United States Department of Agriculture

Animal and Plant Health Inspection Service

Safeguarding Through Science

Center for Plant Health Science and Technology

2009 Accomplishments

Center for Plant Health Science and Technology

Mission

The Center for Plant Health Science and Technology (CPHST) supports the regulatory decisions and operations of the Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine (PPQ) program through methods development, scientific investigation, analyses, and technology.

Strategic Goals

- Enhance PPQ's efforts in pest detection and management
- Provide timely scientific and technical support required for emergency response and management
- Enhance support for APHIS trade-related plant health issues
- Provide current, relevant scientific and technical information to PPQ decisionmakers
- Enhance PPQ's capacity to anticipate and respond to emerging scientific, technical, and regulatory issues through partnership

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Cover photo: Asian longhorned beetle *(Anoplophora glabripennis)*

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Message from the Director

The Center for Plant Health Science and Technology (CPHST) provides scientific support for the regulatory decisions and operations of the Animal and Plant Health Inspection Service's (APHIS) Plant Protection and Quarantine (PPQ) program in order to safeguard U.S. agriculture and natural resources. CPHST is responsible for ensuring that PPQ has the information, tools, and technology to make the most scientifically valid regulatory and policy decisions possible. In addition, CPHST ensures that PPQ's operations have the most scientifically viable and practical tools for pest exclusion, detection, and management. I lead and monitor this effort with the support and expertise of Bill Dickerson, the Associate Director for CPHST. This 2009 CPHST Annual Report is intended to offer an in-depth look at the status of our programs and the progress we have made toward the Center's long-term strategic goals.

The organization is comprised of approximately 250 employees in 7 labs, 3 units, and multiple work stations in the United States, Colombia, and Guatemala. The Light Brown Apple Moth (LBAM) Unit was established in 2009 in Moss Landing, CA, to develop technologies for LBAM management. CPHST is also in the process of establishing a new Agricultural Quarantine Inspection and Port Technology Development Laboratory in Miami, FL, that will provide leadership in commodity treatment technology. This lab will be colocated with USDA's Agricultural Research Service at the Subtropical Horticultural Research Laboratory.

Our work is organized into six National Science Programs: Agricultural Quarantine Inspection and Port Technology; Risk and Pathway Analysis; Domestic Surveillance, Detection, and Identification; Emergency Response; Response and Recovery Systems Technology - Arthropods; and Response and Recovery Systems Technology - Plant Pathogens and Weeds. Our scientists provide leadership and expertise in a wide range of fields, including risk assessments that support trade, commodity quarantine treatments, pest survey and detection methods, molecular diagnostics, biological control techniques, integrated pest management, and mass rearing of insects.

Some highlights of significant CPHST efforts in 2009 include:

Establishment of the National Ornamentals Research Site at Dominican University of California (NORS-DUC). In 2008, CPHST submitted a proposal for funding via Farm Bill Section 10201 to develop the National Ornamentals Research Site, where research could be performed on quarantine pests and pathogens of nursery stock, particularly *Phytophthora ramorum.* Initial funds to set up the nursery were awarded in 2008 and additional funds to bring the facility online and begin *P. ramorum* research were awarded in 2009. CPHST will continue to oversee the research conducted at the site. In addition to supplying data to control the long-range spread of *P. ramorum* and other pests affecting plant health, the NORS-DUC will validate and develop best management practices for nursery stock production; identify new treatment options for soil, water, and plant materials for *P. ramorum* and other pests; and produce valuable epidemiological data on new and emerging species affecting ornamentals.

LBAM Integrated Pest Management and Survey Methods. CPHST has provided numerous tools and methods for the LBAM Program in order to protect U.S. agricultural crops affected by this pest. In 2009, CPHST established an LBAM Unit in Moss Landing, CA, in order to develop the technology needed to implement the sterile insect technique (SIT) for LBAM suppression. This unit developed a 1,000-square-foot mobile mass-rearing system in support of SIT program development. The rearing system is sufficient to provide at least one million moths per week, and the first release of irradiated sterile LBAM was conducted in November 2009. CPHST scientists have also developed mating disruption formulations for LBAM control, lures for California and national surveys, and several phytosanitary treatments to allow for safe movement of nursery stock and agricultural products out of LBAM-infested areas.

Citrus Greening/Huanglongbing Management Tools. CPHST is continuing to develop new management tools to help maintain the production of citrus in areas affected by citrus greening. The Asian citrus psyllid (ACP), *Diaphorina citri* (Kuwayama), is the primary vector of the bacterium *'Candidatus* Liberibacter asiaticus,' the causal agent of citrus greening. An area-wide management pilot project for ACP control is in place for the second year in Texas; the project has demonstrated that certain pesticides can reduce psyllids by 90 percent if applied before the spring flush. In addition, CPHST is developing methods for the mass production of the parasitoid wasp *Tamarixia radiata* as a biocontrol for ACP. A newly collected strain of *T. radiat*a is currently being reared in the CPHST Arthropod Quarantine Facility.

European Grapevine Moth (EGVM) Response. In the fall of 2009, EGVM was detected in California. Survey activity has shown that the moth is present in several grape-producing counties. A CPHST-led technical working group provides information and feedback on issues regarding trapping, lures, mating disruption, treatment, and hosts. During 2010, the effect of treatments and population-limiting strategies will be assessed in order to further optimize the management of EGVM within and outside of California. CPHST is producing lures and monitoring survey activities through the course of the growing season to detect EGVM in and around production areas. CPHST is also initiating projects to develop and/or verify phytosanitary treatments that will allow the safe movement of grapes and grape products for the wine-making, table grape, and raisin industries.

In 2010, we will continue our efforts to provide solutions for mitigating the risks of invasive pests to American agriculture and natural resources. CPHST has been able to leverage significant additional support for these efforts through Farm Bill Section 10201, which provides funds for plant pest detection and surveillance, threat identification and mitigation of plant pests and diseases, and development of certification systems and nursery plant pest risk management systems. In fiscal year 2010, CPHST will be overseeing $8.3 million for 74 Farm Bill projects, most of which will be conducted through cooperative agreements with academia, industry, and other Federal and State agencies.

CPHST is recognized nationally and internationally for its leadership in scientific developments to battle plant pests and diseases. We are issuing this annual report to provide an informative overview of CPHST's accomplishments and projects for our stakeholders in the private and public sectors and our own CPHST staff.

Dr. Philip Berger, Director
Center for Plant Health Science and Technology
USDA-APHIS-PPQ

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National Science Programs

Agricultural Quarantine Inspection and Port Technology

National Science Program Leader - Dr. Mike Hennessey

Who We Are

The Agricultural Quarantine Inspection and Port Technology (AQI&PT) program provides scientific support for agricultural inspections and commodity treatment technologies to prevent the entry or spread of invasive quarantine pests. The AQI&PT program directly supports plant health officers and agriculture specialists stationed at 17 plant inspection stations and over 350 cargo ports throughout the United States as well as numerous international ports that have preclearance programs. The Treatment Quality Assurance Unit (TQAU), a branch within the AQI&PT program, provides treatment certification activities.

What We Do

The AQI&PT program's main function is to provide scientific support—both domestically and internationally—for PPQ and the U.S. Department of Homeland Security's Customs and Border Protection (CBP) inspection and treatment programs. Needs and priorities for methods development are received from PPQ programs for port operations, trade, regional operations, and emergency pest programs, as well as CBP's agriculture inspection program. Projects in 2009 included developing:

- A new agricultural quarantine inspection (AQI) lab in Miami, FL
- Post-harvest treatments for export crops for emergency pests,
- Post-harvest fruit fly treatments,
- Capacity building for irradiation of export specialty crops,
- New equipment for the detection of plant volatiles for inspection,
- A pilot project to use barcodes to enhance plant traceability,
- Methods to use trace element analysis to trace commodity origins,
- New quarantine waste disposal methods,
- New decontamination methods for farm equipment,
- Heat as a methyl bromide alternative for wood products,
- Brushing methods to remove armored scales from fruit, and
- Citrus leaf and fruit washes to remove Asian citrus psyllids (ACPs).

In addition to PPQ funding, these projects are supported by Farm Bill Section 10201 and APHIS-International Services program funding. Projects are being carried out domestically as well as in Colombia and Europe. Collaborators include the USDA's Agricultural Research Service (ARS), the Forest Service, universities, and the International Atomic Energy Association.

Where We're Going

The AQI&PT is emphasizing three high-need areas. First, trade in plant and other commodities relies heavily on methyl bromide fumigation, and production and consumption of this ozone-depleting chemical is being phased out. It is urgent that PPQ implement alternatives to methyl bromide for the high-use commodities such as logs, wood-packing material, tiles, grapes, and asparagus. Therefore, the program is moving towards validating heat treatments for wood, logs, and tile and reevaluating pest pathway status for grapes and asparagus to possibly eliminate the need for treatment in some cases. Second, the inspection burden is very high at the cargo ports and plant inspection stations because of reliance on visual inspection. Researchers are adapting existing advanced inspection equipment to use in agricultural inspection to speed and increase the efficiency of inspection. Third, there is a need to increase the ability to track and traceback quarantined plant material. The application of barcodes and trace element analysis, respectively, is designed to address these needs.

Risk and Pathway Analysis

National Science Program Leader - Dr. Ron Sequeira

Who We Are

The Risk and Pathway Analysis (RPA) program focuses on collecting and interpreting scientific evidence and technical information regarding plant pest risks. RPA products help APHIS design risk-based policies and regulations for import, export, and domestic programs. The work of the RPA staff is essential to identify and assess new pest threats, provide

scientific support for regulatory updates and revisions, and help prioritize resources to maximize plant health safeguarding capabilities.

The RPA program is supported primarily by CPHST's Plant Epidemiology and Risk Analysis Laboratory in Raleigh, NC, with satellite staff in Hawaii and Bogotá, Colombia. Additionally, RPA coordinates collaboration with other CPHST laboratories, other APHIS and USDA groups, academia, foreign counterparts, and stakeholders to develop scientific analyses that are essential to producing risk-based phytosanitary policies and procedures. RPA program capabilities continue to be a central function for PPQ and an international benchmark for pest risk analysis.

What We Do

The foundation of RPA's analytical capacity is its diverse, high-caliber scientific staff—which includes entomologists, plant pathologists, botanists, ecologists, economists, and other specialists—along with its extensive collection of information on plant pests. RPA uses state-of-the-art tools and methodologies for pest risk assessment. These include sophisticated spatial technology systems that integrate weather, pest distribution, and other databases to analyze pest dynamics, identify agro-environmental pests of greatest concern, identify potential pathways for the introduction of harmful exotic pests, and predict the spread of exotic pests. In 2009, the RPA program led APHIS in the development of analytical products to support emergency, domestic, and trade programs. Specific risk and pathway analysis products included those for ACP, citrus greening, citrus canker, European grapevine moth (EGVM), light brown apple moth (LBAM), and invasive fruit flies, as well as the development of a weed risk assessment model. In addition, the RPA program addressed high-profile trade issues linked to commodity importations and produced commodity risk analyses that supported free trade agreements. In 2009, the RPA program finalized 30 commodity import requests.

Where We're Going

Future plans include promoting the continued evolution of risk analysis tools and methodologies while also increasing the transparency and efficiency of risk analysis work processes. To address climate change as one of USDA's new policy objectives, we plan to incorporate climate change scenarios into current risk analysis products. These plans are directed to continue helping APHIS design risk-based policies and regulations based on scientific and technical information for import, export, and domestic programs.

Domestic Survey, Detection, and Identification

National Science Program Leader - Dan Fieselmann

Who We Are

The Domestic Survey, Detection, and Identification (SDI) program provides scientific and technical support to PPQ for rapid detection, identification, and mitigation of plant pests. SDI consists of four cross-functional groups: early detection, identification, spatial technology, and biological control. CPHST scientists work as teams to provide future opportunities and support to PPQ leadership and operations. Additional support is leveraged through cooperation with academic institutions, industry, and government agencies.

What We Do

The early detection team supports pest surveillance through the PPQ Cooperative Agricultural Pest Survey (CAPS) program. Support includes pest prioritization, commodity-based survey guidelines, trap and lure development, and off-shore methods development. This information is used by the CAPS National Survey Coordinator and Program Managers to identify survey and diagnostic tools and by surveyors when planning and conducting surveys. Commodity surveys focus on economically important crops and provide an efficient method of surveying for many exotic pests within a specific crop. In 2009, SDI revised the soybean commodity reference document and initiated the development of the stone fruit and corn commodity references.

The identification technologies team develops computer-based identification tools delivered through the Lucid platform. They address identification challenges and develop advanced technologies to maximize identification capabilities. This includes development of Lucid taxonomic tools and other computer-based identification resources, training and technical support for Lucid tools, and a compendium of "Lucid Resource Tools of Direct Relevance to PPQ." In 2009, the team also conducted four domestic workshops to support training for individuals interested in developing and using Lucid tools. The team released 2 Lucid tools and is developing 15 more for use by regulatory officials both domestically and internationally.

The spatial technologies team provides support for geographic information systems, data analysis, remote sensing, and risk and predictive modeling. Specifically, the team provides risk maps in support of CAPS and emergency programs, internet-based decision support, and forecast modeling. Members supported and developed advanced tools for the North Carolina State University/APHIS Plant Pest Forecasting System (NAPPFAST), which can be used to create models and maps for plant pests. The new tools will allow surveyors to combine risk maps with other types of data, such as pest observations and satellite imagery, to plan survey activities. In addition, new risk maps for hosts, biology, and points of entry have been created and updated for CAPS pest targets and are available at www.nappfast.org.

SDI's Biological Control Unit (BCU) identifies natural enemies for pests of concern and develops rearing and release methods for their implementation in pest control efforts. The unit also ensures the safety of biological control programs through post-release monitoring and the development of educational and programmatic materials for PPQ and collaborators. In 2009, BCU worked with collaborators to continue evaluations of natural enemies of the red palm mite, passionvine mealybug, and coffee mealybug. BCU also began the development of biological control management options for the Harrisia mealybug and *Iceria genistae,* an exotic scale insect. The unit initiated mass-rearing programs for biological control agents of the ACP and yellow toadflax and continued rearing programs for biological control agents of the *Sirex* woodwasp and knapweed. In addition, BCU conducted field trials on natural enemies of fruit flies and Russian knapweed.

Where We're Going

Early detection of pests often provides significant long-term savings by reducing pest control costs and increasing the feasibility of eradication. The SDI program will continue to develop and improve tools and technologies that promote early detection and identification of exotic pests.

Emergency Response

National Science Program Leader - Dr. Russ Bulluck

Who We Are

The Emergency Response program provides support to PPQ during a plant health emergency. This often includes providing scientific information on exotic plant pests with the goal of protecting America's agriculture and natural resources. The Emergency Response program is one of the first points of contact within CPHST in the event of a plant health emergency.

What We Do

The Emergency Response program provides PPQ regulatory officials with scientifically valid and operationally practical information to be used during a plant health emergency. This information is usually related to the biology of the plant pest; the identification of the organism; how, where, and when to survey for the organism; and what can be used to control the plant health pest. During the initial plant health emergency response, a technical working group (TWG) of scientific experts may also be assembled.

The program also facilitates the interactions of the other appropriate response and recovery programs and works in concert with these program leaders to ensure a continuum of scientific support during transitions from emergency response to recovery. The time between transitions from response to recovery varies with each organism. Recent plant health emergencies include outbreaks of EGVM *(Lobesia botrana),* Mediterranean fruit fly (MedFly) *(Ceratitis capitata),* citrus black spot (caused by *Guignardia citricarpa*), and several others.

Another important part of the Emergency Response program is preparing for emergencies. The program works closely with the Emergency Planning and Preparedness group in PPQ's Emergency and Domestic Programs division to prepare New Pest Response Guidelines (NPRG) for new and emerging pests. These guidelines are meant to be used when an exotic pest is detected within the United States. CPHST provides scientific information on the biology of the organism, the ecology of the pest, and control, survey, and identification methods. Recent drafts of NPRG include response plans for *Phytophthora* species in forest and nursery systems, red palm weevil, citrus variegated chlorosis, citrus leprosis, and cotton seed bug.

Where We're Going

By working in concert with other national programs in CPHST and programs within PPQ, the Emergency Response program is able to add scientifically valid and operationally practical information on plant health emergencies.

Response and Recovery Systems Technology - Arthropods

National Science Program Leader - Michael Stefan

Who We Are

The Response and Recovery Systems Technology (RRST) program provides timely scientific support to regulatory program managers and decisionmakers when high-consequence plant pests have been detected in the United States. The program emphasizes science-based preventive measures to reduce or inhibit further spread and develops rapid response and recovery technologies geared towards eradicating or containing newly detected pests.

What We Do

RRST - Arthropods supports a wide range of plant health programs, which are described below. These programs utilize the tools of current integrated pest management strategies, phytosanitary measures, regulatory treatments, and related technologies to impact situations affected by exotic diseases and pests while minimizing adverse effects on the environment, producers, and consumers.

European Grapevine Moth

The EGVM, *Lobesia botrana,* is a significant pest primarily of grapes in areas outside of the United States where it is established. In the fall of 2009, EGVM was detected in California; survey activity has shown that the moth is present in several grape-producing counties within the State. A CPHST-led TWG provides information and feedback on issues regarding trapping, lures, mating disruption, treatment, and hosts. During 2010, the effect of treatments and population-limiting strategies will be assessed in order to further optimize the management of EGVM within and outside of California. CPHST is producing lures and monitoring survey activities through the course of the growing season to detect EGVM in and around production areas.

Light Brown Apple Moth

The LBAM, *Epiphyas postvittana*, was detected and confirmed in Alameda County, CA, in March 2007. If left uncontrolled, LBAM could continue to spread with potential to cause significant damage to many different crops, including stone fruits, pome fruits, grapes, and citrus. CPHST has continued to chair a TWG of scientists from the United States, Australia, and New Zealand to consider potential eradication/control options, develop management recommendations, assess research needs, and provide ongoing scientific input to program operations. In 2009, CPHST established a rearing facility in California to develop sterile insect release technology for LBAM, conduct experiments, and support the control and management goals of the program. In November 2009, the first experimental release of irradiated sterile adult LBAM occurred in Napa County. Data will continue to be collected on experimental releases of sterile insects in 2010 to further optimize the effect of operational releases on wild populations. Initial evaluations were encouraging, and four additional rearing units were delivered and installed at the California facility location.

Fruit Fly Introductions

The program provides scientific support to eradication efforts for Medfly in California and Florida, Mexican fruit fly (Mexfly) outbreaks in California, and the Mexfly eradication program in Texas. Studies on ecology, chemical control, detection methodology, and sterile insect release for Medfly has led to the implementation of the very successful Gradual Advance Plan in Guatemala, which moves the pest further from the U.S. border and reduces the risk of introduction. Quality assurance efforts and new technologies for emergence have saved significant funds in California and allowed expansion of the sterile release area in Florida. CPHST chaired a 2009 TWG review of the Mexfly eradication program in the lower Rio Grande Valley of Texas. The RRST program continues to support genetic barcoding studies for enhanced identification data of Oriental fruit fly and other *Bactrocera* spp. outbreaks.

Drosophila suzukii (spotted-wing Drosophila) was first detected in California in 2008, and then found in Florida, Oregon, and Washington. Currently, there is no regulatory action being taken for this fruit fly. However, CPHST continues to collect and track information regarding host preference, its spread, and its impact.

Emerald Ash Borer Biological Control

The emerald ash borer (EAB) is a nonnative wood-boring beetle that is devastating ash trees in the north-central United States. Since its discovery in Michigan in 2002, APHIS, in conjunction with State, local, and other Federal agencies, has led an aggressive campaign to slow the spread of this pest with quarantines, surveys, tree removal, and public outreach programs. In spite of these efforts, the range of EAB has

expanded to 14 States due to natural spread and accidental introductions. In order to control the pest, the CPHST Otis Lab has been working together with USDA's Forest Service and ARS to implement an EAB biological control program. To date, three parasitoids highly specific to EAB have been identified from China, evaluated in the laboratory, and released in small research plots in a few States. CPHST is supporting a mass-rearing operation in Michigan in order to facilitate widespread field releases of the parasitoids. Additional parasitoids from Korea and the Russian Far East have subsequently been found and are under evaluation by CPHST scientists.

Asian Longhorned Beetle

The RRST program continues to support the APHIS quarantine, control, and eradication programs for Asian longhorned beetle (ALB) in Massachusetts, New York, and New Jersey. In 2010, attractant lures and trapping research being conducted in the field by university cooperators and ARS will be coordinated in Massachusetts and New York. The CPHST Otis lab will also continue to provide technical support to the ALB program through testing of regulatory treatments, control treatments, and discerning infestation dynamics.

Sirex Woodwasp Biological Control

The *Sirex* woodwasp was discovered in New York in 2005. Since the first discovery, the wasp has been detected in New York, Ohio, Pennsylvania, Vermont, Michigan, and in Ontario, Canada. *Sirex* woodwasp has the potential to cause great harm to native pine forests as well as severe economic losses for the lumber industry. From 2006 to 2009, scientists from the CPHST Otis Lab conducted controlled release experiments of the nematode biocontrol agent, *Beddingia siricidicola.* In January 2010, CPHST will lead a TWG meeting to discuss pest status and spread, survey, control, and research needs. CPHST, working together with USDA's Forest Service, continues to develop survey tools and evaluate the effectiveness of *B. siricidicola* and its relationship with native species.

Where We're Going

The program is constantly evolving to meet the challenges presented by the introduction of exotic diseases and pest species into the United States. We will continue to expand our abilities to provide scientific support to plant health emergencies with a focus on providing information that is scientifically relevant to the particular pest and to operational needs.

Response and Recovery Systems Technology - Plant Pathogens and Weeds

National Science Program Leader - Dr. Charla Hollingsworth

Who We Are

The RRST - Plant Pathogens and Weeds (PPW) program is responsible for supporting methods development to prevent the introduction or establishment of plant pathogens and weeds of regulatory concern in the United States. The PPW program is currently working on plant disease issues such as Huanglongbing of citrus, citrus canker, *Phytophthora ramorum* of woody ornamentals, chrysanthemum white rust (CWR), gladiolus rust, and stem rust (strain Ug99) of cereal grains.

What We Do

The program emphasizes an integrated, multifaceted approach for controlling plant disease. We promote the discovery and implementation of effective best management practices for increased control of established pests. Working cooperatively with others within CPHST and elsewhere, we support the development of applied, basic, and technological tools to accomplish effective response and recovery while preserving the integrity of the production environment.

Citrus Health Response Program

The Citrus Health Response Program (CHRP) was formed in response to detections and later establishments of citrus canker and Huanglongbing (HLB, citrus greening) in Florida. Program activities emphasize preserving citrus health in the United States. Numerous TWGs have been formed to address disease issues of citrus. Most recently, two TWGs were convened: one to devise effective uniform national survey standards for the ACP and HLB, and another to evaluate response and recovery efforts for citrus black spot.

Phytophthora ramorum

CPHST provides ongoing scientific support for *P. ramorum,* including participating in science panel meetings, recommending modifications to eradication protocols as new scientific information becomes available, and coordinating assessment teams to evaluate and make recommendations for repeat positive nurseries. CPHST also oversees the National Ornamentals Research Site at Dominican University, which houses and supports research related to *P. ramorum* in a real world setting.

Chrysanthemum White Rust

CPHST provides technical and scientific support for the CWR (causal agent *Puccinia horiana*) regulatory program by updating program leadership as new scientific information develops and by engaging scientists to conduct basic and applied methods development research. We are currently evaluating the potential of *P. horiana* to survive winter environmental conditions on ornamental plants at the Otis Lab as well as looking at the potential distance and rate of spread.

Black Stem Rust

CPHST supports the Black Stem Rust (BSR)/Barberry regulatory program by updating program leadership on new developments concerning the disease and threats posed by the recent emergence of dangerous strains of the pathogen, including Ug99. CPHST and the BSR/Barberry program recently coordinated an update and review of the scientific components of the program, including: new molecular-based identification tools for the pathogen and host varieties, the current status of European barberry in the United States, the relationship between the disease and its host (Japanese barberry), aerial epidemiology of windborne spores, new fungicidal and cultural control treatments, and identification of potential pathways for new pathogen strains like Ug99 into the United States. CPHST is also engaging scientists for applied research into these scientific components in order to improve USDA's ability to respond if dangerous strains such as Ug99 reach the United States.

Where We're Going

The PPW program interacts with researchers, academicians, technical experts, and regulatory program managers in order to bring together the necessary scientific expertise to address the issues posed by plant diseases and weeds of regulatory concern. We contribute to the safeguarding mission by organizing TWG meetings as well as directing cooperative assessment teams that are dispatched to investigate plant diseases across the United States. These outcomes allow timely and directed recommendations for controlling regulatory-significant plant diseases.

Laboratories and Units

CPHST consists of seven laboratories, three units, and supporting work stations throughout the United States and in Guatemala and Colombia. A new laboratory in Miami, FL, is in the process of being established.

CPHST Lab, Beltsville, MD

Lab Director - Dr. Laurene Levy

How We Support the Mission

The CPHST Beltsville Lab utilizes cutting-edge detection technologies from the fields of plant pathology, molecular biology, and clinical diagnostics to develop, adapt, and improve methods for accurate and rapid diagnosis of plant pathogens. In addition, we carefully validate available plant pathogen diagnostic methods prior to stakeholder release to ensure their performance and fit for purpose in regulatory programs. We strive to achieve timely transfer of diagnostic tools that are field deployable for PPQ emergency response and eradication programs. Tools are deployed to stakeholders following onsite and interlaboratory validations through clearly written standard operating procedures; hands-on laboratory training for our end users within and outside of PPQ; and contribution from the CPHST quality assurance program. Many of these projects are performed in collaboration with other Federal agencies, universities, and international partners.

The laboratory also utilizes new diagnostic methods to accurately and rapidly diagnose high-consequence and select agent plant pathogens, or pathogens that require Federal confirmation. The laboratory provides technical support to scientists within the National Plant Pathogen Diagnostic Network, PPQ port and regional identifiers, the PPQ Molecular Diagnostics Laboratory, and State departments of agriculture for the detection of regulatory plant pathogens by providing protocols, hands-on laboratory training, and troubleshooting for PPQ-validated diagnostics. To aid in pathway analysis and to better understand pathogen diversity, the lab is undertaking forensic analysis of pathogen samples identified by PPQ programs.

We are committed to quality in biochemical and molecular diagnostics, and the lab is proficiency tested in the operation of performed diagnostic methods. The lab is nearing completion of International Organization for Standardization (ISO) 17025:2005 certification and will soon pursue ISO certification as a proficiency test (PT) provider.

Recent Accomplishments

- Developed six conventional real-time polymerase chain reaction (PCR) assays and six real-time quantitative PCR assays to test germplasm for S*weet potato mild speckling potyvirus, Columbian datura potyvirus, Blackcurrant reversion nepovirus, Potato yellow vein crinivirus, Sweet potato chlorotic fleck carlavirus,* and S*weet potato chlorotic stunt crinivirus.*
- Developed a genomescan system using 156 genes to identify candidate genes for development of additional real-time PCR confirmation assays for improved detection of citrus greening (Huanglongbing).
- Reduced the time required to conduct a potato cyst nematode assay from 16 hours to 2 hours and extended the assay to differentiate between *Globodera rostochiensis* and *G. tabacum.* We also developed a multiplex, real-time PCR for the detection and identification of both nematodes.
- Determined that a plum pox virus (PPV) isolate illegally transported from the Ukraine in *Prunus* germplasm is closely related to the PPV W strain found only in Canada. A specific real-time PCR method was developed for PPV W subgroup determination. Three international cooperative agreements were developed with countries from Eastern Europe, aimed at finding and characterizing other unusual PPV isolates.
- Established the basic lab methods and procedures for detection of plant pathogens by CANARY™ technology. These methods include B cell and pathogen preparation, sample testing, data analysis, and adaptation of hybridoma cells for monoclonal antibody production. We also demonstrated the detection of *Phytophthora ramorum* from infected Rhododendron leaves by CANARY.
- Validated quantitative PCR assays for detection and diagnosis of *Phytophthora kernoviae,* an exotic pathogen of beech, oak, and other hosts.
- Validated a conventional and a quantitative PCR test for rapid detection of potato wart (*Synchytrium endobioticum).* In addition, we initiated the development of a reliable inoculation protocol for potatoes in order to generate pathogen-infected materials for testing.

- Administered a PT program for high-consequence plant pathogens. We also provided the National Plant Protection Laboratory Accreditation Program with *Phytophthora ramorum* and citrus greening PT panels. In fiscal year 2009, 22 analysts from 14 laboratories were certified to perform *P. ramorum* diagnostics, and 16 analysts from 10 laboratories were certified to perform citrus greening diagnostics.
- Conducted 13 training sessions, 1 of which was delivered in Mexico. We also delivered over 29 new or updated work instructions; 4 of the work instructions for citrus greening were translated into Spanish.

CPHST Lab, Fort Collins, CO

Lab Director - Dr. Richard Zink

How We Support the Mission

The Fort Collins Lab develops and transfers scientifically based methods and innovative tools to APHIS and other Federal and State agencies to reduce risk levels associated with plant pests and plants for planting. In addition, the lab provides scientific support for pest detection and survey methods under the Cooperative Agricultural Pest Survey (CAPS) program. The laboratory transfers methodologies and tools to field operations, ensuring efficient and effective survey, detection, identification, emergency response, and eradication. The lab also develops image-based identification resources to help support rapid, consistent, and accurate identification of pest species.

The Fort Collins Lab develops management methods for invasive plants and plants on the Federal Noxious Weeds list through applications of biological, chemical, and/or cultural controls. PPQ operational programs receive spatial technology support from the Fort Collins Lab to guide them in the application of new geospatial survey and detection methods. At a satellite laboratory in Albany, CA, we continue to improve upon artificial diets and other control tactics for the control of light brown apple moth (LBAM), *Epiphyas postvittana,* and the rearing of biological control insects for two noxious weeds, purple loosestrife *(Lythrum salicaria)* and the knapweed complex *(Centaurea* spp.). In another satellite laboratory in Las Cruces, NM, personnel provide engineering expertise in the automated screening of biological materials for the detection of alien species posing potential risks to agriculture and natural resources.

Recent Accomplishments

- Managed 17 new and ongoing cooperative agreements to produce image-based identification tools (Lucid tools) and delivered two tools available on the Internet and CD. The robotic automation identification (RAPID) project enhanced RitaWeb, a tool to provide complete, electronic survey support.
- Developed a geospatial model to enhance trap placement for Asian gypsy moth (AGM) surveys in Washington, Oregon, and California.
- Conducted pre-release research on nine invasive weed targets: Canada thistle, dyer's woad, garlic mustard, hawkweeds, hoary cress, hound's-tongue, perennial pepperweed, Russian knapweed, and yellow toadflax. Artificial diets for two potential biocontrol insects (one each on loosestrife and the diffuse/spotted knapweed complex) were also improved in 2009.
- Conducted field studies on chemical controls for benghal dayflower (Florida), cogongrass (Florida and Alabama), common tansy (South Dakota), leafy spurge (Colorado), onionweed (Arizona), and yellow toadflax (South Dakota). A prototype magnetic sprayer will be tested in 2010 for spray drift reduction and improved weed control.
- Developed laboratory and greenhouse methods to evaluate plant invasiveness. We also developed molecular diagnostic tools for invasive plants.

CPHST Lab, Gulfport, MS

Lab Director - Anne-Marie Callcott

How We Support the Mission

The CPHST Gulfport Lab consists of two sections: the Analytical Chemistry section and the Imported Fire Ant (IFA) section. The Analytical Chemistry section conducts routine sample analysis for detecting the presence of pesticide residues and toxic substances. The lab directly supports ongoing APHIS operational and emergency programs for several pests, including the IFA, Asian longhorned beetle (ALB), boll weevil, grasshopper/Mormon cricket, and fruit fly. In addition, the chemistry laboratory supports APHIS projects by providing chemistry-based options for PPQ field operatives concerning the identification and detection of prohibited commodities or the detection of invasive insect species. The IFA section develops methods and tools for the survey, detection, regulation, and chemical and biological control of the

IFA. Technology developed by the IFA section is utilized by PPQ, State Plant Regulatory Officials, the nursery industry, the chemical industry, farmers, homeowners, and other stakeholders.

Recent Accomplishments

- Performed chemical analysis of 925 APHIS program support samples and reported within stipulated deliverable times.
- Analyzed an additional 580 project samples supporting APHIS initiatives.
- Developed methods for liquid chromatography-mass spectrometry determination of carbaryl and diflubenzuron in vegetation and soil samples, supporting the Rangeland Grasshopper and Mormon Cricket Suppression Program.
- Verified the percentage of active ingredients of Japanese beetle (JB) lures manufactured by Hercon® (new lures) and Trece® (old lures) for the Oregon JB Program.
- Published APHIS Program Aid No. 1996, "Attention Baled Hay Producers—Don't Transport Imported Fire Ants" in March 2009. This aid, which describes best management practices for protecting hay from infestation by IFA, was distributed to State outlets, such as extension offices, and posted online at www.aphis.usda.gov/plant_health/plant_pest_info/fireants/downloads/BaledHayProducers.pdf.
- Submitted a label change for approval to the U.S. Environmental Protection Agency (EPA) in 2009 for use of bifenthrin on grass sod for the IFA quarantine. EPA label approval and subsequent APHIS approval is expected in 2010. The CPHST Gulfport Lab and the University of Arkansas' Extension Service generated efficacy data to support this use pattern.

CPHST Lab, Miami, FL

Laboratory Director - Vacant

How We Support the Mission

In response to the dynamic port, trade, and safeguarding environment that is associated with some of the highest levels of risk for plant and animal health, APHIS is in the process of establishing a state-of-the-art Agricultural Quarantine Inspection and Port Technology (AQI&PT) Development Laboratory that will provide leadership in agricultural quarantine inspection (AQI) treatment technology.

Vision

The vision is to provide world leadership in the development of phytosanitary measures and port technologies to protect American agriculture and natural environments from invasive alien species.

The AQI&PT Lab will develop scientific expertise regarding pest exclusion, design risk management systems, develop international AQI information networks, develop quarantine treatments, provide technical support for the treatment manual, develop methyl bromide alternatives, develop inspection methods for PPQ and U.S. Department of Homeland Security Customs Agricultural Inspectors, and support validation and certification for domestic and foreign treatment facilities in preclearance and domestic programs.

CPHST Lab, Mission, TX

Laboratory Director - Dr. Paul Parker

How We Support the Mission

Over the past several years, the Mission Lab's focus has transitioned away from large mass-rearing projects for biological control towards other control strategies in domestic and emergency programs. Increased emphasis has also been placed on the development of molecular diagnostic tools for arthropods and invertebrate pests. Other important roles at the Mission Lab include remote sensing/global information systems; epidemiology of certain plant diseases, such as citrus canker; fruit fly trapping; sterile insect technique (SIT) support; and integrated pest management of offshore pest problems. The laboratory still has an experienced cadre of biological control scientists with extensive expertise and accomplishments in weed and arthropod biological control and has added new staff members focused on molecular biology, which has expanded new horizons for the laboratory.

The molecular diagnostics unit is specifically focused on the development of molecular diagnostic tools for pest arthropods, including fruit flies and other invertebrate pests such as gastropods. Recent molecular diagnostic projects have included DNA-based methods to identify immature LBAM. New molecular projects include genetic pathway analysis of the ALB; revision of DNA tools for Mediterranean fruit fly

pathway analyses; population studies of the Asian citrus psyllid (ACP) and its associated parasitoid, *Tamarixia radiata;* and genetic diversity studies for Mexican fruit fly (MexFly). Integrated pest management of the ACP continues to be an important program at the Mission Laboratory with a pilot project in place for the second year. The laboratory also participates in a collaborative effort on the Arundo *(Arundo donax)* biological control program with the USDA Agricultural Research Service's (ARS) laboratory in Weslaco, TX. The Mission Laboratory has received ISO 9000 certification for its molecular diagnostics unit and arthropod quarantine facility.

Recent Accomplishments

- Analyzed fruit fly collections representing pest species in the genera *Anastrepha, Bactrocera,* and *Ceratitis* using DNA barcode technology. We will be evaluating the utility of the technology for identification of fruit fly pests and for future fruit fly molecular diagnostic activities in fiscal year 2010. This barcode program is being conducted in collaboration with ARS, Pennsylvania State University (PSU), the British Museum of Natural History (United Kingdom), and the Royal Museum for Central Africa (Belgium).
- Developed two new DNA-based techniques to improve pathway analysis of the Mediterranean fruit fly. The technologies will be applied to document variability within SIT lab colonies and field collections from Central America, South America, Hawaii, Africa, and Europe. New collections are being generated through collaborations with ARS and the Royal Museum for Central Africa.
- Developed a new DNA-based identification tool for LBAM, *Epiphyas postvittana,* that reduces the cost and service time of moth analyses in California. The method has been developed into an official protocol and deployed to the California Department of Food and Agriculture (CDFA).
- Identified a ladybird beetle *(Anovia circumclusa)* in Puerto Rico that may contribute to the control of soybean scale. There are ongoing foreign exploration efforts in Barbados and Brazil to identify and collect additional natural enemies.
- Developed methods for the mass production of *Tamarixia radiata* as a biocontrol for ACP. A newly collected strain of *T. radiata* from Punjab is currently being reared in the CPHST Arthropod Quarantine Facility.
- Evaluated mitochondrial DNA markers for ALB *(Anoplophora glabripennis)* to assess dispersal patterns.
- Conducted field observation studies that showed that *Gratiana boliviana* beetles released in 2007 and 2008 to control tropical soda apple survived under east Texas conditions. Tropical soda apple plants showed significant signs of distress, feeding damage, and defoliation by the beetles.

CPHST Lab, Otis Air National Guard Base, Buzzards Bay, MA

Laboratory Director - Vic Mastro

How We Support the Mission

The Otis Lab's mission is to identify, develop, and transfer technology for pest survey, exclusion, control, and risk assessment for APHIS and its cooperators. The lab serves a wide variety of PPQ programs that include exotic pest-detection programs such as CAPS, AQI commodity treatments, and emergency response and eradication programs for ALB, LBAM, AGM, emerald ash borer (EAB), *Sirex noctilio* woodwasp, European grapevine moth (EGVM), and other pests. Otis personnel identify high-risk exotic pests and develop survey technology to facilitate early detection of introductions. The lab continues to support the AGM/gypsy moth programs by creating risk maps, developing improved estimates of mate findings at low population densities, and producing the gypsy moth virus product, Gypchek. The Otis Lab also provides technical support for offshore programs in Russia, Korea, Japan, and China to monitor source populations of exotic lymantriid moths and to identify high-risk ships and shipments. Additional work is focused on the development of (1) phytosanitary treatments for various commodities and the means of their conveyance, such as pallets, containers, and ships and (2) biological control programs for the winter moth, EAB, and *S. noctilio.*

To fulfill its mission, lab personnel maintain cooperative relationships with USDA's Forest Service, ARS, universities, and private industry. These cooperative arrangements extend to government organizations and universities in a number of foreign countries, including Australia, China, Chile, Japan, Korea, New Zealand, and Russia. The work includes developing methods to monitor and exclude AGM from North America, predicting the invasiveness of organisms by assessing damage on endemic or expatriate North American plants in foreign locations, developing attractants, and developing control techniques for targeted exotic pests.

Recent Accomplishments

- Developed improved traps and methodologies for EAB surveys. The recommended survey changes were adopted by the EAB program in 2009.
- Confirmed establishment of biological control agents for EAB in the field. Over the next few years, we will be accessing the survival and spread of these natural enemies and their impact on EAB populations.
- Administered an expanded research and development effort on EAB that was carried out primarily through cooperative and interagency agreements with university and government researchers.
- Developed and evaluated mating disruption formulations for LBAM that resulted in the use of mating disruption by 100 percent of the caneberry growers in the affected area.
- Verified the best formulation for pheromone-based trapping lures for the LBAM program and produced approximately 200,000 of these lures until the program was able to contract for lures from commercial sources.
- Developed several phytosanitary treatments for LBAM to allow for safe movement of nursery stock and agricultural products out of LBAM-infested areas.
- Analyzed ALB population data and developed recommendations for survey and control. In addition, new evidence about the host-plant range of ALB has led to changes in the program's survey and control protocols.
- Provided technical support that resulted in the initiation of AGM ship inspections in China, Korea, and Japan, reducing the risk that AGM will be introduced into North America. A cooperative project has been forged with Korean scientists to begin work on AGM behavior and control in ports.
- Evaluated the effectiveness of parasitic nematodes for control of *S. noctilio* in pine trees in New York, and identified a number of chemicals that may prove useful in luring *S. noctilio* to traps. Field studies to determine the effectiveness of these chemicals as attractants are planned for New York and South Africa.
- Initiated five cooperative agreements focused on the identification of behavioral cues that could be exploited for the survey of wood-boring pests, with emphasis on buprestid (metallic wood-boring) and cerambycid (long-horned) beetles.
- Produced and tested prototype traps through a cooperative agreement with PSU. These traps are capable of screening organisms entering the trap, time- and date-stamping the entry, and remotely reporting the information via a satellite link.
- Provided numerous recommendations to exotic pest detection programs about the best strategies for survey. Continued to provide CAPS with 30,000 to 50,000 pheromone lures annually to support survey for a variety of agricultural and forest pests.
- Led a technical working group (TWG) to formulate responses to the recent discovery of EGVM, *Lobesia botrana,* in Napa County, CA. The laboratory is also initiating projects to develop and/or verify phytosanitary treatments that will allow the safe movement of grapes and grape products for the wine-making, table grape, and raisin industries.

CPHST Lab, Phoenix, AZ

Laboratory Director - Dr. Richard Zink

How We Support the Mission

The CPHST Phoenix Lab's mission is to develop, adapt, and implement area-wide control technologies for new and existing program pests. Current work includes developing control methods for LBAM, pink bollworm (PBW), and the grasshopper/Mormon cricket complex. These control technologies include biotechnology, sterile insect pheromone delivery systems, application technology, and geographic information system applications. Our scientists conduct extensive field studies to test materials and validate methods.

The Phoenix Lab's Rangeland Section works with Federal and State customers to provide technical assistance for grasshopper and Mormon cricket control programs. This section also develops and implements solutions to problems and continuously evaluates all projects and tools to maintain state-of-the-art status.

The lab uses specialized equipment, including aerial application technology; environmental chambers and portable mass-rearing modules; a twin-screw extruder for insect diet development; a room that allows for the accurate simulation of aerial applications using sprayed products; a quarantine laboratory for large-scale rearing of genetically modified PBWs; and equipment for testing pesticide and pheromone application technology.

Recent Accomplishments

- Performed tests of aerial and ground applications of a sprayable mating disruption formulation for PBW, named PBW-GEL, in Arizona. GEL was harmless to cotton, easily applied, and effective for 26 to 42 days.
- Evaluated a genetically modified PBW that expresses a fluorescent protein in laboratory and large-scale field experiments. The fluorescence trait is heritable, stable, and detectable with a proper light and filter or by DNA analysis. Using fluorescent identification will vastly reduce the misidentification of wild versus lab-reared moths in the PBW eradication program.
- In collaboration with ARS and Utah State University scientists, tested five candidate formulations of domestic fungi for control of Mormon crickets on mini rangeland plots in Montana and Utah using the Field Aerial Application Spray Simulation Tower Technique. The applications were sufficient to cause 90- to 100-percent mortality.
- Compared the acceptability and toxicity of several pesticides for grasshopper control. Carbaryl on flaky wheat bran continues to be the best overall combination.
- Redesigned a standard all terrain vehicle (ATV)-mounted, commercial rangeland ground spray application system to produce more efficient low volume and ultra-low volume sprays. The modification can be easily adapted to any spray system, greatly broadening the scope of impact on ultra-low volume ground applications.

CPHST Plant Epidemiology and Risk Analysis Laboratory, Raleigh, NC

Laboratory Director - Robert Griffin

How We Support the Mission

The CPHST Plant Epidemiology and Risk Analysis Laboratory (PERAL) is PPQ's primary unit conducting pest risk analysis (PRA). In this laboratory, a diverse group of scientists and professionals provides essential scientific support to risk-based policymaking across a broad range of phytosanitary issues. Staff members use sound science to analyze import and export issues and facilitate safe trade. PRA helps safeguard American agriculture and plant health from harmful exotic plant pests in both managed and unmanaged ecosystems. More specifically, the analyses help PPQ to design risk-based regulations for import and domestic pest management programs, identify and assess new pest threats, monitor the effectiveness of existing programs, and optimize available resources to enhance protection. PERAL personnel also provide technical support documents that PPQ requires for pests, commodities, and pathways. These products may include risk maps that indicate existing or potential range domestically or internationally or that predict ranges from weather- or climate-matching analyses.

Over the years, PERAL has established itself as a global leader in both productivity and quality management. PERAL is currently the only ISO-certified plant health risk analysis unit in the world. The group contributes significantly to the promotion of international dialogue and increased capacity for science-based management of phytosanitary issues through its Risk Analysis Mentoring Program for visiting scientists. In addition, PERAL provides basic PRA training workshops with topics covering the spectrum of concepts, methods, and resources associated with pest risk analysis. PERAL also provides regulatory curriculum training to students in relevant fields on key aspects of regulatory plant protection through cooperative relationships with academic institutions. In addition, PERAL promotes regional and international harmonization of plant health regulations by participating in the North American Plant Protection Organization and the International Plant Protection Convention (IPPC).

Recent Accomplishments

- Finalized 22 original and 36 revised Q-56 PRA in 2009—facilitating safe trade for 26 commodities from 36 different countries. PERAL also completed two original Q-37 PRA and revised several that had been completed previously.
- The New Pest Advisory Group (NPAG) analyzed 46 pests and completed an additional 35 pre-assessments for organisms that were not considered NPAG pests.
- The Exotic Pest Information Collection and Analysis (EPICA) team produced 49 notifications containing 184 articles on pests of regulatory significance.
- Processed risk assessment and informational documents for the organism, pathway, export, and risk mapping areas, including: 9 export, 3 organism, 4 pathway, 5 ad-hoc, 14 risk mapping, and 2 special trade support documents.
- The Global Pest and Disease Database (GPDD) team added 121 new pests and updated an additional 207 pests in the database.
- Completed development and validation of the new weed risk assessment screening tool and used it to assess five plant species, with three of them receiving high-risk ratings and being eligible for listing as Federal noxious weeds.

Biological Control Unit, Raleigh, NC

Coordinator - Dr. Ken Bloem

How We Support the Mission

The Biological Control Unit (BCU)—a virtual team of 10 to 12 CPHST scientists in various CPHST locations—focuses on developing technologies that allow living biological organisms (e.g., natural enemies and competitors) to lessen the impacts of introduced, invasive insect pests and weeds. Use of these organisms also minimizes impacts on the environment and nontarget organisms. The BCU functions within CPHST's Survey, Detection, and Identification National Program. The unit strives to better prepare the agency for potential U.S. exotic pest incursions and to provide effective pest management options. BCU scientists provide technical oversight and expertise to programs to ensure that scientific knowledge gaps are identified and addressed and that developed technologies are quickly transferred to stakeholders.

The BCU also provides support in the discovery and evaluation of new biological control agents occurring domestically and internationally as well as develops cost-effective rearing and monitoring systems for approved biological control agents and their hosts. In addition, the BCU provides permitted biological control agents collected from established field insectaries and laboratory colonies to PPQ project managers and other project cooperators, ensures the safety of biological control agents by continued post-release monitoring, and develops educational and programmatic materials for use by PPQ and other collaborators.

Recent Accomplishments

- Renewed a cooperative agreement with CABI Europe-Switzerland for foreign exploration and offshore host range testing of insect biological control agents attacking garlic mustard, yellow toadflax, hoary cress, hound's-tongue, Russian knapweed, dyer's woad, perennial pepperweed, field bindweed, and Canada thistle.
- Provided a Russian knapweed biological control agent, the gall midge *Jaapiella ivannikovi,* to cooperators for release in Colorado, Wyoming, and Montana.
- Initiated a Colorado-based rearing effort with a yellow toadflax-adapted strain of the stem-mining weevil *Mecinus janthinus.*
- Assisted in collecting, redistributing, and evaluating the spread and efficacy of existing biological control agents for salt cedars, field bindweed, and tropical soda apple.
- Assessed the distribution and impact of unintentionally introduced biological control agents for Canada thistle and hound's-tongue. Both the mite *Aceria anthocoptes* on Canada thistle and the root weevil *Mogulones cruciger* on hound's-tongue were shown to have significant nontarget effects. Therefore, recommendations were made not to actively use and redistribute these agents.
- Initiated efforts to survey for and assess the efficacy of plant pathogens attacking Canada thistle and perennial pepperweed.
- Conducted field tests to determine whether combined large-scale releases of the egg parasitoid *Fopius ceratitivorous* and sterile Mediterranean fruit flies will result in a greater suppression of fly populations.

- Initiated the development of biological control management options for the Harrisia mealybug, which is seriously impacting cactus in Puerto Rico, and *Icerya genistae,* an exotic scale insect in Florida that has the potential to become a serious pest in important agricultural crops such as soybeans, peanuts, and peppers.
- Developed methods for mass-rearing the parasitoid *Tamarixia radiata* as a biological control tool for suppressing the ACP.
- Evaluated a promising predatory mite for control of the red palm mite and a lady beetle to control the Asian cycad scale, which is killing king and queen sago "palms" and other cycads in Florida and Texas.
- Determined that two parasitoids in Trinidad and Puerto Rico, *Leptomastix dactylopii* and *Coccidoxenoides perminutus,* are largely responsible for controlling passionvine mealybug.
- Initiated studies on the coffee mealybug *(Planococcus lilacinus),* an invasive pest of citrus, grapes, potatoes, mangos, and guavas, in the Dominican Republic. In addition, the BCU initiated studies on the red palm weevil *(Rhynchophorus ferrugineus),* an economic pest of palms, in the Netherland Antilles to determine its potential impact and search for local natural enemies.
- Transferred methodologies for rearing *Spathius agrili,* a larval parasitoid of EAB, to the biological control rearing facility in Brighton, MI. Over 6,000 *S. agrili* were released in 2009 in Michigan, Ohio, and Maryland. CPHST scientists also discovered new natural enemies of EAB in the Russian Far East, including possibly new species of *Spathius* and *Tetrastichus.* These parasitoids are currently being reared and evaluated in the Otis Lab quarantine facility.
- Carried out experimental field releases of nematodes for controlling the *Sirex* woodwasp in New York and Pennsylvania. It was determined that the nematodes established and reproduced in North American pine species. Laboratory studies were also initiated to enhance and optimize the mass rearing of *Sirex* nematodes.
- Reared LBAM in support of biological control efforts by cooperators at CDFA and the University of California at Berkeley. CPHST also cooperated with CDFA on biological control of LBAM by utilizing commercially available and native *Trichogramma* egg parasitoid species.
- Determined that the phorid fly *P. tricuspis* that has been released to control the IFA is well established in the southern areas of the IFA-regulated area (Alabama, Florida, Georgia, Louisiana, Mississippi, Texas, and Puerto Rico) and moderately established in Arkansas, North Carolina, and South Carolina. A second species, *P. curvatus,* was found to be moderately well to well established in all southern States and Puerto Rico.

Light Brown Apple Moth Unit, Moss Landing, CA

Coordinator - Dr. Gregory Simmons

How We Support the Mission

The LBAM Unit was established in mid-2009 to coordinate and conduct scientific and technical support activities in response to the 2007 detection of LBAM *(Epiphyas postvittana)* in California. The Unit also supports the USDA and CDFA mission of controlling and managing LBAM to prevent its spread. The main focus of the Unit is to develop the technology needed to implement the SIT for LBAM suppression. This work includes methods development and evaluation of technology for mass-rearing, irradiation, handling, release, and monitoring of sterile LBAM. Field and laboratory evaluations are conducted to measure the mating competitiveness and field performance of released insects, which are the major factors that determine the effectiveness of the SIT. A coordination of efforts among the Moss Landing, Fort Collins, Mission, Otis, and Phoenix laboratories has resulted in methods development advancements in the identification, detection, and control of LBAM. Experiments are also being performed to better understand LBAM's ability to spread and disperse to new areas.

Recent Accomplishments

- Developed a 1,000-square-foot mass-rearing system in support of SIT program development. The facility is based on a modular mobile design that facilitates the quick establishment of a high-quality, contained rearing system. The rearing system is sufficient to provide at least one million moths per week.
- Completed an environmental assessment to document the potential effects of sterile LBAM release in the Napa and Sonoma areas, which was a necessary step before initiating the sterile release evaluation project.

- Used data from radiation biology studies conducted in Moss Landing and from cooperators in ARS, Hawaii, Australia, and New Zealand to obtain a permit application for the first field releases in the Napa and Sonoma County project area.
- Conducted the first release of irradiated sterile LBAMs in Napa County in November 2009.
- Sent 30,380 LBAM lures to 28 States to complete a national survey during fiscal year 2009.
- Developed an identification screening tool (LBAM ID) to distinguish larval and adult LBAM individuals from other tortricid moths.
- Supported the testing of stone fruit fumigation methods in a cooperative project between CPHST's and ARS' Parlier and Salinas, CA, laboratories.
- Initiated work to support testing by ARS' Salinas, CA, laboratory to test alternatives to methyl bromide for commodity fumigation.

Treatment Quality Assurance Unit, Raleigh, NC

Director - Scott Wood

How We Support the Mission

The Treatment Quality Assurance Unit (TQAU) safeguards American agriculture and natural resources by developing, adapting, and supporting technology to detect, identify, and mitigate the risk posed by exotic pests in preclearance programs and at ports-of-entry. APHIS' last line of defense in preventing an exotic pest invasion is the commodity treatment of imports that may harbor these pests. Currently, core activities within TQAU include developing quarantine treatments, contributing to the treatment manual for ports-of-entry, certifying shipping containers and vessels, maintaining the Commodity Treatment Information System (CTIS), training-the-trainer for proper application of treatments, certifying commodity treatment facilities within foreign countries, and conducting quality assurance audits of treatments performed domestically and at foreign sites.

Recent Accomplishments

- Reviewed and analyzed research intended to support adopting new treatments or revising existing treatments. Proposals considered included methyl bromide fumigation of mite *Brevipalpus chilensis* on Chilean grapes; cold treatment for the Mediterranean fruit fly (MedFly) *(Ceratitis capitata)* in dates, for the fruit flies *C. capitata* and *Anastrepha fraterculus* in Argentinean blueberry, and for *A. fraterculus* on pineapple guava; hot water treatment for oversized mangoes from South America; vapor heat treatment for *A. fraterculus* on papaya fruit; and irradiation for mango pulp weevil *(Sternochetus frigidus).* TQAU submitted documentation in support of a USDA-approved generic insect irradiation treatment for consideration and potential adoption by the IPPC.
- Developed new heat treatments for citrus canker on orange peel and for several plant pathogens on dried plant parts. Development of new physical treatments is critical to reducing our dependence on methyl bromide fumigations.
- Certified an irradiation facility in Vietnam, approved new process and packaging configurations in another Vietnam facility, and conducted extensive dose mapping of irradiation facilities in Mexico and Thailand.
- Continued maintenance of CTIS with multiple updates and new features, including cold treatment chart uploads and streamlined analysis as well as inclusion of labels, applicator manuals, and material safety data sheets for all hazardous materials in the PPQ Treatment Manual. We also initiated work on a new version of the 429 Fumigation Database, and we are updating the Irradiation Reporting and Accountability Database System to include new components for domestic irradiation. Both of these system updates will be released in 2010.
- Received ISO Registration (ISO 9001:2000) for cold treatment processes in April 2009. ISO Registration is a key target of the PPQ strategic plan, and successful registration designates TQAU as an organization committed to continually improving, producing quality work, and improving customer communications and satisfaction.
- Completed electronic indexing of 2,500 documents in the TQAU library as we continue to transition to a paperless electronic system for AQI treatments, policies, and research literature. This multi-year initiative now encompasses more than 16,500 documents.
- Cleared 2,873 containers in the 556 Cold Treatment Database and reviewed 138 reefer containers and 57 vessels for cold treatment certification in calendar year 2009.

Project Highlights

Development and Adaptation of Real-Time Polymerase Chain Reaction Assays for Targeted Viruses in Foreign Germplasm

Location: CPHST Lab, Beltsville, MD
Lead Scientist: Mark Nakhla
Team Members: Deric Picton, Kristina Owens, and Gang Wei

Crops such as pome fruits, stone fruits, berries, potatoes, sweet potatoes, corn, sugarcane, and grasses represent an important part of American agriculture. Foreign germplasm is needed in order to incorporate genes of value from outside of the U.S. gene pool. Because germplasm stock may contain many diseases and insects not found in the United States, the importation of these plant species is generally prohibited. However, small quantities of germplasm may be introduced into the United States under quarantine while undergoing a set of pathogen detection tests and therapeutic treatments if needed. When completed, pest-free plant germplasm can be released and distributed to the U.S. user community. There is a need to adapt, develop, and validate molecular diagnostic tests for several diseases for the PPQ Plant Germplasm Quarantine Program (PGQP). Molecular diagnostic methods are much faster than traditional biological indexing methods and more sensitive than serodiagnostic techniques. The availability of such molecular diagnostic methods will speed up the detection of infected material and will shorten the time needed to release disease-free germplasm to the user community.

Many plant viruses can be transmitted to and found in imported germplasm, causing serious problems to American agricultural, rural, or forest ecosystems. State-of-the-art molecular diagnostic tools improve their detection in imported germplasm. Real-time PCR (qPCR) offers a sensitive and accurate diagnostic technology that can be developed, adapted, and validated by the CPHST Beltsville Lab and then transferred to the PGQP. The rapid nature of the qPCR format, in addition to streamlined extraction methods, will increase PGQP's capacity to rapidly screen foreign germplasm for these viruses. PGQP identified a list of several virus groups and independent viruses that they provided to our lab for the development of molecular tests.

The list identified an immediate need for individual virus polymerase chain reaction (PCR) tests for *Columbian datura potyvirus, Black currant reversion nepovirus, Sweet potato chlorotic fleck carlavirus, Sweet potato mild speckling potyvirus, Sweet potato chlorotic stunt crinivirus,* and *Potato yellow vein crinivirus.* Since all of these viruses have RNA genomes, we developed reverse transcription-quantitative PCR (RT-qPCR) work instructions for the detection of each virus. In addition to the RT-qPCR assays, we also adapted or developed reverse-transcription conventional PCR (RT-conv. PCR) assays so that the PCR products could be sequenced if needed. During fiscal year 2009, the Beltsville lab delivered 14 work instructions to PGQP (Table 1) for the detection of targeted viruses in foreign germplasm.

Delivered	Work Instruction
October 2008	Total RNA Extraction
January 2009	Preparation of cDNA from Total RNA
January 2009	Sweet potato mild speckling potyvirus, RT-qPCR
February 2009	Columbian datura potyvirus, RT-qPCR
March 2009	Sweet potato mild speckling potyvirus, RT-conv. PCR
March 2009	Columbian datura potyvirus, RT-conv. PCR
April 2009	Black currant reversion nepovirus, RT-qPCR
April 2009	Potato yellow vein crinivirus, RT-qPCR
May 2009	Black currant reversion nepovirus, RT-conv. PCR
May 2009	Potato yellow vein crinivirus, RT-conv. PCR
June 2009	Sweet potato chlorotic fleck carlavirus, RT-qPCR
June 2009	Sweet potato chlorotic stunt crinivirus RT-qPCR
July 2009	Sweet potato chlorotic fleck carlavirus, RT-conv. PCR
July 2009	Sweet potato chlorotic stunt crinivirus, RT-conv. PCR

Table 1. Work instructions delivered to PGQP by CPHST in fiscal year 2009.

The Ornamental Cultivar, *Imperata cylindrica 'Rubra,'* Reverts to an Invasive Form of Cogongrass, a Federal Noxious Weed

Lead Scientist: Dr. Sharon M. Talley
Team Members: Edward Jones and Dr. Alan Tasker
Cooperator: Dr. Leland J. Cseke, The University of Alabama in Huntsville

Invasive plants cause substantial harm to both natural and agroecosystems, costing the United States an estimated $34.5 billion annually. These costs are expected to rise due to the increased likelihood that invaders will continue to be introduced through the ever-growing globalization of trade. Before a plant taxon can be federally prohibited, there must be substantial evidence that it has the potential to become an invader. However, such supportive information is not always readily available. Our project goal is to develop methodologies to fill key gaps in knowledge about the invasive potential of plants.

One plant that lacks substantial evidence for its invasive potential is the cultivar, *Imperata cylindrica* var. *koenigii* (Retzius), also known as *I. cylindrica* 'Rubra,' Red Baron, and Japanese blood grass (JBG). JBG is a red-leaved ornamental grass that is a cultivar of one of the world's worst weeds, cogongrass *(I. cylindrica).* JBG is putatively sterile, considerably smaller, and much less aggressive than wild-type cogongrass. However, JBG is reported to produce viable seed and revert to a larger, all green invasive form that closely resembles wild-type cogongrass. Until recently, substantial evidence to support JBG fertility and reversions was lacking.

To compare morphological characteristics under controlled conditions, we collected JBG, several independent JBG reversions, and wild-type cogongrass phenotypes from the field and grew them in the greenhouse. JBG had lower chlorophyll content, shorter and thinner leaves and rhizomes, and less leaf area than the reverted and cogongrass phenotypes. In general, the reverted phenotypes more closely resembled wild-type cogongrass than JBG phenotypes. In cogongrass, one of the primary modes of reproduction, spread, and tolerance to herbicides is through the rhizomes. Since the reverted phenotype has considerably larger rhizomes than JBG, the reverted phenotype likely has a greater potential to spread vegetatively than the JBG phenotype does. Likewise, during the course of this project, we observed JBG and its revert flowering in the field and greenhouse. A recent finding from the Maryland Department of Agriculture indicates that wind-blown seeds of JBG are not 100-percent sterile and can produce viable offspring.

To address whether the putative reverts originated from wild-type cogongrass, JBG, or a hybridization of the two forms, we conducted genetic analyses of JBG, cogongrass, and three independent putative JBG reverts discovered in Maryland, South Carolina, and Missouri. Our genetic analysis included in-depth comparisons of five variable regions in nuclear internal transcribed spacer (ITS) and chloroplast DNA *(rbcL, ndhF, trnL-F,* and *TrnH-psbA).* For all regions, the DNA sequences of JBG were an exact match to those of the reverts, indicating that JBG and the reverts have the same genotype and origin. JBG genotypes differed from wild-type cogongrass genotypes in the nrITS and *trnL-F* regions, verifying that wild-type cogongrass is not a recent parent of the JBG reverts. Next, we isolated nuclei for analyses in flow cytometry to determine if the reversion was due to a polyploidy event and if JBG, revert, and cogongrass share the same number of chromosomes. We found that JBG, cogongrass, and the reverts were all diploid, and the chromosome number of JBG and cogongrass genotypes are compatible for potential hybridizations. Given that JBG is not sterile, hybridization may occur with wild-type cogongrass, and compatibility should be addressed in further studies.

Preventing crosses between cogongrass and JBG genotypes is necessary because cogongrass is self-incompatible and requires a different genotype to produce viable seeds. In addition, JBG is more shade- and cold-tolerant than cogongrass, and gene flow between the two genotypes may generate hybrids that have an expanded geographic range. To help maintain geographic separation of reverts from cogongrass, we developed a cost-effective molecular diagnostic method to distinguish between the morphologically similar JBG reverts and wild-type cogongrass using genotype-specific DNA primers for PCR.

Fire Ant-Decapitating Fly Cooperative Release Programs (1994-2008): Two *Pseudacteon* Species, *P. tricuspis* and *P. curvatus,* Rapidly Expand Across Imported Fire Ant Populations in the Southeastern United States

Location: CPHST Lab, Gulfport, MS
Lead Scientist: Anne-Marie Callcott
Team Members: Sanford D. Porter (USDA, ARS), Ronald D. Weeks, Jr., L.C. "Fudd" Graham (Auburn University), Seth J. Johnson (Louisiana State University), and Lawrence E. Gilbert (University of Texas)

Natural enemies of the imported fire ant (IFA), *Solenopsis invicta, S. richteri,* and their hybrid, include a suite of more than 20 fire ant-decapitating phorid flies from South America in the genus *Pseudacteon*. Over the past 13 years, many researchers have cooperated in introducing several species as classical or self-sustaining biological control agents in the United States.

In 2001, APHIS initiated a cooperative program to rear and release decapitating flies as fire ant biocontrol agents in all infested States. The Florida Department of Agriculture's Division of Plant Industry in Gainesville, FL, was contracted to mass-rear the phorid flies and to distribute them for release. In Gainesville, FL, USDA's Agricultural Research Service (ARS) assisted by collecting and evaluating new fly species for potential field release and establishing the initial laboratory colonies of flies. APHIS coordinated releases with State cooperators in each of the fire ant-infested States including Puerto Rico, who in turn released the flies and monitored establishment and spread. The APHIS program began field releases in 2002 with *P. tricuspis* and in 2004 with *P. curvatus,* providing flies for 98 releases between 2002 and 2009. These included 64 releases of *P. tricuspis* (3,400 flies per release) and 34 releases of *P. curvatus* (15,000 flies per release).

As a result of the efforts of APHIS and the many university and other researchers involved in phorid releases, these two species of flies, *P. tricuspis* and *P. curvatus,* are well established across large areas of the southeastern United States. Distributional data from both published and unpublished sources has been compiled for the entire United States with the goal of presenting confirmed and probable distributions as of the fall of 2008. We also used documented rates of expansion to predict the distribution of these flies 3 years later in the fall of 2011. In the fall of 2008, 11 years after the first successful release, we estimate that *P. tricuspis* covered about 50 percent of the fire ant-quarantined area. We estimate that *P. tricuspis* will occur in almost 65 percent of the quarantine area by 2011. Eight years after the first successful release of *P. curvatus,* two biotypes of this species (one biotype occurring predominantly in the black and hybrid IFA, and the other occurring in red IFA) covered almost 60 percent of the fire ant-quarantined area. We estimate that these two biotypes will cover almost 90 percent of the quarantine area by 2011 and 100 percent by 2012 or 2013.

Pseudacteon tricuspis and *P. curvatus* are the first classical biological control agents to be successfully established against invasive ants. Substantial impact on the IFA is not expected with the presence of just two species of phorid flies. Multiple phorid species and other natural enemies need to be established in the United States to provide a collective impact on IFA populations. However, the successful establishment and spread of these two species should encourage exploration and testing of additional natural enemies that can be safely released against social insect pests.

A Pilot Project: Area-Wide Management of Asian Citrus Psyllid in Texas

Location: CPHST Lab, Mission, TX
Lead Scientist: Dr. David Bartels
Team Members: Dr. Matt Ciomperlik, Dr. Paul Parker
Cooperators: Dr. Mamoudou Sétamou and Dr. John da Graça

The Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae), has spread throughout citrus growing regions of Texas since the first report of its presence in 2001. ACP is a known vector of *Candidatus* Liberibacter asiaticus, which causes citrus greening disease or Huanglongbing (HLB). HLB is one of the most devastating citrus diseases because of the lack of effective control measures. Commercial citrus production covers about 28,000 acres in three counties of the Lower Rio Grande Valley in Texas.

An area-wide management approach to control ACP has the potential to lower the risk of HLB establishment and spread. Reducing the vector population can lower the risk of HLB spread and make disease eradication possible if it is detected early. Historically, in areas where ACP and HLB occur together, control of the psyllid vector and removal of infected trees reduces the spread of the disease.

In 2009, the Texas A&M Kingsville Citrus Center and CPHST Mission Lab implemented a pilot project covering almost 1,500 acres of citrus to test area-wide management of ACP and minimize the risk of citrus greening. Our objectives were to:

1. Implement site-specific treatment regimes for ACP control in commercial citrus and refine monitoring methods for ACP populations and infestations pre- and post-treatment;
2. Continue to test the efficacy of different insecticide application methods comprising aerial application (fixed-winged aircraft) and ground application;
3. Monitor and document the effects of different ACP population control options on nontarget arthropods, including beneficial and secondary pest species;
4. Develop effective and acceptable control programs in dooryard citrus using approved bio-pesticides and registered chemicals; and
5. Develop grower and public education programs for dealing with ACP and the threat of HLB in Texas.

We have documented that pesticide applications are effective before spring flush. An aerial application of Danitol reduced ACP adults by 93 percent. The timing of this treatment is critical as adults need to be treated before they begin laying eggs on the spring flush. We learned that treatments with the systemic pesticide imidacloprid did not perform well on mature trees. We also learned that there are more psyllids present on the outside edges of the entire area-wide project compared with the internal locations, indicating that it took longer for ACP populations to rebound in an area with a coordinated treatment application. Another spatial dynamic is that more psyllids are present on the exterior edges of individual orchard blocks compared with the interior of the same block. This behavior potentially could lead to effective use of perimeter treatments, lowering the amount of insecticides needed for ACP management.

We are also collecting an intensive, spatial-referenced data set to analyze the movement of psyllids among commercial citrus orchards and from outside sources, such as dooryard citrus trees. Much of our data will be incorporated into a large modeling effort to determine the dispersal of ACP and the potential spread of HLB.

Biological Control of Emerald Ash Borer *(Agrilus planipennis)*

Location: CPHST Lab, Otis Air National Guard Base, Buzzards Bay, MA
Lead Scientist: Dr. Juli R. Gould

The emerald ash borer (EAB), an invasive wood-boring beetle native to Asia, is threatening ash trees throughout North America. As of October 2009, EAB had been detected in 13 States and was continuing to spread. EAB larvae feed under the bark of ash trees, cutting off the transport of nutrients and resulting in tree mortality. It is estimated that over 70 million of Michigan's ash trees have already succumbed to the beetle. EAB is difficult to detect in the early stages of attack, control treatment options are limited, and relatively few native natural enemies attack the pest. As EAB spreads throughout North America, public agencies are seeking management tools that would reduce EAB population densities, slow its spread, and reduce its impact on ash trees.

Classical biological control involves importing and releasing host-specific natural enemies from a pest's native range to control populations in the area of introduction. Because EAB is from northeastern Asia, U.S. and cooperating scientists have been searching for natural enemies in that region. Two larval and one egg parasitoid of EAB were discovered in collaboration with Chinese scientists. CPHST scientists have been conducting research on one parasitoid wasp of EAB larvae, *Spathius agrili.*

S. agrili parasitizes EAB larvae by drilling through the bark and laying up to 20 eggs on their hosts. The hatching wasp larvae feed and develop on the EAB larvae, eventually killing them. The wasps overwinter as pupae inside cocoons under the bark of ash trees and emerge as adults in the summer. *S. agrili* parasitizes up to 90 percent of EAB larvae in some stands in China. In order to utilize *S. agrili* as a biological control agent for EAB, CPHST scientists first developed methods for continuous rearing of *S. agrili* in the laboratory. The specificity of this parasitoid was also studied extensively to determine if it would parasitize native beetles.

Based on these studies, as well as studies of host-habitat preferences and surveys of the host range in China, an environmental assessment outlining the benefits and risks of releasing the three parasitoids was prepared and published in the Federal Register. International, national, and State scientists and regu-

lators reviewed permit applications for field release of *S. agrili* and the two other parasitoids; release permits were granted in July 2007. In December 2008, technology for rearing *S. agrili* was transferred by CPHST to a mass-rearing facility in Brighton, MI. Production of all three parasitoids has increased every year, with plans to release over 120,000 EAB parasitoids in eight States in 2010. Reproduction and overwintering has been confirmed for all three species following releases in Michigan and Ohio. CPHST scientists have collaborated with USDA colleagues to develop sampling methodology to determine the impact of the parasitoids on EAB population density. The search for climatically matched natural enemies continues in Asia, and a species of *Spathius* from Russia, which may be more cold-hardy than the Chinese strain, is currently being reared at the Otis lab and will undergo safety testing.

Low Volume and Ultra-Low Volume Ground Application Technology for Treating Grasshoppers and Mormon Crickets on Rangeland

Location: CPHST Lab, Phoenix, Arizona
Lead Scientists: Nelson Foster, Larry Jech, Chris Reuter, and Lonnie Black

The APHIS Grasshopper Program coordinates management of grasshoppers and Mormon crickets to reduce damage to rangeland forage during grasshopper outbreaks. Rangeland treatments may include baits and aerial or ground-applied insecticide sprays. The CPHST Phoenix Lab has been developing methods to reduce the amount of insecticide used in these treatments while maintaining effective control of these insects. Low volume sprays apply insecticide at 0.5 to 43 gallons per acre. Ultra-low volume (ULV) sprays are applied at less than 0.5 gallons per acre. Typical ULV sprays rely on very fine atomization and drift of the spray. While successful and accepted in many parts of the world, these characteristics are currently unacceptable in USDA-sponsored control efforts against rangeland pests.

A typical ground sprayer used on rangeland in the United States today, while producing acceptable droplet size and drift, may apply as much as 4.6 gallons per acre. Because of the high volume applied per acre and the slow speed of application, ground systems have time and treatment block size limitations. Application rates are affected mainly by flow rate, swath width, and speed of application. The major impediment in efficient ground applications is a high flow rate, which produces higher volumes per acre than needed. Lower flow rates would translate into less diluent per acre needed, less time for mixing and loading, and more acres treated per tank load. This would substantially reduce the time required to treat an area.

To address these problems, a commercial ground application spray system, a Jackrabbit Pro ATV Sprayer mounted on a Suzuki Vinson QuadRunner ATV, was modified with an adjustable timer-activated solenoid valve to quickly switch the spray on and off. Several candidate nozzles were tested in the unmodified standard system to determine the most productive in terms of swath width. The nozzles with the widest swaths were then tested at numerous on and off intervals with two timers.

The lowest volume per acre delivered by a standard configuration was 1.59 gallons per acre at 12 miles per hour with the BoomJet 5880 (42-foot swath). When a timer-activated solenoid was added to the spray system, a dramatic reduction in the application's total volume per acre resulted. At 12 miles per hour and a timer setting of 0.2 seconds on and 0.6 seconds off, the BoomJet 5880 nozzle delivered 0.36 gallons per acre. In the operational field study comparing the standard set-up with Boominator Nozzles to the new set-up with BoomJet nozzles, no significant difference in efficacy was observed (77- to 78-percent mortality at 7 days after treatment [DAT] and 84- to 92-percent mortality at 14 DAT) when Sevin XLR Plus was sprayed to control grasshoppers on Arizona rangeland. Using the standard system, two ATV operators could apply treatments to 130 acres in an 8-hour period with 19 insecticide tank loads. With the new system, 300 acres could be treated in the same time period and required only 12 loads.

Modifying existing ground spraying systems with a timer-activated solenoid valve to quickly shut the spray on and off greatly reduces flow rates and provides remarkable economic improvement. These modifications save ferrying, mixing, and loading time, as well as reduce the volume of diluents currently required of ground applicators. The modification has been adopted and used in Arizona and North Dakota and is nearing implementation in several other States. This modification should be easily adapted to any spray system.

Thanks are extended to our partners and collaborators: Dewey Murray and David Pierce, PPQ, Phoenix, AZ; David Hirsch, PPQ, Bismarck, ND.

Development of a Rapid Weed Risk Screening Tool To Identify Weeds and Invasive Plants

Location: Plant Epidemiology and Risk Analysis Laboratory, Raleigh, NC
Lead Scientist: Dr. Anthony Koop

Introduced plants sometimes escape, naturalize, and become known as weeds and invasive plants. One out of every 1,000 species introduced is estimated to become problematic. These species cause numerous direct and indirect impacts to agricultural, natural, and urban systems, costing taxpayers billions of dollars annually. Because more species continue to be introduced every day, both intentionally and unintentionally, it is likely that some of today's plant imports and contaminants will become tomorrow's new weeds. Preventing these species from entering the United States is one of our goals under the National Invasive Species Management Plan.

PPQ's current weed risk assessment (WRA) process typically takes several weeks to complete. This is too time-consuming given that a greater number of plants continue to be introduced every year and that plant explorers and breeders continue to introduce new taxa into the United States. PPQ needs a rapid weed risk assessment tool to evaluate these taxa. A rapid tool would also help meet regulatory demand arising from the Q-37 (plants for planting) revision.

Over the last 2 years, CPHST scientists have been developing a new WRA model that is similar in style to the popular Australian WRA system, but uses a modified set of questions that are grouped and weighted differently. We created and validated the model using 204 plant species whose invasive status in the United States is already known. These species range from benign taxa that do not escape cultivation (noninvaders) to aggressive species that are significant pests in agricultural and/or natural systems (major-invaders). To ensure that the new model performed just as well—if not better than—the Australian WRA, we assessed the same 204 species with the Australian WRA.

The new PPQ weed risk assessment model that we completed this year meets many of PPQ's needs. It combines the style associated with rapid screening tools with the structure typically associated with pest risk analysis. Assessments using the new method can be completed in about 2 days, which is considerably faster than the previous method. Rapid assessments will not only decrease response time to new and imminent weeds, but will also allow risk analysts to assess additional species.

As a diagnostic test, the new WRA tool will help PPQ identify weedy and invasive species so that program managers can evaluate appropriate response strategies. During testing, the new model correctly identified 95 percent of the major-invaders and 97 percent of the noninvaders (Table 2). While it maintained the same level of major-invader accuracy associated with the Australian system, it increased non-invader accuracy by about 25 percent. The error rate associated with the new model is expected to be very low as none of the plants were incorrectly classified during testing.

Test	True + Fraction (Maj-I Accuracy)	True – Fraction (Non-I Accuracy)	False Positive Rate	False Negative Rate	Percent Evaluate Further
US - Aus WRA	0.971	0.794	0.088	0	0.098
US - PPQ WRA	0.941	0.971	0	0	0.118
Mean from 7 other studies	0.952	0.696	0.175	0.012	0.071

Table 2. Test accuracy and error for the U.S. tests of the new PPQ weed risk assessment and the Australian WRA. Mean accuracy and error for seven other tests of the Australian WRA are shown for comparison. The false + rate represents the number of noninvaders classified as high risk, while the false – rate represents the number major-invaders classified as low risk. Also shown are the percent of species requiring further evaluation. (Table by Tony Koop, CPHST, Raleigh, NC)

CPHST scientists have begun to use the new WRA to assess plants. An Excel template of the WRA, along with a detailed set of guidelines, is available upon request. Although the current assessment requires users to categorize their uncertainty, in future work, we will incorporate methodology for evaluating the impact of uncertainty on risk scores.

Biological Control of Asian Citrus Psyllid

Location: CPHST Mission Lab/Biological Control Unit
Lead Scientist: Daniel Flores
Team Members: Norman Barr, Leeda Wood, Joe Martinez, Andrew Parker, Steven Rodriguez, Eustorjio Rivas, and Joe Renteria

Accomplishments

- Developed tentative protocol for mass-production of *Tamarixia radiata* parasitoids using a field insectary cage enclosing a mature citrus tree.
- Received new collections of *Tamarixia radiata* from the Punjab region of Pakistan into the PPQ Arthropod Quarantine Laboratory at the CPHST Mission Lab.

Mass Production of Parasitoids

The ACP, *Diaphorina citri* (Kuwayama), is the primary vector of the bacterium *'Candidatus* Liberibacter asiaticus,' the causal agent of Huanglongbing disease in citrus. Huanglongbing, more commonly known as citrus greening disease, is one of the most serious threats to citrus worldwide. A key component to a management program for citrus greening disease is aggressive control of the ACP vector. *Tamarixia radiata* is a parasitic wasp that is recognized as the most important natural enemy of ACP in several geographic areas around the world. Our plans are to evaluate releases of this parasitoid in the Rio Grande Valley and other ACP-affected areas and to be able to transfer these technologies to State cooperators in support of area-wide ACP/citrus greening management programs.

Currently, the CPHST Mission Laboratory is exploring rearing methods for *T. radiata* under greenhouse conditions using large orange jasmine plants. This production supports ongoing research efforts to determine the effectiveness of the parasitoid in controlling ACP populations and as a seed colony for larger mass-rearing efforts. Mass-production techniques are also being developed and tested at the laboratory using mature citrus trees enclosed in 12-feet-x-12-feet-x-10-feet field insectary cages. In this work, tree hedging was first conducted to induce a flush of new growth. Adult psyllids were attracted to the tender growth and began egg-laying. A field insectary cage was installed around each of the hedged trees, and 16 female and 4 male parasitoids were then immediately released into the cage. Two months later, samples were collected and scanned under the microscope to observe parasitism rates and determine total parasitoid production. Parasitism rates in these initial low-volume trials were recorded at 19.8 percent and approximately 2,000 adult parasitoids were produced. With further work, this method may prove to be an excellent tool for releasing and establishing parasitoids directly in commercial and organic groves to help suppress ACP populations. We are currently working to develop methods to increase mass-production to 50,000 agents per tree.

Importation of Parasitoids from Pakistan

The Mission lab strain of *T. radiata* was derived from a lab strain in Florida that was initiated from collections made in Taiwan and Vietnam and subsequently evaluated and permitted for release in Florida in 1999. Parasitism rates of ACP by *T. radiata* in Florida have averaged less than 20 percent during spring and summer, increasing to between 39 and 56 percent in the fall. Unfortunately, its effectiveness in suppressing psyllid populations under field conditions has been variable in Florida and other adjoining regions. *T. radiata* also appears to have spread to Texas along with ACP. In Texas, we have also observed parasitism rates averaging less than 20 percent. More recently, efforts have been made to collect and evaluate *T. radiata* from Pakistan, which has a climate more similar to that of the southern United States and where percent parasitism is reportedly much higher. In addition, diagnostic tools have been developed to discern between haplotypes of the species from differing origins in order to monitor population size during a management program in which large numbers of parasitoids are released and would eventually mix with existing populations.

Arrangements were made with Abdul Rehman of CABI-South Asia to make collections of new strains of *T. radiata.* Collections of *T. radiata* were successfully received and established in quarantine from Punjab, Pakistan, in August 2009. The small parasitic wasps will be undergoing host-specificity testing at the Mission Laboratory and by Dr. Mark Hoddle at the University of California-Riverside to evaluate their

potential impact on nontarget species. The Punjab strain of parasitoids will provide yet another control tool for citrus greening and will potentially produce higher parasitism rates than the original strain.

Our main goals for the coming year will be to continue our host-specificity testing of *T. radiata* and to refine mass-production methods and protocols by making additional parasitoid releases on citrus trees in field insectary cages. Further research is being planned to receive new collections of *T. radiata* from China in 2010. We will also be developing methods to increase parasitism levels, efficiently harvest emerging parasitoids, enhance and monitor production, and evaluate the impact of host-feeding on production.

Methyl Bromide Use Reduction and Potential Treatment Alternatives

Location: Treatment Quality Assurance Unit (TQAU), Raleigh, NC
Lead Scientist: Scott Wood

Methyl bromide is an essential tool in our quarantine treatment arsenal, but it is also an ozone-depleting chemical that has been highly restricted in its use by the Montreal Protocol. We are encountering increasing pressure both domestically and internationally to reduce our dependence on methyl bromide and to ensure human and environmental safety where it continues to be used. A significant amount of the quarantine and pre-shipment (QPS) use of methyl bromide in this country is conducted under the authority of APHIS. Proper stewardship of this highly effective treatment option dictates that we preserve its use for situations where there are no other reasonable options. Therefore, it is incumbent upon us to optimize treatment processes in order to reduce waste and to explore alternative pesticide technologies in order to replace methyl bromide for some uses.

TQAU develops research protocols and reviews pertinent literature to support new quarantine treatments, including methyl bromide alternatives. In 2009, we developed two new heat treatments (citrus canker on citrus peel as well as bacteria and fungi on dried plant parts). Our unit also reviewed several proposals with supporting research to adopt new or modify existing quarantine treatments using cold treatment, irradiation, vapor heat/forced hot air, and steam sterilization as alternative commodity treatments. Two of these reviews resulted in PPQ's adoption of new or revised quarantine treatments.

In cases where no suitable alternatives to methyl bromide exist, process improvements can reduce the amount of methyl bromide used or reduce potential human exposure. For example, TQAU developed a new operational protocol and reviewed several months of data for containerized log export fumigations. Previously, log containers were tarped with their doors open, and the amount of fumigant added was calculated based on the entire volume under the tarpaulin. By closing the container doors during fumigation, approximately 25 percent less fumigant is used because we are now treating only the space inside the container. Safety for personnel is ensured by continuing to use a tarpaulin to trap any escaping gas.

TQAU is also conducting an ongoing study to observe commodities after fumigation and aeration (active and passive dissipation of the fumigant) to better understand how people interact with a released commodity while low-level residues (within legal limits) may still exist. We have also collaborated with industry to design protocols for testing alternative aeration procedures, which may reduce the potential for human exposure while improving commodity quality.

Another technology, methyl bromide recapture, shows some promise for trapping methyl bromide during commodity aeration so that it is not released into the atmosphere. While this is currently feasible on a small scale, TQAU is evaluating its potential for use in fumigations conducted at PPQ's plant inspection stations.

TQAU has also taken steps to ensure that fumigant concentrations are accurately measured during methyl bromide treatments. Accurate measurements provide confidence that treatments are effective, that enclosures are secure, and that we are not leaking gas or adding supplemental gas unnecessarily. After a thorough review, we provided specific guidance to PPQ operations on how methyl bromide monitors should be operated to collect accurate measurements. This includes the proper use of disposable filters/scrubbers and water traps to protect equipment and minimize false readings.

TQAU also collaborates domestically and internationally with industry, States, and other National Plant Protection Organizations to share information and investigate new and

developing technologies. For example, TQAU staff members sit on the International Plant Protection Convention's Technical Panel for Phytosanitary Treatments and the Plant Health Quadrilaterals Scientific Collaboration Working Group.

Finally, TQAU manages and continues to optimize our information management tool, the Commodity Treatment Information System. In 2009, we began developing an updated version of the 429 Fumigation Database, which will provide a more user-friendly data entry interface while facilitating treatment quality analyses and providing a reporting tool for methyl bromide usage.

Selected Publications

CPHST employees published a number of scientific articles in 2009. The following is a selected list of those publications.

Barak, A., V.W. Yang, D. Yu, Y. Jiao, L. Kang, Z. Chen, X. Ling, and G. Zhang. 2009. Methyl bromide as a quarantine treatment for *Chlorophorus annularis* (Coleoptera: Cerambycidae) in raw bamboo poles. Journal of Economic Entomology 102: 913–920.

Barr, N.B., A. Cook, P. Elder, J. Molongoski, D. Prasher, and D.R. Robinson. 2009. Application of a DNA barcode using the 16S rRNA gene to diagnose *Arion* species in the USA. Journal of Molluscan Studies 75: 187–191.

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Barr, N.B. 2009. Pathway analysis of *Ceratitis capitata* (Diptera: Tephritidae) using mitochondrial DNA. Journal of Economic Entomology 102: 401–411.

Barr, N.B. and B.M. Wiegmann. 2009. Phylogenetic relationships of *Ceratitis* fruit flies inferred from nuclear CAD and tango/ARNT gene fragments: testing monophyly of the subgenera *Ceratitis (Ceratitis)* and *C. (Pterandrus).* Molecular Phylogenetics and Evolution 53: 412–424.

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Böröczky, K., D.J. Crook, T.H. Jones, J.C. Kenny, K.E. Zylstra, V.C. Mastro, and J.H. Tumlinson. 2009. Monoalkenes as contact sex pheromone components of the woodwasp *Sirex noctilio.* Journal of Chemical Ecology 35: 1202–1211.

Chong, J.H., J.J. Tefel, A.L. Roda, and C.M. Mannion. 2009. Effects of beetle density and time of day on the dispersal of *Gratiana boliviana* (Coleoptera: Chrysomelidae). Florida Entomologist 92: 99–106.

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Appendix A. List of International Partners/Collaborators

International partners and collaborators provide support for safeguarding our borders from invasive plant pests. CPHST collaborated with 38 countries on national and global projects.

Aruba
Argentina
Australia
Austria
Barbados
Belgium
Brazil
Bulgaria
Canada
Chile
China
Colombia
Curacao
Dominican Republic
Egypt
Germany
Guatemala
India
Italy
Japan
Kenya
Mexico
New Zealand
Pakistan
Panama
Romania
Russia
South Africa
South Korea
Switzerland
Thailand
Trinidad
Uganda
Ukraine
United Kingdom
United States
Uruguay
Venezuela

Appendix B. List of Funded Projects for Fiscal Year 2009

Funding Category	Amount ($)
AQI-User Fee	12,499,810
Plant Methods	8,007,126
Biocontrol	3,300,000
Light Brown Apple Moth	3,235,000
Emerald Ash Borer	2,200,000
Farm Bill	2,096,383
Pest Detection	1,200,000
Miscellaneous Pest	968,209
Sirex	840,000
Citrus Health Response Program	820,100
Grasshopper	500,000
Potato Cyst Nematode	400,000
Fruit Fly	268,000
Asian Longhorned Beetle	250,000
Sudden Oak Death	250,000
Imported Fire Ant	214,307
Select Agents	200,000
Cotton and Other Pests	295,000
Total	37,543,935

Table 3. Allocation of funding for CPHST in fiscal year 2009. Includes allocated funds of $35.4 million and Farm Bill Section 10201 funds of $2.1 million.

Beltsville Lab

- Adaptation of a real-time PCR for the detection of the citrus variegated chlorosis strain of *Xylella fastidiosa*
- Sampling methods for improved detection and identification of the causal bacterium of citrus huanglongbing (HLB)
- Adaptation and validation of PCR detection methods for citrus leprosis virus
- Development and adaptation of real-time PCR assays for targeted viruses in foreign germplasm
- Development of group-specific nucleic acid-based diagnostic assays for the improved detection of geminiviruses and potyviruses infecting imported germplasm
- Implementation of PCR and real-time PCR diagnostics for rapid onsite detection of potato wart
- Validation of PCR diagnostics methods for *Phytophthora kernoviae*
- Advanced development of plum pox virus diagnostics
- Development of lateral flow microarrays for regulated plant pathogens
- Development of microelectronic chip technology for rapid detection of plum pox virus, citrus canker, and sudden oak death diseases
- Adaptation of CANARY™ biosensors for rapid detection of regulated plant pathogens
- Development of proficiency test reagents for high-consequence plant pathogens for delivery to the National Plant Protection Laboratory Accreditation Program for laboratory certification

Fort Collins Lab

Pest Identification Technologies

- Lucid Resource to Invasive Ants of the Pacific Basin
- Lucid Resource to Grasshoppers of the Western United States, Edition 3.0
- Wood Boring Beetles of the World: Lucid Resource to Wood Boring Beetle Families
- Wood Boring Beetles of the World: Lucid Resource to Genera of the *Bostrichidae*
- Wood Boring Beetles of the World: Lucid Resource to Genera of the *Buprestidae*
- Wood Boring Beetles of the World: Genera of *Xyleborina Ambrosia* Beetles
- Lucid Resource for Diagnosing Light Brown Apple Moth and Related Western U.S. Leafrollers (Archipini: Tortricidae)
- Lucid Resource to Pests and Diseases of Cultivated Palms in the United States and Caribbean
- Lucid Resource to Pests and Diseases of Cultivated Citrus in the United States
- Lucid Resource for the Fruit Fly Species of *Anastrepha* I. The *Anastrepha daciformis, grandis, robusta, schausi,* and *serpentina* species groups
- Lucid Resource to Identification of Imported Dried Botanicals

- ID Source: Creating an Identification Resource for Plant Protection and Quarantine
- RAPID-PCN: Spectral Technology for the Detection of PCN in Processed Soil Samples
- RAPID: Automation Technology Based Tools for Survey, Detection, and ID of Pests
- Spiders Associated with California Central Valley Table Grapes
- Weed Seeds Associated with California Central Valley Table Grapes
- TortAI: Tortricids of Agricultural Importance
- Federal Noxious Weeds Disseminules of the U.S., Edition 2.0
- Identification of Flat Mites (Acari: Tenuipalpidae) of the World: *Brevipalpus* and *Raoiella*
- Molluscs of Agricultural Significance to the United States
- Wood Boring Beetles of the World: North American Genera of Ironclad and Cylindrical Bark Beetles (Coleoptera: Zopheridae)
- Wood Boring Beetles of the World: World Genera of Longhorn Wood Boring Beetles (Coleoptera: Cerambycidae: Onciderini)

Biological Control

- Technology transfer and information services in weed management and biological control
- Assessment of classical biological control for management of musk thistle (*Carduus nutans)* and Scotch thistle *(Onopordum acanthium)*
- Biological control of dyer's woad *(Isatis tinctoria)* and perennial pepperweed *(Lepidium latifolium)*
- Biological control of field bindweed *(Convolvulus arvensis)*
- Biological control of garlic mustard *(Alliaria petiolata)* and yellow toadflax *(Linaria vulgaris)*
- Biological control of hoary cress *(Cardaria draba)* in the United States
- Biological control of hound's-tongue *(Cynoglossum officinale)*
- Biological control of orange hawkweed *(Hieracium aurantiacum)* and other invasive exotic hawkweeds
- Biological control of Russian knapweed *(Acroptilon repens)*
- Biological control of saltcedars *(Tamarix* spp.) in the western United States
- Biological control of Canada thistle *(Cirsium arvense)*
- Survey for natural enemies of Canada thistle (*Cirsium arvense)*
- Survey for natural enemies of perennial pepperweed *(Lepidium latifolium)*
- Perfecting a rearing system for light brown apple moth *(Epiphyas postvittana)*
- Development of rearing systems for root feeding biological control agents

Weed Control

- Benghal dayflower (Commelina benghalensis L.) control with herbicides and cover crops
- Common tansy *(Tanacetum vulgare)* control with herbicides and adjuvants: third year results
- Cogongrass *(Imperata cylindrica)* control with herbicides and magnetic spraying systems
- Use of global positioning system (GPS) and geographic information systems (GIS) technology to estimate patch spread rate for several invasive plant species
- Risk assessment of Japanese bloodgrass, an ornamental variety of cogongrass *(Imperata cylindrica)*
- Molecular identification technologies for *Imperata cylindrica*
- Conduct a risk assessment of *Oplismenus hirtellus* subspecies *variegatus* and *undulatifolius*
- Analysis of seeds dormancy characteristics between invasive and noninvasive plants

Pest Survey

- Development of commodity-based survey documents for the CAPS community
- Commodity reference and survey guidelines for exotic pests of corn
- Commodity reference and survey guidelines for exotic pests of potato
- Risk assessments for exotic pests of woody plants

- Commodity reference and survey guidelines for exotic pests of stone fruit
- Commodity reference and survey guidelines for exotic pests of cotton

Spatial Technologies

- Modeling pest spread based on landscape connectivity concepts
- Enhancing Asian gypsy moth *(Lymantria dispar)* trapping in California
- A spatial evaluation of how environmental variables contribute to grasshopper outbreaks
- Evaluating global weather patterns and their relation to grasshopper populations
- Modeling pest spread based on landscape connectivity concepts
- Monitoring control strategies for ACP in Texas
- Correlations between ethnic population centers and recurring fruit fly introductions in California

Gulfport Lab

The chemistry unit does not have traditional stand-alone projects, but conducts work as requested in support of other CPHST labs and APHIS programs.

Biological Control of Imported Fire Ants

- Biological control of the imported fire ant (IFA) using phorid flies: cooperative rearing and release program
- Biological control of the IFA: monitoring of field releases of *Thelohania solenopsae* and *Pseudacteon* spp.

Development of Quarantine Treatments for Imported Fire Ants

- Grass sod and bait treatments for control of imported fire ants
- Development of quarantine treatments for field grown/balled-and-burlapped nursery stock
- New treatments for containerized nursery stock

Mission Lab

Fruit Fly Programs Support

- Monitoring, identification, and management of microbes affecting the mass rearing of the Mexican fruit fly *(Anastrepha ludens)*
- Mexican fruit fly diet formulations
- Mexican fruit fly strain development
- Implementation of the incubation of Mexican fruit fly eggs by bubbling
- Thermodynamics in rearing fruit flies
- Mexfly eradication project enhancement LRGV: brushland survey, summer fruit sampling

Management of Citrus Pests

- Development of integrated pest management strategies to manage Asian citrus psyllid
- Sentinel tree monitoring for citrus canker and HLB in the Rio Grande Valley, TX
- Survey of citrus leprosis/flat mites in the Lower Rio Grande Valley, TX
- Asian citrus psyllid and *Tamarixia radiata*
- A pilot project: area-wide management of Asian citrus psyllid in Texas

Molecular Diagnostics

- Developing a molecular diagnostic tool for the genus *Anastrepha*
- Replication of *Sirex noctilio* DNA sequencing/PCR analysis
- Development of diagnostic tools for identifying species and geographic sources of intercepted dacine fruit flies (Tephritidae: Dacinae)
- The development of molecular diagnostic techniques for mollusks of economic importance to American agriculture
- Improve identification of immature light brown apple moth
- Development of molecular techniques that identify cryptic thrip species

- Develop molecular diagnostic techniques that identify foreign sources of fruit fly pest introductions

Integrated Pest Management

- Operation of the CPHST Arthropod Quarantine Facility
- Survey, detection, and management of significant agricultural pests in the Caribbean basin
- Crypticerya integrated pest management strategies
- Tropical soda apple project
- Asian cycad scale project
- Efficacy of packinghouse procedures on mitigation of armored scales on Hass avocado

Otis Lab

Forest Pests Program Support and Methods Development

- Support for the Russian/Japanese/Chinese/Korean Exotic Lymantria Exclusion Program
- Forecasting pest potential through offshore assessments
- Molecular analysis of male gypsy moths trapped in the U.S. ports and other high-risk areas
- Biosensor development

Biological Control/Integrated Pest Management

- Production of insect diets and life stages for use in APHIS and other cooperative research programs

AQI/Commodity Treatment Program Support/ Methods Development

- Radio frequency (RF) wave technology and metabolic stress of pest insect in perishable commodities
- Alternative quarantine treatments for invasive hitchhiking snails
- Fumigation as a control for wood boring insects in pallets/solid wood packing material to meet IPPC Rule 16 Request
- Phosphine gas in combination with sustained cold treatment and gamma radiation as a methyl bromide alternative for imported fruits

Pest Survey and Detection Program Support

- Development of odor-based detection and monitoring systems for exotic pests
- Survey, detection, and treatment evaluation on insects associated with wood packaging materials from China

Other Projects

- Methods for managing or eradicating *Cactoblastis cactorum* in North America
- Tactical support for participating in fruit fly trapping program

Emerald Ash Borer

- Infestation dynamics of ALB and EAB in North America
- Evaluation of preference and suitability of tree species (funded in part by ALB)
- Evaluation of soil applications for EAB control
- EAB alternative control strategies
- Evaluation of systemic insecticides in China
- Distribution of EAB in China
- Fumigation studies for woodborers
- Behavior, biology, and control of wood-boring beetles (Elkinton/UMass)
- Control of exotic wood borers
- Pesticide residue determination
- Application of remote sensing for EAB survey
- Ecology of EAB
- Quarantine treatments for EAB
- Survey methods for low-density EAB populations (Storer)
- Semiochemicals of EAB (Cosse/Agricultural Research Service)
- EAB infesting firewood (Hoover/Pennsylvania State University)
- Identification of mechanisms of genetic resistance of ash to EAB (Bonello/Ohio State University)
- Risk and regulatory assessment (Jacobi/Colorado State University)
- Ash decline model (Knight/Forest Service)

- Assessing the efficacy of mobile *Cerceris fumipennis* colonies (Careless/Forest Service)
- Development of survey tools for EAB
- Reverse engineering of the *Agrilus planipennis* elytral cuticle to produce interference colors on nano fabricated surfaces for use in sticky monitoring traps (Baker/Pennsylvania State University)
- Mechanisms of inter/intra specific variation in resistance of ash to EAB (Hermes/Ohio State University)

Asian Longhorned Beetle

- Improved rearing technology for ALB
- Molecular and genetic analysis of *Anoplophora* (China)
- Evaluation of insecticides for ALB control

Sirex Woodwasp

- Development of monitoring tools for *Sirex*
- Biological control of *Sirex*
- Validation of treatment options
- Development of degree-day model for *Sirex*
- Infestation dynamics of *Sirex* (Ayres/Dartmouth)
- Behavior and sensory ecology
- Development of regulatory treatments for *Sirex*

Light Brown Apple Moth

- Optimize traps and lures for LBAM detection and delimitation
- Geographic and strain-related variation in LBAM pheromone (Cardé/UC Riverside)
- Assess and optimize mating disruption methods and materials for LBAM
- Characterize LBAM population dynamics (UC Davis)
- Develop improved regulatory treatments for nursery stock in LBAM-infested areas
- Evaluate insecticides for control of LBAM
- Produce LBAM lures for national survey

Potato Cyst Nematode

- Sanitation of nematode-infested farm equipment

Phoenix Lab

- Pink bollworm (PBW) eradication program support, pheromone, and methods development
- Development and implementation of new protocols for use in the PBW Rearing Facility to reduce production costs, improve insect quality, and evaluate extrusion technology for other insect diets
- Development of an advanced marked autocidal strain of pink bollworm
- Lethal low-temperature threshold for light brown apple moth (LBAM)
- Evaluation of recent isolates of *Metarhizium anisopliae* against caged Mormon crickets on field plots
- Field evaluation of Spinosad with a drift management/deposition aid
- New toxicants compared with carbaryl on Crumbles®, Tast-E-bait®, and wheat bran carriers in field cages on rangeland grasshoppers
- Initial comparison of the standard organophosphate treatment, malathion (Fyfanon®), and a pyrethroid, ßCyfluthrin (Baythroid® XL) applied at the label rates for control of rangeland grasshoppers
- Developments and advances in replacing traditional volumes of oil and water in ultra-low volume diflubenzuron sprays with alternative diluent mixes for rangeland grasshoppers
- Improving low volume ground application technology and developing ultra-low volume ground application capability for treating grasshoppers and Mormon crickets on rangeland

Plant Epidemiology and Risk Analysis Lab

Commodity Pest Risk Analysis

- Produce scientific documentation in support of trade decisions regarding the importation of commodities
- Prepare pest risk assessments, identify potential mitigations, and review pest risk assessments prepared by other countries
- Identify and develop improvements in the pest risk assessment and risk management process

Exports

- Promote trade facilitation of agriculture exports
- Provide support to export opportunities that are blocked by technical barriers
- Prepare export risk analysis products (focus is on pest lists of arthropods and plant pathogens) associated with various commodities for export to foreign countries

Risk Analysis for Individual Organisms

- Through the New Pest Advisory Group (NPAG), assess new and imminent pest introductions into the United States and make recommendations to PPQ management regarding appropriate agency responses to exotic plant pests, including arthropods, mollusks, pathogens, and weeds

Accreditation and Certification of Risk Analysis Functions

- Through audits and improvements, maintain certification for the lab's commodity risk assessments and New Pest Advisory Group

Outreach and Training/Capacity Building/ Regulatory Curricula

- Provide instructors for a regulatory science minor at North Carolina State University (NCSU)
- Engage in cooperative online courses (international standards and risk management) as part of a second regulatory curriculum program at Michigan State University
- Maintain the strong cooperative relationship established between CPHST, NCSU, and other academic institutions
- Support a regulatory curriculum that provides training to students in relevant fields on key aspects of regulatory plant protection
- Host risk analysts from other countries, pairing visiting scientists with resident analysts as mentors to provide training in risk analysis methods

Plants for Propagation (Q-37) Analyses and Regulatory Overhaul

- In support of the major initiative to revise and update 7 Code of Federal Regulations 319.37, the quarantine that regulates the import of plants for planting, advance the regulatory process through the development of methodologies and analyses to support the APHIS decisionmaking processes associated with evaluating pest risk prior to authorizing the entry of propagative material into the United States

International Standards: IPPC, NAPPO

- Lend support, time, and expertise to international organizations, such as the IPPC and NAPPO, by participating on international working groups to write standards and reviewing draft standards as they become available
- Manage and maintain the Web site for the Phytosanitary Alert System Panel, which provides oversight to early warning initiatives for NAPPO countries

Information Systems and Biosurveillance Analysis Forecasting

- Maintain and expand the Global Pest and Disease Database
- Through the NCSU/APHIS Plant Pest Forecasting (NAPPFAST) System, support the predictive pest mapping needs of the CAPS program and the risk assessment activities of the lab
- Generate Global Plant Hardiness Maps and post them on the NAPPFAST Web site (www.nappfast.org/)
- Create risk maps for the CAPS Top 50 Pests and for CAPS 2010, CAPS historical pests, and CAPS commodity surveys
- Support the APHIS CAPS program by producing pest prioritization lists using the analytic hierarchy process
- Produce and circulate the Exotic Pest Information Collection and Analysis notifications

Weed Risk Assessment

- Generate model and pest list for weeds
- Conduct weed analysis
- In support of the Q-37 revision, revise weed risk assessment guidelines to improve and streamline the process
- Validate the risk assessment model and compare its accuracy with that of the Australian weed risk assessment model that is being used elsewhere
- Conduct weed risk assessments of plants that pose a risk to the United States as defined by the Plant Protection Act of 2000

Biological Control Unit

Since the Biocontrol Unit is comprised of a virtual team of scientists from multiple CPHST labs, biocontrol projects are listed under each lab's project listing. One scientist, Amy Roda, reports directly to the CPHST Director's Office, and her projects include:

- Field release and evaluation of natural enemies of tropical soda apple
- Canal zone sentinel survey
- Offshore mitigation of invasive pests

Treatment Quality Assurance Unit

- Evaluation of monitoring devices approved by PPQ for methyl bromide treatments with emphasis on recommendations for appropriate application and use
- Development of a quarantine heat treatment for citrus canker on citrus peel
- Advanced tracking technologies for identification and traceback of nursery stock
- Analysis of treatments associated with proposal to import unroasted coffee into Hawaii and Puerto Rico

Appendix C. Abbreviations and Acronyms

ACP	Asian citrus psyllid
AGM	Asian gypsy moth
ALB	Asian longhorned beetle
AQI	Agricultural quarantine inspection
AQI&PT	Agricultural Quarantine Inspection and Port Technology
APHIS	Animal and Plant Health Inspection Service
ARS	Agricultural Research Service
ATV	All terrain vehicle
BCU	Biological Control Unit
BSR	Black stem rust
CAPS	Cooperative Agricultural Pest Survey
CBP	Customs and Border Protection
CDFA	California Department of Food and Agriculture
CHRP	Citrus Health Response Program
CPHST	Center for Plant Health Science and Technology
CTIS	Commodity Treatment Information System
CWR	Chrysanthemum white rust
EAB	Emerald ash borer
EGVM	European grapevine moth
EPA	Environmental Protection Agency
EPICA	Exotic Pest Information Collection and Analysis
GPDD	Global Pest and Disease Database
HLB	Huanglongbing (also known as citrus greening)
IFA	Imported fire ant
IPPC	International Plant Protection Convention
ISO	International Organization for Standardization
ITS	Internal transcribed spacer
JB	Japanese beetle
JBG	Japanese blood grass
LBAM	Light brown apple moth
Medfly	Mediterranean fruit fly
Mexfly	Mexican fruit fly
NAPPFAST	North Carolina State University/APHIS Plant Pest Forecasting System
NAPPC	North American Plant Protection Convention
NAPPO	North American Plant Protection Organization
NPAG	New Pest Advisory Group
PBW	Pink bollworm

PCN	Potato cyst nematode
PCR	Polymerase chain reaction
PERAL	Plant Epidemiology and Risk Analysis Laboratory
PGQP	Plant Germplasm Quarantine Program
PPQ	Plant Protection and Quarantine
PPV	Plum pox virus
PPW	Plant Pathogens and Weeds
PRA	Pest risk analysis
PT	Proficiency test
QPS	Quarantine and pre-shipment
RAPID	Robotic Automated Pest Identification
RITAWEB	Robotic Information Technology Assistant Web Interface
RPA	Risk and pathway analysis
RRST	Response and Recovery Systems Technology
RT-qPCR	Reverse transcription-quantitative PCR
RT-conv.PCR	Reverse transcription-conventional PCR
SDI	Survey, Detection, and Identification
SIT	Sterile insect technique
TQAU	Treatment Quality Assurance Unit
TWG	Technical working group
USDA	United States Department of Agriculture
WRA	Weed risk assessment