	248	2,260	1,930	1,751	3,864	3,902
Pacific Northwest:															
Oregon	6,518	6,526	6,066	4,819	4,217	1,178	1,185	1,135	897	723	1,535	1,535	1,124	1,198	628
Washington	6,522	6,523	6,937	5,703	2,859	358	372	335	141	121	1,311	1,311	1,319	1,124	507
Total	13,040	13,049	13,003	10,522	7,076	1,536	1,557	1,470	1,038	844	2,846	2,846	2,443	2,322	1,135
Pacific Southwest:															
California	9,550	8,337	7,464	3,693	2,828	3,477	2,264	2,184	1,133	1,276	319	319	554	283	218
Hawaii	276	276	276	198	220	0	0	0	0	0	122	122	122	95	99
Total	9,826	8,613	7,740	3,891	3,048	3,477	2,264	2,184	1,133	1,276	441	440	676	378	317
Pacific Coast total:	25,739	24,808	24,952	18,635	14,313	5,112	3,997	3,800	2,408	2,368	5,547	5,216	4,870	6,564	5,354
United States:	364,257	351,816	314,081	266,096	184,090	31,856	29,789	26,561	21,567	13,556	38,920	36,645	31,379	26,460	16,516

Table 23—(continued).

Region, subregion, and State	Forest industry					Nonindustrial private[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
	Million cubic feet									
North:										
Northeast:										
Connecticut	0	0	0	0	2	2,232	1,943	1,950	2,047	1,023
Delaware	14	2	8	10	13	519	429	444	429	202
Maine	3,582	3,582	3,711	3,311	2,215	5,215	5,215	3,947	3,099	3,094
Maryland	53	107	102	97	53	3,459	3,157	3,146	2,342	1,858
Massachusetts	12	82	94	43	96	2,797	2,575	2,442	2,085	980
New Hampshire	378	452	628	629	241	3,648	3,745	2,890	2,380	995
New Jersey	0	0	0	28	2	1,712	1,473	1,017	1,072	868
New York	1,522	1,522	1,253	902	721	13,572	13,560	12,650	8,183	6,537
Pennsylvania	1,120	1,120	1,246	945	512	15,706	15,706	15,688	15,321	8,498
Rhode Island	0	0	0	0	0	300	294	285	288	135
Vermont	292	277	346	533	385	4,546	4,607	3,049	2,319	1,582
West Virginia	1,558	1,558	1,447	1,138	502	14,980	14,975	10,997	9,892	6,897
Total	8,531	8,700	8,835	7,636	4,742	68,686	67,680	58,505	49,457	32,669
North Central:										
Illinois	18	14	14	12	15	5,032	4,196	4,196	3,801	2,267
Indiana	26	26	24	22	21	5,600	5,599	4,263	3,243	2,619
Iowa	0	0	0	12	5	1,487	1,487	1,099	902	1,332
Michigan	1,572	1,572	1,744	1,657	1,175	12,130	12,130	8,394	7,530	4,438
Minnesota	369	369	430	371	213	5,383	5,383	4,627	3,708	2,036
Missouri	137	137	185	146	109	6,688	6,688	5,985	4,667	4,654
Ohio	198	198	105	183	87	8,727	8,727	6,599	5,436	2,807
Wisconsin	957	957	928	973	423	9,445	9,444	7,721	6,349	4,232
Total	3,277	3,274	3,430	3,376	2,048	54,492	53,655	42,884	35,636	24,385
North total:	11,808	11,974	12,265	11,012	6,790	123,178	121,335	101,389	85,093	57,054
South:										
Southeast:										
Florida	1,230	1,230	1,477	1,511	1,053	3,378	3,378	3,232	2,764	2,285
Georgia	1,914	1,914	2,388	2,097	1,178	12,718	12,718	11,067	9,941	6,561
North Carolina	1,433	1,433	1,540	1,402	1,762	16,099	16,099	15,735	14,459	9,428
South Carolina	972	1,262	1,554	1,418	651	6,866	6,658	6,601	6,008	4,490
Virginia	1,017	1,017	1,198	1,114	944	15,579	15,579	14,852	13,306	9,552
Total	6,566	6,857	8,157	7,542	5,588	54,640	54,432	51,487	46,478	32,316
South Central:										
Alabama	1,435	1,921	1,739	1,647	887	12,510	9,220	8,089	7,380	5,360
Arkansas	1,923	1,923	2,337	2,023	1,359	7,324	7,324	6,150	5,303	7,094
Kentucky	230	230	231	241	171	13,129	13,125	12,077	9,833	5,192
Louisiana	1,778	1,778	1,652	1,851	1,077	6,171	6,171	5,881	5,442	5,476
Mississippi	1,379	1,379	1,357	1,407	664	8,460	8,460	7,687	6,030	5,363
Oklahoma	173	173	157	211	129	1,811	1,811	854	668	637
Tennessee	1,550	919	984	881	408	14,699	11,046	9,256	7,904	5,961
Texas	1,165	1,165	1,137	1,400	961	3,542	3,542	3,477	3,276	2,586
Total	9,633	9,488	9,594	9,661	5,656	67,646	60,699	53,471	45,836	37,669
South total:	16,199	16,344	17,751	17,203	11,244	122,286	115,131	104,958	92,314	69,985

Table 23—(continued).

Region, subregion, and State	Forest industry					Nonindustrial private[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
	Million cubic feet									
Rocky Mountain:										
Great Plains:										
Kansas	0	0	0	0	0	1,170	1,170	801	560	461
Nebraska	0	0	0	0	0	590	590	295	290	278
North Dakota	0	0	0	0	0	294	294	200	178	178
South Dakota	0	0	0	1	0	147	145	50	96	64
Total	0	0	0	1	0	2,201	2,198	1,346	1,124	981
Intermountain:										
Arizona	0	0	0	0	0	151	204	0	39	32
Colorado	0	0	0	0	0	1,049	1,049	1,042	625	516
Idaho	20	20	17	28	35	381	381	185	79	59
Montana	10	10	16	6	9	407	407	316	173	156
Nevada	1	1	0	0	0	0	0	1	0	0
New Mexico	0	0	0	0	13	147	163	147	327	241
Utah	0	0	0	0	0	383	383	241	289	234
Wyoming	0	0	0	3	3	186	186	184	90	75
Total	31	31	33	37	60	2,704	2,773	2,116	1,622	1,313
Rocky Mountain total:	31	31	33	38	60	4,905	4,971	3,462	2,746	2,294
Pacific Coast:										
Alaska:										
Alaska	0	0	0	0	0	515	1,040	2,312	121	39
Total	0	0	0	0	0	515	1,040	2,312	121	39
Pacific Northwest:										
Oregon	1,502	1,502	1,524	1,302	940	2,303	2,303	2,283	1,422	1,926
Washington	1,973	1,973	2,364	2,053	960	2,882	2,882	2,919	2,385	1,271
Total	3,475	3,475	3,888	3,355	1,900	5,185	5,185	5,202	3,807	3,197
Pacific Southwest:										
California	1,701	1,701	1,374	679	336	4,054	4,054	3,352	1,598	998
Hawaii	0	0	0	0	0	154	154	154	103	121
Total	1,701	1,701	1,374	679	336	4,208	4,208	3,506	1,701	1,119
Pacific Coast total:	5,176	5,176	5,262	4,034	2,236	9,908	10,433	11,020	5,629	4,355
United States:	33,214	33,526	35,311	32,287	20,330	260,277	251,870	220,829	185,782	133,688

[a] Native American lands have been exclusively in the nonindustrial private owner group since 1997. For 1987 and earlier years, these lands may be included in the other public owner group.

Note: Data may not add to totals because of rounding.

Table 24—Net volume of growing stock on timberland in the Western United States by species, region, and subregion, 2002, 1997, 1987, 1977, and 1963

			Softwoods								
Region and subregion	Year	All species	Total softwoods	Douglas-fir	Ponderosa and Jeffrey pines	True fir	Western hemlock	Sugar pine	Western white pine	Redwood	Sitka spruce
					Million cubic feet						
Rocky Mountain:											
Great Plains	2002	4,259	1,880	0	1,278	0	0	0	0	0	0
	1997	3,931	1,563	0	1,028	0	0	0	0	0	0
	1987	3,394	1,912	0	1,834	0	0	0	0	0	0
	1977	3,072	1,799	0	1,707	0	0	0	0	0	0
	1963	2,574	1,472	0	1,388	0	0	0	0	0	0
Intermountain	2002	127,399	118,957	30,336	16,827	19,879	1,091	0	562	0	0
	1997	121,368	113,118	29,052	16,426	18,912	1,063	1	534	0	0
	1987	104,603	98,386	22,560	15,544	14,861	971	2	1,578	0	0
	1977	98,177	93,312	20,475	14,762	13,591	1,462	1	2,184	0	0
	1963	96,245	91,751	19,913	15,650	12,984	1,694	4	3,069	0	0
Rocky Mountain total:	2002	131,658	120,837	30,336	18,105	19,879	1,091	0	562	0	0
	1997	125,299	114,681	29,052	17,454	18,912	1,063	1	534	0	0
	1987	107,997	100,298	22,560	17,378	14,861	971	2	1,578	0	0
	1977	101,249	95,111	20,475	16,469	13,591	1,462	1	2,184	0	0
	1963	98,819	93,223	19,913	17,038	12,984	1,694	4	3,069	0	0
Pacific Coast:											
Alaska[a]	2002	31,998	29,124	0	0	6	11,224	0	0	0	8,641
	1997	32,955	29,810	0	0	2	11,425	0	0	0	8,519
	1987	41,262	37,051	0	0	15	15,873	0	0	0	10,145
	1977	52,499	48,277	0	0	179	30,259	0	0	0	10,500
	1963	53,617	49,426	0	0	97	30,083	0	0	0	16,111
Pacific Northwest	2002	148,635	135,591	69,454	11,563	16,261	19,772	681	372	32	328
	1997	149,018	135,969	69,559	11,564	16,332	19,806	689	386	32	328
	1987	143,700	130,711	63,660	11,094	17,060	20,049	588	343	45	1,771
	1977	143,057	132,535	60,076	12,634	16,926	24,266	761	888	91	1,466
	1963	154,241	144,994	64,250	15,613	19,816	24,892	900	1,231	46	1,601
Pacific Southwest	2002	58,182	48,355	14,491	8,962	12,687	31	2,691	293	4,599	0
	1997	57,785	49,172	13,898	9,722	13,346	31	2,960	276	4,610	0
	1987	54,055	46,311	12,700	8,695	12,689	42	3,031	319	5,114	36
	1977	49,870	45,979	12,786	9,124	12,804	129	3,355	231	4,302	48
	1963	56,559	53,365	17,277	10,210	13,428	69	3,694	305	5,352	33
Pacific Coast total:	2002	238,814	213,071	83,945	20,525	28,953	31,028	3,373	665	4,631	8,969
	1997	239,758	214,951	83,457	21,286	29,680	31,262	3,649	662	4,642	8,848
	1987	239,017	214,073	76,361	19,789	29,765	35,964	3,619	662	5,159	11,952
	1977	245,426	226,791	72,862	21,758	29,909	54,654	4,116	1,119	4,393	12,014
	1963	264,417	247,785	81,526	25,823	33,340	55,044	4,594	1,537	5,398	17,745
West total:	2002	370,472	333,907	114,281	38,630	48,832	32,118	3,373	1,227	4,631	8,969
	1997	365,057	329,631	112,509	38,741	48,592	32,324	3,650	1,196	4,642	8,848
	1987	347,014	314,371	98,921	37,166	44,626	36,935	3,621	2,240	5,159	11,952
	1977	346,675	321,902	93,337	38,226	43,500	56,116	4,117	3,303	4,393	12,014
	1963	363,236	341,008	101,439	42,861	46,324	56,739	4,598	4,606	5,398	17,745

Table 24—(continued).

		Softwoods					Hardwoods				
Region and subregion	Year	Englemann and other spruces	Western larch	Incense-cedar	Lodgepole pine	Other soft-woods	Total hard-woods	Cotton-wood and aspen	Red alder	Oak	Other hard woods
						Million cubic feet					
Rocky Mountain:											
Great Plains	2002	92	0	0	0	510	2,380	14	0	1	2,364
	1997	48	0	0	0	486	2,368	9	0	0	2,359
	1987	61	0	0	0	17	1,482	463	0	314	705
	1977	62	0	0	0	30	1,273	424	0	197	651
	1963	63	0	0	0	21	1,102	387	0	217	499
Intermountain	2002	16,623	3,748	4	23,224	6,662	8,442	8,190	0	1	251
	1997	15,260	3,704	3	22,269	5,896	8,250	7,808	0	0	442
	1987	13,515	4,816	3	21,131	3,405	6,217	6,172	0	0	45
	1977	12,932	3,876	1	19,857	4,171	4,865	4,758	0	0	107
	1963	12,689	6,153	4	16,806	2,785	4,494	4,421	6	0	67
Rocky Mountain total:	2002	16,715	3,748	4	23,224	7,172	10,822	8,204	0	2	2,616
	1997	15,308	3,704	3	22,269	6,382	10,618	7,817	0	0	2,801
	1987	13,576	4,816	3	21,131	3,422	7,699	6,635	0	314	750
	1977	12,994	3,876	1	19,857	4,201	6,138	5,182	0	197	759
	1963	12,752	6,153	4	16,806	2,806	5,596	4,808	6	217	565
Pacific Coast:											
Alaska	2002	4,287	3	0	81	4,884	2,873	843	73	0	1,957
	1997	4,605	0	0	38	4,827	3,145	1,555	33	0	1,557
	1987	6,052	0	0	39	4,927	4,211	1,827	62	0	2,322
	1977	2,889	0	0	57	4,392	4,222	1,863	214	0	2,145
	1963	6	0	0	28	3,101	4,191	3,706	436	0	48
Pacific Northwest	2002	2,817	2,236	723	4,001	7,350	13,044	739	7,536	479	4,289
	1997	2,825	2,254	723	4,012	7,459	13,049	740	7,535	484	4,290
	1987	1,863	2,365	624	4,479	6,768	12,990	600	8,290	606	3,494
	1977	1,273	2,568	648	5,640	5,298	10,522	348	6,781	486	2,906
	1963	1,386	2,413	776	3,826	8,243	9,247	346	5,111	756	3,034
Pacific Southwest	2002	37	0	2,884	1,195	487	9,826	71	230	4,932	4,594
	1997	36	0	2,849	911	534	8,613	35	218	4,320	4,041
	1987	14	0	2,365	861	445	7,744	20	133	5,728	1,863
	1977	7	0	2,004	870	319	3,891	21	64	1,796	2,010
	1963	0	0	1,699	903	395	3,194	41	61	892	2,200
Pacific Coast total:	2002	7,141	2,239	3,606	5,277	12,720	25,743	1,653	7,839	5,411	10,840
	1997	7,466	2,254	3,571	4,960	12,821	24,808	2,330	7,786	4,804	9,888
	1987	7,929	2,365	2,989	5,379	12,140	24,944	2,447	8,485	6,334	7,679
	1977	4,169	2,568	2,652	6,567	10,009	18,635	2,232	7,059	2,282	7,062
	1963	1,392	2,413	2,476	4,757	11,739	16,632	4,094	5,609	1,647	5,282
West total:[a]	2002	23,856	5,987	3,611	28,501	19,892	36,565	9,857	7,839	5,414	13,456
	1997	22,773	5,958	3,574	27,229	19,203	35,425	10,147	7,786	4,804	12,689
	1987	27,072	7,181	2,992	26,549	20,412	32,644	9,082	8,485	6,648	8,429
	1977	19,697	6,444	2,653	26,481	18,509	24,773	7,414	7,059	2,480	7,821
	1963	13,970	8,567	2,479	21,592	17,586	22,228	8,901	5,615	1,864	5,848

[a] Data for Englemann and other spruces included in other softwoods for 1963.

Note: Data may not add to totals because of rounding.

Table 25—Net volume of all growing stock on timberland in the United States by ownership group, region, subregion, and State, 2002, 1997, 1987, 1977, and 1953

Region, subregion, and State	All owners					National forest					Other public[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
								Million cubic feet							
North:															
Northeast:															
Connecticut	3,192	2,755	2,707	2,662	1,304	0	0	0	0	0	556	412	412	240	137
Delaware	695	639	642	625	455	0	0	0	0	0	52	47	25	27	9
Maine	20,891	20,891	22,448	22,603	15,471	93	93	51	68	33	875	875	780	352	163
Maryland	5,092	4,511	4,490	3,492	2,770	0	0	0	0	0	891	511	515	342	170
Massachusetts	5,732	4,862	4,729	3,893	1,871	0	0	0	0	0	1,245	820	774	589	242
New Hampshire	9,015	9,039	7,879	7,286	3,965	1,170	929	1,087	899	736	748	783	453	187	100
New Jersey	2,819	2,378	1,895	1,534	1,167	0	0	0	0	0	778	603	571	240	73
New York	21,831	21,828	20,089	13,256	10,523	17	24	7	0	0	2,058	2,062	1,893	1,089	861
Pennsylvania	24,903	24,903	24,746	23,403	12,945	1,045	1,045	1,252	1,244	482	5,156	5,156	4,875	4,388	2,409
Rhode Island	496	394	428	413	161	0	0	0	0	0	138	68	110	21	12
Vermont	8,696	8,675	6,243	4,990	3,479	488	404	376	194	187	753	741	637	249	147
West Virginia	20,309	20,303	15,837	14,154	9,114	1,982	1,982	1,979	1,980	1,004	878	878	561	309	365
Total	123,671	121,179	112,133	98,311	63,225	4,795	4,478	4,752	4,385	2,442	14,128	12,956	11,606	8,033	4,688
North Central:															
Illinois	5,943	4,835	4,835	4,266	2,404	418	304	304	233	74	386	275	275	189	36
Indiana	6,900	6,900	5,216	3,759	2,903	309	309	239	170	53	751	751	528	270	200
Iowa	1,669	1,669	1,251	1,038	1,361	0	0	0	0	1	164	164	145	118	19
Michigan	26,661	26,735	20,972	18,304	9,980	3,531	3,604	3,026	2,346	849	5,363	5,363	4,332	3,831	1,953
Minnesota	15,147	15,268	13,731	11,455	6,951	2,103	2,223	1,964	1,871	1,350	5,691	5,691	5,418	4,464	2,549
Missouri	8,965	8,998	7,935	6,023	5,714	1,151	1,184	1,172	842	712	505	505	287	165	114
Ohio	10,159	10,159	7,553	6,395	3,249	330	330	222	206	79	577	577	347	337	196
Wisconsin	18,513	18,509	16,412	13,457	7,961	1,906	1,905	1,813	1,357	700	3,376	3,376	3,620	2,697	1,678
Total	93,957	93,072	77,905	64,697	40,523	9,748	9,859	8,740	7,025	3,818	16,813	16,702	14,952	12,071	6,745
North total:	217,628	214,251	190,038	163,008	103,748	14,543	14,337	13,492	11,410	6,260	30,941	29,657	26,558	20,104	11,433
South:															
Southeast:															
Florida	15,366	15,366	14,970	13,450	8,901	1,264	1,264	1,087	1,099	652	2,607	2,607	1,896	990	388
Georgia	31,704	31,704	30,787	29,418	19,351	1,428	1,428	1,251	1,309	977	2,129	2,129	1,557	1,299	906
North Carolina	32,742	32,742	32,064	29,231	21,420	2,459	2,459	2,452	1,958	1,273	1,512	1,512	1,153	786	470
South Carolina	17,702	16,685	17,733	16,797	10,212	935	951	1,151	1,143	777	1,289	966	921	740	188
Virginia	26,487	26,487	25,219	22,803	17,197	2,663	2,663	2,410	2,116	1,179	1,300	1,300	1,118	947	477
Total	124,001	122,985	120,773	111,699	77,081	8,749	8,764	8,351	7,625	4,858	8,837	8,514	6,645	4,762	2,429
South Central:															
Alabama	27,847	23,075	21,812	20,958	12,352	1,164	931	985	820	425	1,137	733	559	419	181
Arkansas	21,686	21,686	19,241	17,021	14,109	3,837	3,837	3,206	2,767	1,542	1,440	1,440	863	630	401
Kentucky	15,956	15,952	14,610	11,968	6,351	1,041	1,041	963	780	453	536	536	397	355	244
Louisiana	18,844	18,844	18,992	17,155	11,009	1,024	1,024	1,065	938	357	1,026	1,026	894	512	197
Mississippi	20,611	20,611	19,815	17,235	10,044	2,133	2,133	2,136	1,755	723	1,312	1,312	631	742	541
Oklahoma	3,624	3,624	2,219	2,062	1,381	294	294	249	202	116	225	225	188	147	33
Tennessee	22,456	16,646	14,292	12,001	8,250	1,322	1,004	972	777	496	1,986	1,390	957	699	480
Texas	12,939	12,939	12,887	13,274	7,893	1,379	1,379	1,392	1,207	796	246	246	276	237	68
Total	143,963	133,377	123,868	111,674	71,389	12,194	11,645	10,968	9,246	4,908	7,908	6,907	4,765	3,741	2,145
South total:	267,964	256,361	244,641	223,373	148,470	20,943	20,409	19,319	16,871	9,766	16,745	15,421	11,410	8,503	4,574

Table 25—(continued).

Region, subregion, and State	All owners					National forest					Other public[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
								Million cubic feet							
Rocky Mountain:															
Great Plains:															
Kansas	1,254	1,254	853	585	477	0	0	0	0	0	68	68	46	24	16
Nebraska	856	854	489	452	358	54	54	32	29	19	77	75	33	26	11
North Dakota	330	330	242	257	257	2	2	0	0	0	32	32	39	79	79
South Dakota	1,819	1,492	1,796	1,778	1,315	1,408	1,099	1,279	1,354	1,048	56	55	129	122	64
Total	4,259	3,931	3,380	3,072	2,407	1,464	1,155	1,311	1,383	1,067	233	230	247	251	170
Intermountain:															
Arizona	6,193	5,977	6,316	4,983	4,774	4,190	4,095	4,327	3,341	2,991	63	47	1,938	1,497	1,635
Colorado	20,943	20,028	19,448	15,037	12,713	15,238	14,323	13,687	11,124	9,352	1,646	1,646	1,669	863	742
Idaho	40,050	39,256	32,591	31,885	28,890	30,641	29,848	23,592	21,656	18,971	3,468	3,468	3,629	3,316	3,034
Montana	35,167	34,815	28,016	27,978	27,615	25,608	25,256	18,635	18,136	17,472	2,354	2,354	2,491	2,605	2,390
Nevada	543	339	419	263	247	358	154	233	99	91	62	62	13	9	9
New Mexico	7,013	5,578	6,124	6,396	5,971	4,802	3,497	4,038	3,112	2,756	198	140	717	1,379	1,377
Utah	7,336	7,363	4,794	4,440	4,555	5,694	5,721	3,603	3,252	3,331	500	500	413	557	594
Wyoming	10,154	8,012	6,891	7,195	5,448	7,880	5,739	4,618	5,650	4,136	803	803	951	634	538
Total	127,399	121,370	104,599	98,177	90,213	94,411	88,632	72,733	66,370	59,100	9,094	9,020	11,821	10,860	10,319
Rocky Mountain total:	131,658	125,300	107,979	101,249	92,620	95,875	89,787	74,044	67,753	60,167	9,327	9,250	12,068	11,111	10,489
Pacific Coast:															
Alaska:															
Alaska	31,998	32,955	41,260	52,499	53,338	19,856	18,909	24,214	35,651	39,098	7,450	7,020	7,631	16,064	13,983
Total	31,998	32,955	41,260	52,499	53,338	19,856	18,909	24,214	35,651	39,098	7,450	7,020	7,631	16,064	13,983
Pacific Northwest:															
Oregon	83,212	83,296	76,620	79,554	91,797	49,096	49,178	43,237	45,801	46,211	13,592	13,593	13,929	13,907	15,900
Washington	65,413	65,724	67,067	63,503	64,853	27,380	27,693	23,832	22,974	25,625	11,034	11,034	15,117	14,324	13,112
Total	148,625	149,020	143,687	143,057	156,650	76,476	76,871	67,069	68,775	71,836	24,626	24,627	29,046	28,231	29,012
Pacific Southwest:															
California	57,902	57,505	53,771	49,668	60,834	32,200	31,803	29,397	29,206	30,866	1,639	1,639	1,799	1,391	2,110
Hawaii	280	280	280	202	224	0	0	0	0	0	125	125	125	98	102
Total	58,182	57,785	54,051	49,870	61,058	32,200	31,803	29,397	29,206	30,866	1,764	1,763	1,924	1,489	2,212
Pacific Coast total:	238,805	239,760	238,998	245,426	271,046	128,532	127,583	120,680	133,632	141,800	33,840	33,410	38,601	45,784	45,207
United States:	856,055	835,672	781,656	733,056	615,884	259,893	252,115	227,535	229,666	217,993	90,853	87,738	88,637	85,502	71,703

Table 25—(continued).

Region, subregion, and State	Forest industry					Nonindustrial private[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
						Million cubic feet				
North:										
Northeast:										
Connecticut	0	0	0	0	2	2,636	2,343	2,295	2,422	1,165
Delaware	38	20	26	38	27	606	573	591	560	419
Maine	8,352	8,352	11,560	12,431	6,409	11,571	11,571	10,057	9,752	8,866
Maryland	113	187	181	188	117	4,088	3,813	3,794	2,962	2,483
Massachusetts	22	168	158	67	148	4,465	3,874	3,797	3,237	1,481
New Hampshire	631	721	1,061	1,429	612	6,466	6,607	5,278	4,771	2,517
New Jersey	0	0	0	28	3	2,042	1,775	1,324	1,266	1,091
New York	1,877	1,877	1,656	1,284	1,019	17,879	17,864	16,533	10,883	8,643
Pennsylvania	1,202	1,202	1,337	1,016	561	17,500	17,500	17,282	16,755	9,493
Rhode Island	0	0	0	0	0	358	326	318	392	149
Vermont	391	350	474	745	569	7,063	7,180	4,756	3,802	2,576
West Virginia	1,627	1,627	1,573	1,234	521	15,822	15,816	11,724	10,631	7,224
Total	14,253	14,503	18,026	18,460	9,988	90,496	89,243	77,749	67,433	46,107
North Central:										
Illinois	18	14	14	13	16	5,121	4,242	4,242	3,831	2,278
Indiana	26	26	24	23	21	5,814	5,814	4,425	3,296	2,629
Iowa	0	0	0	12	5	1,505	1,505	1,106	908	1,336
Michigan	2,336	2,336	2,629	2,465	1,738	15,431	15,431	10,985	9,662	5,440
Minnesota	672	672	766	636	445	6,681	6,681	5,583	4,484	2,607
Missouri	173	173	206	167	116	7,136	7,136	6,270	4,849	4,772
Ohio	223	223	107	187	91	9,029	9,029	6,877	5,665	2,883
Wisconsin	1,257	1,257	1,337	1,563	533	11,974	11,972	9,642	7,840	5,050
Total	4,705	4,700	5,083	5,066	2,965	62,691	61,811	49,130	40,535	26,995
North total:	18,958	19,204	23,109	23,526	12,953	153,187	151,053	126,879	107,968	73,102
South:										
Southeast:										
Florida	3,541	3,541	4,164	4,300	2,742	7,954	7,954	7,822	7,061	5,119
Georgia	5,141	5,141	5,831	4,933	3,209	23,007	23,007	22,148	21,877	14,259
North Carolina	3,317	3,317	3,186	2,559	3,308	25,454	25,454	25,273	23,928	16,369
South Carolina	2,709	2,934	3,328	2,835	1,351	12,769	11,833	12,333	12,079	7,896
Virginia	2,154	2,154	2,365	2,057	1,781	20,370	20,370	19,326	17,683	13,760
Total	16,862	17,088	18,874	16,684	12,391	89,554	88,619	86,902	82,628	57,403
South Central:										
Alabama	3,789	4,920	4,541	4,530	2,521	21,756	16,491	15,727	15,189	9,225
Arkansas	5,394	5,394	5,528	5,143	3,731	11,015	11,015	9,644	8,481	8,435
Kentucky	242	242	237	247	181	14,137	14,133	13,013	10,586	5,473
Louisiana	4,633	4,633	4,431	4,576	3,029	12,161	12,161	12,602	11,129	7,426
Mississippi	3,270	3,270	3,179	3,133	2,118	13,896	13,896	13,869	11,605	6,662
Oklahoma	748	748	507	728	488	2,357	2,357	1,275	985	744
Tennessee	2,108	1,221	1,273	1,113	482	17,041	13,032	11,090	9,412	6,792
Texas	3,291	3,291	3,413	4,621	2,844	8,023	8,023	7,806	7,209	4,185
Total	23,475	23,719	23,109	24,091	15,394	100,386	91,106	85,026	74,596	48,942
South total:	40,337	40,807	41,983	40,775	27,785	189,940	179,725	171,928	157,224	106,345

Table 25—(continued).

Region, subregion, and State	Forest industry					Nonindustrial private[a]				
	2002	1997	1987	1977	1953	2002	1997	1987	1977	1953
						Million cubic feet				
Rocky Mountain:										
Great Plains:										
Kansas	0	0	0	0	0	1,186	1,186	807	561	461
Nebraska	0	0	0	0	0	725	725	424	397	328
North Dakota	0	0	0	0	0	296	296	203	178	178
South Dakota	0	0	12	20	8	355	339	376	282	195
Total	0	0	12	20	8	2,562	2,546	1,810	1,418	1,162
Intermountain:										
Arizona	0	0	0	0	0	1,941	1,835	51	145	148
Colorado	0	0	0	21	19	4,059	4,059	4,092	3,029	2,600
Idaho	2,613	2,613	2,329	2,941	3,473	3,328	3,328	3,041	3,972	3,412
Montana	2,167	2,167	2,979	2,103	3,113	5,038	5,038	3,911	5,134	4,640
Nevada	24	24	0	16	15	100	100	173	139	132
New Mexico	0	0	3	0	126	2,013	1,942	1,366	1,905	1,712
Utah	0	0	0	0	0	1,142	1,142	778	631	630
Wyoming	0	0	53	64	55	1,471	1,470	1,269	847	719
Total	4,804	4,803	5,364	5,145	6,801	19,092	18,914	14,681	15,802	13,993
Rocky Mountain total:	4,804	4,803	5,376	5,165	6,809	21,654	21,461	16,491	17,220	15,155
Pacific Coast:										
Alaska:										
Alaska	0	0	0	0	0	4,692	7,027	9,415	784	257
Total	0	0	0	0	0	4,692	7,027	9,415	784	257
Pacific Northwest:										
Oregon	11,175	11,176	11,535	13,412	20,000	9,349	9,349	7,919	6,434	9,686
Washington	13,504	13,504	16,768	15,770	18,600	13,495	13,493	11,350	10,435	7,516
Total	24,679	24,680	28,303	29,182	38,600	22,844	22,842	19,269	16,869	17,202
Pacific Southwest:										
California	10,293	10,294	9,292	8,136	11,604	13,770	13,769	13,283	10,935	16,254
Hawaii	0	0	0	0	0	156	156	155	104	122
Total	10,293	10,294	9,292	8,136	11,604	13,926	13,925	13,438	11,039	16,376
Pacific Coast total:	34,972	34,973	37,595	37,318	50,204	41,462	43,794	42,122	28,692	33,835
United States:	99,071	99,787	108,063	106,784	97,751	406,243	396,032	357,420	311,104	228,437

[a] Native American lands have been included exclusively in the nonindustrial private owner group since 1997. For 1987 and earlier years, these lands may be included in the other public owner group.

Note: Data may not add to totals because of rounding.

Table 26—Net volume of hardwood growing stock on timberland in the Eastern United States by species, subregion, and diameter class, 2002

Subregion and diameter class (in inches)	Total	Select white oaks	Select red oaks	Other white oaks	Other red oaks	Hickory	Yellow birch	Hard maple	Soft maple	Beech
Million cubic feet										
Northeast:										
5.0 - 6.9	7,929	257	325	250	202	254	320	954	2,010	558
7.0 - 8.9	13,139	496	703	558	457	465	520	1,635	3,107	829
9.0 - 10.9	15,694	693	1,032	758	686	577	603	1,981	3,384	977
11.0 - 12.9	14,337	676	1,269	710	748	523	512	1,853	2,656	849
13.0 - 14.9	12,344	663	1,243	635	751	421	396	1,570	2,144	658
15.0 - 16.9	9,436	515	1,130	477	651	290	272	1,205	1,396	541
17.0 - 18.9	6,497	385	896	311	504	162	184	768	885	407
19.0 - 20.9	4,408	285	611	198	374	116	115	527	571	274
21.0 - 28.9	6,769	410	1,104	282	614	109	181	923	866	397
29.0 +	1,639	141	292	48	137	11	26	243	245	53
Total	92,191	4,521	8,605	4,227	5,124	2,927	3,129	11,659	17,265	5,542
North Central:										
5.0 - 6.9	7,325	433	195	163	342	341	81	1,076	1,046	55
7.0 - 8.9	10,501	655	434	225	551	528	106	1,385	1,347	80
9.0 - 10.9	12,198	915	699	226	726	608	127	1,413	1,353	113
11.0 - 12.9	11,386	981	866	219	833	610	114	1,178	1,088	115
13.0 - 14.9	9,813	1,048	878	197	840	533	100	964	852	132
15.0 - 16.9	7,580	994	758	165	734	425	92	782	620	124
17.0 - 18.9	5,450	789	623	107	541	301	58	579	461	124
19.0 - 20.9	3,675	558	471	76	402	138	40	400	309	95
21.0 - 28.9	6,093	1,027	883	86	681	196	62	562	556	231
29.0 +	1,535	243	232	10	182	14	4	50	200	54
Total	75,555	7,643	6,038	1,476	5,832	3,694	783	8,388	7,832	1,125
Southeast:										
5.0 - 6.9	5,514	383	114	330	841	259	8	47	783	51
7.0 - 8.9	7,805	628	165	642	1,246	417	11	62	906	70
9.0 - 10.9	9,525	893	241	763	1,574	577	12	57	851	101
11.0 - 12.9	10,139	1,022	334	778	1,694	570	3	53	832	117
13.0 - 14.9	9,669	1,051	377	754	1,664	542	6	56	696	122
15.0 - 16.9	8,430	945	410	626	1,409	447	11	60	512	137
17.0 - 18.9	6,387	712	332	571	1,120	320	8	44	375	130
19.0 - 20.9	4,688	528	311	404	890	221	7	29	243	84
21.0 - 28.9	7,441	848	665	765	1,540	267	17	44	323	175
29.0 +	1,647	166	208	287	390	24	0	12	44	29
Total	71,244	7,177	3,157	5,919	12,367	3,642	83	464	5,565	1,016

Table 26—(continued).

Subregion and diameter class (in inches)	Total	Select white oaks	Select red oaks	Other white oaks	Other red oaks	Hickory	Yellow birch	Hard maple	Soft maple	Beech
					Million cubic feet					
South Central:										
5.0 - 6.9	6,832	662	162	560	847	690	4	195	469	46
7.0 - 8.9	10,117	1,087	322	947	1,403	1,098	1	249	499	79
9.0 - 10.9	12,316	1,412	476	1,186	2,027	1,357	1	262	428	110
11.0 - 12.9	12,075	1,494	557	1,125	2,164	1,360	2	226	328	146
13.0 - 14.9	11,838	1,461	577	1,098	2,346	1,217	1	202	289	156
15.0 - 16.9	10,253	1,263	582	907	2,199	953	1	150	236	181
17.0 - 18.9	7,965	989	565	702	1,779	619	2	105	143	196
19.0 - 20.9	5,754	629	490	484	1,383	367	2	89	111	169
21.0 - 28.9	9,523	973	1,001	814	2,432	490	0	85	163	396
29.0 +	2,031	133	266	186	614	105	0	33	34	99
Total	88,703	10,102	5,000	8,010	17,194	8,257	14	1,595	2,699	1,579
East total:										
5.0 - 6.9	27,599	1,734	796	1,303	2,232	1,545	413	2,272	4,307	709
7.0 - 8.9	41,562	2,866	1,624	2,373	3,657	2,507	637	3,331	5,859	1,058
9.0 - 10.9	49,732	3,913	2,449	2,933	5,012	3,118	742	3,712	6,017	1,302
11.0 - 12.9	47,938	4,173	3,025	2,832	5,438	3,063	630	3,309	4,904	1,227
13.0 - 14.9	43,665	4,222	3,075	2,685	5,601	2,713	503	2,791	3,981	1,068
15.0 - 16.9	35,699	3,718	2,880	2,174	4,993	2,115	376	2,197	2,764	983
17.0 - 18.9	26,299	2,876	2,416	1,692	3,944	1,402	252	1,496	1,864	857
19.0 - 20.9	18,524	2,000	1,883	1,162	3,049	841	164	1,046	1,233	623
21.0 - 28.9	29,825	3,258	3,652	1,948	5,267	1,062	259	1,614	1,908	1,199
29.0 +	6,851	683	999	531	1,323	154	30	338	522	235
Total	327,693	29,444	22,800	19,632	40,517	18,520	4,008	22,107	33,362	9,262

Table 26—(continued).

Subregion and diameter class (in inches)	Sweetgum	Tupelo and black gum	Ash	Basswood	Yellow-poplar	Cotton-wood and aspen	Black walnut	Black cherry	Other eastern hard-woods
					Million cubic feet				
Northeast:									
5.0 - 6.9	40	99	463	70	149	410	23	319	1,226
7.0 - 8.9	70	96	688	157	317	723	39	547	1,732
9.0 - 10.9	101	97	836	195	497	803	46	737	1,691
11.0 - 12.9	108	79	766	260	637	694	49	770	1,180
13.0 - 14.9	114	70	635	263	703	499	50	728	802
15.0 - 16.9	94	58	498	207	715	277	32	594	485
17.0 - 18.9	50	30	312	126	647	108	18	424	279
19.0 - 20.9	19	24	200	94	474	70	12	274	168
21.0 - 28.9	62	41	275	102	748	52	12	350	241
29.0 +	11	2	89	14	153	13	1	53	105
Total	670	595	4,762	1,489	5,039	3,651	282	4,795	7,908
North Central:									
5.0 - 6.9	11	27	628	218	58	1,178	50	192	1,230
7.0 - 8.9	17	30	834	402	106	1,829	92	257	1,623
9.0 - 10.9	21	29	815	567	169	2,437	126	297	1,558
11.0 - 12.9	26	21	707	591	198	2,311	152	265	1,112
13.0 - 14.9	28	30	601	467	227	1,739	156	240	781
15.0 - 16.9	26	18	432	333	232	1,069	108	146	521
17.0 - 18.9	18	14	311	200	215	543	79	110	374
19.0 - 20.9	15	6	209	135	180	268	42	66	264
21.0 - 28.9	15	14	265	169	297	458	33	76	483
29.0 +	0	5	40	22	36	264	4	7	168
Total	178	194	4,842	3,104	1,716	12,095	843	1,657	8,114
Southeast:									
5.0 - 6.9	763	683	152	12	436	5	9	71	567
7.0 - 8.9	1,021	924	187	27	680	8	20	67	725
9.0 - 10.9	1,257	1,097	246	37	934	7	34	60	783
11.0 - 12.9	1,198	1,178	259	52	1,259	8	38	43	702
13.0 - 14.9	1,082	1,024	221	54	1,352	16	31	28	594
15.0 - 16.9	825	837	193	56	1,444	14	25	15	464
17.0 - 18.9	567	543	147	31	1,147	7	10	17	307
19.0 - 20.9	394	346	119	29	856	2	15	6	206
21.0 - 28.9	564	422	174	25	1,249	9	11	10	334
29.0 +	90	102	30	9	175	10	2	2	67
Total	7,760	7,155	1,728	330	9,531	86	194	320	4,749

Table 26—(continued).

Subregion and diameter class (in inches)	Sweetgum	Tupelo and black gum	Ash	Basswood	Yellow-poplar	Cotton-wood and aspen	Black walnut	Black cherry	Other eastern hard-woods
					Million cubic feet				
South Central:									
5.0 - 6.9	978	385	252	21	284	7	34	93	1,143
7.0 - 8.9	1,437	581	399	27	489	20	59	94	1,325
9.0 - 10.9	1,677	704	437	33	684	32	87	109	1,292
11.0 - 12.9	1,419	673	415	55	800	36	74	60	1,141
13.0 - 14.9	1,330	661	405	41	876	43	57	66	1,012
15.0 - 16.9	994	547	346	45	915	53	53	55	773
17.0 - 18.9	704	356	263	36	757	52	20	31	645
19.0 - 20.9	463	188	195	19	624	73	15	12	439
21.0 - 28.9	706	225	284	42	893	207	15	21	775
29.0 +	70	42	27	3	139	116	0	3	161
Total	9,780	4,362	3,024	322	6,462	641	414	544	8,706
East total:									
5.0 - 6.9	1,793	1,193	1,495	321	927	1,600	117	674	4,166
7.0 - 8.9	2,545	1,630	2,108	612	1,591	2,580	210	965	5,406
9.0 - 10.9	3,057	1,927	2,335	832	2,284	3,279	292	1,204	5,324
11.0 - 12.9	2,751	1,950	2,147	959	2,893	3,049	313	1,138	4,135
13.0 - 14.9	2,554	1,785	1,862	824	3,158	2,297	294	1,062	3,189
15.0 - 16.9	1,939	1,460	1,470	642	3,306	1,413	218	810	2,243
17.0 - 18.9	1,340	943	1,034	394	2,766	710	126	582	1,605
19.0 - 20.9	891	565	722	277	2,133	414	84	359	1,077
21.0 - 28.9	1,346	702	997	338	3,187	726	71	457	1,832
29.0 +	172	151	186	47	502	403	7	64	501
Total	18,388	12,305	14,356	5,245	22,748	16,472	1,733	7,317	29,478

Note: Data may not add to totals because of rounding. Total volume by State in this table may differ slightly from volume by State in other tables because of rounding.

Table 27—Net volume of softwood growing stock on timberland in the Eastern United States by species, subregion, and diameter class, 2002

Subregion and diameter class (in inches)	Total	Longleaf and slash pines	Loblolly and shortleaf pines	Other yellow pines	White and red pines	Jack pine	Spruce and balsam fir	Eastern hemlock	Cypress	Other soft-woods
					Million cubic feet					
Northeast:										
5.0 - 6.9	3,738	0	63	207	502	3	1,917	611	0	436
7.0 - 8.9	5,298	0	101	375	864	2	2,375	944	0	637
9.0 - 10.9	5,167	0	121	372	1,097	5	1,946	1,032	0	594
11.0 - 12.9	4,776	0	115	322	1,270	3	1,395	1,145	0	526
13.0 - 14.9	3,908	0	87	208	1,394	1	763	1,098	0	355
15.0 - 16.9	2,856	0	70	107	1,151	0	439	854	0	235
17.0 - 18.9	1,900	0	44	37	942	0	192	561	1	123
19.0 - 20.9	1,286	0	38	17	767	0	78	339	1	47
21.0 - 28.9	2,073	0	19	8	1,439	0	72	503	4	28
29.0 +	474	0	0	0	398	0	0	76	0	0
Total	31,476	0	658	1,653	9,823	14	9,178	7,164	6	2,980
North Central:										
5.0 - 6.9	3,543	0	84	53	585	270	1,425	39	0	1,087
7.0 - 8.9	4,140	0	134	90	944	433	1,265	63	0	1,210
9.0 - 10.9	3,322	0	164	89	831	398	824	107	0	909
11.0 - 12.9	2,377	0	150	64	704	259	474	137	0	590
13.0 - 14.9	1,580	0	110	34	565	121	246	154	1	348
15.0 - 16.9	1,062	0	56	26	451	45	150	157	2	175
17.0 - 18.9	769	0	20	14	401	16	91	135	3	89
19.0 - 20.9	543	0	13	4	335	4	45	100	2	41
21.0 - 28.9	891	0	3	0	640	2	37	168	9	31
29.0 +	177	0	0	0	151	0	0	21	4	1
Total	18,402	0	734	374	5,608	1,547	4,557	1,079	21	4,481
Southeast:										
5.0 - 6.9	6,737	1,682	3,473	961	100	0	3	36	365	118
7.0 - 8.9	9,702	2,222	5,106	1,532	148	0	4	35	557	98
9.0 - 10.9	9,315	1,963	4,773	1,600	180	0	5	34	671	90
11.0 - 12.9	8,039	1,719	4,167	1,211	175	0	7	44	663	53
13.0 - 14.9	6,436	1,401	3,371	802	177	0	2	33	603	47
15.0 - 16.9	4,833	932	2,824	380	199	0	3	45	418	33
17.0 - 18.9	3,082	517	1,877	169	177	0	0	41	286	14
19.0 - 20.9	1,968	255	1,215	79	183	0	0	29	196	12
21.0 - 28.9	2,294	196	1,347	64	319	0	0	67	293	9
29.0 +	353	2	89	2	67	0	1	36	155	1
Total	52,758	10,888	28,242	6,799	1,725	0	24	402	4,205	473

Table 27—(continued).

Subregion and diameter class (in inches)	Total	Longleaf and slash pines	Loblolly and shortleaf pines	Other yellow pines	White and red pines	Jack pine	Spruce and balsam fir	Eastern hemlock	Cypress	Other soft- woods
					Million cubic feet					
South Central:										
5.0 - 6.9	5,132	409	4,116	237	18	0	0	18	54	279
7.0 - 8.9	7,983	683	6,393	436	21	0	0	24	127	299
9.0 - 10.9	8,348	853	6,550	525	30	0	0	32	153	204
11.0 - 12.9	8,507	915	6,643	505	28	0	0	32	251	133
13.0 - 14.9	7,737	813	6,070	372	48	0	0	32	324	79
15.0 - 16.9	6,320	548	5,087	224	47	0	0	29	348	36
17.0 - 18.9	4,372	329	3,532	116	29	0	0	27	321	20
19.0 - 20.9	2,826	148	2,267	94	56	0	0	28	225	8
21.0 - 28.9	3,619	92	2,754	132	107	0	0	51	479	4
29.0 +	417	7	227	5	28	0	0	11	139	0
Total	55,260	4,799	43,639	2,646	411	0	0	285	2,421	1,061
East total:										
5.0 - 6.9	19,149	2,091	7,737	1,458	1,204	273	3,344	704	419	1,919
7.0 - 8.9	27,123	2,906	11,734	2,432	1,978	435	3,644	1,067	683	2,243
9.0 - 10.9	26,151	2,816	11,608	2,585	2,138	403	2,775	1,205	824	1,796
11.0 - 12.9	23,700	2,634	11,075	2,103	2,177	262	1,876	1,358	914	1,302
13.0 - 14.9	19,660	2,214	9,639	1,416	2,184	122	1,011	1,317	929	828
15.0 - 16.9	15,071	1,480	8,037	737	1,849	45	592	1,086	768	478
17.0 - 18.9	10,123	846	5,473	336	1,549	16	283	764	611	246
19.0 - 20.9	6,622	403	3,532	194	1,341	4	123	496	423	108
21.0 - 28.9	8,876	287	4,123	205	2,504	2	109	789	785	73
29.0 +	1,420	9	316	7	643	0	2	144	297	2
Total	157,896	15,687	73,274	11,472	17,567	1,561	13,759	8,930	6,653	8,994

Note: Data may not add to totals because of rounding. Total volume by State in this table may differ slightly from volume by State in other tables because of rounding.

Table 28—Net volume of growing stock on timberland in the Western United States by species, subregion, and diameter class, 2002

			Softwoods							
Subregion and diameter class (in inches)	Total	Total soft-woods	Douglas-fir	Ponderosa and Jeffrey pines	True fir	Western hemlock	Sugar pine	Western white pine	Redwood	Sitka spruce
					Million cubic feet					
Great Plains:										
5.0 - 6.9	306	129	0	71	0	0	0	0	0	0
7.0 - 8.9	495	267	0	187	0	0	0	0	0	0
9.0 - 10.9	616	348	0	250	0	0	0	0	0	0
11.0 - 12.9	551	309	0	214	0	0	0	0	0	0
13.0 - 14.9	531	291	0	200	0	0	0	0	0	0
15.0 - 16.9	453	240	0	168	0	0	0	0	0	0
17.0 - 18.9	325	138	0	85	0	0	0	0	0	0
19.0 - 20.9	242	89	0	58	0	0	0	0	0	0
21.0 - 28.9	486	69	0	46	0	0	0	0	0	0
29.0 +	255	0	0	0	0	0	0	0	0	0
Total	4,259	1,880	0	1,278	0	0	0	0	0	0
Intermountain:										
5.0 - 6.9	10,272	8,934	1,388	595	1,926	72	0	18	0	0
7.0 - 8.9	16,943	14,914	2,518	1,256	2,573	121	0	38	0	0
9.0 - 10.9	18,561	16,628	3,343	1,780	2,827	121	0	39	0	0
11.0 - 12.9	17,448	16,140	3,816	2,045	2,803	152	0	57	0	0
13.0 - 14.9	14,608	13,841	3,754	2,072	2,368	134	0	89	0	0
15.0 - 16.9	11,997	11,519	3,554	1,823	1,964	100	0	80	0	0
17.0 - 18.9	9,222	9,002	2,920	1,513	1,511	89	0	44	0	0
19.0 - 20.9	7,094	6,966	2,297	1,192	1,120	83	0	41	0	0
21.0 - 28.9	15,179	15,010	4,919	3,102	2,030	159	0	110	0	0
29.0 +	6,075	6,002	1,826	1,449	758	59	0	46	0	0
Total	127,399	118,957	30,336	16,827	19,879	1,091	0	562	0	0
Alaska:										
5.0 - 6.9	1,439	800	0	0	0	258	0	0	0	72
7.0 - 8.9	2,364	1,604	0	0	0	444	0	0	0	146
9.0 - 10.9	2,405	1,941	0	0	0	588	0	0	0	258
11.0 - 12.9	2,580	2,236	0	0	1	713	0	0	0	338
13.0 - 14.9	2,378	2,192	0	0	0	735	0	0	0	402
15.0 - 16.9	2,389	2,182	0	0	0	789	0	0	0	489
17.0 - 18.9	2,095	2,023	0	0	0	783	0	0	0	550
19.0 - 20.9	1,943	1,911	0	0	0	847	0	0	0	543
21.0 - 28.9	6,662	6,547	0	0	3	3,156	0	0	0	2,097
29.0 +	7,743	7,688	0	0	0	2,910	0	0	0	3,745
Total	31,998	29,124	0	0	6	11,224	0	0	0	8,641

Table 28—(continued).

Subregion and diameter class (in inches)	Total	Total soft-woods	Softwoods							
			Douglas-fir	Ponderosa and Jeffrey pines	True fir	Western hemlock	Sugar pine	Western white pine	Redwood	Sitka spruce
					Million cubic feet					
Pacific Northwest:										
5.0 - 6.9	4,478	3,735	1,211	335	540	607	6	12	0	1
7.0 - 8.9	8,375	6,926	2,540	584	956	1,235	7	18	0	4
9.0 - 10.9	10,943	9,043	3,603	864	1,169	1,645	15	36	1	5
11.0 - 12.9	12,457	10,369	4,418	989	1,369	1,925	18	31	1	9
13.0 - 14.9	12,096	10,403	4,815	1,013	1,316	1,820	15	25	2	9
15.0 - 16.9	11,670	10,247	4,996	946	1,290	1,729	15	28	1	10
17.0 - 18.9	10,700	9,595	4,722	864	1,266	1,560	17	33	3	9
19.0 - 20.9	9,633	8,896	4,522	848	1,210	1,284	18	26	4	9
21.0 - 28.9	28,078	26,700	13,740	2,741	3,574	3,648	97	86	6	39
29.0 +	40,205	39,678	24,889	2,378	3,571	4,319	474	78	15	233
Total	148,635	135,591	69,454	11,563	16,261	19,772	681	372	32	328
Pacific Southwest:										
5.0 - 6.9	1,535	805	298	123	228	3	17	2	40	0
7.0 - 8.9	2,435	1,365	428	250	399	1	34	4	67	0
9.0 - 10.9	3,142	2,019	579	398	607	3	60	7	134	0
11.0 - 12.9	3,468	2,451	641	512	747	5	64	13	169	0
13.0 - 14.9	3,738	2,755	727	563	832	0	86	10	209	0
15.0 - 16.9	3,889	3,072	776	650	914	5	75	9	298	0
17.0 - 18.9	3,900	3,164	777	679	934	3	116	18	284	0
19.0 - 20.9	3,844	3,208	802	660	891	0	128	13	373	0
21.0 - 28.9	12,817	11,187	2,807	2,333	3,036	7	565	60	1,296	0
29.0 +	19,414	18,329	6,656	2,794	4,099	5	1,545	156	1,728	0
Total	58,182	48,355	14,491	8,962	12,687	31	2,691	293	4,599	0
West total:										
5.0 - 6.9	18,029	14,403	2,896	1,123	2,695	941	22	32	40	73
7.0 - 8.9	30,612	25,076	5,486	2,278	3,928	1,800	41	60	67	150
9.0 - 10.9	35,666	29,978	7,524	3,293	4,603	2,357	75	82	135	263
11.0 - 12.9	36,503	31,506	8,875	3,760	4,920	2,795	82	101	170	347
13.0 - 14.9	33,352	29,482	9,296	3,847	4,516	2,689	101	125	211	411
15.0 - 16.9	30,398	27,261	9,326	3,588	4,167	2,624	89	117	299	499
17.0 - 18.9	26,243	23,922	8,418	3,141	3,712	2,435	133	95	287	559
19.0 - 20.9	22,755	21,070	7,622	2,758	3,220	2,215	147	80	377	552
21.0 - 28.9	63,223	59,513	21,466	8,223	8,643	6,970	663	256	1,302	2,136
29.0 +	73,692	71,697	33,371	6,621	8,428	7,293	2,019	279	1,743	3,978
Total	370,472	333,907	114,281	38,630	48,832	32,118	3,373	1,227	4,631	8,969

Table 28—(continued).

Subregion and diameter class (in inches)	Softwoods — continued						Hardwoods				
	Engelmann and other spruces	Western larch	Incense-cedar	Lodge-pole pine	Western red-cedar	Other soft-woods	Total hard-woods	Cotton-wood and aspen	Red alder	Oak	Other hard-woods
					Million cubic feet						
Great Plains:											
5.0 - 6.9	4	0	0	0	0	53	177	5	0	1	17
7.0 - 8.9	10	0	0	0	0	70	228	4	0	0	224
9.0 - 10.9	18	0	0	0	0	80	269	4	0	0	265
11.0 - 12.9	13	0	0	0	0	83	241	2	0	0	240
13.0 - 14.9	19	0	0	0	0	72	240	0	0	0	240
15.0 - 16.9	14	0	0	0	0	58	213	0	0	0	213
17.0 - 18.9	7	0	0	0	0	47	187	0	0	0	187
19.0 - 20.9	7	0	0	0	0	24	153	0	0	0	153
21.0 - 28.9	0	0	0	0	0	22	418	0	0	0	418
29.0 +	0	0	0	0	0	0	255	0	0	0	255
Total	92	0	0	0	0	510	2,380	14	0	1	2,364
Intermountain:											
5.0 - 6.9	724	197	0	3,580	199	235	1,338	1,267	0	0	70
7.0 - 8.9	1,337	382	0	6,013	204	471	2,029	1,952	0	0	77
9.0 - 10.9	1,753	503	0	5,476	247	539	1,932	1,880	0	0	52
11.0 - 12.9	2,041	487	1	3,945	236	558	1,308	1,285	0	0	23
13.0 - 14.9	2,093	434	0	2,170	234	492	767	744	0	0	22
15.0 - 16.9	1,932	340	1	1,099	209	417	478	474	0	0	4
17.0 - 18.9	1,643	324	0	510	173	275	220	218	0	0	2
19.0 - 20.9	1,393	234	0	214	158	234	128	128	0	0	0
21.0 - 28.9	2,894	612	1	199	483	501	169	169	0	0	0
29.0 +	814	234	2	18	558	238	73	72	0	0	1
Total	16,623	3,748	4	23,224	2,701	3,961	8,442	8,190	0	1	251
Alaska:											
5.0 - 6.9	382	0	0	3	13	72	639	175	7	0	456
7.0 - 8.9	829	3	0	10	26	146	760	166	14	0	581
9.0 - 10.9	824	0	0	13	42	216	464	111	10	0	343
11.0 - 12.9	812	0	0	14	57	300	343	76	9	0	258
13.0 - 14.9	616	0	0	11	73	355	186	51	9	0	127
15.0 - 16.9	430	0	0	12	79	383	207	47	4	0	156
17.0 - 18.9	225	0	0	5	81	379	72	39	7	0	26
19.0 - 20.9	91	0	0	5	106	319	32	25	0	0	6
21.0 - 28.9	75	0	0	9	306	901	115	98	13	0	4
29.0 +	4	0	0	0	430	600	55	54	0	0	1
Total	4,287	3	0	81	1,213	3,671	2,873	843	73	0	1,957

Table 28—(continued).

	Softwoods — continued						Hardwoods				
Subregion and diameter class (in inches)	Engelmann and other spruces	Western larch	Incense-cedar	Lodgepole pine	Western redcedar	Other softwoods	Total hardwoods	Cottonwood and aspen	Red alder	Oak	Other hardwoods
						Million cubic feet					
Pacific Northwest:											
5.0 - 6.9	70	94	20	669	127	42	743	15	375	41	312
7.0 - 8.9	118	170	30	938	227	100	1,449	34	865	44	506
9.0 - 10.9	190	240	33	843	248	152	1,900	65	1,195	60	580
11.0 - 12.9	232	249	30	634	286	179	2,088	68	1,410	54	556
13.0 - 14.9	243	252	28	404	286	175	1,694	44	1,119	66	465
15.0 - 16.9	260	233	39	227	275	197	1,422	65	941	41	375
17.0 - 18.9	247	230	25	145	280	195	1,105	62	667	48	328
19.0 - 20.9	230	187	40	70	266	180	737	70	374	28	265
21.0 - 28.9	559	436	145	63	983	585	1,378	206	530	63	579
29.0 +	667	146	334	9	2,056	511	527	112	60	32	323
Total	2,817	2,236	723	4,001	5,034	2,317	13,044	739	7,536	479	4,289
Pacific Southwest:											
5.0 - 6.9	1	0	71	15	0	9	730	2	17	376	335
7.0 - 8.9	0	0	119	47	1	15	1,070	5	41	549	475
9.0 - 10.9	1	0	126	76	0	28	1,123	8	56	565	495
11.0 - 12.9	0	0	174	92	0	32	1,017	7	38	485	488
13.0 - 14.9	4	0	178	110	0	36	983	7	28	472	476
15.0 - 16.9	4	0	197	115	0	30	816	12	12	373	419
17.0 - 18.9	0	0	205	104	0	43	737	2	5	364	366
19.0 - 20.9	3	0	185	111	0	41	636	5	10	282	339
21.0 - 28.9	10	0	664	310	0	98	1,630	19	15	818	778
29.0 +	14	0	964	215	0	153	1,085	5	8	648	424
Total	37	0	2,884	1,195	1	485	9,826	71	230	4,932	4,594
West total:											
5.0 - 6.9	1,182	291	91	4,267	338	412	3,626	1,464	399	418	1,345
7.0 - 8.9	2,294	555	149	7,007	459	803	5,536	2,160	921	593	1,862
9.0 - 10.9	2,785	743	159	6,407	538	1,015	5,688	2,067	1,261	626	1,734
11.0 - 12.9	3,099	736	205	4,684	578	1,152	4,997	1,438	1,456	539	1,564
13.0 - 14.9	2,975	686	206	2,695	593	1,130	3,869	846	1,155	539	1,330
15.0 - 16.9	2,640	573	237	1,453	563	1,085	3,137	598	958	415	1,167
17.0 - 18.9	2,121	554	229	765	534	939	2,320	321	679	412	908
19.0 - 20.9	1,723	422	225	401	530	798	1,685	228	384	310	763
21.0 - 28.9	3,538	1,048	810	580	1,772	2,107	3,710	492	559	881	1,778
29.0 +	1,499	380	1,300	242	3,044	1,501	1,995	243	67	680	1,004
Total	23,856	5,987	3,611	28,501	8,949	10,943	36,565	9,857	7,839	5,414	13,456

Note: Data may not add to totals because of rounding. Total volume by State in this table may differ slightly from volume by State in other tables because of rounding.

Table 29—Net volume of growing stock on planted and natural timberland in the Eastern and Western United States by forest type group and major ownership group, 2002

	All ownership groups			Public ownerships			Private ownerships		
Forest type group[a]	Total	Planted	Natural	Total	Planted	Natural	Total	Planted	Natural
				Million cubic feet					
North:									
White-red-jack pine	19,314	4,189	14,914	4,758	1,849	2,812	14,556	2,340	12,102
Spruce-fir	17,259	478	16,576	4,805	228	4,514	12,455	250	12,062
Longleaf-slash pine	0	0	0	0	0	0	0	0	0
Loblolly-shortleaf pine	2,214	357	1,857	727	142	585	1,486	215	1,272
Oak-pine	4,844	320	4,523	774	95	679	4,070	226	3,844
Oak-hickory	67,861	239	67,309	11,283	55	11,138	56,578	184	56,171
Oak-gum-cypress	1,000	11	989	167	11	156	834	0	834
Elm-ash-cottonwood	11,290	89	11,148	2,143	20	2,106	9,147	69	9,042
Maple-beech-birch	76,029	226	74,390	14,365	80	13,940	61,663	147	60,450
Aspen-birch	17,804	57	17,126	6,458	15	6,254	11,345	42	10,872
Nonstocked	14	0	12	6	0	5	8	0	7
North total:	217,628	5,966	208,845	45,486	2,494	42,190	172,142	3,473	166,655
South:									
White-red-jack pine	1,808	259	1,549	536	52	484	1,272	208	1,065
Spruce-fir	16	0	16	7	0	7	9	0	9
Longleaf-slash pine	13,621	6,026	7,595	3,169	561	2,608	10,452	5,465	4,987
Loblolly-shortleaf pine	68,152	21,174	46,978	9,331	1,350	7,981	58,820	19,824	38,996
Oak-pine	33,646	1,796	31,851	4,963	179	4,784	28,683	1,617	27,067
Oak-hickory	97,016	392	96,624	12,946	47	12,899	84,069	344	83,725
Oak-gum-cypress	48,378	51	48,327	5,925	0	5,925	42,453	50	42,403
Elm-ash-cottonwood	3,594	47	3,546	478	0	478	3,115	47	3,068
Maple-beech-birch	1,722	2	1,719	331	0	331	1,390	2	1,388
Aspen-birch	0	0	0	0	0	0	0	0	0
Nonstocked	12	1	11	1	0	1	12	1	11
South total:	267,965	29,749	238,216	37,688	2,189	35,498	230,277	27,559	202,718
Western[b]:									
Douglas-fir	107,187	[b]	[b]	77,029	[b]	[b]	30,157	[b]	[b]
Ponderosa pine	40,401	[b]	[b]	20,660	[b]	[b]	19,742	[b]	[b]
Western white pine	318	[b]	[b]	273	[b]	[b]	46	[b]	[b]
Fir-spruce	68,394	[b]	[b]	59,882	[b]	[b]	8,511	[b]	[b]
Hemlock-Sitka spruce	56,190	[b]	[b]	42,953	[b]	[b]	13,237	[b]	[b]
Larch	3,059	[b]	[b]	2,327	[b]	[b]	732	[b]	[b]
Lodgepole pine	27,467	[b]	[b]	24,047	[b]	[b]	3,421	[b]	[b]
Redwood	4,990	[b]	[b]	634	[b]	[b]	4,356	[b]	[b]
Other softwoods	21,205	[b]	[b]	20,835	[b]	[b]	369	[b]	[b]
Western hardwoods	40,639	[b]	[b]	18,593	[b]	[b]	22,046	[b]	[b]
Pinyon-juniper	347	[b]	[b]	230	[b]	[b]	117	[b]	[b]
Nonstocked	267	[b]	[b]	111	[b]	[b]	156	[b]	[b]
Western total:	370,464	[b]	[b]	267,574	[b]	[b]	102,890	[b]	[b]
United States:	856,057	[b]	[b]	350,748	[b]	[b]	505,309	[b]	[b]

[a] Forest type reflects the current dominant species by plurality of stocking and may not reflect the actual species planted at the time of stand origin.

[b] Approximately 13.6 million acres of forest in the West are planted, primarily to augment natural regeneration after a harvest and ensure adequate stocking of desired species. The species planted are usually native, making these stands difficult to detect during field sampling. Additionally, there are thousands of acres of more traditional plantations such as those found in the East that are not currently identified during field sampling. Refer to the text accompanying this report for a discussion of planted forest in the West.

Note: Data may not add to totals because of rounding.

Table 30—Net volume of softwood growing stock on timberland in the United States by diameter class, region, and subregion, 2002, 1997, 1987, 1977, and 1953

			Diameter class (Inches)									
Region and subregion	Year	Total	5.0 to 6.9	7.0 to 8.9	9.0 to 10.9	11.0 to 12.9	13.0 to 14.9	15.0 to 16.9	17.0 to 18.9	19.0 to 20.9	21.0 to 28.9	29.0+
			Million cubic feet									
North:												
Northeast	2002	31,476	3,738	5,298	5,167	4,776	3,908	2,856	1,900	1,286	2,073	474
	1997	30,945	3,744	5,318	5,133	4,751	3,810	2,783	1,827	1,227	1,935	417
	1987	31,609	4,751	6,404	6,043	4,919	3,351	2,288	1,426	904	1,291	232
	1977	30,991	7,639	7,255	5,431	3,877	2,547	1,711	1,018	607	767	138
	1953	20,028	4,628	4,734	3,147	2,498	1,791	1,190	721	527	702	90
North Central	2002	18,402	3,543	4,140	3,322	2,377	1,580	1,062	769	543	891	177
	1997	18,431	3,571	4,149	3,316	2,374	1,579	1,058	772	542	893	178
	1987	16,009	3,429	3,816	2,939	1,964	1,285	865	609	426	598	81
	1977	12,859	3,163	3,103	2,190	1,430	949	695	491	315	461	60
	1953	7,025	1,802	1,592	1,167	862	516	348	261	161	274	41
North total:	2002	49,878	7,281	9,438	8,488	7,153	5,487	3,918	2,669	1,829	2,963	651
	1997	49,376	7,314	9,467	8,449	7,125	5,389	3,841	2,599	1,769	2,828	595
	1987	47,618	8,180	10,220	8,982	6,883	4,636	3,153	2,035	1,330	1,889	313
	1977	43,850	10,802	10,358	7,621	5,307	3,496	2,406	1,509	922	1,228	198
	1953	27,053	6,430	6,326	4,314	3,360	2,307	1,538	982	688	976	131
South:												
Southeast	2002	52,758	6,737	9,702	9,315	8,039	6,436	4,833	3,082	1,968	2,294	353
	1997	51,861	6,621	9,358	9,146	8,043	6,447	4,732	3,032	1,888	2,293	301
	1987	52,619	6,483	9,420	9,878	8,847	6,834	4,544	2,886	1,640	1,845	242
	1977	51,008	6,929	9,384	9,780	8,535	6,467	4,337	2,500	1,408	1,487	181
	1953	35,548	4,547	6,776	7,473	6,574	4,265	2,550	1,464	805	969	125
South Central	2002	55,260	5,132	7,983	8,348	8,507	7,737	6,320	4,372	2,826	3,619	417
	1997	52,985	4,772	7,530	8,014	8,364	7,602	6,117	4,172	2,677	3,344	393
	1987	52,994	4,765	7,521	8,985	8,978	7,515	5,788	3,885	2,418	2,844	298
	1977	50,200	5,178	7,691	8,771	8,451	6,923	5,126	3,406	2,082	2,340	232
	1953	24,914	2,596	3,834	4,554	4,338	3,473	2,556	1,645	886	910	122
South total:	2002	108,018	11,868	17,685	17,663	16,546	14,173	11,153	7,454	4,794	5,913	769
	1997	104,846	11,393	16,888	17,160	16,407	14,049	10,849	7,204	4,564	5,637	694
	1987	105,613	11,248	16,941	18,863	17,825	14,349	10,332	6,771	4,058	4,689	540
	1977	101,208	12,107	17,075	18,551	16,986	13,390	9,463	5,906	3,490	3,827	413
	1953	60,462	7,143	10,610	12,027	10,912	7,738	5,106	3,109	1,691	1,879	247
Rocky Mountain:												
Great Plains	2002	1,880	129	267	348	309	291	240	138	89	69	0
	1997	1,563	145	267	271	266	221	157	107	64	63	2
	1987	1,912	162	278	334	339	285	215	156	74	69	1
	1977	1,799	147	267	324	315	263	195	130	83	72	2
	1953	1,309	68	132	174	197	177	176	136	111	131	8
Intermountain	2002	118,957	8,934	14,914	16,628	16,140	13,841	11,519	9,002	6,966	15,010	6,002
	1997	113,118	9,164	14,678	15,933	15,176	12,897	10,605	8,428	6,485	14,056	5,695
	1987	98,386	8,639	12,318	13,388	12,425	10,685	8,957	7,142	5,603	13,161	6,074
	1977	93,318	9,383	11,772	11,883	10,950	9,682	8,172	6,912	5,681	13,305	5,580
	1953	86,237	8,573	8,455	8,956	8,968	8,542	7,858	6,884	5,886	14,935	7,178

Table 30—(continued).

			Diameter class (Inches)									
Region and subregion	Year	Total	5.0 to 6.9	7.0 to 8.9	9.0 to 10.9	11.0 to 12.9	13.0 to 14.9	15.0 to 16.9	17.0 to 18.9	19.0 to 20.9	21.0 to 28.9	29.0+
						Million cubic feet						
Rocky Mountain total:	2002	120,837	9,063	15,180	16,976	16,449	14,132	11,760	9,141	7,055	15,079	6,002
	1997	114,681	9,309	14,945	16,204	15,442	13,118	10,762	8,535	6,549	14,120	5,697
	1987	100,298	8,801	12,596	13,722	12,764	10,970	9,172	7,298	5,677	13,230	6,075
	1977	95,111	9,529	12,038	12,206	11,264	9,944	8,366	7,041	5,763	13,376	5,581
	1953	87,546	8,641	8,587	9,130	9,165	8,719	8,034	7,020	5,997	15,066	7,186
Pacific Coast:												
Alaska	2002	29,124	800	1,604	1,941	2,236	2,192	2,182	2,023	1,911	6,547	7,688
	1997	29,810	743	1,538	1,830	2,044	2,162	1,995	2,052	2,008	6,908	8,530
	1987	37,051	956	1,934	2,394	2,705	2,675	2,662	2,750	2,506	8,797	9,670
	1977	48,277	1,346	1,849	2,754	3,521	3,996	4,116	3,685	3,424	11,547	12,042
	1953	49,149	1,103	1,495	2,279	3,097	3,619	3,963	3,792	3,624	12,414	13,764
Pacific Northwest	2002	135,591	3,735	6,926	9,043	10,369	10,403	10,247	9,595	8,896	26,700	39,678
	1997	135,969	3,767	6,983	9,101	10,397	10,471	10,273	9,629	8,884	26,732	39,732
	1987	130,684	4,154	7,662	9,780	10,863	10,636	10,266	9,527	8,533	24,926	34,337
	1977	132,535	5,821	7,235	8,235	8,800	8,719	8,682	8,493	7,859	26,299	42,392
	1953	149,574	4,264	5,593	6,366	7,370	7,242	8,090	7,844	7,967	29,507	65,331
Pacific Southwest	2002	48,355	805	1,365	2,019	2,451	2,755	3,072	3,164	3,208	11,187	18,329
	1997	49,172	820	1,444	2,064	2,462	2,676	3,070	3,134	3,201	11,369	18,931
	1987	46,311	891	1,417	1,754	2,135	2,383	2,627	2,791	2,664	10,222	19,429
	1977	45,979	769	1,259	1,613	1,885	2,213	2,387	2,456	2,511	10,016	20,870
	1953	58,010	766	1,245	1,603	1,835	2,055	2,160	2,269	2,282	10,141	33,654
Pacific Coast total:	2002	213,070	5,341	9,895	13,002	15,056	15,350	15,502	14,782	14,015	44,434	65,695
	1997	214,951	5,330	9,966	12,994	14,903	15,309	15,339	14,815	14,093	45,009	67,193
	1987	214,046	6,001	11,013	13,928	15,703	15,694	15,555	15,068	13,703	43,945	63,436
	1977	226,791	7,936	10,343	12,602	14,206	14,928	15,185	14,634	13,794	47,862	75,304
	1953	256,733	6,133	8,333	10,248	12,302	12,916	14,213	13,905	13,873	52,062	112,749
United States:	2002	491,803	33,552	52,199	56,129	55,206	49,142	42,332	34,045	27,692	68,389	73,117
	1997	483,854	33,346	51,266	54,808	53,877	47,865	40,791	33,153	26,975	67,593	74,179
	1987	467,575	34,230	50,770	55,495	53,175	45,649	38,212	31,172	24,768	63,753	70,364
	1977	466,960	40,374	49,812	50,980	47,763	41,758	35,419	29,089	23,968	66,295	81,495
	1953	431,794	28,346	33,857	35,719	35,737	31,679	28,892	25,016	22,248	69,981	120,314

Note: Data may not add to totals because of rounding. Total volume by subregion in this table may differ slightly from total volume by subregion in other tables because of rounding.

Table 31—Net volume of hardwood growing stock on timberland in the United States by diameter class, region, and subregion, 2002, 1997, 1987, 1977, and 1953

Region and subregion	Year	Total	Diameter class (Inches) 5.0 to 6.9	7.0 to 8.9	9.0 to 10.9	11.0 to 12.9	13.0 to 14.9	15.0 to 16.9	17.0 to 18.9	19.0 to 20.9	21.0 to 28.9	29.0+
			Million cubic feet									
North:												
Northeast	2002	92,191	7,929	13,139	15,694	14,337	12,344	9,436	6,497	4,408	6,769	1,639
	1997	90,234	8,137	13,420	15,604	14,110	12,048	9,054	6,165	4,145	6,160	1,391
	1987	80,524	9,280	13,288	14,328	12,619	10,359	7,344	5,022	3,090	4,402	794
	1977	67,320	10,488	12,220	12,275	9,872	7,790	5,458	3,558	2,240	2,968	451
	1953	43,197	6,926	7,703	7,332	5,712	4,652	3,578	2,532	1,660	2,709	395
North Central	2002	75,555	7,325	10,501	12,198	11,386	9,813	7,580	5,450	3,675	6,093	1,535
	1997	74,640	7,436	10,575	12,210	11,341	9,678	7,475	5,305	3,499	5,798	1,323
	1987	61,896	8,177	10,121	10,432	9,074	7,103	5,452	3,829	2,604	4,076	1,028
	1977	51,838	7,773	9,665	9,338	7,414	5,925	4,203	2,775	1,753	2,468	521
	1953	33,498	4,766	5,925	6,037	4,359	3,630	2,705	1,928	1,319	2,401	428
North total:	2002	167,746	15,253	23,640	27,892	25,724	22,157	17,016	11,947	8,083	12,861	3,174
	1997	164,874	15,573	23,995	27,814	25,451	21,726	16,529	11,471	7,644	11,958	2,714
	1987	142,420	17,457	23,409	24,760	21,693	17,462	12,796	8,851	5,694	8,478	1,822
	1977	119,158	18,261	21,885	21,613	17,286	13,715	9,661	6,333	3,993	5,436	972
	1953	76,695	11,692	13,628	13,369	10,071	8,282	6,283	4,460	2,979	5,110	823
South:												
Southeast	2002	71,244	5,514	7,805	9,525	10,139	9,669	8,430	6,387	4,688	7,441	1,647
	1997	71,124	5,598	7,861	9,542	10,208	9,781	8,365	6,387	4,613	7,219	1,550
	1987	68,154	5,963	8,156	9,556	10,345	9,516	7,805	5,787	3,815	5,947	1,264
	1977	60,691	6,005	8,037	9,192	9,239	8,346	6,500	4,616	2,985	4,766	1,005
	1953	41,533	3,558	5,218	6,391	6,315	5,900	4,309	3,293	2,226	3,603	720
South Central	2002	88,703	6,832	10,117	12,316	12,075	11,838	10,253	7,965	5,754	9,523	2,031
	1997	80,392	6,605	9,823	11,838	11,180	10,815	8,941	6,848	4,877	7,807	1,657
	1987	70,874	7,385	9,914	11,340	10,493	9,487	7,505	5,295	3,430	5,129	891
	1977	61,474	7,426	8,978	9,843	8,852	8,019	6,404	4,380	2,782	4,055	733
	1953	46,475	4,529	6,170	7,308	7,028	6,304	4,901	3,553	2,354	3,739	589
South total:	2002	159,947	12,346	17,922	21,841	22,214	21,508	18,683	14,352	10,441	16,964	3,677
	1997	151,516	12,202	17,684	21,380	21,389	20,596	17,306	13,235	9,490	15,026	3,207
	1987	139,028	13,348	18,070	20,896	20,838	19,003	15,310	11,082	7,245	11,076	2,155
	1977	122,165	13,431	17,015	19,035	18,091	16,365	12,904	8,996	5,767	8,821	1,738
	1953	88,008	8,087	11,388	13,699	13,343	12,204	9,210	6,846	4,580	7,342	1,309
Rocky Mountain:												
Great Plains	2002	2,380	177	228	269	241	240	213	187	153	418	255
	1997	2,368	175	225	265	240	239	212	187	153	418	255
	1987	1,468	168	158	177	148	136	116	96	82	230	161
	1977	1,273	133	149	169	155	136	114	90	76	230	21
	1953	1,098	92	130	139	106	121	113	97	78	199	22
Intermountain	2002	8,442	1,338	2,029	1,932	1,308	767	478	220	128	169	73
	1997	8,250	1,462	1,933	1,837	1,222	750	439	216	139	178	74
	1987	6,213	1,086	1,423	1,424	888	550	317	167	124	163	75
	1977	4,865	797	1,164	1,007	738	462	278	175	95	133	14
	1953	3,976	444	802	817	660	467	298	188	114	158	25

Table 31—(continued).

			Diameter class (Inches)									
Region and subregion	Year	Total	5.0 to 6.9	7.0 to 8.9	9.0 to 10.9	11.0 to 12.9	13.0 to 14.9	15.0 to 16.9	17.0 to 18.9	19.0 to 20.9	21.0 to 28.9	29.0+
						Million cubic feet						
Rocky Mountain total:	2002	10,822	1,515	2,257	2,201	1,549	1,007	691	407	281	587	328
	1997	10,618	1,636	2,158	2,103	1,461	989	652	402	292	596	328
	1987	7,681	1,254	1,581	1,601	1,036	686	433	263	206	393	236
	1977	6,138	930	1,313	1,176	893	598	392	265	171	363	35
	1953	5,074	536	932	956	766	588	411	285	192	357	47
Pacific Coast:												
Alaska	2002	2,873	639	760	464	343	186	207	72	32	115	55
	1997	3,145	583	710	466	359	224	281	124	102	233	63
	1987	4,209	664	1,030	675	562	335	337	187	135	216	70
	1977	4,222	616	915	744	416	373	304	203	148	313	190
	1953	4,189	610	874	720	407	370	305	208	155	335	205
Pacific Northwest	2002	13,044	743	1,449	1,900	2,088	1,694	1,422	1,105	737	1,378	527
	1997	13,049	742	1,454	1,905	2,083	1,698	1,417	1,113	731	1,380	524
	1987	13,005	826	1,567	2,079	2,116	1,813	1,364	1,020	633	1,151	438
	1977	10,522	1,199	1,475	1,594	1,520	1,299	971	762	511	924	267
	1953	7,076	1,037	1,062	1,049	961	807	529	458	321	671	187
Pacific Southwest	2002	9,826	730	1,070	1,123	1,017	983	816	737	636	1,630	1,085
	1997	8,613	641	892	876	948	882	704	661	583	1,548	879
	1987	7,740	551	798	823	781	750	699	626	485	1,412	819
	1977	3,891	254	411	415	391	368	365	299	266	720	402
	1953	3,048	193	320	250	281	301	257	242	203	536	466
Pacific Coast total:	2002	25,743	2,112	3,279	3,487	3,448	2,862	2,446	1,913	1,405	3,123	1,667
	1997	24,808	1,966	3,055	3,247	3,391	2,804	2,403	1,899	1,416	3,162	1,466
	1987	24,954	2,041	3,395	3,577	3,459	2,898	2,400	1,833	1,253	2,779	1,327
	1977	18,635	2,069	2,801	2,753	2,327	2,040	1,640	1,264	925	1,957	859
	1953	14,313	1,840	2,256	2,019	1,649	1,478	1,091	908	679	1,542	858
United States:	2002	364,259	31,225	47,098	55,420	52,935	47,534	38,836	28,619	20,209	33,535	8,846
	1997	351,815	31,377	46,892	54,544	51,692	46,115	36,890	27,006	18,843	30,742	7,715
	1987	314,083	34,100	46,455	50,834	47,026	40,049	30,939	22,029	14,398	22,726	5,540
	1977	266,096	34,691	43,014	44,577	38,597	32,718	24,597	16,858	10,856	16,577	3,604
	1953	184,090	22,155	28,204	30,043	25,829	22,552	16,995	12,499	8,430	14,351	3,037

Note: Data may not add to totals because of rounding. Total volume by subregion in this table may differ slightly from total volume by subregion in other tables because of rounding.

Table 32—Net volume of growing stock on timberland in the United States by diameter class, region, and subregion, 2002, 1997, 1987, 1977, and 1953

			Diameter class (Inches)									
Region and subregion	Year	Total	5.0 to 6.9	7.0 to 8.9	9.0 to 10.9	11.0 to 12.9	13.0 to 14.9	15.0 to 16.9	17.0 to 18.9	19.0 to 20.9	21.0 to 28.9	29.0+
						Million cubic feet						
North:												
Northeast	2002	123,667	11,667	18,437	20,860	19,113	16,251	12,293	8,397	5,694	8,841	2,113
	1997	121,179	11,880	18,738	20,738	18,862	15,858	11,838	7,992	5,372	8,094	1,808
	1987	112,133	14,031	19,692	20,371	17,538	13,710	9,632	6,448	3,994	5,693	1,026
	1977	98,311	18,127	19,475	17,706	13,749	10,337	7,169	4,576	2,847	3,735	589
	1953	63,225	11,554	12,437	10,479	8,210	6,443	4,768	3,253	2,187	3,411	485
North Central	2002	93,957	10,867	14,641	15,519	13,764	11,393	8,642	6,219	4,217	6,983	1,712
	1997	93,072	11,007	14,724	15,526	13,714	11,257	8,533	6,078	4,042	6,691	1,501
	1987	77,905	11,606	13,937	13,371	11,038	8,388	6,317	4,438	3,030	4,674	1,109
	1977	64,697	10,936	12,768	11,528	8,844	6,874	4,898	3,266	2,068	2,929	581
	1953	40,523	6,568	7,517	7,204	5,221	4,146	3,053	2,189	1,480	2,675	469
North total:	2002	217,625	22,534	33,078	36,380	32,877	27,644	20,935	14,616	9,911	15,825	3,824
	1997	214,251	22,887	33,462	36,264	32,576	27,115	20,371	14,070	9,413	14,785	3,308
	1987	190,038	25,637	33,629	33,742	28,576	22,098	15,949	10,886	7,024	10,367	2,135
	1977	163,008	29,063	32,243	29,234	22,593	17,211	12,067	7,842	4,915	6,664	1,170
	1953	103,748	18,122	19,954	17,683	13,431	10,589	7,821	5,442	3,667	6,086	954
South:												
Southeast	2002	124,001	12,250	17,507	18,840	18,178	16,105	13,263	9,469	6,655	9,736	1,999
	1997	122,985	12,218	17,219	18,688	18,252	16,229	13,097	9,419	6,500	9,512	1,850
	1987	120,773	12,446	17,576	19,434	19,192	16,350	12,349	8,673	5,455	7,792	1,506
	1977	111,699	12,934	17,421	18,972	17,774	14,813	10,837	7,116	4,393	6,253	1,186
	1953	77,081	8,105	11,994	13,864	12,889	10,165	6,859	4,757	3,031	4,572	845
South Central	2002	143,964	11,964	18,100	20,664	20,582	19,576	16,573	12,337	8,580	13,141	2,448
	1997	133,377	11,377	17,353	19,852	19,544	18,417	15,058	11,020	7,554	11,151	2,051
	1987	123,868	12,150	17,435	20,325	19,471	17,002	13,293	9,180	5,848	7,973	1,189
	1977	111,674	12,604	16,669	18,614	17,303	14,942	11,530	7,786	4,864	6,395	965
	1953	71,389	7,125	10,004	11,862	11,366	9,777	7,457	5,198	3,240	4,649	711
South total:	2002	267,965	24,214	35,607	39,504	38,760	35,681	29,835	21,806	15,235	22,877	4,447
	1997	256,361	23,595	34,572	38,540	37,796	34,645	28,155	20,439	14,054	20,664	3,901
	1987	244,641	24,596	35,011	39,759	38,663	33,352	25,642	17,853	11,303	15,765	2,695
	1977	223,373	25,538	34,090	37,586	35,077	29,755	22,367	14,902	9,257	12,648	2,151
	1953	148,470	15,230	21,998	25,726	24,255	19,942	14,316	9,955	6,271	9,221	1,556
Rocky Mountain:												
Great Plains	2002	4,259	306	495	616	551	531	453	325	242	486	255
	1997	3,931	320	492	536	506	460	369	294	217	481	257
	1987	3,380	330	436	511	487	421	331	252	156	299	162
	1977	3,072	280	416	493	470	399	309	220	159	302	23
	1953	2,407	160	262	313	303	298	289	233	189	330	30
Intermountain	2002	127,399	10,272	16,943	18,561	17,448	14,608	11,997	9,222	7,094	15,179	6,075
	1997	121,368	10,626	16,611	17,770	16,397	13,647	11,044	8,644	6,625	14,235	5,769
	1987	104,599	9,725	13,741	14,812	13,313	11,235	9,274	7,309	5,727	13,324	6,149
	1977	98,183	10,180	12,936	12,890	11,688	10,144	8,450	7,087	5,776	13,438	5,594
	1953	90,213	9,017	9,257	9,773	9,628	9,009	8,156	7,072	6,000	15,093	7,203

Table 32—(continued).

			Diameter class (Inches)									
Region and subregion	Year	Total	5.0 to 6.9	7.0 to 8.9	9.0 to 10.9	11.0 to 12.9	13.0 to 14.9	15.0 to 16.9	17.0 to 18.9	19.0 to 20.9	21.0 to 28.9	29.0+
			Million cubic feet									
Rocky Mountain total:	2002	131,658	10,577	17,437	19,177	17,999	15,139	12,450	9,547	7,336	15,665	6,330
	1997	125,299	10,945	17,103	18,306	16,903	14,107	11,414	8,938	6,842	14,716	6,026
	1987	107,979	10,055	14,177	15,323	13,800	11,656	9,605	7,561	5,883	13,623	6,311
	1977	101,255	10,460	13,352	13,383	12,158	10,543	8,759	7,307	5,935	13,740	5,617
	1953	92,620	9,177	9,519	10,086	9,931	9,307	8,445	7,305	6,189	15,423	7,233
Pacific Coast:												
Alaska	2002	31,998	1,439	2,364	2,405	2,580	2,378	2,389	2,095	1,943	6,662	7,743
	1997	32,955	1,326	2,248	2,296	2,403	2,387	2,277	2,175	2,110	7,141	8,593
	1987	41,260	1,620	2,964	3,069	3,267	3,010	2,999	2,937	2,641	9,013	9,740
	1977	52,499	1,962	2,764	3,498	3,937	4,369	4,420	3,888	3,572	11,860	12,232
	1953	53,338	1,713	2,369	2,999	3,504	3,989	4,268	4,000	3,779	12,749	13,969
Pacific Northwest	2002	148,635	4,478	8,375	10,943	12,457	12,096	11,670	10,700	9,633	28,078	40,205
	1997	149,018	4,509	8,438	11,006	12,480	12,169	11,690	10,743	9,615	28,112	40,256
	1987	143,698	4,979	9,230	11,859	12,989	12,450	11,630	10,546	9,166	26,077	34,775
	1977	143,057	7,020	8,710	9,829	10,320	10,018	9,653	9,255	8,370	27,223	42,659
	1953	156,650	5,301	6,655	7,415	8,331	8,049	8,619	8,302	8,288	30,178	65,518
Pacific Southwest	2002	58,182	1,535	2,435	3,142	3,468	3,738	3,889	3,900	3,844	12,817	19,414
	1997	57,785	1,461	2,336	2,939	3,411	3,557	3,775	3,795	3,784	12,917	19,810
	1987	54,051	1,442	2,215	2,577	2,916	3,133	3,326	3,417	3,149	11,634	20,248
	1977	49,870	1,023	1,670	2,028	2,276	2,581	2,752	2,755	2,777	10,736	21,272
	1953	61,058	959	1,565	1,853	2,116	2,356	2,417	2,511	2,485	10,677	34,120
Pacific Coast total:	2002	238,814	7,452	13,175	16,489	18,504	18,213	17,948	16,695	15,419	47,557	67,361
	1997	239,758	7,296	13,022	16,241	18,294	18,113	17,742	16,713	15,509	48,170	68,659
	1987	239,009	8,041	14,409	17,505	19,172	18,593	17,955	16,900	14,956	46,724	64,763
	1977	245,426	10,005	13,144	15,355	16,533	16,968	16,825	15,898	14,719	49,819	76,163
	1953	271,046	7,973	10,589	12,267	13,951	14,394	15,304	14,813	14,552	53,604	113,607
United States:	2002	856,062	64,778	99,297	111,549	108,141	96,677	81,168	62,665	47,902	101,924	81,963
	1997	835,669	64,723	98,158	109,352	105,569	93,981	77,681	60,159	45,818	98,335	81,894
	1987	781,667	68,329	97,226	106,329	100,211	85,699	69,151	53,200	39,166	86,479	75,904
	1977	733,062	75,066	92,829	95,558	86,361	74,477	60,018	45,949	34,826	82,871	85,101
	1953	615,884	50,502	62,060	65,762	61,568	54,232	45,886	37,515	30,679	84,334	123,350

Note: Data may not add to totals because of rounding. Total volume by subregion in this table may differ slightly from total volume by subregion in other tables because of rounding.

Table 33—Annual mortality of growing stock on timberland in the United States by ownership group, region, subregion, and species group, 2001, 1996, 1986, 1976, and 1952

Region, subregion, and species group	All owners					National forest					Other public[a]				
	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
	Thousand cubic feet														
North:															
Northeast:															
Softwoods	274,607	273,609	257,140	191,544	150,800	7,705	7,549	5,393	1,746	3,570	18,814	16,790	14,875	10,561	6,911
Hardwoods	535,577	514,142	418,217	356,773	248,200	27,500	26,217	15,518	10,823	9,810	82,359	73,113	51,156	33,580	21,982
Total	810,272	787,750	675,357	548,317	399,000	35,201	33,766	20,911	12,569	13,380	101,155	89,902	66,031	44,141	28,893
North Central:															
Softwoods	182,572	181,907	110,926	132,777	64,834	32,998	32,973	19,836	21,732	16,214	60,390	60,153	41,299	36,930	19,644
Hardwoods	690,051	658,116	456,852	467,451	226,384	55,800	55,959	44,034	36,115	18,417	124,715	121,076	87,701	102,796	38,737
Total	872,899	840,022	567,778	600,228	291,218	88,850	88,932	63,870	57,847	34,631	185,176	181,229	129,000	139,726	58,381
North total:															
Softwoods	457,179	455,516	368,066	324,321	215,634	40,704	40,522	25,229	23,478	19,784	79,204	76,943	56,174	47,491	26,555
Hardwoods	1,225,628	1,172,257	875,069	824,224	474,584	83,300	82,176	59,552	46,938	28,227	207,074	194,189	138,857	136,376	60,719
Total	1,683,171	1,627,773	1,243,135	1,148,545	690,218	124,051	122,698	84,781	70,416	48,011	286,331	271,132	195,031	183,867	87,274
South:															
Southeast:															
Softwoods	451,263	629,975	489,320	416,000	234,700	34,841	58,533	30,147	21,447	11,800	33,125	41,084	26,081	18,553	11,100
Hardwoods	535,766	603,553	371,125	286,783	283,800	48,325	53,034	35,262	24,358	18,600	31,795	31,725	14,171	13,018	6,300
Total	987,000	1,233,528	860,445	702,783	518,500	83,176	111,567	65,409	45,805	30,400	64,921	72,809	40,252	31,571	17,400
South Central:															
Softwoods	467,255	405,829	351,451	216,201	98,700	47,226	34,270	29,491	19,769	12,132	19,621	17,169	11,919	6,983	3,000
Hardwoods	622,344	596,714	460,976	359,267	355,200	38,791	28,680	18,285	14,497	12,227	52,257	50,648	30,302	18,081	8,359
Total	1,089,498	1,002,543	812,427	575,468	453,900	86,022	62,950	47,776	34,266	24,359	71,871	67,817	42,221	25,064	11,359
South total:															
Softwoods	918,519	1,035,804	840,771	632,201	333,400	82,067	92,803	59,638	41,216	23,932	52,746	58,253	38,000	25,536	14,100
Hardwoods	1,158,110	1,200,267	832,101	646,050	639,000	87,116	81,714	53,547	38,855	30,827	84,052	82,373	44,473	31,099	14,659
Total	2,076,498	2,236,071	1,672,872	1,278,251	972,400	169,198	174,517	113,185	80,071	54,759	136,792	140,626	82,473	56,635	28,759
Rocky Mountain:															
Great Plains:															
Softwoods	6,896	9,563	7,033	3,940	3,300	3,968	6,857	4,483	3,543	3,025	692	666	38	130	59
Hardwoods	38,146	38,025	7,803	29,312	24,730	241	245	61	0	0	2,958	2,902	474	4,379	3,896
Total	45,086	47,587	14,836	33,252	28,030	4,215	7,102	4,544	3,543	3,025	3,648	3,568	512	4,509	3,955
Intermountain:															
Softwoods	1,012,139	889,962	487,864	454,779	565,300	838,061	708,911	365,637	270,479	388,200	55,731	55,212	51,122	66,643	66,354
Hardwoods	99,806	103,244	42,628	39,160	34,600	65,726	70,177	22,143	17,860	17,200	4,442	4,036	4,082	6,709	5,443
Total	1,111,941	993,206	530,492	493,939	599,900	903,759	779,088	387,780	288,339	405,400	60,171	59,249	55,204	73,352	71,797
Rocky Mountain total:															
Softwoods	1,019,035	899,525	494,897	458,719	568,600	842,029	715,768	370,120	274,022	391,225	56,423	55,878	51,160	66,773	66,413
Hardwoods	137,952	141,268	50,431	68,472	59,330	65,967	70,422	22,204	17,860	17,200	7,399	6,939	4,556	11,088	9,339
Total	1,157,027	1,040,793	545,328	527,191	627,930	907,974	786,190	392,324	291,882	408,425	63,819	62,817	55,716	77,861	75,752
Pacific Coast:															
Alaska:															
Softwoods	155,407	194,542	172,267	213,596	224,700	103,856	123,624	99,767	146,799	171,090	27,394	32,908	25,451	63,781	52,563
Hardwoods	8,786	10,163	9,912	9,395	9,467	1,049	430	154	1,536	1,608	6,346	6,450	5,742	7,656	7,756
Total	164,187	204,705	182,179	222,991	234,167	104,899	124,054	99,921	148,335	172,698	33,740	39,358	31,193	71,437	60,319
Pacific Northwest:															
Softwoods	783,755	777,610	657,843	699,600	952,500	468,498	468,829	422,000	326,700	407,300	96,921	95,810	113,227	172,200	210,000
Hardwoods	120,090	118,232	72,131	71,800	50,500	4,326	4,953	4,000	6,600	6,100	24,539	23,946	12,559	11,900	13,700
Total	903,875	895,842	729,974	771,400	1,003,000	472,809	473,783	426,000	333,300	413,400	121,470	119,756	125,786	184,100	223,700
Pacific Southwest:															
Softwoods	262,315	263,106	247,804	137,700	366,800	149,871	151,846	171,205	80,800	199,500	6,096	6,002	6,395	5,100	16,500
Hardwoods	57,311	51,763	24,316	6,792	10,100	7,767	2,174	5,217	2,300	7,400	3,386	3,381	2,399	870	300
Total	319,829	314,869	272,120	144,492	376,900	157,695	154,020	176,422	83,100	206,900	9,456	9,383	8,794	5,970	16,800

Table 33—(continued).

	All owners					National forest					Other public[a]				
Region, subregion, and species group	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
								Thousand cubic feet							
Pacific Coast total:															
Softwoods	1,201,477	1,235,258	1,077,914	1,050,896	1,544,000	722,225	744,299	692,972	554,299	777,890	130,411	134,721	145,073	241,081	279,063
Hardwoods	186,187	180,158	106,359	87,987	70,067	13,142	7,558	9,371	10,436	15,108	34,271	33,777	20,700	20,426	21,756
Total	1,387,892	1,415,416	1,184,273	1,138,883	1,614,067	735,403	751,857	702,343	564,735	792,998	164,666	168,498	165,773	261,507	300,819
United States:															
Softwoods	3,596,210	3,626,102	2,781,648	2,466,137	2,661,634	1,687,024	1,593,393	1,147,959	893,015	1,212,831	318,784	325,794	290,407	380,881	386,131
Hardwoods	2,707,877	2,693,950	1,863,960	1,626,733	1,242,981	249,525	241,870	144,674	114,089	91,362	332,796	317,278	208,586	198,989	106,473
Total	6,304,588	6,320,052	4,645,608	4,092,870	3,904,615	1,936,625	1,835,262	1,292,633	1,007,104	1,304,193	651,607	643,072	498,993	579,870	492,604

Table 33—(continued).

Region, subregion, and species group	Forest Industry					Nonindustrial private[a]				
	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
	Thousand cubic feet									
North:										
Northeast:										
Softwoods	100,864	101,024	95,216	65,375	37,876	147,224	148,245	141,656	113,862	102,443
Hardwoods	54,548	54,258	45,889	43,585	29,138	371,170	360,554	305,654	268,785	187,270
Total	155,545	155,283	141,105	108,960	67,014	518,372	508,799	447,310	382,647	289,713
North Central:										
Softwoods	17,149	17,149	13,254	22,180	8,308	72,034	71,632	36,537	51,935	20,668
Hardwoods	26,134	26,164	23,373	43,938	15,279	483,403	454,916	301,744	284,602	153,951
Total	43,318	43,313	36,627	66,118	23,587	555,555	526,548	338,281	336,537	174,619
North total:										
Softwoods	118,014	118,174	108,470	87,555	46,184	219,258	219,877	178,193	165,797	123,111
Hardwoods	80,682	80,422	69,262	87,523	44,417	854,573	815,470	607,398	553,387	341,221
Total	198,863	198,596	177,732	175,078	90,601	1,073,927	1,035,347	785,591	719,184	464,332
South:										
Southeast:										
Softwoods	61,572	87,772	71,127	64,000	44,200	321,725	442,587	361,965	312,000	167,600
Hardwoods	55,042	72,996	57,090	40,125	43,800	400,603	445,798	264,602	209,282	215,100
Total	116,622	160,767	128,217	104,125	88,000	722,282	888,385	626,567	521,282	382,700
South Central:										
Softwoods	96,987	97,501	85,998	64,935	38,748	303,421	256,889	224,043	124,514	44,820
Hardwoods	89,420	92,647	71,521	61,844	50,775	441,876	424,739	340,868	264,845	283,839
Total	186,369	190,148	157,519	126,779	89,523	745,235	681,628	564,911	389,359	328,659
South total:										
Softwoods	158,560	185,273	157,125	128,935	82,948	625,146	699,476	586,008	436,514	212,420
Hardwoods	144,463	165,642	128,611	101,969	94,575	842,479	870,538	605,470	474,127	498,939
Total	302,991	350,915	285,736	230,904	177,523	1,467,517	1,570,013	1,191,478	910,641	711,359
Rocky Mountain:										
Great Plains:										
Softwoods	0	0	0	24	9	2,236	2,040	2,512	243	207
Hardwoods	0	0	0	0	0	34,947	34,877	7,268	24,933	20,834
Total	0	0	0	24	9	37,223	36,917	9,780	25,176	21,041
Intermountain:										
Softwoods	41,158	41,152	27,696	22,407	22,197	77,189	84,687	43,409	95,250	88,549
Hardwoods	223	223	0	359	441	29,415	28,807	16,403	14,232	11,516
Total	41,381	41,375	27,696	22,766	22,638	106,631	113,494	59,812	109,482	100,065
Rocky Mountain total:										
Softwoods	41,158	41,152	27,696	22,431	22,206	79,425	86,727	45,921	95,493	88,756
Hardwoods	223	223	0	359	441	64,363	63,685	23,671	39,165	32,350
Total	41,381	41,375	27,696	22,790	22,647	143,854	150,412	69,592	134,658	121,106
Pacific Coast:										
Alaska:										
Softwoods	0	0	0	0	0	24,157	38,010	47,049	3,016	1,047
Hardwoods	0	0	0	0	0	1,392	3,283	4,016	203	103
Total	0	0	0	0	0	25,549	41,293	51,065	3,219	1,150
Pacific Northwest:										
Softwoods	113,150	111,361	74,475	134,300	255,200	105,186	101,609	48,141	66,400	80,000
Hardwoods	39,665	38,955	23,938	25,600	12,800	51,559	50,378	31,634	27,700	17,900
Total	152,839	150,316	98,413	159,900	268,000	156,758	151,987	79,775	94,100	97,900
Pacific Southwest:										
Softwoods	53,540	52,939	29,539	20,600	53,500	52,809	52,319	40,665	31,200	97,300
Hardwoods	13,927	13,976	5,280	1,700	1,100	32,230	32,232	11,420	1,922	1,300
Total	67,478	66,915	34,819	22,300	54,600	85,201	84,550	52,085	33,122	98,600

Table 33—(continued).

Region, subregion, and species group	Forest Industry					Nonindustrial private[a]				
	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
	Thousand cubic feet									
Pacific Coast total:										
Softwoods	166,690	164,300	104,014	154,900	308,700	182,152	191,938	135,855	100,616	178,347
Hardwoods	53,592	52,931	29,218	27,300	13,900	85,182	85,892	47,070	29,825	19,303
Total	220,316	217,231	133,232	182,200	322,600	267,507	277,830	182,925	130,441	197,650
United States:										
Softwoods	484,421	508,898	397,305	393,821	460,038	1,105,981	1,198,017	945,977	798,420	602,638
Hardwoods	278,959	299,218	227,091	217,151	153,333	1,846,596	1,835,585	1,283,609	1,096,504	891,813
Total	763,550	808,116	624,396	610,972	613,371	2,952,805	3,033,602	2,229,586	1,894,924	1,494,447

[a] Native American lands have been included exclusively in the nonindustrial private owner group since 1997. For 1987 and earlier years, these lands may be included in the other public owner group.

Note: Data may not add to totals because of rounding.

Table 34—Net annual growth of growing stock on timberland in the United States by ownership group, region, subregion, and species group, 2001, 1996, 1986, 1976, and 1952

Region, subregion, and species group	All owners				
	2001	1996	1986	1976	1952
	Thousand cubic feet				
North:					
Northeast:					
Softwoods	658,040	646,083	701,741	1,067,271	652,600
Hardwoods	2,174,717	2,223,289	2,246,366	2,072,571	1,358,000
Total	2,832,478	2,869,371	2,948,107	3,139,842	2,010,600
North Central:					
Softwoods	524,811	523,127	586,546	490,986	320,702
Hardwoods	2,060,589	2,027,493	1,977,350	1,718,072	1,385,188
Total	2,585,392	2,550,620	2,563,896	2,209,058	1,705,890
North total:					
Softwoods	1,182,850	1,169,210	1,288,287	1,558,257	973,302
Hardwoods	4,235,306	4,250,781	4,223,716	3,790,643	2,743,188
Total	5,417,870	5,419,991	5,512,003	5,348,900	3,716,490
South:					
Southeast:					
Softwoods	3,097,488	2,778,801	2,622,053	3,104,000	1,874,017
Hardwoods	2,059,494	1,951,849	2,104,004	2,186,000	1,291,618
Total	5,157,047	4,730,651	4,726,057	5,290,000	3,165,635
South Central:					
Softwoods	3,369,692	3,110,078	2,876,764	3,210,598	1,767,400
Hardwoods	2,995,358	2,871,358	2,382,778	2,822,683	1,749,700
Total	6,365,191	5,981,436	5,259,542	6,033,281	3,517,100
South total:					
Softwoods	6,467,180	5,888,879	5,498,817	6,314,598	3,641,417
Hardwoods	5,054,852	4,823,208	4,486,782	5,008,683	3,041,318
Total	11,522,238	10,712,087	9,985,599	11,323,281	6,682,735
Rocky Mountain:					
Great Plains:					
Softwoods	41,542	50,448	47,412	43,521	22,220
Hardwoods	45,211	44,808	38,438	39,818	30,500
Total	86,747	95,256	85,850	83,339	52,720
Intermountain:					
Softwoods	1,816,084	1,912,245	1,909,449	1,550,496	1,077,700
Hardwoods	158,787	426,175	131,347	99,098	56,800
Total	1,975,024	2,338,421	2,040,796	1,649,594	1,134,500
Rocky Mountain total:					
Softwoods	1,857,626	1,962,694	1,956,861	1,594,017	1,099,920
Hardwoods	203,998	470,983	169,785	138,916	87,300
Total	2,061,771	2,433,676	2,126,646	1,732,933	1,187,220
Pacific Coast:					
Alaska:					
Softwoods	122,008	136,888	102,686	162,499	103,600
Hardwoods	84,859	85,888	93,664	6,824	6,725
Total	206,873	222,776	196,350	169,323	110,325

Table 34—(continued).

Region, subregion, and species group	All owners 2001	1996	1986	1976	1952
	Thousand cubic feet				
Pacific Northwest:					
Softwoods	2,841,124	3,080,632	3,270,724	2,158,700	1,472,500
Hardwoods	312,753	391,648	498,155	400,800	221,500
Total	3,154,055	3,472,280	3,768,879	2,559,500	1,694,000
Pacific Southwest:					
Softwoods	1,195,754	1,155,171	889,365	713,200	444,000
Hardwoods	130,575	133,172	156,834	79,137	75,000
Total	1,326,267	1,288,343	1,046,199	792,337	519,000
Pacific Coast total:					
Softwoods	4,158,887	4,372,692	4,262,775	3,034,399	2,020,100
Hardwoods	528,187	610,708	748,653	486,761	303,225
Total	4,687,196	4,983,400	5,011,428	3,521,160	2,323,325
United States:					
Softwoods	13,666,543	13,393,474	13,006,740	12,501,271	7,734,739
Hardwoods	10,022,342	10,155,680	9,628,936	9,425,003	6,175,031
Total	23,689,074	23,549,154	22,635,676	21,926,274	13,909,770

Table 34—(continued).

Region, subregion, and species group	National forest					Other public[a]				
	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
	Thousand cubic feet									
North:										
Northeast:										
Softwoods	15,043	13,839	19,019	18,359	13,282	63,368	60,666	53,518	48,791	27,166
Hardwoods	68,185	68,469	131,021	116,999	69,443	193,588	194,964	265,069	237,900	142,264
Total	83,369	82,308	150,040	135,358	82,725	256,973	255,631	318,587	286,691	169,430
North Central:										
Softwoods	94,053	94,231	117,617	97,660	57,215	140,746	140,565	168,327	142,017	92,256
Hardwoods	145,114	138,894	154,278	158,742	112,026	305,106	302,427	340,975	304,325	213,120
Total	239,121	233,124	271,895	256,402	169,241	445,980	442,991	509,302	446,342	305,376
North total:										
Softwoods	109,096	108,070	136,636	116,019	70,497	204,114	201,231	221,845	190,808	119,422
Hardwoods	213,299	207,362	285,299	275,741	181,469	498,694	497,391	606,044	542,225	355,384
Total	322,490	315,433	421,935	391,760	251,966	702,953	698,622	827,889	733,033	474,806
South:										
Southeast:										
Softwoods	79,022	57,179	93,774	137,000	80,313	155,163	144,516	147,893	149,000	70,017
Hardwoods	108,059	104,629	139,288	141,000	73,208	106,485	97,390	85,918	71,000	27,169
Total	187,179	161,808	233,062	278,000	153,521	261,644	241,906	233,811	220,000	97,186
South Central:										
Softwoods	205,458	192,018	230,844	245,340	211,300	80,538	65,607	54,534	71,156	56,388
Hardwoods	155,266	144,271	134,532	144,064	67,265	146,332	131,442	100,875	108,706	55,182
Total	360,747	336,289	365,376	389,404	278,565	226,885	197,049	155,409	179,862	111,570
South total:										
Softwoods	284,480	249,197	324,618	382,340	291,613	235,701	210,122	202,427	220,156	126,405
Hardwoods	263,325	248,901	273,820	285,064	140,473	252,816	228,833	186,793	179,706	82,351
Total	547,927	498,097	598,438	667,404	432,086	488,529	438,955	389,220	399,862	208,756
Rocky Mountain:										
Great Plains:										
Softwoods	32,564	41,741	32,989	31,087	14,700	862	835	3,105	2,977	1,469
Hardwoods	624	375	554	676	100	3,398	3,300	3,266	3,552	2,615
Total	33,194	42,117	33,543	31,763	14,800	4,259	4,135	6,371	6,529	4,084
Intermountain:										
Softwoods	1,127,238	1,231,826	1,263,727	1,013,396	673,400	168,530	167,534	216,692	158,464	117,646
Hardwoods	88,854	142,370	56,642	65,498	31,300	14,459	60,282	24,216	6,945	5,462
Total	1,216,207	1,374,195	1,320,369	1,078,894	704,700	182,985	227,816	240,908	165,409	123,108
Rocky Mountain total:										
Softwoods	1,159,802	1,273,567	1,296,716	1,044,483	688,100	169,392	168,369	219,797	161,441	119,115
Hardwoods	89,477	142,745	57,196	66,174	31,400	17,857	63,582	27,482	10,497	8,077
Total	1,249,402	1,416,312	1,353,912	1,110,657	719,500	187,244	231,951	247,279	171,938	127,192

Table 34—(continued).

	National forest					Other public[a]				
Region, subregion, and species group	**2001**	**1996**	**1986**	**1976**	**1952**	**2001**	**1996**	**1986**	**1976**	**1952**
	Thousand cubic feet									
Pacific Coast:										
Alaska:										
Softwoods	52,500	85,386	15,378	22,627	10,367	54,173	40,496	66,723	136,877	92,588
Hardwoods	1,809	4,060	768	15	16	71,949	61,201	55,309	6,609	6,609
Total	54,321	89,446	16,146	22,642	10,383	126,122	101,696	122,032	143,486	99,197
Pacific Northwest:										
Softwoods	1,084,957	1,097,597	1,076,000	538,800	440,900	486,449	557,893	634,145	467,000	258,900
Hardwoods	67,376	66,961	67,000	14,700	13,600	63,922	81,629	87,510	93,000	33,500
Total	1,152,331	1,164,558	1,143,000	553,500	454,500	550,459	639,522	721,655	560,000	292,400
Pacific Southwest:										
Softwoods	658,004	616,239	421,551	363,500	162,000	28,782	28,872	25,198	13,900	14,000
Hardwoods	1,516	4,123	0	16,100	29,000	5,249	5,248	15,865	7,735	6,000
Total	659,522	620,362	421,551	379,600	191,000	34,015	34,121	41,063	21,635	20,000
Pacific Coast total:										
Softwoods	1,795,461	1,799,222	1,512,929	924,927	613,267	569,404	627,261	726,066	617,777	365,488
Hardwoods	70,701	75,144	67,768	30,815	42,616	141,120	148,078	158,684	107,344	46,109
Total	1,866,174	1,874,366	1,580,697	955,742	655,883	710,596	775,339	884,750	725,121	411,597
United States:										
Softwoods	3,348,839	3,430,056	3,270,899	2,467,769	1,663,477	1,178,612	1,206,983	1,370,135	1,190,182	730,430
Hardwoods	636,802	674,152	684,083	657,794	395,958	910,487	937,884	979,003	839,772	491,921
Total	3,985,992	4,104,208	3,954,982	3,125,563	2,059,435	2,089,323	2,144,867	2,349,138	2,029,954	1,222,351

Table 34—(continued).

Region, subregion, and species group	Forest industry					Nonindustrial private[a]				
	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
	Thousand cubic feet									
North:										
Northeast:										
Softwoods	66,388	64,526	188,430	377,359	178,928	513,241	507,051	440,774	622,762	433,224
Hardwoods	191,003	195,939	230,023	226,164	128,574	1,721,941	1,763,917	1,620,253	1,491,508	1,017,719
Total	257,376	260,465	418,453	603,523	307,502	2,234,760	2,270,967	2,061,027	2,114,270	1,450,943
North Central:										
Softwoods	35,442	35,442	50,172	55,090	43,288	254,571	252,890	250,430	196,219	127,943
Hardwoods	86,241	86,260	105,370	118,401	99,057	1,524,129	1,499,913	1,376,727	1,136,604	960,985
Total	121,658	121,701	155,542	173,491	142,345	1,778,634	1,752,803	1,627,157	1,332,823	1,088,928
North total:										
Softwoods	101,829	99,968	238,602	432,449	222,216	767,812	759,941	691,204	818,981	561,167
Hardwoods	277,244	282,199	335,393	344,565	227,631	3,246,070	3,263,829	2,996,980	2,628,112	1,978,704
Total	379,034	382,167	573,995	777,014	449,847	4,013,393	4,023,770	3,688,184	3,447,093	2,539,871
South:										
Southeast:										
Softwoods	966,345	889,665	724,829	688,000	374,583	1,896,958	1,687,442	1,655,557	2,130,000	1,349,104
Hardwoods	199,194	191,390	245,858	259,000	170,797	1,645,756	1,558,440	1,632,940	1,715,000	1,020,444
Total	1,165,427	1,081,055	970,687	947,000	545,380	3,542,797	3,245,882	3,288,497	3,845,000	2,369,548
South Central:										
Softwoods	1,207,415	1,135,049	829,133	894,423	707,496	1,876,280	1,717,403	1,762,253	1,999,679	792,216
Hardwoods	349,178	358,018	347,608	452,703	202,822	2,344,582	2,237,627	1,799,763	2,117,210	1,424,431
Total	1,556,542	1,493,068	1,176,741	1,347,126	910,318	4,221,017	3,955,030	3,562,016	4,116,889	2,216,647
South total:										
Softwoods	2,173,760	2,024,714	1,553,962	1,582,423	1,082,079	3,773,239	3,404,846	3,417,810	4,129,679	2,141,320
Hardwoods	548,372	549,408	593,466	711,703	373,619	3,990,338	3,796,067	3,432,703	3,832,210	2,444,875
Total	2,721,968	2,574,122	2,147,428	2,294,126	1,455,698	7,763,813	7,200,912	6,850,513	7,961,889	4,586,195
Rocky Mountain:										
Great Plains:										
Softwoods	0	0	340	608	233	8,116	7,872	10,978	8,849	5,818
Hardwoods	0	0	0	62	5	41,189	41,133	34,618	35,528	27,780
Total	0	0	340	670	238	49,293	49,005	45,596	44,377	33,598
Intermountain:										
Softwoods	125,962	125,967	124,840	103,030	78,404	394,354	386,918	304,190	275,606	208,250
Hardwoods	695	7,867	980	793	660	54,779	215,657	49,509	25,862	19,378
Total	126,682	133,834	125,820	103,823	79,064	449,150	602,575	353,699	301,468	227,628
Rocky Mountain total:										
Softwoods	125,962	125,967	125,180	103,638	78,637	402,469	394,790	315,168	284,455	214,068
Hardwoods	695	7,867	980	855	665	95,968	256,789	84,127	61,390	47,158
Total	126,682	133,834	126,160	104,493	79,302	498,444	651,580	399,295	345,845	261,226

Table 34—(continued).

Region, subregion, and species group	Forest industry					Nonindustrial private[a]				
	2001	1996	1986	1976	1952	2001	1996	1986	1976	1952
						Thousand cubic feet				
Pacific Coast:										
Alaska:										
Softwoods	0	0	0	0	0	15,335	11,007	20,585	2,995	645
Hardwoods	0	0	0	0	0	11,101	20,628	37,587	200	100
Total	0	0	0	0	0	26,429	31,635	58,172	3,195	745
Pacific Northwest:										
Softwoods	804,261	883,870	1,029,287	691,200	399,000	465,457	541,274	531,292	461,700	373,700
Hardwoods	72,899	100,919	154,079	145,200	75,300	108,557	142,138	189,566	147,900	99,100
Total	877,169	984,788	1,183,366	836,400	474,300	574,096	683,412	720,858	609,600	472,800
Pacific Southwest:										
Softwoods	246,506	247,112	204,912	138,500	90,000	262,462	262,948	237,704	197,300	178,000
Hardwoods	45,515	45,497	45,596	19,100	11,000	78,294	78,305	95,373	36,202	29,000
Total	292,010	292,608	250,508	157,600	101,000	340,720	341,253	333,077	233,502	207,000
Pacific Coast total:										
Softwoods	1,050,767	1,130,981	1,234,199	829,700	489,000	743,254	815,228	789,581	661,995	552,345
Hardwoods	118,414	146,415	199,675	164,300	86,300	197,951	241,071	322,526	184,302	128,200
Total	1,169,180	1,277,396	1,433,874	994,000	575,300	941,246	1,056,299	1,112,107	846,297	680,545
United States:										
Softwoods	3,452,319	3,381,630	3,151,943	2,948,210	1,871,932	5,686,774	5,374,805	5,213,763	5,895,110	3,468,900
Hardwoods	944,726	985,888	1,129,514	1,221,423	688,215	7,530,328	7,557,756	6,836,336	6,706,014	4,598,937
Total	4,396,863	4,367,519	4,281,457	4,169,633	2,560,147	13,216,896	12,932,561	12,050,099	12,601,124	8,067,837

[a] Native American lands have been included exclusively in the nonindustrial private owner group since 1997. For 1987 and earlier years, these lands may be included in the other public owner group.

Note: Data may not add to totals because of rounding.

Table 35—Annual removals of growing stock on timberland in the United States by ownership group, region, subregion, and species group, 2001, 1996, 1986, and 1976

Region, subregion, and species group	All owners				National forest	Other public	Forest industry	Non-industrial private
	2001	1996	1986	1976	2001	2001	2001	2001
					Thousand cubic feet			
North:								
Northeast:								
Softwoods	414,216	413,718	520,797	498,576	965	13,487	117,552	282,212
Hardwoods	857,400	860,999	781,162	803,694	6,655	45,498	158,074	647,174
Total	1,271,616	1,274,717	1,301,959	1,302,270	7,620	58,984	275,626	929,387
North Central:								
Softwoods	228,599	254,630	204,719	193,534	14,352	59,262	25,397	129,587
Hardwoods	1,210,611	1,243,071	1,201,539	999,059	49,027	211,813	92,594	857,176
Total	1,439,210	1,497,701	1,406,258	1,192,593	63,379	271,076	117,991	986,764
North total:								
Softwoods	642,815	668,348	725,516	692,110	15,318	72,749	142,949	411,800
Hardwoods	2,068,011	2,104,070	1,982,701	1,802,753	55,681	257,311	250,668	1,504,351
Total	2,710,826	2,772,418	2,708,217	2,494,863	70,999	330,060	393,617	1,916,150
South:								
Southeast:								
Softwoods	2,913,288	2,947,436	2,411,562	2,028,804	9,788	111,824	928,285	1,863,392
Hardwoods	1,390,533	1,511,833	1,260,821	1,002,521	13,616	50,148	221,709	1,105,060
Total	4,303,821	4,459,269	3,672,383	3,031,325	23,403	161,972	1,149,994	2,968,452
South Central:								
Softwoods	3,600,177	3,530,826	2,905,505	2,407,658	36,826	62,525	1,300,939	2,199,887
Hardwoods	2,166,136	2,194,685	1,625,779	1,239,717	17,108	54,703	406,205	1,688,120
Total	5,766,313	5,725,511	4,531,284	3,647,375	53,934	117,228	1,707,144	3,888,007
South total:								
Softwoods	6,513,465	6,478,262	5,317,067	4,436,462	46,614	174,349	2,229,224	4,063,279
Hardwoods	3,556,668	3,706,518	2,886,600	2,242,238	30,724	104,851	627,914	2,793,180
Total	10,070,134	10,184,780	8,203,667	6,678,700	77,337	279,200	2,857,138	6,856,459
Rocky Mountain:								
Great Plains:								
Softwoods	23,682	20,181	25,797	21,322	16,567	529	0	6,586
Hardwoods	15,803	15,113	16,260	20,600	15	381	0	15,408
Total	39,486	35,294	42,057	41,922	16,582	910	0	21,993
Intermountain:								
Softwoods	487,135	480,943	817,031	821,687	62,164	50,306	150,054	224,611
Hardwoods	10,490	15,757	11,635	3,054	2,159	2,007	3,398	2,926
Total	497,625	496,700	828,666	824,741	64,323	52,313	153,453	227,537
Rocky Mountain total:								
Softwoods	510,818	501,124	842,828	843,009	78,731	50,836	150,054	231,196
Hardwoods	26,293	30,870	27,895	23,654	2,174	2,387	3,398	18,334
Total	537,111	531,994	870,723	866,663	80,905	53,223	153,453	249,530

Table 35—(continued).

Region, subregion, and species group	All owners 2001	1996	1986	1976	National forest 2001	Other public 2001	Forest industry 2001	Non-industrial private 2001
	Thousand cubic feet							
Pacific Coast:								
Alaska:								
Softwoods	138,695	177,298	117,881	107,437	13,814	4,642	0	120,240
Hardwoods	3,634	5,229	5,211	3,164	119	796	0	2,719
Total	142,329	182,527	123,092	110,601	13,933	5,437	0	122,959
Pacific Northwest:								
Softwoods	1,623,663	1,621,480	3,121,025	3,101,707	53,201	226,575	800,856	543,031
Hardwoods	106,502	99,492	98,375	106,286	467	12,686	39,693	53,657
Total	1,730,165	1,720,969	3,219,400	3,207,993	53,668	239,260	840,548	596,688
Pacific Southwest:								
Softwoods	624,853	618,021	818,897	818,402	41,824	22,925	356,938	203,166
Hardwoods	8,660	10,036	11,579	16,805	1,534	100	5,020	2,005
Total	633,513	628,056	830,476	835,207	43,359	23,025	361,958	205,171
Pacific Coast total:								
Softwoods	2,387,211	2,416,799	4,057,803	4,027,546	108,839	254,141	1,157,794	866,437
Hardwoods	118,796	114,757	115,165	126,255	2,120	13,582	44,713	58,381
Total	2,506,007	2,531,552	4,172,968	4,153,801	110,960	267,723	1,202,506	924,818
United States:								
Softwoods	10,054,310	10,064,531	10,943,214	9,999,127	249,502	552,075	3,680,020	5,572,712
Hardwoods	5,769,768	5,956,213	5,012,361	4,194,900	90,699	378,130	926,693	4,374,246
Total	15,824,078	16,020,744	15,955,575	14,194,027	340,201	930,205	4,606,714	9,946,958

Note: Data may not add to totals because of rounding.

Table 36—Net annual growth, removals, and mortality of growing stock on timberland in the United States by species group, region, subregion, and State, 2002

Region, subregion, and State	All species			Softwoods			Hardwoods		
	Net growth	Removals	Mortality	Net growth	Removals	Mortality	Net growth	Removals	Mortality
				Thousand cubic feet					
North:									
Northeast:									
Connecticut	55,496	11,691	16,344	8,459	3,013	1,768	47,078	8,678	14,575
Delaware	16,168	7,654	7,868	4,202	3,966	2,085	11,965	3,688	5,777
Maine	402,086	441,729	223,378	181,603	234,026	164,644	220,688	207,703	58,674
Maryland	107,091	40,507	36,964	23,673	12,891	6,264	83,409	27,617	30,696
Massachusetts	97,467	15,703	26,437	38,943	7,987	6,117	58,466	7,715	20,300
New Hampshire	169,877	140,282	50,471	77,972	44,737	22,662	91,881	95,545	27,799
New Jersey	55,431	10,549	16,475	14,613	753	4,417	40,813	9,795	12,070
New York	589,718	141,068	109,260	145,115	42,645	23,270	444,715	98,422	86,013
Pennsylvania	630,403	215,912	177,131	69,745	18,739	11,019	560,768	197,173	166,138
Rhode Island	8,032	1,742	2,841	2,916	588	336	5,105	1,154	2,505
Vermont	190,367	77,355	48,025	69,408	38,530	15,233	120,966	38,825	32,747
West Virginia	510,343	167,425	95,077	21,393	6,340	16,791	488,863	161,085	78,282
Total	2,832,478	1,271,616	810,272	658,040	414,216	274,607	2,174,717	857,400	535,577
North Central:									
Illinois	172,023	69,338	72,316	5,451	585	1,358	166,559	68,752	70,957
Indiana	223,783	96,532	60,789	8,721	655	2,789	215,043	95,877	57,992
Iowa	41,151	25,251	15,878	840	206	59	40,314	25,046	15,823
Michigan	756,369	315,660	198,293	227,239	69,647	62,075	529,170	246,013	136,160
Minnesota	370,145	316,130	215,962	114,072	62,293	66,068	256,075	253,837	149,850
Missouri	239,428	167,895	65,718	27,581	12,248	3,031	211,839	155,647	62,561
Ohio	293,485	101,216	56,147	10,904	2,848	4,399	282,593	98,368	51,766
Wisconsin	489,009	347,187	187,797	130,004	80,117	42,792	358,994	267,071	144,942
Total	2,585,392	1,439,210	872,899	524,811	228,599	182,572	2,060,589	1,210,611	690,051
North total:	5,417,870	2,710,826	1,683,171	1,182,850	642,815	457,179	4,235,306	2,068,011	1,225,628
South:									
Southeast:									
Florida	684,925	560,475	100,027	526,274	470,670	49,962	158,565	89,804	50,080
Georgia	1,518,775	1,447,941	296,065	1,006,769	1,082,359	159,542	511,841	365,582	136,546
North Carolina	1,159,595	957,675	263,957	589,829	588,255	116,369	569,755	369,419	147,573
South Carolina	945,451	682,901	151,191	657,445	475,339	70,414	288,102	207,562	80,794
Virginia	848,302	654,829	175,759	317,170	296,665	54,977	531,231	358,164	120,773
Total	5,157,047	4,303,821	987,000	3,097,488	2,913,288	451,263	2,059,494	1,390,533	535,766
South Central:									
Alabama	1,460,114	1,298,533	274,289	871,754	888,314	153,850	588,321	410,219	120,447
Arkansas	896,350	795,789	140,756	546,133	495,947	44,997	350,141	299,842	95,767
Kentucky	384,128	276,220	88,571	25,114	14,738	12,851	359,015	261,482	75,741
Louisiana	834,049	958,981	157,635	526,081	697,829	77,642	307,926	261,152	79,997
Mississippi	1,104,531	1,149,880	163,263	639,086	752,347	74,777	465,523	397,532	88,495
Oklahoma	243,259	133,401	15,066	117,100	79,609	3,250	125,997	53,792	11,822
Tennessee	737,547	384,009	156,619	140,633	100,609	46,301	597,020	283,400	110,340
Texas	705,212	769,501	93,300	503,792	570,783	53,588	201,415	198,718	39,735
Total	6,365,191	5,766,313	1,089,498	3,369,692	3,600,177	467,255	2,995,358	2,166,136	622,344
South total:	11,522,238	10,070,134	2,076,498	6,467,180	6,513,465	918,519	5,054,852	3,556,668	1,158,110

Table 36—(continued).

Region, subregion, and State	All species			Softwoods			Hardwoods		
	Net growth	Removals	Mortality	Net growth	Removals	Mortality	Net growth	Removals	Mortality
					Thousand cubic feet				
Rocky Mountain:									
Great Plains:									
Kansas	25,844	7,182	19,427	1,028	54	57	24,829	7,128	19,365
Nebraska	14,181	10,387	13,029	4,042	3,509	1,484	10,138	6,879	11,528
North Dakota	6,663	1,005	4,473	112	6	0	6,552	1,000	4,471
South Dakota	40,059	20,910	8,157	36,360	20,113	5,355	3,691	797	2,781
Total	86,747	39,486	45,086	41,542	23,682	6,896	45,211	15,803	38,146
Intermountain:									
Arizona	124,452	13,529	20,971	121,078	13,529	17,610	3,333	0	3,340
Colorado	291,334	20,598	183,375	212,072	16,368	134,425	79,174	4,230	48,974
Idaho	634,578	252,866	431,281	625,746	247,498	414,437	8,812	5,368	16,843
Montana	583,139	167,842	274,272	568,909	167,835	269,959	14,214	7	4,310
Nevada	5,708	1,342	5,248	3,857	1,342	4,698	1,851	0	556
New Mexico	140,494	18,964	21,614	128,794	18,953	17,202	11,744	11	4,406
Utah	76,787	8,311	103,286	46,128	7,437	86,070	30,635	874	17,214
Wyoming	118,533	14,174	71,895	109,499	14,174	67,738	9,024	0	4,162
Total	1,975,024	497,625	1,111,941	1,816,084	487,135	1,012,139	158,787	10,490	99,806
Rocky Mountain total:	2,061,771	537,111	1,157,027	1,857,626	510,818	1,019,035	203,998	26,293	137,952
Pacific Coast:									
Alaska:									
Alaska	206,873	142,329	164,187	122,008	138,695	155,407	84,859	3,634	8,786
Total	206,873	142,329	164,187	122,008	138,695	155,407	84,859	3,634	8,786
Pacific Northwest:									
Oregon	1,728,058	863,395	458,259	1,536,422	826,392	417,548	191,472	37,003	40,737
Washington	1,425,997	866,770	445,616	1,304,702	797,271	366,206	121,282	69,499	79,353
Total	3,154,055	1,730,165	903,875	2,841,124	1,623,663	783,755	312,753	106,502	120,090
Pacific Southwest:									
California	1,325,279	633,513	318,742	1,195,754	624,853	262,315	129,587	8,660	56,223
Hawaii	988	0	1,088	0	0	0	988	0	1,088
Total	1,326,267	633,513	319,829	1,195,754	624,853	262,315	130,575	8,660	57,311
Pacific Coast total:	4,687,196	2,506,007	1,387,892	4,158,887	2,387,211	1,201,477	528,187	118,796	186,187
United States:	23,689,074	15,824,078	6,304,588	13,666,543	10,054,310	3,596,210	10,022,342	5,769,768	2,707,877

Note: Data may not add to totals because of rounding.

Table 37—Net all live biomass on timberland in the Eastern and Western United States by rural-urban continuum class and forest type group, 2002

		Predominant county population continuum class				
Forest type group	Total	Major metro	Intermediate-small metro	Large town	Small town	Rural
				Million dry tons		
East:						
White-red-jack pine	558	104	130	20	222	81
Spruce-fir	547	8	61	91	320	68
Longleaf-slash pine	379	76	39	14	149	107
Loblolly-shortleaf pine	2,025	327	222	80	913	438
Oak-pine	1,298	255	144	42	559	298
Oak-hickory	6,250	1,285	764	153	2,504	1,644
Oak-gum-cypress	1,637	312	197	55	757	316
Elm-ash-cottonwood	515	135	70	19	219	73
Maple-beech-birch	2,665	396	393	194	1,255	427
Aspen-birch	538	14	73	34	276	140
Nonstocked	1	0	0	0	1	0
East total:	16,413	2,912	2,093	701	7,174	3,532
West:						
Douglas-fir	2,181	445	522	223	644	347
Ponderosa pine	840	54	121	149	364	152
Western white pine	7	0	1	0	4	1
Fir-spruce	1,260	87	130	107	566	370
Hemlock-Sitka spruce	1,197	113	150	86	440	408
Larch	62	0	1	10	34	17
Lodgepole pine	529	13	26	63	260	168
Redwood	106	27	38	37	4	0
Other hardwoods	1,060	158	255	123	337	187
Other softwoods	452	69	47	8	282	45
Pinyon-juniper	8	0	4	0	2	1
Nonstocked	6	1	0	1	3	1
West total:	7,707	969	1,294	806	2,941	1,697
United States:	24,120	3,881	3,387	1,508	10,115	5,222

Note: Data may not add to totals because of rounding.

Table 38—Biomass on timberland in the United States by region, subregion, State, and tree component, 2002

Region, subregion, and State	All biomass	Live trees				Sound dead
		All live	Boles	Tops	Saplings	
	Million dry tons					
North:						
Northeast:						
Connecticut	106	105	75	23	7	1
Delaware	25	25	19	3	3	0
Maine	772	759	461	163	136	13
Maryland	167	166	132	20	13	1
Massachusetts	180	179	126	39	14	1
New Hampshire	292	289	195	63	30	3
New Jersey	109	108	83	14	11	2
New York	746	741	494	158	90	5
Pennsylvania	905	896	608	215	73	9
Rhode Island	18	18	12	4	1	0
Vermont	282	279	191	61	26	3
West Virginia	717	714	487	169	58	4
Total	4,319	4,277	2,883	933	461	42
North Central:						
Illinois	195	193	132	46	15	2
Indiana	217	216	149	52	14	2
Iowa	78	77	51	19	7	1
Michigan	817	812	523	190	100	5
Minnesota	473	468	291	105	72	5
Missouri	498	496	308	123	65	2
Ohio	367	364	237	83	44	3
Wisconsin	588	576	379	138	58	12
Total	3,232	3,200	2,070	756	374	32
North total:	7,551	7,477	4,953	1,689	835	73
South:						
Southeast:						
Florida	464	464	323	78	62	0
Georgia	888	888	676	91	121	0
North Carolina	953	953	697	153	103	0
South Carolina	505	505	370	81	54	0
Virginia	836	836	609	140	87	0
Total	3,645	3,645	2,675	543	428	0
South Central:						
Alabama	897	897	644	145	109	0
Arkansas	846	839	560	176	102	7
Kentucky	660	655	440	153	62	5
Louisiana	651	650	453	133	64	1
Mississippi	783	780	518	163	99	3
Oklahoma	196	196	119	40	36	1
Tennessee	805	805	600	140	66	0
Texas	470	468	319	93	56	2
Total	5,308	5,290	3,653	1,044	594	18
South total:	8,954	8,936	6,328	1,586	1,021	18

Table 38—(continued).

Region, subregion, and State	All biomass	All live	Boles	Tops	Saplings	Sound dead
		Live trees				
			Million dry tons			
Rocky Mountain:						
Great Plains:						
Kansas	53	52	36	13	4	1
Nebraska	32	31	22	8	2	1
North Dakota	15	14	9	4	1	1
South Dakota	42	40	28	9	3	2
Total	142	137	95	33	9	4
Intermountain:						
Arizona	149	138	98	33	7	10
Colorado	497	454	337	97	21	44
Idaho	853	772	597	131	44	81
Montana	812	734	526	142	66	78
Nevada	13	12	8	3	0	1
New Mexico	167	155	107	36	12	12
Utah	180	156	108	36	12	24
Wyoming	238	198	142	42	13	40
Total	2,909	2,618	1,924	519	175	291
Rocky Mountain total:	3,051	2,756	2,020	552	184	295
Pacific Coast:						
Alaska:						
Alaska	844	830	501	227	101	14
Total	844	830	501	227	101	14
Pacific Northwest:						
Oregon	1,693	1,629	1,148	458	23	64
Washington	1,192	1,159	873	255	31	33
Total	2,886	2,789	2,021	714	54	97
Pacific Southwest:						
California	1,330	1,328	864	415	49	2
Hawaii	4	4	4	0	0	0
Total	1,334	1,332	868	415	49	2
Pacific Coast total:	5,064	4,951	3,391	1,356	204	113
United States:	24,619	24,120	16,692	5,183	2,245	499

Note: Data may not add to totals because of rounding.

Table 39—Volume of roundwood products harvested in the United States by source of material, species group, region, subregion, and product, 2001

				Source of material					
	All sources			Growing stock			Other sources		
Region, subregion, and product	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
				Thousand cubic feet					
North:									
Northeast:									
Saw logs	715,703	260,429	455,274	610,860	208,491	402,368	104,843	51,938	52,906
Veneer logs	33,538	2,566	30,972	29,451	2,054	27,396	4,088	512	3,576
Pulpwood	518,958	213,911	305,047	416,890	167,230	249,660	102,068	46,681	55,387
Composite products	2,118	179	1,940	1,727	140	1,587	391	39	352
Fuelwood	466,267	53,254	413,013	62,521	4,979	57,542	403,746	48,275	355,471
Posts, poles, and pilings	7,612	1,854	5,758	6,290	1,231	5,059	1,323	623	700
Miscellaneous products	23,605	13,119	10,486	17,922	8,710	9,212	5,684	4,410	1,274
Total	1,767,801	545,312	1,222,490	1,145,661	392,835	752,824	622,143	152,478	469,666
North Central:									
Saw logs	555,595	76,113	479,482	505,512	73,586	431,926	50,083	2,527	47,556
Veneer logs	25,487	504	24,983	23,294	454	22,840	2,193	50	2,143
Pulpwood	511,120	127,649	383,471	426,613	112,970	313,643	84,507	14,679	69,828
Composite products	209,614	11,926	197,688	192,220	9,716	182,505	17,394	2,211	15,183
Fuelwood	247,472	14,045	233,427	44,590	5,588	39,002	202,882	8,457	194,425
Posts, poles, and pilings	10,824	8,418	2,406	8,328	7,051	1,277	2,496	1,367	1,129
Miscellaneous products	18,462	3,245	15,218	16,320	3,158	13,162	2,142	86	2,056
Total	1,578,574	241,900	1,336,675	1,216,877	212,523	1,004,355	361,697	29,377	332,320
North total:									
Saw logs	1,271,298	336,542	934,756	1,116,372	282,077	834,294	154,926	54,465	100,462
Veneer logs	59,025	3,070	55,955	52,745	2,508	50,236	6,281	562	5,719
Pulpwood	1,030,078	341,560	688,518	843,503	280,200	563,303	186,575	61,360	125,215
Composite products	211,732	12,105	199,628	193,947	9,856	184,092	17,785	2,250	15,535
Fuelwood	713,739	67,299	646,440	107,111	10,567	96,544	606,628	56,732	549,896
Posts, poles, and pilings	18,436	10,272	8,164	14,618	8,282	6,336	3,819	1,990	1,829
Miscellaneous products	42,067	16,364	25,704	34,242	11,868	22,374	7,826	4,496	3,330
Total	3,346,375	787,212	2,559,165	2,362,538	605,358	1,757,179	983,840	181,855	801,986
South:									
Southeast:									
Saw logs	1,585,027	1,238,337	346,690	1,523,541	1,196,528	327,013	61,486	41,809	19,677
Veneer logs	243,363	195,453	47,910	236,397	188,945	47,452	6,966	6,508	457
Pulpwood	1,626,855	1,138,425	488,430	1,498,780	1,060,402	438,378	128,075	78,023	50,052
Composite products	139,219	101,505	37,714	126,783	93,811	32,972	12,436	7,694	4,743
Fuelwood	229,834	27,786	202,048	182,208	21,125	161,083	47,626	6,661	40,965
Posts, poles, and pilings	34,669	34,598	71	31,990	31,930	60	2,679	2,668	11
Miscellaneous products	25,809	21,895	3,914	21,797	18,257	3,540	4,012	3,638	374
Total	3,884,776	2,757,999	1,126,777	3,621,496	2,610,998	1,010,498	263,280	147,001	116,279
South Central:									
Saw logs	2,155,328	1,493,312	662,016	2,042,730	1,446,287	596,442	112,599	47,025	65,574
Veneer logs	644,236	595,976	48,260	624,281	578,816	45,465	19,955	17,161	2,795
Pulpwood	2,127,566	1,277,963	849,603	1,898,466	1,150,758	747,708	229,101	127,205	101,896
Composite products	95,231	59,370	35,861	79,495	50,857	28,638	15,736	8,513	7,222
Fuelwood	154,821	16,325	138,496	127,284	11,759	115,525	27,538	4,566	22,972
Posts, poles, and pilings	31,997	31,997	1	29,296	29,296	1	2,701	2,701	0
Miscellaneous products	2,611	967	1,644	1,559	714	845	1,052	253	798
Total	5,211,790	3,475,910	1,735,881	4,803,111	3,268,487	1,534,624	408,682	207,424	201,257

Table 39—(continued).

Region, subregion, and product	All sources			Source of material					
				Growing stock			Other sources		
	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
				Thousand cubic feet					
South total:									
Saw logs	3,740,355	2,731,649	1,008,706	3,566,271	2,642,815	923,455	174,085	88,834	85,251
Veneer logs	887,599	791,429	96,170	860,678	767,761	92,917	26,921	23,669	3,252
Pulpwood	3,754,421	2,416,388	1,338,033	3,397,246	2,211,160	1,186,086	357,176	205,228	151,948
Composite products	234,450	160,875	73,575	206,278	144,668	61,610	28,172	16,207	11,965
Fuelwood	384,655	44,111	340,544	309,492	32,884	276,608	75,164	11,227	63,937
Posts, poles, and pilings	66,666	66,595	72	61,286	61,226	61	5,380	5,369	11
Miscellaneous products	28,420	22,862	5,558	23,356	18,971	4,385	5,064	3,891	1,172
Total	9,096,566	6,233,909	2,862,658	8,424,607	5,879,485	2,545,122	671,962	354,425	317,536
Rocky Mountain:									
Great Plains:									
Saw logs	29,587	20,962	8,625	28,769	20,769	8,000	818	193	625
Veneer logs	99	0	99	98	0	98	1	0	1
Pulpwood	0	0	0	0	0	0	0	0	0
Composite products	919	829	91	760	685	75	159	144	16
Fuelwood	28,688	1,029	27,659	876	48	828	27,811	981	26,830
Posts, poles, and pilings	845	327	518	158	157	0	688	169	518
Miscellaneous products	219	138	81	219	138	81	0	0	0
Total	60,357	23,285	37,073	30,880	21,797	9,082	29,477	1,487	27,990
Intermountain:									
Saw logs	375,259	374,678	581	346,215	345,685	530	29,044	28,992	51
Veneer logs	57,414	57,414	0	56,428	56,428	0	986	986	0
Pulpwood	28,536	28,536	0	20,052	20,052	0	8,483	8,483	0
Composite products	4,465	0	4,465	4,424	0	4,424	40	0	40
Fuelwood	79,649	55,213	24,436	4,739	1,952	2,786	74,910	53,261	21,650
Posts, poles, and pilings	12,433	12,391	41	11,073	11,034	40	1,359	1,358	1
Miscellaneous products	15,569	13,497	2,072	10,195	8,132	2,063	5,373	5,365	9
Total	573,325	541,729	31,595	453,126	443,283	9,843	120,196	98,445	21,751
Rocky Mountain total:									
Saw logs	404,846	395,640	9,206	374,984	366,454	8,530	29,862	29,185	676
Veneer logs	57,513	57,414	99	56,526	56,428	98	987	986	1
Pulpwood	28,536	28,536	0	20,052	20,052	0	8,483	8,483	0
Composite products	5,384	829	4,556	5,184	685	4,499	199	144	56
Fuelwood	108,337	56,242	52,095	5,615	2,000	3,614	102,721	54,242	48,480
Posts, poles, and pilings	13,278	12,718	559	11,231	11,191	40	2,047	1,527	519
Miscellaneous products	15,788	13,635	2,153	10,414	8,270	2,144	5,373	5,365	9
Total	633,682	565,014	68,668	484,006	465,080	18,925	149,672	99,932	49,741
Pacific Coast:									
Alaska:									
Saw logs	12,742	12,656	86	12,501	12,416	85	241	240	1
Veneer logs	0	0	0	0	0	0	0	0	0
Pulpwood	23,199	23,128	71	20,817	20,753	63	2,383	2,375	7
Composite products	0	0	0	0	0	0	0	0	0
Fuelwood	8,391	5,155	3,236	6,830	4,346	2,484	1,561	809	752
Posts, poles, and pilings	0	0	0	0	0	0	0	0	0
Miscellaneous products	66,521	66,519	2	66,521	66,519	2	0	0	0
Total	110,853	107,458	3,395	106,669	104,034	2,634	4,185	3,424	760

Table 39—(continued).

				Source of material					
	All sources			Growing stock			Other sources		
Region, subregion, and product	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
				Thousand cubic feet					
Pacific Northwest:									
Saw logs	1,214,799	1,161,979	52,820	1,180,540	1,127,761	52,779	34,260	34,218	42
Veneer logs	300,651	287,604	13,047	276,837	263,993	12,844	23,814	23,611	202
Pulpwood	41,321	37,483	3,838	35,069	31,433	3,636	6,251	6,049	202
Composite products	1,491	1,491	0	1,257	1,257	0	234	234	0
Fuelwood	138,003	91,473	46,531	83,053	50,620	32,433	54,951	40,853	14,098
Posts, poles, and pilings	69,282	69,282	0	69,282	69,282	0	0	0	0
Miscellaneous products	2,231	2,231	0	1,584	1,584	0	647	647	0
Total	1,767,778	1,651,543	116,236	1,647,622	1,545,930	101,692	120,157	105,612	14,544
Pacific Southwest:									
Saw logs	517,919	517,919	0	475,642	475,642	0	42,277	42,277	0
Veneer logs	34,003	33,918	85	27,700	27,615	85	6,303	6,303	0
Pulpwood	0	0	0	0	0	0	0	0	0
Composite products	0	0	0	0	0	0	0	0	0
Fuelwood	165,447	113,235	52,212	62,497	54,721	7,775	102,950	58,514	44,436
Posts, poles, and pilings	10,058	10,058	0	10,058	10,058	0	0	0	0
Miscellaneous products	256	256	0	4	4	0	252	252	0
Total	727,683	675,386	52,297	575,901	568,040	7,860	151,782	107,346	44,436
Pacific Coast total:									
Saw logs	1,745,460	1,692,554	52,906	1,668,683	1,615,819	52,864	76,778	76,735	43
Veneer logs	334,654	321,522	13,132	304,537	291,608	12,929	30,117	29,914	202
Pulpwood	64,520	60,611	3,909	55,886	52,186	3,699	8,634	8,424	209
Composite products	1,491	1,491	0	1,257	1,257	0	234	234	0
Fuelwood	311,841	209,863	101,979	152,380	109,687	42,692	159,462	100,176	59,286
Posts, poles, and pilings	79,340	79,340	0	79,340	79,340	0	0	0	0
Miscellaneous products	69,008	69,006	2	68,109	68,107	2	899	899	0
Total	2,606,314	2,434,387	171,928	2,330,192	2,218,004	112,186	276,124	216,382	59,740
United States:									
Saw logs	7,161,959	5,156,385	2,005,574	6,726,310	4,907,165	1,819,143	435,651	249,219	186,432
Veneer logs	1,338,791	1,173,435	165,356	1,274,486	1,118,305	156,180	64,306	55,131	9,174
Pulpwood	4,877,555	2,847,095	2,030,460	4,316,687	2,563,598	1,753,088	560,868	283,495	277,372
Composite products	453,057	175,300	277,759	406,666	156,466	250,201	46,390	18,835	27,556
Fuelwood	1,518,572	377,515	1,141,058	574,598	155,138	419,458	943,975	222,377	721,599
Posts, poles, and pilings	177,720	168,925	8,795	166,475	160,039	6,437	11,246	8,886	2,359
Miscellaneous products	155,283	121,867	33,417	136,121	107,216	28,905	19,162	14,651	4,511
Total	15,682,937	10,020,522	5,662,419	13,601,343	9,167,927	4,433,412	2,081,598	852,594	1,229,003

Note: Data may not add to totals because of rounding.

Table 40—Roundwood products, logging residues, and other removals from growing stock and other sources by species group, region, and subregion, 2001

Region, subregion, class of material, and source of material	Total	Species group	
		Softwoods	Hardwoods
		Thousand cubic feet	
North:			
Northeast:			
Roundwood products—			
Growing stock	1,145,660	392,835	752,824
Other sources	622,143	152,477	469,666
Total	1,767,803	545,312	1,222,490
Logging residues—			
Growing stock[a]	125,957	21,381	104,576
Other sources[b]	585,493	173,648	411,845
Total	711,450	195,029	516,421
Other removals—			
Growing stock[c]	0	0	0
Other sources[d]	10,669	1,400	9,270
Total	10,669	1,400	9,270
Total, all classes—			
Growing stock	1,271,617	414,216	857,400
Other sources	1,218,305	327,525	890,781
Total, all materials	2,489,922	741,741	1,748,181
North Central:			
Roundwood products—			
Growing stock	1,216,878	212,524	1,004,354
Other sources	361,697	29,376	332,321
Total	1,578,575	241,900	1,336,675
Logging residues—			
Growing stock[a]	129,795	8,915	120,880
Other sources[b]	508,842	77,903	430,939
Total	638,637	86,818	551,819
Other removals—			
Growing stock[c]	92,537	7,159	85,377
Other sources[d]	73,385	4,177	69,207
Total	165,922	11,336	154,584
Total, all classes—			
Growing stock	1,439,210	228,598	1,210,611
Other sources	943,924	111,456	832,467
Total, all materials	2,383,134	340,054	2,043,078
North Total:			
Roundwood products—			
Growing stock	2,362,538	605,359	1,757,178
Other sources	983,840	181,853	801,987
Total	3,346,378	787,212	2,559,165
Logging residues—			
Growing stock[a]	255,752	30,296	225,456
Other sources[b]	1,094,335	251,551	842,784
Total	1,350,087	281,847	1,068,240

Table 40—(continued).

Region, subregion, class of material, and source of material	Total	Species group	
		Softwoods	Hardwoods
		Thousand cubic feet	
Other removals—			
Growing stock[c]	92,537	7,159	85,377
Other sources[d]	84,054	5,577	78,477
Total	176,591	12,736	163,854
Total, all classes—			
Growing stock	2,710,827	642,814	2,068,011
Other sources	2,162,229	438,981	1,723,248
Total, all materials	4,873,056	1,081,795	3,791,259
South:			
Southeast:			
Roundwood products—			
Growing stock	3,621,496	2,610,998	1,010,498
Other sources	263,280	147,001	116,280
Total	3,884,776	2,757,999	1,126,778
Logging residues—			
Growing stock[a]	351,122	169,950	181,172
Other sources[b]	169,860	58,984	110,876
Total	520,982	228,934	292,048
Other removals—			
Growing stock[c]	331,203	132,340	198,863
Other sources[d]	144,997	43,190	101,807
Total	476,200	175,530	300,670
Total, all classes—			
Growing stock	4,303,821	2,913,288	1,390,533
Other sources	578,137	249,175	328,963
Total, all materials	4,881,958	3,162,463	1,719,496
South Central:			
Roundwood products—			
Growing stock	4,803,110	3,268,487	1,534,623
Other sources	408,681	207,424	201,257
Total	5,211,791	3,475,911	1,735,880
Logging residues—			
Growing stock[a]	545,089	200,069	345,020
Other sources[b]	403,575	134,943	268,631
Total	948,664	335,012	613,651
Other removals—			
Growing stock[c]	418,114	131,622	286,493
Other sources[d]	133,674	27,775	105,898
Total	551,788	159,397	392,391
Total, all classes—			
Growing stock	5,766,313	3,600,178	2,166,136
Other sources	945,930	370,142	575,786
Total, all materials	6,712,243	3,970,320	2,741,922

Table 40—(continued).

Region, subregion, class of material, and source of material	Total	Species group: Softwoods	Species group: Hardwoods
	Thousand cubic feet		
South total:			
Roundwood products—			
Growing stock	8,424,606	5,879,485	2,545,121
Other sources	671,961	354,425	317,537
Total	9,096,567	6,233,910	2,862,658
Logging residues—			
Growing stock[a]	896,211	370,019	526,192
Other sources[b]	573,435	193,927	379,507
Total	1,469,646	563,946	905,699
Other removals—			
Growing stock[c]	749,317	263,962	485,356
Other sources[d]	278,671	70,965	207,705
Total	1,027,988	334,927	693,061
Total, all classes—			
Growing stock	10,070,134	6,513,466	3,556,669
Other sources	1,524,067	619,317	904,749
Total, all materials	11,594,201	7,132,783	4,461,418
Rocky Mountain:			
Great Plains:			
Roundwood products—			
Growing stock	30,880	21,797	9,083
Other sources	29,478	1,488	27,990
Total	60,358	23,285	37,073
Logging residues—			
Growing stock[a]	3,115	1,742	1,374
Other sources[b]	9,817	7,054	2,763
Total	12,932	8,796	4,137
Other removals—			
Growing stock[c]	5,490	143	5,346
Other sources[d]	10,241	150	10,091
Total	15,731	293	15,437
Total, all classes—			
Growing stock	39,485	23,682	15,803
Other sources	49,536	8,692	40,844
Total, all materials	89,021	32,374	56,647
Intermountain:			
Roundwood products—			
Growing stock	453,128	443,284	9,843
Other sources	120,196	98,445	21,751
Total	573,324	541,729	31,594
Logging residues—			
Growing stock[a]	44,498	43,851	646
Other sources[b]	105,212	102,484	2,727
Total	149,710	146,335	3,373

Table 40—(continued).

Region, subregion, class of material, and source of material	Total	Species group	
		Softwoods	Hardwoods
	Thousand cubic feet		
Other removals—			
Growing stock[c]	0	0	0
Other sources[d]	0	0	0
Total	0	0	0
Total, all classes—			
Growing stock	497,626	487,135	10,489
Other sources	225,408	200,929	24,478
Total, all materials	723,034	688,064	34,967
Rocky Mountain total:			
Roundwood products—			
Growing stock	484,008	465,081	18,926
Other sources	149,674	99,933	49,741
Total	633,682	565,014	68,667
Logging residues—			
Growing stock[a]	47,613	45,593	2,020
Other sources[b]	115,029	109,538	5,490
Total	162,642	155,131	7,510
Other removals—			
Growing stock[c]	5,490	143	5,346
Other sources[d]	10,241	150	10,091
Total	15,731	293	15,437
Total, all classes—			
Growing stock	537,111	510,817	26,292
Other sources	274,944	209,621	65,322
Total, all materials	812,055	720,438	91,614
Pacific Coast:			
Alaska:			
Roundwood products—			
Growing stock	106,669	104,034	2,635
Other sources	4,184	3,424	760
Total	110,853	107,458	3,395
Logging residues—			
Growing stock[a]	33,654	32,666	989
Other sources[b]	23,415	22,727	688
Total	57,069	55,393	1,677
Other removals—			
Growing stock[c]	2,006	1,996	10
Other sources[d]	0	0	0
Total	2,006	1,996	10
Total, all classes—			
Growing stock	142,329	138,696	3,634
Other sources	27,599	26,151	1,448
Total, all materials	169,928	164,847	5,082

Table 40—(continued).

Region, subregion, class of material, and source of material	Total	Species group	
		Softwoods	Hardwoods
		Thousand cubic feet	
Pacific Northwest:			
Roundwood products—			
Growing stock	1,647,622	1,545,931	101,692
Other sources	120,157	105,612	14,544
Total	1,767,779	1,651,543	116,236
Logging residues—			
Growing stock[a]	81,538	77,127	4,411
Other sources[b]	83,423	80,151	3,272
Total	164,961	157,278	7,683
Other removals—			
Growing stock[c]	1,005	605	400
Other sources[d]	0	0	0
Total	1,005	605	400
Total, all classes—			
Growing stock	1,730,165	1,623,663	106,503
Other sources	203,580	185,763	17,816
Total, all materials	1,933,745	1,809,426	124,319
Pacific Southwest:			
Roundwood products—			
Growing stock	575,900	568,040	7,860
Other sources	151,782	107,346	44,436
Total	727,682	675,386	52,296
Logging residues—			
Growing stock[a]	57,590	56,804	786
Other sources[b]	46,386	46,386	0
Total	103,976	103,190	786
Other removals—			
Growing stock[c]	22	9	13
Other sources[d]	222	77	145
Total	244	86	158
Total, all classes—			
Growing stock	633,512	624,853	8,659
Other sources	198,390	153,809	44,581
Total, all materials	831,902	778,662	53,240
Pacific Coast total:			
Roundwood products—			
Growing stock	2,330,191	2,218,005	112,187
Other sources	276,123	216,382	59,740
Total	2,606,314	2,434,387	171,927
Logging residues—			
Growing stock[a]	172,782	166,597	6,186
Other sources[b]	153,224	149,264	3,960
Total	326,006	315,861	10,146
Other removals—			
Growing stock[c]	3,033	2,610	423
Other sources[d]	222	77	145
Total	3,255	2,687	568

Table 40—(continued).

Region, subregion, class of material, and source of material	Total	Species group	
		Softwoods	Hardwoods
		Thousand cubic feet	
Total, all classes—			
Growing stock	2,506,006	2,387,212	118,796
Other sources	429,569	365,723	63,845
Total, all materials	2,935,575	2,752,935	182,641
United States:			
Roundwood products—			
Growing stock	13,601,343	9,167,930	4,433,412
Other sources	2,081,598	852,593	1,229,005
Total	15,682,941	10,020,523	5,662,417
Logging residues—			
Growing stock[a]	1,372,358	612,505	759,854
Other sources[b]	1,936,023	704,280	1,231,741
Total	3,308,381	1,316,785	1,991,595
Other removals—			
Growing stock[c]	850,377	273,874	576,502
Other sources[d]	373,188	76,769	296,418
Total	1,223,565	350,643	872,920
Total, all classes—			
Growing stock	15,824,078	10,054,309	5,769,768
Other sources	4,390,809	1,633,642	2,757,164
Total, all materials	20,214,887	11,687,951	8,526,932

[a] Growing-stock volume cut or knocked down during harvest but left at the harvest site.

[b] Wood volume other than growing stock cut or knocked down during harvest but left on the ground. This volume is net of wet rot or advanced dry rot, and excludes old punky logs; consists of material sound enough to chip; includes downed dead and cull trees, tops above the 4-inch growing-stock top, and smaller than 5 inches d.b.h.; excludes stumps and limbs.

[c] Growing-stock volume removed by cultural operations or timberland clearing.

[d] Wood volume other than growing stock removed by cultural operations or timberland clearing. This volume is net of wet rot or advanced dry rot, and excludes old punky logs; consists of material sound enough to chip; includes downed dead and cull trees, tops above the 4-inch growing-stock top, and smaller than 5 inches dbh; excludes stumps and limbs.

Note: Data may not add to totals because of rounding.

Table 41—Weight of bark and wood residue from primary wood-using mills by type of material, species group, region, subregion, and type of use, 2001

	Total residue			Bark residue			All materials			Coarse materials			Fine materials		
Region, subregion, and type of use	Total	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods	Total	Soft-woods	Hard-woods
							Thousand dry tons								
North:															
Northeast:															
Fiber products	1,484	329	1,155	46	13	32	1,438	316	1,122	1,369	285	1,084	70	31	38
Fuel	1,971	397	1,574	317	70	247	1,654	327	1,327	997	215	782	656	112	544
Other uses	2,208	499	1,709	717	135	582	1,490	364	1,126	302	65	237	1,188	299	889
Not used	404	101	302	109	28	80	295	73	222	158	44	114	137	29	108
Total	6,067	1,326	4,740	1,189	246	941	4,877	1,080	3,797	2,826	609	2,217	2,051	471	1,579
North Central:															
Fiber products	1,486	166	1,320	29	0	28	1,458	166	1,292	1,404	164	1,240	53	1	52
Fuel	3,512	585	2,927	1,739	332	1,407	1,773	253	1,520	761	56	705	1,012	196	816
Other uses	2,329	225	2,104	867	69	799	1,462	156	1,306	606	79	527	856	78	779
Not used	388	49	340	117	16	101	271	33	238	110	15	95	162	18	144
Total	7,715	1,025	6,691	2,752	417	2,335	4,964	608	4,356	2,881	314	2,567	2,083	293	1,791
North total:															
Fiber products	2,970	495	2,475	74	14	61	2,896	482	2,414	2,773	449	2,324	123	33	90
Fuel	5,483	982	4,501	2,057	403	1,654	3,427	579	2,847	1,758	271	1,487	1,668	308	1,360
Other uses	4,537	724	3,813	1,585	204	1,381	2,952	520	2,432	908	143	764	2,045	377	1,668
Not used	792	150	642	226	44	182	566	106	461	268	59	209	298	47	252
Total	13,782	2,351	11,431	3,942	665	3,278	9,841	1,687	8,154	5,707	922	4,784	4,134	765	3,370
South:															
Southeast:															
Fiber products	5,815	4,441	1,374	5	3	2	5,810	4,438	1,372	4,884	3,579	1,305	926	859	67
Fuel	5,914	4,039	1,875	2,780	1,890	889	3,134	2,149	985	271	160	111	2,863	1,989	874
Other uses	2,049	1,438	611	1,041	632	409	1,008	806	201	280	193	87	727	613	114
Not used	123	48	75	51	27	24	72	21	51	33	14	18	40	7	33
Total	13,901	9,966	3,935	3,877	2,552	1,324	10,024	7,414	2,609	5,468	3,946	1,521	4,556	3,468	1,088
South Central:															
Fiber products	11,727	9,197	2,530	1	0	1	11,726	9,197	2,529	10,694	8,231	2,463	1,032	966	66
Fuel	15,440	10,594	4,846	7,362	4,935	2,427	8,078	5,660	2,419	1,166	670	496	6,912	4,990	1,922
Other uses	3,197	2,056	1,141	1,111	617	494	2,086	1,439	647	767	563	204	1,319	877	442
Not used	450	158	291	103	33	69	347	125	222	161	34	127	186	91	95
Total	30,814	22,005	8,808	8,577	5,585	2,991	22,237	16,421	5,817	12,788	9,498	3,290	9,449	6,924	2,525
South total:															
Fiber products	17,542	13,638	3,904	6	3	3	17,536	13,635	3,901	15,578	11,810	3,768	1,958	1,825	133
Fuel	21,354	14,633	6,721	10,142	6,825	3,317	11,212	7,808	3,404	1,438	830	608	9,775	6,978	2,796
Other uses	5,246	3,494	1,752	2,152	1,249	903	3,094	2,246	848	1,047	756	292	2,046	1,490	557
Not used	573	206	367	154	60	93	419	146	273	194	48	146	225	97	128
Total	44,715	31,971	12,744	12,454	8,137	4,316	32,261	23,835	8,426	18,257	13,444	4,814	14,004	10,390	3,614
Rocky Mountain:															
Great Plains:															
Fiber products	111	107	4	0	0	0	111	107	4	91	87	4	19	19	0
Fuel	47	41	5	32	30	1	15	11	4	8	5	3	7	6	0
Other uses	94	25	69	31	15	16	63	11	52	31	1	31	32	10	22
Not used	23	5	19	6	2	4	17	3	14	11	1	10	6	2	5
Total	275	178	97	69	47	21	206	132	74	141	94	48	64	37	27

Table 41—(continued).

	Total residue			Bark residue			All materials			Coarse materials			Fine materials		
Region, subregion, and type of use	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods
							Thousand dry tons								
Intermountain:															
Fiber products	4,325	4,321	4	0	0	0	4,325	4,321	4	3,186	3,182	4	1,139	1,139	0
Fuel	2,147	2,143	4	1,137	1,136	1	1,011	1,007	4	151	150	1	860	857	3
Other uses	409	406	3	137	136	1	272	270	2	81	81	0	191	189	2
Not used	268	265	3	131	130	1	136	135	2	67	65	1	70	70	0
Total	7,149	7,135	14	1,405	1,402	3	5,744	5,733	12	3,485	3,478	6	2,260	2,255	5
Rocky Mountain total:															
Fiber products	4,436	4,428	8	0	0	0	4,436	4,428	8	3,277	3,269	8	1,159	1,159	0
Fuel	2,194	2,184	10	1,168	1,166	2	1,026	1,018	8	160	155	4	866	863	3
Other uses	503	431	72	168	151	18	335	280	55	112	81	31	223	199	24
Not used	291	270	21	137	132	5	154	138	16	78	67	11	76	71	5
Total	7,424	7,313	111	1,473	1,449	25	5,951	5,864	87	3,627	3,572	54	2,324	2,292	32
Pacific Coast:															
Alaska:															
Fiber products	69	69	0	0	0	0	69	69	0	69	69	0	0	0	0
Fuel	28	28	0	0	0	0	28	28	0	8	8	0	20	20	0
Other uses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Not used	128	118	10	89	86	3	39	32	7	29	24	6	10	9	2
Total	225	215	10	89	86	3	136	129	7	106	101	6	30	29	2
Pacific Northwest:															
Fiber products	7,304	6,987	317	1	1	0	7,303	6,986	316	5,062	4,772	291	2,240	2,215	26
Fuel	3,986	3,606	380	2,385	2,221	165	1,601	1,385	216	561	443	119	1,039	942	97
Other uses	1,219	1,110	109	335	305	31	884	805	79	600	566	34	284	239	45
Not used	15	15	0	7	7	0	7	7	0	4	4	0	4	4	0
Total	12,524	11,718	806	2,728	2,534	196	9,795	9,183	611	6,227	5,785	444	3,567	3,400	168
Pacific Southwest:															
Fiber products	2,147	2,144	3	15	15	0	2,132	2,129	3	1,592	1,589	3	540	540	0
Fuel	2,286	2,284	1	850	849	1	1,436	1,436	0	544	544	0	892	891	0
Other uses	382	382	0	119	119	0	263	263	0	88	88	0	175	175	0
Not used	8	8	0	8	8	0	0	0	0	0	0	0	0	0	0
Total	4,823	4,818	4	992	991	1	3,831	3,828	3	2,224	2,221	3	1,607	1,606	0
Pacific Coast total:															
Fiber products	9,520	9,200	320	16	15	0	9,504	9,185	320	6,724	6,430	294	2,781	2,755	26
Fuel	6,300	5,918	382	3,235	3,069	166	3,064	2,848	216	1,114	995	119	1,951	1,853	97
Other uses	1,602	1,492	110	454	424	31	1,147	1,068	79	688	654	34	459	414	45
Not used	151	141	10	104	101	3	47	40	7	33	27	6	14	12	2
Total	17,573	16,751	822	3,809	3,609	200	13,762	13,141	622	8,559	8,106	453	5,205	5,034	170
United States:															
Fiber products	34,469	27,762	6,707	96	32	64	34,373	27,730	6,643	28,352	21,958	6,394	6,020	5,771	249
Fuel	35,331	23,718	11,614	16,602	11,463	5,139	18,729	12,254	6,475	4,469	2,251	2,218	14,260	10,003	4,257
Other uses	11,887	6,141	5,746	4,359	2,027	2,332	7,528	4,114	3,414	2,756	1,634	1,121	4,773	2,480	2,293
Not used	1,807	767	1,040	621	338	283	1,186	429	757	572	201	371	614	228	386
Total	83,494	58,388	25,107	21,678	13,860	7,818	61,816	44,527	17,289	36,149	26,044	10,104	25,667	18,482	4,892

Note: Data may not add to totals because of rounding.

Smith, W. Brad; Miles, Patrick D.; Vissage, John S.; Pugh, Scott A. 2003. **Forest Resources of the United States, 2002.** Gen. Tech. Rep. NC-241. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Research Station. 137 p.

An update of forest statistics from the 1997 Resources Planning Act (RPA) Assessment were updated to 2002 to provide current information on the Nation's forests. Resource tables present estimates of forest area, volume, mortality, growth, removals, and timber products output in various ways, such as by ownership, region, or State. Historic data for 1953, 1963, 1977, 1987, and 1997 are included for resource trend analysis. A compact disk contains the summary data, and a computerized tool that allows readers to make customized analyses.

KEY WORDS: RPA, assessment, inventory, forest statistics, area, volume, trends.

RPA DATA WIZ CD

The included CD contains the RPA Data Wiz, a computer desktop application that allows custom summaries of Resource Planning Act (RPA) Assessment forest information. Summary tables, graphs, and choropleth maps can be produced with this software. A number of variables can be analyzed. Volumes for growing stock, live cull, dead salvable, net growth, and mortality can be estimated. Acreage, biomass, and tree count estimates are also available. Currently, removals are not available in this software. There is an English and a Metric version of RPA Data Wiz.

Requirements to use RPA Data Wiz

Your computer must have one of the following operating systems:

- Windows 95, 98, XP, 2000 or NT 4.0
- Windows 2000 Service Pack 2 or higher

Your computer must have the following:

- CD-ROM or DVD-ROM drive
- Color monitor with 256 or more colors
- Microsoft Internet Explorer Version 5.0 or higher
- 848 MB of hard disk space for one version (1030 MB for both English and metric versions)

The following items are recommendations, but are not essential:

- 200 MB of virtual memory
- 512 MB of RAM
- Pentium III processor or later
- 14 inch computer monitor
- Monitor resolution of 1024 X 768
- High color (16 bit) display

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Can *Eucalyptus* invade native forest fragments close to commercial stands?

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ABSTRACT

Some *Eucalyptus* species are widely used as a plantation crop in tropical and subtropical regions. One reason for this is the diversity of end uses, but the main reason is the high level of wood production obtained from commercial plantings. With the advancement of biotechnology it will be possible to expand the geographical area in which eucalypts can be used as commercial plantation crops, especially in regions with current climatic restrictions. Despite the popularity of eucalypts and their increasing range, questions still exist, in both traditional planting areas and in the new regions: Can eucalypts invade areas of native vegetation, causing damage to natural ecosystems biodiversity?

The objective of this study it was to assess whether eucalypts can invade native vegetation fragments in proximity to commercial stands, and what factors promote this invasive growth. Thus, three experiments were established in forest fragments located in three different regions of Brazil. Each experiment was composed of 40 plots ($1\ m^2$ each one), 20 plots located at the border between the forest fragment and eucalypts plantation, and 20 plots in the interior of the forest fragments. In each experimental site, the plots were paired by two soil exposure conditions, 10 plots in natural conditions and 10 plots with soil exposure (no plant and no litter). During the rainy season, 2 g of eucalypts seeds were sown in each plot, including *Eucalyptus grandis* or a hybrid of *E. urophylla* × *E. grandis*, the most common commercial eucalypt species planted in the three region. At 15, 30, 45, 90, 180, 270 and 360 days after sowing, we assessed the number of seedlings of eucalypts and the number of seedlings of native species resulting from natural regeneration. Fifteen days after sowing, the greatest number of eucalypts seedlings ($37\ m^{-2}$) was observed in the plots with lower luminosity and exposed soil. Also, for native species, it was observed that exposed soil improved natural germination reaching the highest number of 163 seedlings per square meter. Site and soil exposure were the factors that have the greatest influence on seed germination of both eucalypt and native species. However, 270 days after sowing, eucalypt seedlings were not observed at any of the three experimental sites. The result shows the inability of eucalypts to adapt to condition outside of their natural range. However, native species demonstrated their strong capacity for natural regeneration in forest fragments under the same conditions where eucalypts were seeded.

1. Introduction

Around the world, the introduction of exotic forest species has resulted in major social and economic benefits, especially in areas that were unfavorable for agricultural production (Sampaio et al., 2000). Annually, commercial reforestation accounts for 4.5 million hectares of planted forest, with the majority of this area devoted to conifers. In South America and Africa, *Eucalyptus* species are widely used in commercial reforestation (FAO, 2000) as several species of the *Eucalyptus* genus have good productivity in tropical or subtropical areas. With the advance of biotechnology it will soon be possible to expand commercial plantations to areas previously inappropriate for eucalypts plantations because of climatic restrictions. In Brazil, the eucalypt has been planted in all regions of the country, totaling 3752 million hectares (ABRAF, 2007). Eucalypts are used in commercial forestation because of their rapid growth and plasticity, adaptation to different environments (different altitudes, climates and soil types) and their multiple end uses.

In Brazil, eucalypt plantations are the ecosystems with the highest wood production. The average production is 20 tons $ha^{-1}\ year^{-1}$ of wood seven years after planting. This productivity is clearly related to the environmental conditions (Stape et al., 2007) of the plantation and reflects the adaptation of the species to

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various regions. To obtain such a high productivity, commercial plantation owners have selected over many years superior genotypes that are physiologically adapted to the environmental conditions of the planting site and the sites are carefully managed.

This physiological adaptation, however, does not reflect ecological adaptation. The level of growth within commercial plantations that receive all the necessary and carefully managed conditions for development cannot be compared with the natural capacity of the species to establish itself through natural regeneration from the germination of seeds produced by the planted forests. The capacity for natural regeneration of species is a product of the relationship between environmental and genetic characteristics that reflect the adaptation of species to local conditions (Erfmeier and Bruelheide, 2010). If not properly managed, an ecologically adapted exotic species can alter local diversity and forest structure by invading and dominating the natural vegetation. These species may create soil seed banks and germinate more rapidly than the native species, which make them aggressive in the process of regeneration in forest habitats (Cordell et al., 2009). The invasion process is dependent on the characteristics of the species and the structure and composition of the ecosystem, which are influenced by climatic and physical factors (Godfree et al., 2004). It is possible to observe distinct behavior of exotic species in different sites; the same species can be invasive in some places and not in others (Williams and Wardle, 2007).

In the case of eucalypt species, which were introduced and planted extensively outside their natural range, some rare species of the genus have caused problems with invasion in some introduced regions (Ruthrof, 2004). However, the regeneration of eucalypts rarely occurs in native forest fragments and only a few cases have been observed within commercial areas and with human intervention (Mattei and Longhi, 2001). In some cases, the seeds can germinate when the moisture content is adequate, but in order for the seedlings to survive and subsequently establish themselves, it is necessary that conditions remain suitable for the species (Ottone, 1969). Thus, it is important to understand both the conditions that affect germination as well as the species that was introduced and extensively used in commercial forest plantations, in order to ensure the appropriate management and avoid negative impacts on natural ecosystems.

In order to assess the potential impact of invasive species on native ecosystems, it is necessary to clarify: (1) if eucalypts can invade the native fragments in proximity to commercial stands, and (2) the factors which promote germination and regeneration. Within this context, the aim of this study is to evaluate the invasive potential of eucalypt species in different areas of natural (remaining) fragments adjacent to commercial plantations, considering the site, soil exposure, the position relative to the fragment (border and interior) and the interaction between these factors in regeneration. The following questions were addressed: (i) Are there differences in the regeneration of eucalypt species between different sites, levels of soil exposure (covered and exposed), and position (border vs. interior)?; (ii) Do eucalypts have a higher capacity for regeneration than native species?; and (iii) Which of the environmental factors interact to significantly affect regeneration success?

2. Materials and methods

To assess the invasive potential of eucalypts, three experiments were set up under different conditions/sites (Table 1). At each site a fragment of remaining natural vegetation adjacent to a commercial stand of eucalypts was chosen as the study site. Each experiment consisted of 40 plots of 1 m^2: 20 plots located at random along a 3 m wide border between the fragment and the stand of eucalypts, called “border plots”; 20 plots were placed inside the fragment, in an area without disturbance, called “interior plots.” At both the border and interior, plots were paired with two conditions of soil exposure: 10 plots were natural or undisturbed, called “soil unchanged” (SU) and 10 plots had the plants and the litter removed, called “soil exposed” (SE).

Therefore, the experiments at different sites were composed of four treatments (SU-Border, SE-Border, SU-Interior and SE-Interior), in which plot were seeded 2 g of eucalypt seeds (approximately 250 seeds m^{-2}), corresponding to 20 kg of seeds per hectare (2.5 million seeds). To promote germination, seeds were distributed during the rainy season (January to March 2009). The eucalypts species (*Eucalyptus grandis* and *E. grandis* × *E. urophylla*) was chosen based on the most commercially used eucalypt species in the region. The experiments were monitored at 15, 30, 45, 90, 180, 270 and, 360 days after sowing. At each monitoring stage, we counted the number of eucalypt seedlings that had germinated and the number of seedlings of native species that had germinated from the soil seed bank (naturally occurring in each plot).

The data collected from each plot were analyzed to verify significant differences for each treatment using analysis of variance (ANOVA) and Tukey's test. In order to perform variance analysis, the data were transformed. The analyses were carried out individually for each time (15, 30, 45, 90, 180, 270 and, 360 days after sowing). In the analyses, the source of variation for site (type of vegetation), species (eucalypts and native species), soil exposure (unchanged and exposed) and fragment position (border and interior) were adopted as a fixed effect.

3. Results

Data from the three experiments were analyzed together to assess the factors that influence germination and the establishment of seedlings. Significant differences were observed among sites, species (eucalypts vs. native species), and soil exposure. However, there were no significant differences in germination due to the position of plots within the fragment (border vs. interior). This result could be attributed to the effect generated by the lowest luminosity observed in the experimental site 3. However, most of interactions were highly significant ($P < 0.0001$), there were significant correlations between site and species; species and soil exposure; and among site, species and position during all the study. The interactions were highly significant just in the initial period, up to 90 days, in all interactions with site and soil exposure. None of the studied factors alone were significantly affected by the position of the plot within the fragment (Table 2).

In all experiments exposed soil improved the germination of eucalypts and no difference was observed relating to the position of the plot within the fragment. However, from 270 days after sowing, no eucalypt seedlings were observed in the three experiments (Table 3), indicating that eucalypts could not establish themselves in these environments.

For native species, we observed that soil exposure improved germination in all experiments. Sites 1 and 2 had higher germination in the experimental plots with exposed soil located in the fragment interior and at site 3 the highest germination rate was observed in plots with exposed soil, but located on the border of the fragment (Table 4).

In site 1, experiments with the highest eucalypts seed germination had exposed soil and a lower luminosity (due to their site in the interior of the fragment). The maximum number of eucalypt seedlings per plot was 37 seedlings 15 days after sowing. However,

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Table 1
Sites location and characterization.

Characteristics	Site 1	Site 2	Site 3
City	Santa Rita do Passa Quatro, SP	Jacareí, SP	Belo Oriente, MG
Latitude	21°35′53″S	23°21′54″S	19°17′49″S
Longitude	47°30′46″W	46°02′57″W	42°24′31″W
Natural vegetation	Seasonal forest	Semideciduous forest	Semideciduous forest seasonal submontane (Atlantic forest)
Successional stage	Secondary	Secondary	Secondary
Conservation status	Well conserved	Regenarating	Conserved
Comum species	*Copaifera langsoorffii*; *Pterodon pubescens*; *Cariocar brasiliense*	*Cupania vernalis*; *Cróton floribundus*; *Syagrus romanzoffiana*; *Jacarandá puberula*; *Cecropia hololeuca*	*Anadenanthera* spp.; *Trema micrantha*
Liana/vine	No infested	Infested	Low infested
Soil type	Entisol	Cambisol	Cambisol
Climate classification	Subtropical warm and winter dry – Cwa	Subtropical warm and winter dry – Cwa	Subtropical warm and winter dry – Cwa
Relief	Plan to gently undulating	Strongly undulated	Undulated
Annual average temperature	21.1 °C	20.0 °C	23.1 °C
Average temperature for the planting month	23.4 °C	21.2 °C	24.5 °C
Annual average rainfall	1500 mm	1232 mm	1235 mm
Rainfall during the experiment	1974 mm (01/09–12/09))	1587 mm (03/09–02/10)	1456 mm (01/09–12/09)
Rainfall during the first 3 months	628 mm (01/09–03/09)	255 mm (03/09–05/09)	542 mm (01/09–03/09)
Average luminosity in the plots			
Border	95 klx	60 klx	26 klx
Interior	21 klx	6.8 klx	4.6 klx
Species used	*E. urophylla* × *E. grandis*	*E. grandis*	*E. urophylla* × *E. grandis*
Planting date	01/05/2009	03/10/2009	01/12/2009

Table 2
Significance level (*P* value) of variance analysis at each time.

Source of variation	DF	Evaluation time						
		15 days	30 days	45 days	90 days	180 days	270 days	360 days
Site (vegetation)	2	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Species (eucalypts and native)	1	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Soil exposure (SE and SU)	1	<0.0001	<0.0001	<0.0001	<0.0001	0.0004	0.0002	0.0008
Position (border and internal)	1	0.1382	0.0755	0.8118	0.3933	0.8572	0.0772	0.6581
Site × species	2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Site × soil exposure	2	0.0024	<0.0001	0.0004	0.0781	0.0685	0.0527	0.4523
Site × position	2	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.002	<0.0001
Species × soil exposure	1	0.0017	<0.0001	<0.0001	<0.0001	0.0005	0.0003	0.0010
Species × position	1	0.0100	0.1105	0.7835	0.0047	0.7584	0.0649	0.6238
Soil exposure × position	1	0.8820	0.4085	0.8289	0.2059	0.2888	0.6000	0.8953
Site × species × soil exposure	2	<0.0001	0.0006	0.0007	0.2110	0.0916	0.0685	0.4747
Site × species × position	2	0.0010	<0.0001	<0.0001	<0.0001	<0.0001	0.0029	<0.0001
Species × soil exposure × position	1	0.0409	0.1887	0.6211	0.0327	0.2441	0.5456	0.9333
Site × species × soil exp. × position	4	0.0031	0.002	0.0004	0.0159	0.9599	0.5080	0.5204

DF, degrees of freedom; high significant if $P < 0.01$; significant if $0.05 > P > 0.01$; non-significant if $P > 0.05$.

Table 3
Eucalypts seedlings observed within the experimental plots over 360 days.

Site	Position	Soil	Average number of seedlings per plot						
			15	30	60	90	180	270	360
1	Border	SE	4	1	0	0	0	0	0
		SU	3	1	0	0	0	0	0
	Interior	SE	37	0	0	0	0	0	0
		SU	1	4	0	0	0	0	0
2	Border	SE	7	3	5	1	0	0	0
		SU	3	0	0	0	0	0	0
	Interior	SE	9	3	2	0	0	0	0
		SU	1	0	0	0	0	0	0
3	Border	SE	5	4	3	2	1	0	0
		SU	4	1	2	1	0	0	0
	Interior	SE	1	1	1	0	0	0	0
		SU	0	0	0	0	0	0	0

SE, soil exposed; SU, soil unchanged.

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Table 4
Native species seedlings observed within the experimental plots over 360 days.

Site	Position	Soil	Average number of seedlings per plot						
			15	30	60	90	180	270	360
1	Border	SE	4	7	7	8	3	3	2
		SU	2	2	3	3	3	3	2
	Interior	SE	5	15	20	20	19	16	13
		SU	7	9	12	14	11	10	8
2	Border	SE	9	9	9	2	4	3	9
		SU	1	1	0	0	0	1	2
	Interior	SE	30	49	51	23	18	8	11
		SU	1	1	2	1	7	3	4
3	Border	SE	163	134	124	82	63	35	31
		SU	62	78	57	54	45	22	23
	Interior	SE	78	77	75	59	44	29	21
		SU	38	34	41	31	24	19	17

SE, soil exposed; SU, soil unchanged.

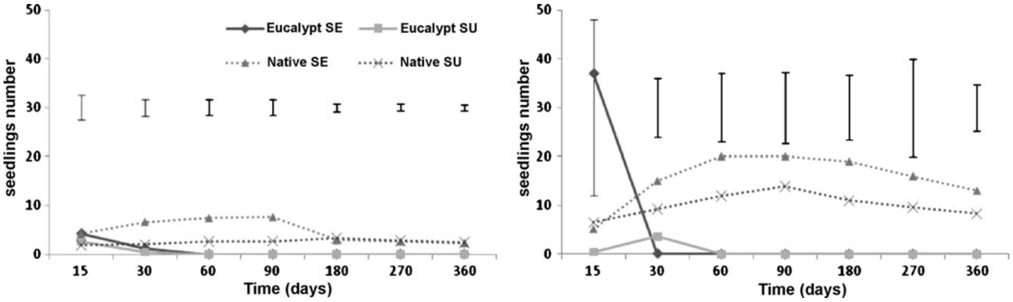

Fig. 1. Number of seedlings observed in the plots (A) border fragment and (B) interior fragment at experiment site 1 (the bar represents the least significant difference, by the Tukey test).

30 days after sowing we observed a significant mortality episode of the eucalypt seedlings (Fig. 1).

In site 2, the plots with exposed soil also stimulated seed germination. The plots with exposed soil and lower luminosity (interior fragment) showed the greatest number of native seedlings, 51 seedlings/m^2 at 60 days. The exposure of the soil in the plots located inside the forest fragment generated the most favorable germination condition for native species from the soil seed bank (Fig. 2).

In site 3, again the exposed soil improved the germination of seeds, especially native species, and the number of eucalypt seedlings was lower than native species. The native species had 31 seedlings per square meter after one year of study. The plots established at the border of the fragment, with higher luminosity, had the largest amount of seedlings. In both conditions (border and interior), we observed that the exposed soil improved germination and regeneration in the initial phase; however, at 270 days the number of seedlings in exposed soil or unchanged soil conditions were similar (Fig. 3).

4. Discussion

4.1. Invasive capacity of eucalypts and its implications

The results of this study show that eucalypts do not have the ability to “invade” the existing native fragments in proximity to the commercial stands in the studied sites. Even with sown seeds and favorable conditions, seedlings of eucalypt trees die shortly after germination. While some seeds were able to germinate, a high mortality occurred during the initial phase of seedling growth. This is likely due to unsuitable environmental conditions, predation by animals, or competition with other plants (Collins, 2003; Chaneton et al., 2010). It should be emphasized that these experiments were carried out during the rainy season and in sites with relatively high temperatures, factors which are favorable for the eucalypt germination and establishment. In cold or dry periods, germination of seeds can be compromised (Tian and Tang, 2010; Thomas et al., 2010).

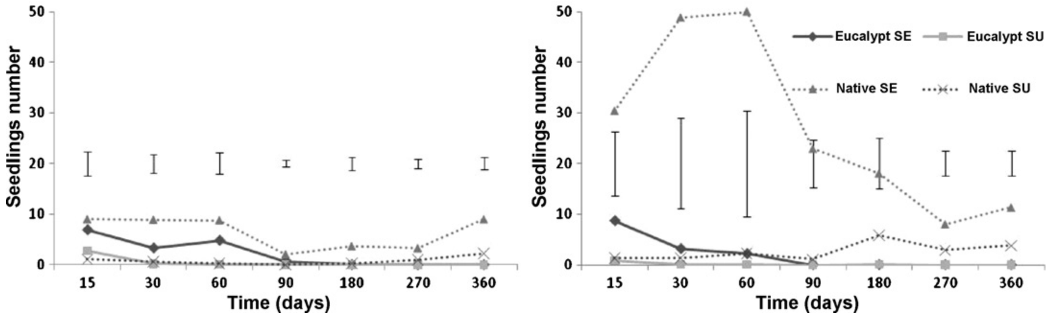

Fig. 2. Number of seedlings observed in the plots (A) border fragment and (B) interior fragment at experiment site 2 (the bar represents the least significant difference, by the Tukey test).

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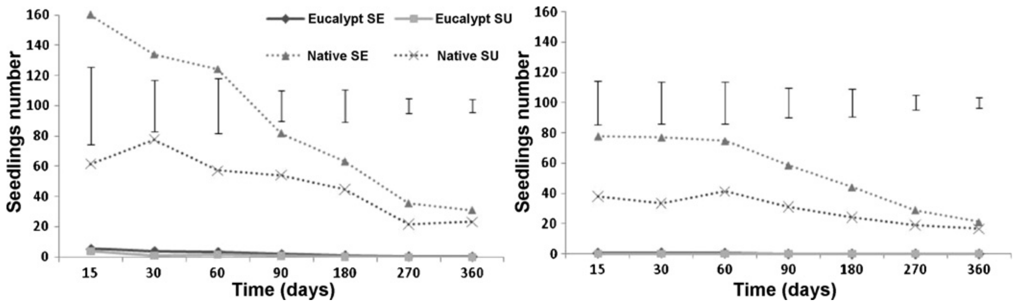

Fig. 3. Number of seedlings observed in the plots (A) border fragment and (B) interior fragment at experiment site 3 (the bar represents the least significant difference, by the Tukey test).

Human activities can promote plant invasions by altering habitat conditions and encouraging the dispersal of propagules of invasive plants, especially in areas in the process of regeneration. It is common for native species to suffer significantly more herbivory than exotic species, which will facilitate exotic regeneration (Flory and Clay, 2009). However, this was not observed in our study. Native species germinated from the soil seed bank and after a year were well established, demonstrating a high regenerative potential in these experimental areas.

One key factor in natural regeneration is the seed dispersal. Thus, the distance from the source of seed, as a plantation forest, so the risk of invasion is higher in border areas than interior areas of native fragments. Seeds of eucalypt species are dispersed by gravity and generally close to seed trees, influenced mainly by wind (Jones et al., 2007). However, unusual mechanisms of long distance dispersal are possible with a small quantity of seeds being dispersed over long distances (220 m) by bees (Wallace et al., 2008).

A native species seed bank in the surface soil is important for natural regeneration in tropical forests (Martins and Engel, 2007; Nobrega et al., 2009). The distance from the seed source is important for the formation of the seed bank in the soil. In remote locations and areas with an intensive cultivation history the seed bank is either weak or nonexistent. Regeneration involving the planting or sowing of local species is therefore required if the function of the area shifts from commercial to native vegetation restoration (Jun et al., 2009).

Invasive species may have divergent effects on different types of ecosystems. Exotic species can, in some cases and with correct management, facilitate the regeneration of native species. This is a dilemma in conservation, but it can also bring new perspectives or approaches to the restoration of ecosystems (Fischer et al., 2009). Some exotic species will have a negative effect on the environment by damaging the interactions of native plants and the ecosystem (Werner et al., 2010). However, in the case of eucalypts that do not have the ability to regenerate naturally, as observed here, this species could be used in the restoration of native vegetation by creating a suitable habitat for local species to succeed (Onofre et al., 2010). Eucalypts play a significant role in promoting the regeneration of native tree species, facilitating the process of natural forest succession (Selwyn and Ganesan, 2009). The use of eucalypt species could provide an economic return in restoration forestry by harvesting wood from eucalypts after a certain number of years while allowing the natural regeneration to continue.

4.2. Factors involved in natural regeneration

It is known that changes in microclimate conditions, light and competition alter germination and plant establishment (Huebner and Tobin, 2006). In this study the site represent different types of natural vegetation and it is the factor that had the most significant impact in relation to the number of seedlings of native species found in the plots. The lowest number of native species germination was in site 1, and the highest germination was on site 3. Considering the existence of a soil seed bank, natural regeneration of plants is correlated with canopy cover (Guilherme, 2000) and the development and establishment of seedlings is directly related to luminosity (Coopman et al., 2010; Iijima and Shibuya, 2010). This explains why the position (fragment border or border) was not a significant factor among the three studied sites.

In conditions with good soil fertility and the presence of well-adapted native species, seedling establishment of eucalypts can be compromised as eucalypt seedlings are less privileged than the competing native species (Skinner et al., 2010). Exposing the soil by removing the litter and plants improved the germination of both eucalypts and local species in all plots studied. This effect was only observed in the initial phases of the experiment. The eucalypt seedlings disappeared within a short time frame and after one year, the number of native species seedlings was similar in the plots with exposed soil and in unchanged soil. Changes in soil or vegetation create microenvironments that positively influence germination of seeds and reduce competition above ground (Van Uytvanck et al., 2010). But in tropical conditions, these microenvironments vanish quickly due to the strength of local regeneration.

Another important factor in controlling the invasion of eucalypts is herbivory. In this study, we observed an attack of leaf-cutter ants, which are a pest in commercial eucalypt plantations in Brazil. The process of herbivory attributed to the leaf-cutting ants may also have contributed to the mortality of eucalypts seedlings, as observed in the three experimental sites. In this study probably the leaf-cutter ants (*Atta* spp. and *Acromyrmex* spp.) prefer eucalypts leaves than native species. Sometimes, herbivory is important in controlling the spread of exotic species due to the direct effect on seedling survival (Becerra and Bustamante, 2008), depending on the vegetation and habitat conditions as well as the exotic species. But some exotic species do not have natural “enemies” in new places of settlement. Therefore, studies on the behavior of invasive species are critical and must be conducted with all commercial exotic species that could be a threat to natural habitats.

5. Conclusions

The site and soil exposure were the factors that most influenced seed germination of eucalypts and native species. Despite the abundant seed germination of eucalypts, it was not observed its establishment. The majority of seedlings died in the plots during the initial observation period, up to ninety days after sowing. In our study eucalypts demonstrate poor ecological adaptation, being unable to establish in fragments of native vegetation close to commercial plantations. For this invasion to occur, specific conditions would be necessary to promote germination and seedling establishment such as good microclimatic conditions, no interspecific competition and no herbivory. Therefore, this study showed

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that while the eucalyptus seedlings failed to establish in forest fragments, the native vegetation established naturally in the experimental plots.

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