ENVIRONMENTAL ASSESSMENT
(Final)

AQUATIC MAMMAL DAMAGE MANAGEMENT IN TEXAS

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)
ANIMAL AND PLANT HEALTH INSPECTION SERVICE (APHIS)
WILDLIFE SERVICES (WS)

In Cooperation With:

TEXAS AGRILIFE EXTENSION-WILDLIFE SERVICES,
THE TEXAS A&M UNIVERSITY SYSTEM

October 2016

TABLE OF CONTENTS

ACRONYMS

AMDUCA	Animal Medicinal Drug Use Clarification Act
APHIS	Animal and Plant Health Inspection Service
CDC	Centers for Disease Control and Prevention
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CWA	Clean Water Act
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLIR	Forward Looking Infrared
FR	Federal Register
FY	Fiscal Year
IC	Intracardiac
IV	Intravenous
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NRCS	Natural Resources Conservation Service
NWP	Nationwide Permit
NWRC	National Wildlife Research Center
PL	Public Law
SOP	Standard Operating Procedure
T&E	Threatened and Endangered
TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TPWD	Texas Parks and Wildlife Department
TWDMA	Texas Wildlife Damage Management Association
TWSP	Texas Wildlife Services Program
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Services
WS	Wildlife Services

CHAPTER 1: PURPOSE AND NEED FOR ACTION

1.1 PURPOSE

The United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) program, in cooperation with the Texas A&M University System, through the Texas A&M AgriLife Extension Service, continues to receive requests for assistance or anticipates receiving requests for assistance to resolve or prevent damage associated with beaver (*Castor canadensis*), muskrats (*Ondatra zibethicus*), nutria (*Myocastor coypus*), and river otter (*Lontra canadensis*). This document will collectively refer to these species as aquatic mammals.

The WS[1] program is the federal agency responsible for providing federal leadership with managing conflicts with animals. Pursuant to the Texas Health and Safety Code, the Texas A&M University System, through the Texas A&M AgriLife Extension Service, and the WS program have signed a Memorandum of Understanding (MOU)[2] to conduct a cooperative program to alleviate damage caused by animals. In addition, the Texas Wildlife Damage Management Association (TWDMA), which consists of local cooperative groups, including county governments, private associations, and/or individuals, also signed the MOU. This document will refer to the cooperative program created by the MOU as the Texas Wildlife Services Program (TWSP), which includes the federal WS program, the Texas A&M AgriLife Extension Service, and the TWDMA.

In Texas, beaver, muskrat, nutria, and otter are classified as furbearers. Furbearers are protected by State law and the Texas Parks and Wildlife Department (TPWD) is responsible for management of those species. Under State law, private landowners or their lessees, public entities, or others can address furbearers when those species are a nuisance or causing damage. The TWSP is an agency in Texas that responds to requests for assistance associated with aquatic mammals. However, the TWSP works with TPWD to assist in providing data on harvest so that they can determine management objectives for the different species of aquatic mammals.

The purpose of this Environmental Assessment (EA) is to evaluate the cumulative effects of potential actions conducted by the TWSP to manage damage and threats of damage associated with aquatic mammal species. This EA will evaluate previous and anticipated future actions taken by the TWSP to address damage caused by aquatic mammals in order to determine if those effects could have a significant impact on the human environment.

The TWSP previously developed an EA and a supplement to that EA that evaluated the effects of activities conducted by the TWSP to manage damage and threats of damage caused by aquatic mammals in the State. Based on the analyses in that EA and the supplement to the EA, WS signed a Decision and Finding of No Significant Impact for the proposed action alternative. The proposed action alternative implemented a program that integrates a variety of methods. The TWSP is preparing this EA to: 1) facilitate planning, 2) promote interagency coordination, 3) streamline program management, 4) clearly communicate to the public the analysis of individual and cumulative impacts of proposed activities, and 5) determine if there would be any potentially significant or cumulative effects from the alternative approaches developed to meet the need for action. Since this EA will re-evaluate activities conducted under the previous EA, this analysis and the outcome of the Decision issued based on the analyses in this EA will supersede the previous EA that addressed managing damage caused by aquatic mammals. The analyses contained in this EA are based on information derived from WS' Management Information

---

[1] The WS program is authorized to protect agriculture and other resources from damage caused by animals through the Act of March 2, 1931 (46 Stat. 1468; 7 USC 426-426b) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 426c).

[2] The MOU also allows for the sharing of direct operating costs between the entities associated with providing assistance.

System, published documents (see Appendix A), interagency consultations, and public involvement.

This EA will analyze several alternative approaches to address the need for action and assist in determining if the proposed management of damage associated with aquatic mammals could have a significant impact on the environment for both people and other organisms. This EA will also document and inform the public of the environmental consequences that could occur from implementing the alternatives to comply with the National Environmental Policy Act (NEPA). In addition, the TWSP will use this EA to coordinate efforts associated with meeting the need for action. The TWSP will make this EA available to the public for review and comment prior to the issuance of a Decision[3].

1.2 NEED FOR ACTION

Some species of wildlife have adapted to and have thrived in human altered habitats. Those species, in particular, are often responsible for the majority of conflicts between people and wildlife. Those conflicts often lead people to request assistance with reducing damage to resources and to reduce threats to human safety. Beaver, muskrat, nutria, and otter are aquatic mammals that have adapted to habitats near human populations where conflicts between people and those species can occur.

Historically, habitat conditions and exploitation by Native Americans likely limited beaver populations in North America, since climax forest types that historically covered the eastern United States have a relatively low carrying capacity for beaver in comparison with forests in younger growth stages, and beaver were important to Native Americans for food, clothing, tools, and items of trade. Those factors, coupled with the onset of the North American fur trade by Europeans in the early 1600s and the westward advancement of settlement, led to the decline in beaver populations in North America (Lowery 1974, Hill 1976, Woodward 1983, Novak 1987, Baker and Hill 2003). Beaver pelts were the most important item in the early fur trade (Wright 1987). Through overharvest and loss of habitat, the beaver population in the United States rapidly declined in the late 1800s and early 1900s with beaver nearly trapped to extinction by the late 1890s (Hill 1976, Wesley 1978, Baker and Hill 2003). In the 1700s, beaver harvests remained high, but harvests declined continually during the 1800s and reached a record low between 1900 and 1919 (Novak 1987).

The pelts of aquatic mammals were common in many fur markets and provided economic revenue for many people. In addition, people have used the meat of beaver, muskrat, and nutria for food, primarily by subsistence hunters and trappers; however, some organizations have promoted muskrat and nutria meat as table fare in restaurants. People have also used their meat to produce food for pets and pen-raised alligators. After the formation of federal, state, and provincial wildlife conservation agencies and the enactment of new regulations that controlled beaver harvest, beaver populations began to recover. In addition, many states began restocking programs in the 1920s through the 1950s (Salyer 1946, Hill 1982, Baker and Hill 2003). Today, beaver occur throughout most of North America, including Canada, Alaska, all 48 contiguous states of the United States, and northern portions of Mexico (Deems and Pursley 1978, Novak 1987, Baker and Hill 2003, Linzey and NatureServe 2013).

Following the decimation of the beaver population in the late 1800s and early 1900s, the number of beaver trappers declined. As beaver populations began to recover and trapping seasons were re-opened, the number of beaver trappers and demand for fur had declined. Consequently, interest in harvesting beaver declined, which allowed the beaver population to expand and continue to increase. Today, beaver

---

[3]After the development of the EA by the TWSP and after public involvement in identifying new issues and alternatives, the TWSP will issue a Decision. Based on the analyses in the EA after public involvement, the TWSP will make a decision to publish a Notice of Intent to prepare an Environmental Impact Statement or the TWSP will issue a Finding of No Significant Impact notice to the public in accordance to the NEPA and the Council of Environmental Quality regulations.

occur throughout most of their original range (Hill 1982, Novak 1987, Baker and Hill 2003) and some people now view beaver as a nuisance species because of the damage they can cause (Hill 1976, Hill 1982, Woodward 1983, Woodward et al. 1985, Novak 1987, Dickson 2001, Baker and Hill 2003).

Although beaver may cause extensive damage, they can be beneficial in many situations, especially where their activities do not compete with human use of land or property (Wade and Ramsey 1986). Beaver can be ecosystem engineers by constructing dams that impound water, trap sediment, and increase the productivity of riparian zones (Rosell et al. 2005). Positive ecological influences on wetland habitats (Arner et al. 1967*a*, Arner et al. 1967*b*, Reese and Hair 1976, Snodgrass 1997, Pollock et al. 2004, Pollock et al. 2012, Pollock et al. 2014) and economic gains from fur production (Arner and Dubose 1978*a*, Arner and Dubose 1978*b*) make beaver important animals in the United States. Opinions and attitudes of individuals, communities, and organizations vary greatly and are primarily influenced and formed by the positive and negative experiences of the person or entity expressing the judgment (Hill 1982, Baker and Hill 2003). Property ownership, options for public and private land use, and effects on adjacent property impact public attitudes toward beaver (Hill 1982, Baker and Hill 2003). In some situations, the damage and threats caused by beaver outweigh the benefits (Grasse and Putnam 1955, Woodward et al. 1985, Novak 1987, Baker and Hill 2003).

Woodward et al. (1976) found that 24% of landowners who reported beaver activity on their property indicated benefits to having beaver ponds on their land, including aesthetic enjoyment, increased livestock water sources, providing irrigation water, and the creation of beaver ponds for waterfowl hunting, fishing, and recreational trapping. However, many landowners request assistance with beaver pond management (Hill 1976, Woodward et al. 1985). Some of the benefits of beaver ponds include activities such as photography, trapping, hunting, and fishing. In agricultural landscapes, beaver ponds can provide a potential water source for livestock. The ecological value of beaver ponds in the natural environment can also be important. For example, beaver ponds can contribute to the stabilization of water tables, help reduce rapid run-off from rain (Wade and Ramsey 1986, Pollock et al. 2014), and serve as basins for the entrapment of streambed silt and eroding soil (Hill 1982, Baker and Hill 2003, Pollock et al. 2014). Beaver ponds can also function as sinks, helping to filter nutrients and reduce sedimentation downstream, which can maintain the quality of nearby water systems (Arner and Hepp 1989). Pollock et al. (2014) proposed using beaver to restore degraded stream ecosystems.

Beaver may increase habitat diversity by flooding and opening forest habitats, which can result in greater interspersion of vegetative successional stages and increase the floral and faunal diversity (Hill 1982, Arner and Hepp 1989, Baker and Hill 2003). Hood and Bayley (2008) found that ponds with beaver had nine times more open-water than when beaver were not present in those same ponds. Creation of standing water, edge habitat, and an increase in plant diversity can result in excellent wildlife habitat (Hill 1982, Baker and Hill 2003, Cooke and Zack 2008). Habitat modification by beaver, primarily dam building and tree cutting, can benefit many species of wildlife (Jenkins and Busher 1979, Arner and DuBose 1982, Hill 1982, Arner and Hepp 1989, Medin and Clary 1990, Medin and Clary 1991, Baker and Hill 2003, Cooke and Zack 2008). The impounding of water by beaver through their dam building activities may be beneficial to some fish, reptiles, amphibians, waterfowl, shorebirds, and furbearers, such as muskrats, river otter, and mink (*Neovision vison*) (Arner and DuBose 1982, Naimen et al. 1986, Miller and Yarrow 1994, Snodgrass 1997, Snodgrass and Meffe 1998, Snodgrass and Meffe 1999, Metts et al. 2001, Cunningham et al. 2007, Stevens et al. 2007). Hood and Larson (2014) found that beaver could alter shallow-water wetlands, which can influence aquatic invertebrate diversity and abundance. Hood and Larson (2015) found that beaver can increase the volume-to-surface area ratio of impoundments by nearly 50% and can increase the average perimeter edge of water impoundments by over 575% through their digging and channeling behaviors.

Beaver created impoundments can also be attractive to some fish species (Hanson and Campbell 1963, Pullen 1971, Snodgrass and Meffe 1998, Snodgrass and Meffe 1999). In South Carolina, Snodgrass and Meffe (1998) found that beaver activities altered streams by decreasing water current and by increasing water depth, stream width, siltation, and aquatic vegetation, which influenced the richness of fish species in their study area. However, Snodgrass and Meffe (1998) noted that fish species richness was dependent on watershed position and the age of the beaver ponds located on the stream. Snodgrass and Meffe (1998) stated, "*For example, at one of our study sites…, 158 fish and 11 species were collected from a 45-m reach of unimpounded stream. Approximately 3* [months] *later, following beaver impoundment of the reach, only 11 fish and 3 species were collected from the same stream reach*…". In addition, Snodgrass and Meffe (1998) found that fish species richness was highest in beaver ponds that were 9 to 17 years old and decreased to the lowest species richness in beaver ponds more than 17 years old.

Pollock et al. (2004) concluded that beaver ponds could be an integral part of increasing the production of Coho Salmon (*Oncorhynchus kisutch*) in a river basin within Washington. Pollock et al. (2012) also proposed encouraging beaver activities in an Oregon stream system to restore salmon habitat. Stevens et al. (2007) found that beaver created impoundments on small streams in the Boreal Foothills of west-central Alberta in Canada contained a higher number of three species of frogs than those streams with no obstructions. Metts et al. (2001) found that the abundance, species richness, and species diversity of reptiles was higher at beaver impoundments when compared to unimpounded streams; however, the species richness, species diversity, and evenness of amphibians were higher at unimpounded streams compared to beaver impoundments. Russell et al. (1999) found the species richness and species abundance of reptiles was statistically higher at older beaver ponds (≥10 years) when compared to newer beaver ponds (≤5 years) and unimpounded streams. Similarly to Metts et al. (2001), Russell et al. (1999) found that species richness and the total abundance of amphibians was not statistically different among new beaver ponds (≤5 years), older beaver ponds (≥10 years), and unimpounded streams.

Beaver impoundments can provide aesthetic and recreational opportunities for wildlife observation through the attractiveness of habitat diversity and environmental education (Wade and Ramsey 1986). In addition, beaver ponds may be beneficial to threatened and endangered (T&E) species. For example, some beaver ponds in Mississippi over three years in age were found to have developed plant communities that increased their value as nesting and brood rearing habitat for wood ducks (Arner and DuBose 1982). Reese and Hair (1976) found that beaver pond habitats were highly attractive to a large number of birds throughout the year and that the value of the beaver pond habitat to waterfowl was minor when compared to other species of birds (Novak 1987). Similarly, Edwards and Otis (1999) found that established beaver ponds (10 to 35 years old) were attractive to several bird species seasonally, with the average species richness during all seasons ranging from 23.3 to 30.3 bird species. The average species richness was highest during the spring and lowest during the fall and winter (Edwards and Otis 1999). Cooke and Zack (2008) suggested that beaver dams could be important to creating riparian conditions that foster rich and abundant bird communities in semiarid regions.

Like beaver, muskrats can have an economic value from the sale of their meat and pelt, as well as filling an important niche in the ecosystem. Historically, muskrats have been the most heavily utilized furbearer in North America with six to 20 million harvested annually between the 1930s and 1980s (Boutin and Birkenholz 1987). Muskrats provide opportunities for recreation and satisfaction to people that like to observe wildlife in a natural setting. In the prairie pothole region of the United States and Canada, muskrats clear or open small areas through feeding and house building in otherwise dense cattail marshes. The small openings create nesting and brood rearing habitat for nesting waterfowl.

Nutria, which are native to Central and South America, were introduced with the "*fur ranching*" trade. The establishment of nutria in the wild occurred after accidental and intentional releases prior to 1950. In some areas, nutria were released to control aquatic weeds (Wade and Ramsey 1986, Kinler et al. 1987). Trappers and conservation agencies initially regarded newly established feral populations of nutria as a new fur resource. The species provided a means of income for hunters and trappers through the sale of meat and fur. From 1977 to 1984, people harvested approximately $7.3 million worth of nutria fur in the United States (Boutin and Birkenholz 1987, Kinler et al. 1987). However, Lowe et al. (2000) ranked nutria as one of the 100 worst invasive species in the world.

Beaver, muskrats, and nutria can also be potential food sources for many other species of wildlife. Coyotes (*Canis latrans*), black bears (*Ursus americanus*), bobcats (*Lynx rufus*), fishers (*Mustela pennanti*), red fox (*Vulpes vulpes*), river otters, mink, and large raptors, such as hawks and owls, can prey on beaver (Tesky 1993, Baker and Hill 2003, Jackson and Decker 2004). Predators of muskrat include great horned owls, barred owls, red-tailed hawks, bald eagles, raccoons, mink, river otter, coyotes, bobcat, red fox, gray fox (*Urocyon cinereoargenteus*), Northern pike (*Esox lucius*), largemouth bass (*Micropterus salmoides*), snapping turtles (*Chelydra serpentine*), and bullfrogs (*Rana catesbeiana*). Nutria can also provide a major food source for wild alligators (Valentine et al. 1972, Wolfe et al. 1987).

River otters are semi-aquatic mammals that can occur anywhere there is cold water. While they usually prefer freshwater, they can also occur in saltwater along the coast. They will often make their homes around secluded rivers, lakes, ponds, and streams that are shallower and have easy access to land. These bodies of water are usually located in forests, wetlands, swamps, and marshes. Otters will make their burrows, also called a holt, near the water with sticks, reeds, and mud but will also take up residence in a burrow in a bank or in an abandoned beaver den. They are often mistaken for beaver.

Otters are omnivores and they will hunt for food both in the water and on land. Otters direct most of their activity toward hunting and eating their food. On an average day, otters will consume almost half of their own body weight in food. Otters, like most predatory animals, prey upon the most readily accessible species. Fish is a favored food among otter, but they also consume various amphibians (such as salamanders and frogs), freshwater clams, mussels, snails, small turtles, and crayfish. Instances of river otters eating small mammals and occasionally birds have been reported as well (Melquist and Dronkert 1987).

Human perceptions of wildlife, including beaver, muskrat, nutria, and otter, can range drastically. In general, people regard wildlife as providing economic, recreational, and aesthetic benefits. For some people, wildlife holds an intrinsic value. Knowing that wildlife exists in the natural environment provides its own benefit. People who have had negative encounters with wildlife resulting in economic losses to agricultural resources, natural resources, property, and even threats to human health and safety, may view wildlife negatively. Being aware of these varying perspectives will aid managers in finding a balance between the needs of various groups of people and the needs of wildlife. When addressing damage or threats of damage caused by wildlife, managers must consider not only the needs of those people directly affected by wildlife damage but also the environmental, sociocultural, and economic implications of their decisions.

Resolving wildlife damage problems requires consideration of both sociological and biological carrying capacities. The wildlife acceptance capacity, or cultural carrying capacity, is the limit of human tolerance for wildlife or the maximum number of a given species that can coexist compatibly with local human populations. Biological carrying capacity is the land or habitat's ability to support healthy populations of wildlife without degradation to the species' health or their environment during an extended period of time (Decker and Purdy 1988). Those phenomena are especially important because they define the sensitivity of a person or community to a wildlife species. For any given damage situation, there are varying thresholds of tolerance exhibited by those people directly and indirectly affected by the species and any associated damage. This damage threshold determines the wildlife acceptance capacity. While the biological carrying capacity of the habitat may support higher populations of wildlife, in many cases the wildlife acceptance capacity is lower. Once the wildlife acceptance capacity is met or exceeded, people begin to implement population or damage management to alleviate damage or address threats to human health and safety.

Wildlife damage management is the alleviation of damage or other problems caused by or related to the behavior of wildlife and can be an integral component of wildlife management (Berryman 1991, The Wildlife Society 2015). The threat of damage or loss of resources is often sufficient for people to initiate individual actions and the need for damage management can occur from specific threats to resources. Those species have no intent to do harm. They utilize habitats (*e.g.*, feed, shelter, reproduce) where they can find a niche. If their activities result in lost economic value of resources or threaten human safety, people often characterize this as damage. When damage exceeds or threatens to exceed an economic threshold and/or pose a threat to human safety, people often seek assistance with resolving damage or reducing threats to human safety. The threshold triggering a request for assistance is often unique to the individual person requesting assistance and many factors can influence when people request assistance (*e.g.*, economic, social, aesthetics). Therefore, what constitutes damage is often unique to the individual person. What one individual person considers damage, another person may not consider as damage. However, the use of the term "*damage*" is consistently used to describe situations where the individual person has determined the losses associated with wildlife is actual damage requiring assistance (*i.e*., has reached an individual threshold). Many people define the term "*damage*" as economic losses to resources or threats to human safety; however, "*damage*" could also occur from a loss in the aesthetic value of property and other situations where the behavior of wildlife was no longer tolerable to an individual person.

The need for action to manage damage and threats associated with aquatic mammals in Texas arises from requests for assistance[4] received by the TWSP. The TWSP receives requests to reduce or prevent damage from occurring to four major categories: agricultural resources, natural resources, property, and threats to human health and safety. Through a review of previous requests for assistance, the TWSP has identified those aquatic mammal species most likely to be responsible for causing damage to those four categories in the State. Table 1.1 lists the technical assistance projects conducted by the TWSP associated with aquatic mammal damage or threats of damage in Texas from the federal fiscal year[5] (FY) 2013 through FY 2015.

Table 1.1 – Technical assistance projects conducted by the TWSP, FY 2013 - FY 2015[†]

	Fiscal Year			
Species	**2013**	**2014**	**2015**	**TOTAL**
Beaver	342	406	545	**1,293**
Muskrat	0	0	0	**0**
Nutria	42	17	29	**88**
Otter	11	8	11	**30**

[†]Information provided in the table includes technical assistance projects only and does not include direct operational assistance projects that the TWSP conducted. See Chapter 3 for further discussion on technical assistance and direct operational assistance.

As shown in Table 1.1, the TWSP has conducted 1,411 technical assistance projects in Texas from FY 2013 through FY 2015 associated with beaver, nutria, and otter. Nearly 92% of the technical assistance projects conducted by the TWSP have involved beaver. Technical assistance provides information and recommendations on activities to alleviate aquatic mammal damage that the requester could conduct without the direct involvement of the TWSP in managing or preventing the damage. Table 1.1 does not include direct operational assistance projects conducted by the TWSP where a person requested the

[4]WS would only conduct aquatic mammal damage management after receiving a request for assistance. Before initiating damage management activities, WS and the cooperating entity would sign a Memorandum of Understanding, work initiation document, or another comparable document that would list all the methods the property owner or manager would allow WS to use on property they owned and/or managed.
[5] The federal fiscal year begins on October 1 and ends on September 30 the following year.

assistance of the TWSP through the direct application of methods. This EA discusses technical assistance and direct operational assistance activities further in Chapter 3.

Between FY 2013 and FY 2015, the TWSP verified and cooperators reported over $12.4 million in damages and losses from beaver, nutria, muskrat, and otter in Texas (see Table 1.2). On properties owned or managed by people requesting assistance from the TWSP, aquatic mammals caused over $3.1 million in economic damages to timber resources. Damage to timber was primarily associated with beaver, where dams built by beaver impounded water that caused areas to flood, which can result in the death of trees if inundation occurs for extended periods. Overall, aquatic mammals caused over $4.7 million in damages to dams, ditches, roads, and bridges, primarily from burrowing into embankments and from flooding. Table 1.2 only reflects damage to resources associated with someone requesting assistance from the TWSP; therefore, the damage information presented in Table 1.2 does not reflect all damage that could occur annually in the State.

Table 1.2 – Losses to resources caused by aquatic mammals in Texas, FY 2013 - FY 2015†

Resource	Economic Loss‡ by Fiscal Year			TOTAL
	2013	2014	2015	
Roads/Bridges	$411,478	$641,975	$1,077,765	**$2,131,218**
Timber	$1,286,504	$1,283,502	$570,887	**$3,140,893**
Dams/Ditches	$2,056,743	$1,567,323	$1,134,901	**$4,758,967**
Crops	$88,676	$1,042,727	$432,568	**$1,563,971**
Other	$80,141	$66,237	$620,309	**$766,687**
TOTAL	**$3,923,542**	**$4,601,764**	**$3,836,430**	**$12,361,736**

†Losses to resources associated with assistance requests received by the TWSP; damage does not necessarily reflect all damage that occurs.

‡Resources damaged as reported by a cooperator or verified by the TWSP through site visits.

As shown in Table 1.3, the activities of the TWSP to alleviate aquatic mammal damage prevented further damage from occurring to resources on properties where owners or managers requested direct operational assistance from the TWSP. The TWSP estimates that activities conducted from FY 2013 through FY 2015 prevented over $19 million in additional damages from occurring to roads, bridges, timber, dams, ditches, agricultural crops, and other resources. The activities of the TWSP to alleviate aquatic mammal damage prevented almost $2.8 million in damages to timber resources from FY 2013 through FY 2015. Overall, the activities of the TWSP prevented an additional $12.3 million in damages to roads, bridges, dams, and ditches within the State. The activities of the TWSP prevented nearly $3.3 million in damages to agricultural crops in the State between FY 2013 and FY 2015.

Table 1.3 – Aquatic mammal damage prevented by activities of the TWSP, FY 2013 - FY 2015

Resource	Resources Saved‡ by Fiscal Year			TOTAL
	2013	2014	2015	
Roads/Bridges	$332,430	$641,975	$2,769,856	**$3,744,261**
Timber	$590,951	$1,251,117	$935,323	**$2,777,391**
Dams/Ditches	$2,131,035	$1,459,023	$5,140,295	**$8,730,353**
Crops	$123,025	$798,127	$2,345,507	**$3,266,659**
Other	$51,574	$197,650	$249,676	**$498,900**
TOTAL	**$3,229,015**	**$4,347,892**	**$11,440,657**	**$19,017,564**

‡The resources that aquatic mammals could have damaged further without WS' involvement in resolving and preventing the initial damage originating from a request for assistance.

The TWSP periodically updates the resource values per unit of measure for resource types to remain current and to reflect changes in the value of resources; therefore, the value of resources damaged in FY

2013 may be different from the value for the same resources in FY 2015. For example, the value of 10 acres of hardwood timber that floods from water impounded by a beaver dam during FY 2013 may have a different value for the same 10 acres during FY 2015 because of changes in timber prices. Crop prices can also change from year to year so the value of crop damage during one year may change the following year.

Miller (1983) estimated that the annual damage in the United States caused by beaver alone was $75 to $100 million. The value of beaver damage is perhaps greater than that of any other single wildlife species in the United States. Arner and Dubose (1982) estimated the economic damage that beaver caused in the southeastern United States alone exceeded $4 billion over a 40-year period.

In 1991 and 1992, Dams et al. (1995) surveyed a river drainage in the southern Appalachian Mountains for beaver impacts on streams and timber damage. Dams et al. (1995) located 62 streams within the river drainage and found 413 beaver dams and 222 impoundments on 36 streams. Dams et al. (1995) characterized 11 streams as "*heavily to severely impacted*" by beaver activities (17 to 35 dams and ponds per mile), nine streams as "*moderately impacted*" (10 to 16 dams and ponds per mile), and 16 streams as "*slightly impacted*" (1 to 9 dams and ponds per mile). On those streams with beaver dams, Dams et al. (1995) found that dam frequency ranged from one to 29 dams per mile and averaged 7.4 dams per mile of stream. In addition, seven streams had more than 16.1 dams per mile. The dams ranged from three to 200 feet in length and 0.5 to 6.6 feet in height with an average of 21.7 feet in length, 2.5 feet in height, and 4.9 feet in width (Dams et al. 1995). The beaver dams were constructed of a variety of materials with smaller dams (less than one foot in height) constructed mostly of mud and debris pushed up from the stream channel. Larger dams consisted primarily of woody stems up to six inches in diameter and four to six feet in length (Dams et al. 1995).

Of the 62 streams surveyed by Dams et al. (1995), 26 streams showed no signs of beaver activities. Those streams with no sign of beaver activity generally had steep gradients and narrow stream channels with a mean average slope of 6.5% and generally no associated floodplains. The mean average slope of the 36 streams that showed signs of beaver activity was 4.3%. In streams with the highest beaver activities, the slopes were equal to or less than 2% (Dams et al. 1995).

Aquatic mammal species can cause damage to or pose threats to a variety of resources. In Texas, most requests for assistance that the TWSP receives are associated with damage or threats of damage that aquatic mammal species can cause to property. The following subsections provide more information on the threats that aquatic mammals can pose to human safety and the damage that can occur to agricultural resources, natural resources, and property.

Need for Aquatic Mammal Damage Management to Protect Human Health and Safety

Zoonotic diseases (*i.e.*, wildlife diseases transmissible to people) can be a major concern of cooperators when requesting assistance with managing threats from aquatic mammals. Individuals or property owners that request assistance with aquatic mammals frequently are concerned about potential disease risks but are unaware of the types of diseases those animals could transmit. In many circumstances, when human health concerns are the primary reason for requesting the assistance of the TWSP there may have been no actual cases of transmission of disease to people by aquatic mammals. Thus, the risk of disease transmission would be the primary reason for requesting assistance from the TWSP.

In most cases when human exposure occurs, the presence of a disease vector across a broad range of naturally occurring sources, including occurring in wildlife populations, can complicate determining the origin of the vector. Disease transmission directly from wildlife to people is uncommon. However, the infrequency of such transmission does not diminish the concerns of those people requesting assistance since disease transmission could occur. The TWSP actively attempts to educate the public about the risks associated with disease transmission from wildlife to people through technical assistance and by providing technical leaflets on the risks of exposure.

Beaver, which can be carriers of the intestinal parasite *Giardia lamblia*, can contaminate human water supplies and cause outbreaks of the disease Giardiasis in people (Woodward 1983, Beach and McCulloch 1985, Wade and Ramsey 1986, Miller and Yarrow 1994). Giardiasis is an illness caused by a microscopic parasite that the Centers for Disease Control and Prevention (CDC) report as one of the most common causes of waterborne disease in people across the United States (CDC 2015). People can contract giardiasis by swallowing contaminated water or putting anything in their mouth that has touched the fecal matter of an infected animal or person. Symptoms of giardiasis include diarrhea, cramps, and nausea (CDC 2015). Beaver can also be carriers of tularemia, a bacterial disease that is transmittable to people through bites by insect vectors, bites of infected animals, or by handling animals or carcasses that are infected (Wade and Ramsey 1986). In cattle ranching sections of Wyoming, Skinner et al. (1984) found that the fecal bacteria count was much higher in beaver ponds than in other ponds, something that can be a concern to ranchers and recreationists.

Beaver activity in certain situations can become a threat to public health and safety (*e.g.*, burrowing into or flooding of roadways and railroad beds can result in serious accidents) (Miller 1983, Woodward 1983). Increased water levels in urban areas resulting from beaver activity can lead to unsanitary conditions and potential health problems by flooding septic systems and sewage treatment facilities (DeAlmeida 1987, Loeb 1994). Beaver can dig burrows into embankments with underwater entrances along shorelines and burrowing may not be readily evident until serious damage has occurred. When water levels drop, beaver often expand the entrances of their burrows to keep pace with the retreating water level. In addition, when water levels rise, beaver often expand the entrances upward. Those burrows can collapse when people or animals walk upon them and when crossed over with heavy equipment (*e.g.*, mowers, tractors). Beaver damming activity can also create conditions favorable to mosquitoes and can hinder mosquito control efforts or result in population increases of these insects (Wade and Ramsey 1986). While the presence of these insects is largely a nuisance, mosquitoes can transmit diseases, such as encephalitis (Mallis 1982) and West Nile Virus (CDC 2000). Furthermore, damming of streams sometimes increases the presence of aquatic snakes, including the venomous cottonmouth (*Agkistrodon piscivorus*) (Wade and Ramsey 1986).

Although reports of rabies in beaver, muskrats, and otter are not common, those species of aquatic mammals have tested positive for rabies in the United States. Between 2008 and 2013, two muskrats, 10 otters, and 10 beaver across the United States have tested positive for the rabies virus (see Table 1.4). Beaver infected with the rabies virus have aggressively attacked pets and people (Brakhage and Sampson 1952, CDC 2002, Caudell 2012). In 2001, a beaver tested positive for rabies that was exhibiting aggressive behavior by charging canoes and kayaks on a river in Florida (CDC 2002). A beaver that tested positive for rabies attacked a person wading in a New York river during 2012 (Caudell 2012). The person suffered six puncture wounds over their body and underwent treatment for rabies (Caudell 2012). No reports of positive rabies tests in nutria have occurred.

Table 1.4 – Muskrat and beaver reported with rabies in the United States, 2008 – 2013†

Species	Year						TOTAL
	2008	2009	2010	2011	2012	2013	
Beaver	1	2	0	3	4	0	10
Muskrat	0	1	1	0	0	0	2
River Otter	1	1	3	1	1	3	10

†Based on information from Blanton et al. (2009), Blanton et al. (2010), Blanton et al. (2011), Blanton et al. (2012), Dyer et al. (2013), Dyer et al. (2014)

There are several pathogens and parasites that nutria can transmit to people, livestock, and pets (LeBlanc

1994). However, the role of nutria in the spread of diseases, such as equine encephalomyelitis, leptospirosis, hemorrhagic septicemia (pasteurellosis), paratyphoid, and salmonellosis, is unknown.

Nutria also may host a number of parasites, including the nematodes and blood flukes that cause nutria- or swimmers-itch (*Strongyloides myopotami* and *Schistosoma mansoni*, respectively)**,** the protozoan responsible for giardiasis, tapeworms (*Taenia spp*.), and common flukes (*Fasciola hepatica*). The threat of disease may be an important consideration in some situations, such as when livestock drink from water contaminated by nutria feces and urine.

Burrowing by muskrats, nutria, beaver, and otters may sometimes threaten earthen dams as they form networks of burrows, which can weaken such structures, causing erosion and failure. Such incidents can threaten the safety and lives of people living downstream from the dam. For that reason, managers of such sites are concerned with preventing excessive burrowing by those animals at dam sites. Much of the damage caused by muskrats is primarily through their burrowing activity (Miller 1994, Linzey 1998, Erb and Perry 2003) in dikes, dams, ditches, ponds, and shorelines. Muskrats can dig burrows into banks and levees, which can compromise the integrity of embankments (Linzey 1998, Erb and Perry 2003).

Muskrats can dig burrows with underwater entrances along shorelines and burrowing may not be readily evident until serious damage has occurred. When water levels drop, muskrats often expand the holes and tunnels to keep pace with the retreating water level. Additionally, when water levels rise muskrats expand the burrows upward. Those burrows can collapse when people or animals walk over them and when heavy equipment (*e*.*g*., mowers, tractors) crosses over.

Disease Surveillance and Monitoring

Public awareness and health risks associated with zoonotic diseases have increased in recent years. This EA briefly addressed some of the more commonly known zoonotic diseases associated with aquatic mammals. Those zoonotic diseases remain a concern and continue to pose threats to human safety where people encounter aquatic mammals. The TWSP has received requests to assist with reducing damage and threats associated with several aquatic mammal species in Texas and could conduct or assist with disease monitoring or surveillance activities for any of the aquatic mammal species addressed in this EA. Most disease sampling would occur ancillary to other wildlife damage management activities (*i.e*., disease sampling would occur after wildlife have been captured or lethally removed for other purposes).

Need for Aquatic Mammal Damage Management to Alleviate Agricultural Damage

Beaver are the largest member of the Order Rodentia in North America, which consists of species that have upper and lower incisors (teeth) that grow continually. To prevent the overgrowth of the incisors, beaver must wear down their teeth through gnawing. Beaver feed and gnaw on woody vegetation to keep teeth worn to appropriate levels. This feeding and gnawing behavior often girdles trees and other woody vegetation leading to the death of the vegetation. Beaver also feed on agricultural crops, such as soybeans and corn (Chapman 1949, Roberts and Arner 1984). Where beaver are located near agricultural fields, consumption of crops can be high. During stomach content analyses of beaver, Roberts and Arner (1984) found that the stomachs of 83% of the beaver sampled in the summer near soybean fields contained only soybeans. From FY 2013 through FY 2015, the TWSP has received reports of or has verified about $1.6 million in crop damage from aquatic mammals. Damage is typically from feeding/gnawing or the flooding of crops.

Flooding damage associated with beaver occurs when crops or pastures are inundated causing the death of plants. Flooding can also prevent access of agricultural producers to crops or livestock to forage areas.

Beaver dams across irrigation canals can prevent irrigation activities and flood surrounding cropland. Beaver often burrow into earthen embankments of canals, which can weaken the structural integrity of the structure through erosion and by allowing water to seep into the interior of the structure. Beaver damage can lead to the failure of the embankments leading to costly repairs of the embankment and the potential for flooding.

Aquaculture, the cultivation of finfish and invertebrates in captivity, has grown exponentially in the past several decades (Price and Nickum 1995). Economic loss due to muskrat damage can be very high in some areas, particularly in aquaculture producing areas. In some states, damage may be as much as $1 million per year (Miller 1994). Damage to aquaculture resources could occur from the economic losses associated with muskrats killing, consuming, and/or injuring fish and other commercially raised aquatic wildlife. Also of concern to aquaculture facilities is the transmission of diseases by muskrats and beaver from the outside environment to aquaculture facilities, between impoundments, and from facility to facility. Given the confinement of aquatic wildlife inside impoundments at aquaculture facilities and the high densities of those organisms in the impoundments, the introduction of a disease can result in substantial economic losses since the entire impoundment is likely to become infected, which can result in extensive mortality. Although the actual transmission of diseases through transport by muskrats and beaver is difficult to document, large rodents have the capability of spreading diseases through fecal droppings and possibly through other mechanical means such as on fur and feet.

While river otter damage is not a major problem in Texas, they can cause serious losses to individuals locally by preying on fish, crayfish, and other types of commercially produced aquaculture products (Hill 1994). Muskrats eat a variety of natural emergent vegetation (Linzey 1998, Erb and Perry 2003) and cultivated crops (Erb and Perry 2003). Some of the cultivated crops eaten by muskrats include corn, alfalfa, carrots, rice, and soybeans (Erb and Perry 2003). Nutria depredation on crops also occurs (LeBlanc 1994). Crops that nutria have damaged include corn, milo (grain sorghum), sugar and table beets, alfalfa, wheat, barley, oats, peanuts, various melons, and a variety of vegetables from home gardens and truck farms.

Need for Aquatic Mammal Damage Management to Alleviate Natural Resources Damage

Aquatic mammals can also cause damage to natural resources. Natural resources can be those assets belonging to the public that government agencies, as representatives of the people, often manage and hold in trust. Such resources may be plants or animals, including threatened or endangered species, historic properties, or habitats in general. Examples of natural resources in Texas may include parks and recreational areas; natural areas, including unique habitats or topographic features; threatened or endangered plants and animals; and any plant or animal populations that the public has identified as a natural resource.

While beaver activity can enhance habitat for some species, the presence of beaver in some areas could destroy habitat and negatively affect some wildlife species. Knudsen (1962) and Avery (1992) reported that the presence of beaver dams could negatively affect some fisheries. Beaver dams may adversely affect stream ecosystems by increasing sedimentation in streams upstream of the dam; thereby, affecting wildlife that depend on clear water, such as certain species of fish and mussels. Stagnant water impounded by beaver dams can increase the temperature of water impounded upstream of the dam, which can negatively affect aquatic organisms. Beaver dams can also act as barriers that inhibit movement of aquatic organisms and prevent the migration of fish to spawning areas.

Increased soil moisture both within and surrounding beaver-flooded areas can result in reduced timber growth and mast production and increased bank destabilization. These habitat modifications can conflict with human land or resource management objectives and can oppress some plants and animals, including threatened or endangered species. The TWSP could receive requests to conduct activities to protect threatened or endangered species in the State.

Muskrats are largely herbivores; however, they also eat other animals as part of their diet (Erb and Perry 2003). Schwartz and Schwartz (1959), Neves and Odom (1989), and Miller (1994) reported muskrats also ate animal matter including mussels, clams, snails, crustaceans (*e.g*., crayfish), and young birds. Muskrats may also feed upon fish, frogs, and small turtles. Muskrats could feed upon some mussels and small turtles that the United States Fish and Wildlife Service (USFWS) list as T&E species under the Endangered Species Act (ESA) and numerous mussels, snails, crustaceans, fish, frogs, turtles, and birds that muskrats consume could be state listed. For example, Neves and Odom (1989) reported that muskrats appeared to be inhibiting the recovery of some endangered mussel species, and they were likely placing pigtoe mussels in further jeopardy along the Clinch and Holston Rivers in Virginia. Muskrats can negatively affect native vegetation. When muskrats become over-populated an "*eat-out*" may occur which denudes large areas of aquatic vegetation. Those events may result in the feeding area being unsuitable for other wildlife species for a number of years (O'Neil 1949). The loss of vegetation removes food and cover for muskrats and other wildlife. Marsh damage from muskrats is inevitable when areas heavily populated by muskrats are under-trapped (Lynch et al. 1947). While overgrazing of vegetation can be beneficial to some bird species, it can also result in stagnant water, which predisposes the same birds to diseases (Lynch et al. 1947).

Nutria primarily inhabit brackish or freshwater marshes, but are also found in swamps, rivers, ponds, and lakes. Nutria live in dense vegetation, in abandoned burrows, or in burrows they dig along stream banks or shorelines (Wade and Ramsey 1986). Nutria are almost entirely herbivorous and eat animal material (mostly insects) incidentally. In some parts of their range, nutria occasionally eat freshwater mussels and crustaceans. Marshes are generally wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation that are adapted to saturated soil conditions. The emergent vegetation associated with marsh habitats often form thick, fibrous root mats that stabilizes the underlying soil and acts to catch soil sediments in the water.

The digging and feeding behavior of nutria can be destructive to marsh ecosystems. Nutria forage directly on the emergent vegetation and the vegetative root mat in a wetland, leaving a marsh pitted with digging sites and fragmented with deeply cut swimming canals. When nutria compromise the fibrous vegetative mat, emergent marshlands are quickly reduced to unconsolidated mudflats. The complete loss of emergent vegetation and root mats that occur from nutria are often called "*eat-outs*", where the foraging and digging behavior of nutria completely denude large areas of marsh vegetation. Those denuded areas are devoid of most plant life and essentially become mud flats, providing fewer habitats for the spawning and production of fish and shellfish, birds and other aquatic mammals, and is the greatest direct impact of nutria (Haramis 1997, Haramis 1999, Southwick Associates 2004). The denuding of marsh vegetation can expose the soil and accelerate erosion associated with tidal currents and wave action along with a general lowering of existing elevation levels in marshlands. The loss of vegetation can also facilitate saltwater intrusion into marsh interiors. For example, in Louisiana, nutria damaged an estimated 100,000 acres of coastal marsh (Kinler et al. 1987). Nutria are opportunistic feeders and eat approximately 25% of their body weight daily (LeBlanc 1994).

Need for Aquatic Mammal Damage Management to Alleviate Property Damage

Aquatic mammals cause damage to a variety of property types in Texas each year. Property damage can occur in a variety of ways. Aquatic mammal damage to property occurs primarily through direct damage to structures. Beaver can flood land, roads, and railways. They can girdle trees, consume landscaping, and burrowing activities may cause damage to earthen dams and roadways. In addition, aquatic mammals crossing runways and taxiways near water bodies can contribute to aircraft strike risks. Between FY 2013 and FY 2015, those people in Texas requesting assistance from the TWSP reported or the TWSP verified during site visits nearly $6.9 million in damages to roads, bridges, dams, and ditches (see Table 1.2).

In some situations, the damage and threats caused by beaver outweigh the benefits (Grasse and Putnam 1955, Woodward et al. 1985, Novak 1987). Damage to resources associated with beaver are most often a result of their feeding, burrowing, and dam building behaviors. Beaver cause an estimated $75 to $100 million dollars in economic losses annually in the United States, with total losses in the southeastern United States over a 40-year period estimated to be $4 billion (Novak 1987).

Beaver often will gnaw through trees and other woody vegetation for use in dam building, food caches, and the building of lodges. The girdling and felling of trees and other woody vegetation can cause economic losses, can threaten human safety and property when trees fall, and the loss of trees can be aesthetically displeasing to property owners. The loss of timber (*e.g*., from flooding, gnawing) is the most common type of damage associated with beaver (Hill 1976, Hill 1982, Woodward et al. 1985, Baker and Hill 2003). Tracts of bottomland hardwood timber up to several thousand acres in size may be lost to beaver activity (Miller and Yarrow 1994). Timber damage caused by beaver in the southeastern United States has been estimated at $2.2 million annually in Mississippi (Arner and Dubose 1982), $2.2 million in Alabama (Hill 1976), and $45 million in Georgia (Godbee and Price 1975). Shwiff et al. (2011) estimated the Beaver Control Assistance Program in Mississippi provided average direct program benefits that ranged from $25 million to $57 million per year between 2005 and 2009. In 1991 and 1992, Dams et al. (1995) estimated beaver caused $817.28 in damages to timber resources per acre in areas of northwestern South Carolina where beaver activities occurred.

In addition to damage associated with beaver feeding and gnawing on trees, damage can occur from dam building activities. Beaver dams impound water, which can flood property resulting in economic damage. Flooding from beaver dams can cause damage to roads, impede traffic, inundate timber, weaken earthen embankments, and cause damage to residential and commercial utilities.

Beaver often inhabit sites in or adjacent to urban/suburban areas and cut or girdle trees and shrubs in yards, undermine yards and walkways by burrowing, flood homes and other structures, destroy pond and reservoir dams by burrowing into levees, gnaw on boat houses and docks, and cause other damage to private and public property (Wade and Ramsey 1986). Additionally, impounded water may damage roads and railroads by saturating roadbeds or railroad beds (Jensen et al. 2001). Burrowing by beaver, muskrats, and nutria can compromise the banks of roadbeds and railroad beds. During a survey of people in the United States and Canada, D'Eon et al. (1995) found that culvert blockage and road flooding were the most frequently reported types of beaver damage. Jensen et al. (2001) stated, "*Small culverts may be especially prone to plugging for numerous reasons. Small culverts often constrict streams, which increases stream velocity and generates sound that beavers may respond to (Novak 1987)*". Their burrowing activities can also pose risks to earthen dams that retain water (Federal Emergency Management Agency 2005). In addition, aircraft have struck beaver and muskrats at air facilities in the United States (Dolbeer et al. 2015) and strikes could occur at air facilities in Texas.

Damage caused by muskrats is usually not a major problem, but can be important in some situations (Wade and Ramsey 1986), such as in aquaculture systems or when burrowing into earthen embankments. Economic loss is often associated with muskrat feeding and burrowing into banks, dikes, levees, shorelines, and dams associated with ponds, lakes, and drainages (Miller 1994, Linzey 1998, Erb and Perry 2003). In some states, damage may be as much as $1 million per year (Miller 1994). Elsewhere, economic losses caused by muskrats may be limited and confined primarily to burrowing or feeding on desirable plants in farm ponds. In such areas, the cost of the damage can often outweigh the benefits of having a muskrat population present in the pond.

Burrowing activity of muskrats can seriously weaken dams and levees causing them to leak or collapse (Erb and Perry 2003, Federal Emergency Management Agency 2005). Loss of water from irrigated areas or flooding may lead to loss of crops (Wade and Ramsey 1986). Entrances to burrows are normally underwater and may not be evident until serious damage has occurred. Associated burrows and dens can erode along the shorelines of lakes and create washouts of associated properties when they collapse, posing a hazard to humans, livestock, and equipment used on site. In 2008, the burrowing activities of muskrats likely caused the failure of a Missouri levee holding back floodwaters along the Mississippi River (Caudell 2008). The muskrat burrows likely weakened the structure and caused the levee to collapse, resulting in the flooding of a community.

Nutria can also burrow into the Styrofoam floatation under boat docks and wharves, causing these structures to lean and sink. Nutria burrow under buildings, which may lead to uneven settling or failure of the foundations. Burrows can weaken roadbeds, railroad beds, stream banks, dams, and dikes, which may collapse when rain or high water saturate the soil or when subjected to heavy objects on the surface (*e.g.*, vehicles, farm machinery, or grazing livestock). Rain and wave action can wash out and enlarge collapsed burrows, which can intensify the damage. Nutria girdle fruit, nut, and shade trees and ornamental shrubs. They also dig up lawns and golf courses when feeding on the tender roots and shoots of sod grasses. Gnawing damage to wooden structures is also common. Nutria feed on valuable wetland vegetation and cultivated crops such as sugar cane and rice (Wade and Ramsey 1986). Nutria may feed on the bark of trees, such as black willow (*Salix nigra*) and bald cypress (*Taxodium distichum*), in winter months when more preferred herbaceous vegetation is dormant.

The TWSP has received numerous requests in the past for assistance in resolving property damage caused by aquatic mammals. As part of the proposed program, the TWSP could provide assistance, upon request, involving target aquatic mammal species to any requester experiencing such damage throughout Texas.

1.3 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

Actions Analyzed

This EA documents the need for managing damage caused by aquatic mammals, the issues associated with meeting that need, and alternative approaches to address those issues and to meet the need for action. The mission of the TWSP is to provide federal leadership with managing damage and threats of damage associated with animals (see WS Directive 1.201). The TWSP would only provide assistance when the appropriate property manager or property owner requested assistance from the TWSP. The TWSP could receive a request for assistance from a property owner or manager to conduct activities on property they own or manage, which could include federal, state, tribal, municipal, and private land within the State of Texas.

Appendix B of this EA discusses the methods available for use or recommendation under each of the alternative approaches evaluated[6]. The alternatives and Appendix B also discuss how the TWSP and other entities could recommend or employ methods to manage damage and threats associated with aquatic mammals in the State. Therefore, the actions evaluated in this EA are the use or recommendation of those methods available under the alternatives and the employment or recommendation of those methods by the TWSP to manage or prevent damage and threats associated with aquatic mammals from occurring when requested by the appropriate resource owner or manager. The activities of the TWSP that could involve the lethal removal of target aquatic mammal species under the alternatives would only occur when agreed

[6]Appendix B contains a complete list of chemical and non-chemical methods available for use under the identified alternatives. However, listing methods neither implies that all methods would be used by TWSP to resolve requests for assistance nor does the listing of methods imply that all methods would be used to resolve every request for assistance.

upon by the requester.

Federal, State, County, City, and Private Lands

The TWSP could continue to provide damage management activities on federal, state, county, municipal, and private land in Texas when the TWSP receives a request for such services by the appropriate resource owner or manager. In those cases where a federal agency requests assistance from the TWSP with managing damage caused by aquatic mammals on property they own or manage, the requesting agency would be responsible for analyzing those activities in accordance with the NEPA. However, this EA could cover such actions if the requesting federal agency determined the analyses and scope of this EA were appropriate for those actions and the requesting federal agency adopted this EA through their own Decision based on the analyses in this EA. Therefore, the scope of this EA analyzes actions that could occur on federal, state, county, municipal, and private lands, when requested.

Native American Lands and Tribes

The TWSP would only conduct damage management activities on Native American lands when requested by a Native American Tribe. The TWSP would only conduct activities after the TWSP and the Tribe requesting assistance signed a MOU, a work initiation document, or a similar document. Therefore, the Tribe would determine what activities would be allowed and when assistance from the TWSP was required. Because Tribal officials would be responsible for requesting assistance from the TWSP and determining what methods would be available to alleviate damage, no conflict with traditional cultural properties or beliefs would likely occur. Those methods available to alleviate damage associated with aquatic mammals on federal, state, county, municipal, and private properties under the alternatives analyzed in this EA would be available for use to alleviate damage on Tribal properties when the Tribe requesting assistance approved the use of those methods. Therefore, the activities and methods addressed under the alternatives would include those activities that the TWSP could employ on Native American lands, when requested and when agreed upon by the Tribe and the TWSP.

Period for which this EA is Valid

If the preparation of an Environmental Impact Statement (EIS) is not warranted based on the analyses associated with this EA, the TWSP would review activities conducted under the selected alternative to ensure those activities occurred within the parameters evaluated in the EA. This EA would remain valid until the TWSP determines that new needs for action, changed conditions, new issues, or new alternatives having different environmental impacts must be analyzed. At that time, the TWSP would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Under the alternative analyzing no involvement by the TWSP, no review or additional analyses would occur based on the lack of involvement by the TWSP. The monitoring of activities by the TWSP would ensure the EA remained appropriate to the scope of damage management activities conducted by the TWSP under the selected alternative, when requested.

Site Specificity

As mentioned previously, the TWSP would only conduct damage management activities when requested by the appropriate resource owner or manager. This EA analyzes the potential impacts of managing damage caused by aquatic mammals based on previous activities conducted on private and public lands in Texas where the TWSP and the appropriate entities entered into a MOU, work plans, work initiation document, or another comparable document. The EA also addresses the potential impacts of managing aquatic mammal damage in areas where the TWSP and a cooperating entity could sign additional agreements in the future. Because the need for action would be to reduce damage and because the program's goals and directives would be to provide services when requested, within the constraints of available funding and workforce, it is conceivable that additional damage management efforts could occur. Thus, this EA anticipates those additional efforts and analyzes the impacts of those efforts as part of the alternatives.

Those aquatic mammal species addressed in this EA occur statewide and throughout the year in the State; therefore, damage or threats of damage could occur wherever those aquatic mammals occur. Planning for the management of aquatic mammal damage must be viewed as being conceptually similar to the actions of other entities whose missions are to stop or prevent adverse consequences from anticipated future events for which the actual sites and locations where they would occur are unknown but could be anywhere in a defined geographic area. Examples of such agencies and programs include fire departments, police departments, emergency clean-up organizations, and insurance companies. Although the TWSP could predict some locations where aquatic mammal damage would occur, the TWSP could not predict every specific location or the specific time where such damage would occur in any given year. In addition, the threshold triggering an entity to request assistance from the TWSP to manage damage associated with aquatic mammals is often unique to the individual; therefore, predicting where and when the TWSP would receive such a request for assistance would be difficult. This EA emphasizes major issues as those issues relate to specific areas whenever possible; however, many issues apply wherever aquatic mammal damage and the resulting management actions occurs and are treated as such.

Chapter 2 of this EA identifies and discusses issues relating to managing damage caused by aquatic mammals in Texas. The standard WS Decision Model (Slate et al. 1992; see WS Directive 2.201) would be the site-specific procedure for individual actions that the TWSP could conduct in the State (see Chapter 3 for a description of the Decision Model and its application). Decisions made using the model would be in accordance with WS' directives and Standard Operating Procedures (SOPs) described in this EA, as well as relevant laws and regulations in accordance with WS Directive 2.210. The analyses in this EA would apply to any action that may occur in any locale and at any time within Texas. In this way, the TWSP believes it meets the intent of the NEPA with regard to site-specific analysis and that this is the only practical way for the TWSP to comply with the NEPA and still be able to accomplish its mission.

Summary of Public Involvement

The TWSP initially developed the issues associated with conducting damage management in consultation with the TPWD, and the USFWS. The TWSP defined the issues and identified the preliminary alternatives through the scoping process. As part of this process, and as required by the Council on Environmental Quality (CEQ) and APHIS implementing regulations for the NEPA, the TWSP will make this document available to the public for review and comment. The TWSP will make the document available to the public through legal notices published in local print media, through direct notification of parties that have requested notification, or that the TWSP has identified as having a potential interest in the reduction of threats and damage associated with aquatic mammals in the State. In addition, the TWSP will post notice of availability for the EA on the APHIS website for review and comment.

The TWSP will provide for a minimum of a 30-day comment period for the public and interested parties to provide new issues, concerns, and/or alternatives. Through the public involvement process, the TWSP will clearly communicate to the public and interested parties the analyses of potential environmental impacts on the quality of the human environment. The TWSP would fully consider new issues, concerns, or alternatives the public identifies during the public involvement period to determine whether the TWSP should revisit the EA and, if appropriate, revise the EA prior to issuance of a Decision.

1.4 RELATIONSHIP OF THIS EA TO OTHER ENVIRONMENTAL DOCUMENTS

WS' Environmental Assessment – Aquatic Mammal Damage Management: The TWSP has previously developed an EA and a supplement to the EA that analyzed the need for action to manage damage associated with aquatic mammals in the State. This current EA will address more recently identified changes in activities and will assess the potential environmental impacts of program alternatives based on those changes, primarily a need to evaluate new information. This EA will re-evaluate activities conducted under the previous EA and the supplement to the EA to address the new need for action and the associated affected environment. Therefore, the outcome of the Decision issued based on the analyses in this EA will supersede the previous EA and the supplement to the EA that addressed managing damage caused by aquatic mammals.

1.5 AUTHORITY OF FEDERAL AND STATE AGENCIES

Below are brief discussions of the authorities of the entities within the TWSP and other agencies, as those authorities relate to conducting wildlife damage management.

WS' Legislative Authority

The primary statutory authority for the WS program is the Act of March 2, 1931 (46 Stat. 1468; 7 USC 426-426b) as amended, and the Act of December 22, 1987 (101 Stat. 1329-331, 7 USC 426c). The WS program is the lead federal authority in managing damage to agricultural resources, natural resources, property, and threats to human safety associated with animals. WS' directives define program objectives and guide WS' activities when managing damage.

United States Environmental Protection Agency (EPA)

The EPA is responsible for implementing and enforcing the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which regulates the registration and use of pesticides. The EPA is also responsible for administering and enforcing the Section 404 program of the Clean Water Act (CWA) with the United States Army Corps of Engineers that established a permit program for the review and approval of water quality standards that directly affect wetlands.

Authority of the United States Fish and Wildlife Service

The USFWS is the primary federal agency responsible for conserving, protecting, and enhancing the nation's fish and wildlife resources and their habitats. The USFWS mission is to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people. Responsibilities are shared with other federal, state, tribal, and local entities. However, the USFWS has specific responsibilities for the protection of T&E species under the ESA, migratory birds, inter-jurisdictional fish, and certain marine mammals, as well as, for lands and waters that the USFWS administers for the management and protection of those resources, such as the National Wildlife Refuge System. Under 50 CFR 30.11, feral animals without ownership that have reverted to the wild from a domestic state may be taken by authorized federal or state personnel or by private persons operating under permit in accordance with applicable provisions of federal or state law or regulation on National Wildlife Refuges.

Natural Resources Conservation Service (NRCS)

The NRCS is responsible for making certified wetland determinations/delineations on agricultural lands and at the request of USDA program participants. All wetland determinations/delineations are conducted or verified on-site by properly trained NRCS personnel. County offices of the Farm Services Agency maintains maps of wetlands certified by the NRCS.

United States Army Corps of Engineers

The United States Army Corps of Engineers regulates and permits activities regarding waters of the United States including protection and utilization under Section 404 of the Clean Water Act.

Texas A&M AgriLife Extension Service

The Smith-Lever Act of 1914 (7 USC 341 et seq.) authorizes and provides for the conduct of cooperative extension work in agriculture and related subjects by the land-grant colleges and universities in several states where the USDA is cooperating with that state. The Texas Legislature accepted the provisions of this Act in 1915 with the passing of House Concurrent Resolution No. 2 and designated The Texas A&M University System as the institution to receive and administer funds made available under the Smith-Lever Act. The Texas A&M AgriLife Extension Service is an agency within The Texas A&M University System. The Texas Legislature has authorized the State of Texas to cooperate through The Texas A&M University System with the appropriate federal officers and agencies to control predatory animals and rodent pests (Texas Health and Safety Code, Title 10, Ch. 825).

The Wildlife Services unit of the Texas A&M AgriLife Extension Service is part of the TWSP that works cooperatively with local livestock associations and county governments to provide assistance for their constituents. The TWSP would provide assistance with managing damage or threats associated with aquatic mammals statewide in areas where funding was available. Activities could occur on both private and public lands.

Texas Wildlife Damage Management Association

The TWDMA consists of local cooperative groups, including county governments, private associations, and/or individuals that contribute and provide funding to the TWSP to address predators. The TWDMA is a participant in the TWSP.

Texas Parks and Wildlife Department

The TPWD has the primary responsibility to protect the State's fish and wildlife resources as directed in the Texas Statutes (Titles 1-7), including (furbearers). In addition, the TPWD has many programs that help protect and manage wetlands and coordinated the development of a Texas Wetlands Conservation Plan.

Texas Department of Agriculture (TDA)

The TDA is responsible for regulating pesticide use. The TWSP registers pesticides with the TDA and has one registration, zinc phosphide, for muskrat and nutria control. Personnel with the TWSP that use restricted-use pesticides in their job duties must become a certified pesticide applicator by the TDA to use them, or be supervised by a certified applicator.

Texas Commission on Environmental Quality (TCEQ)

The TCEQ is responsible for implementing much of the Texas Water Code and the federal Clean Water Act. The TCEQ reviews applications for Clean Water Act Section 404 permits. They have adopted, for the most part, the identical regulations of the federal Clean Water Act.

1.6 COMPLIANCE WITH LAWS AND STATUTES

Several laws or statutes would authorize, regulate, or otherwise affect activities of the TWSP under the alternatives. The TWSP would comply with applicable federal, state, and local laws and regulations in accordance with WS Directive 2.210. Below are brief discussions of those laws and regulations that would relate to damage management activities that the TWSP could conduct in the State.

National Environmental Policy Act

All federal actions are subject to the NEPA (Public Law 9-190, 42 USC 4321 et seq.). WS follows the CEQ regulations implementing the NEPA (40 CFR 1500 et seq.) along with the USDA (7 CFR 1b) and the APHIS implementing guidelines (7 CFR 372) as part of the decision-making process. Those laws, regulations, and guidelines generally outline five broad types of activities that federal agencies must accomplish as part of any project: public involvement, analysis, documentation, implementation, and monitoring. The NEPA also sets forth the requirement that all major federal actions be evaluated in terms of their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts. In part, the CEQ, through regulations in 40 CFR, Parts 1500-1508, regulate federal activities that could affect the physical and biological environment. In accordance with regulations of the CEQ and the USDA, the APHIS has published guidelines concerning the implementation of the NEPA (see 44 CFR 50381-50384).

Pursuant to the NEPA and the CEQ regulations, this EA documents the analyses resulting from proposed federal actions, informs decision-makers and the public of reasonable alternatives capable of avoiding or minimizing adverse impacts, and serves as a decision-aiding mechanism to ensure that WS infuses the policies and goals of the NEPA into agency actions. The TWSP prepared this EA by integrating as many of the natural and social sciences as warranted, based on the potential effects of the alternatives, including the potential direct, indirect, and cumulative effects of the alternatives.

Endangered Species Act

Under the ESA, all federal agencies will seek to conserve T&E species and will utilize their authorities in furtherance of the purposes of the Act (Sec.2(c)). The TWSP conducts consultations with the USFWS pursuant to Section 7 of the ESA to ensure that "*any action authorized... funded or carried out by such an agency…is not likely to jeopardize the continued existence of any endangered or threatened species….Each agency will use the best scientific and commercial data available*" (Sec.7 (a)(2)). Evaluation of the alternatives in regards to the ESA will occur in Chapter 4 of this EA.

Federal Insecticide, Fungicide, and Rodenticide Act

The FIFRA and its implementing regulations (Public Law 110-426, 7 USC 136 et. seq.) require the registration, classification, and regulation of all pesticides used in the United States. The EPA is responsible for implementing and enforcing the FIFRA. The EPA and the TDA regulate pesticides that could be available to manage damage associated with aquatic mammals in the State.

National Historic Preservation Act (NHPA) of 1966, as amended

The NHPA and its implementing regulations (see 36 CFR 800) require federal agencies to initiate the Section 106 process if an agency determines that the agency's actions are undertakings as defined in Section 800.16(y) and, if so, whether it is a type of activity that has the potential to cause effects on historic properties. If the undertaking is a type of activity that does not have the potential to cause effects on historic properties, assuming such historic properties were present, the agency official has no further obligations under Section 106. None of the aquatic mammal damage management methods described in this EA that would be available cause major ground disturbance, any physical destruction or damage to property, any alterations of property, wildlife habitat, or landscapes, nor would involve the sale, lease, or transfer of ownership of any property. In general, the use of such methods also do not have the potential to introduce visual, atmospheric, or audible elements to areas that could result in effects on the character or use of historic properties. Therefore, the methods that would be available under the alternatives would not generally be the types of methods that would have the potential to affect historic properties. If the TWSP planned an individual activity with the potential to affect historic resources under an alternative selected because of a decision on this EA, the TWSP would conduct the site-specific consultation, as required by Section 106 of the NHPA, as necessary.

The use of noise-making methods, such as firearms, at or in close proximity to historic or cultural sites for the purposes of removing wildlife have the potential for audible effects on the use and enjoyment of historic property. However, the TWSP would only use such methods at a historic site at the request of the owner or manager of the site to resolve a damage problem, which means such use, would be to benefit or protect the historic property. A built-in minimization factor for this issue is that virtually all the methods involved would only have temporary effects on the audible nature of a site and could be ended at any time to restore the audible qualities of such sites to their original condition with no further adverse effects. The TWSP could conduct site-specific consultation as required by the Section 106 of the NHPA, as necessary, in those types of situations.

Native American Graves Protection and Repatriation Act of 1990

The Native American Graves Protection and Repatriation Act (Public Law 101-106, 25 USC 3001) requires federal agencies to notify the Secretary of the Department that manages the federal lands upon the discovery of Native American cultural items on federal or tribal lands. Federal agencies are to discontinue work until the agency has made a reasonable effort to protect the items and notify the proper authority.

Federal Food, Drug, and Cosmetic Act (21 USC 360)

This law places administration of pharmaceutical drugs, including those immobilizing drugs used for wildlife capture and handling, under the Food and Drug Administration.

Controlled Substances Act of 1970 (21 USC 821 et seq.)

This law requires an individual or agency to have a special registration number from the United States Drug Enforcement Administration to possess controlled substances, including controlled substances used for wildlife capture and handling.

Animal Medicinal Drug Use Clarification Act of 1994

The Animal Medicinal Drug Use Clarification Act (AMDUCA) and its implementing regulations (21 CFR 530) establish several requirements for the use of animal drugs, including those animal drugs used to capture and handle wildlife in damage management programs. Those requirements are: (1) a valid "*veterinarian-client-patient*" relationship, (2) well defined record keeping, (3) a withdrawal period for animals that have been administered drugs, and (4) identification of animals. A veterinarian, either on staff or on an advisory basis, would be involved in the oversight of the use of animal capture and handling drugs under any alternative where WS could use those immobilizing and euthanasia drugs. Veterinary authorities in each state have the discretion under this law to establish withdrawal times (*i.e*., a period after a drug was administered that must lapse before an animal may be used for food) for specific drugs. Animals that people might consume within the withdrawal period must be identifiable (*e.g.*, use of ear tags) and labeled with appropriate warnings.

Section 401 of the Clean Water Act

As required by Section 401 of the CWA (see 33 USC 1341), an applicant for a permit issued pursuant to Section 404 of the CWA must also possess a permit from the state in which the discharge originates or will originate, when applicable. The Texas Commission on Environmental Quality is responsible for reviewing Water Quality Certifications applications required by Section 401 of the CWA.

Section 404 of the Clean Water Act

Section 404 (see 33 USC 1344) of the CWA prohibits the discharge of dredged or fill material into waters of the United States without a permit from the United States Army Corps of Engineers unless the specific activity is exempted in 33 CFR 323 or covered by a nationwide permit (NWP) in 33 CFR 330.

Food Security Act

The Wetland Conservation provision (Swampbuster) of the 1985 (16 USC 3801-3862), 1990 (as amended by Public Law 101-624), and 1996 (as amended by Public Law 104-127) farm bills require all agricultural producers to protect wetlands on the farms they own. Wetlands converted to farmland prior to December 23, 1985 are not subject to wetland compliance provisions even if wetland conditions return because of lack of maintenance or management. If prior converted cropland is not planted to an agricultural commodity (crops, native and improved pastures, rangeland, tree farms, and livestock production) for more than five consecutive years and wetland characteristics return, the cropland is considered abandoned and then becomes a wetland subject to regulations under Swampbuster and Section 404 of the CWA.

Coastal Zone Management Act of 1972, as amended (16 USC 1451-1464, Chapter 33; Public Law 92-583, October 27, 1972; 86 Stat. 1280)

This law established a voluntary national program within the Department of Commerce to encourage coastal states to develop and implement coastal zone management plans. Subsequent to federal approval of their plans, the Department of Commerce could award grants for implementation purposes. In order to be eligible for federal approval, each state's plan was required to define boundaries of the coastal zone, identify uses of the area to be regulated by the state, determine the mechanism (criteria, standards or regulations) for controlling such uses, and develop broad guidelines for priorities of uses within the coastal zone. In addition, this law established a system of criteria and standards for requiring that federal actions occur in a manner consistent with the federally approved plan. The standard for determining consistency varied depending on whether the federal action involved a permit, license, financial assistance, or a federally authorized activity. As appropriate, TWSP would conduct a consistency determination to assure management actions would be consistent with the State's Coastal Zone Management Program.

Protection of Wetlands – Executive Order 11990

Executive Order 11990 was signed to "*minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands*". To meet those objectives, Executive Order 11990 requires federal agencies to consider alternatives to wetland sites, in planning their actions, and to limit potential damage, if a federal agency cannot avoid an activity affecting a wetland.

Environmental Justice in Minority and Low Income Populations - Executive Order 12898

Executive Order 12898 promotes the fair treatment of people of all races, income levels, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Environmental justice is the pursuit of equal justice and protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socio-economic status. Executive Order 12898 requires federal agencies to make environmental justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of federal programs, policies, and activities on minority and low-income persons or populations. This EA will evaluate activities addressed in the alternatives for their potential impacts on the human environment and compliance with Executive Order 12898.

Protection of Children from Environmental Health and Safety Risks - Executive Order 13045

Children may suffer disproportionately for many reasons from environmental health and safety risks, including the development of their physical and mental status. The TWSP makes it a high priority to identify and assess environmental health and safety risks that may disproportionately affect children. Executive Order 13045 helps ensure the policies, programs, activities, and standards of federal agencies address disproportionate risks to children that result from environmental health risks or safety risks.

Invasive Species - Executive Order 13112

Executive Order 13112 establishes guidance for federal agencies to use their programs and authorities to prevent the spread or to control populations of invasive species that cause economic or environmental harm or harm to human health. The Order states that each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law: 1) reduce invasion of exotic species and the associated damages, 2) monitor invasive species populations and provide for restoration of native species and habitats, 3) conduct research on invasive species and develop technologies to prevent introduction, and 4) provide for environmentally sound control and promote public education of invasive species. Pursuant to Executive Order 13112, the National Invasive Species Council has designated the nutria as meeting the definition of an invasive species.

Title 10 Health and Safety Code Subchapters 825.001 - 825.007

These statues of the Health and Safety Code establish the cooperative arrangement between the federal WS program and the Texas A&M University System and allows the TWSP to operate as a cooperative program controlling predatory animals and rodents to protect livestock, food and feed supplies, crops, and ranges. The statutes also allow local governing bodies, such as counties, to enter into an agreement with the TWSP. Section 825.007 specifically exempts personnel performing their duties under this subchapter from licensing requirements under Title 5 of the Parks and Wildlife Code.

Title 5 Parks and Wildlife Code Subchapter 71.004

This statute allows landowners or their agents to take nuisance furbearing animals in any number by any means at any time on that person’s land to relieve damage-related situations without a hunting or trapping license.

Title 5 Parks and Wildlife Code Subchapter 68.001 - 68.021

Chapter 68 of the Parks and Wildlife Code established Texas’ endangered species law equivalent to the

ESA. The statute requires that federally listed T&E species be placed on the list. In addition, on the basis of investigations on wildlife, other available scientific and commercial data and after consultation with wildlife agencies in other states, appropriate federal agencies, local and tribal governments and other interested persons and organizations, the commission director shall by regulation develop a list of those species of wildlife indigenous to the state that are determined to be threatened or endangered within Texas.

Title 5 Parks and Wildlife Code Subchapter 65.378

This statute requires any person relocating a furbearing animal to have a permit from the TPWD and a letter from the property owner where the animal(s) are to be released.

Title 5 Parks and Wildlife Code Subchapter 43.151-57

These statutes provide the permitting process to control protected wildlife, including T&E species that are causing damage or public health concerns.

1.7 DECISIONS TO BE MADE

Based on agency relationships, MOUs, and legislative authorities, the TWSP is the lead agency for this EA, and therefore, responsible for the scope, content, and decisions made. The USFWS, the United States Army Corps of Engineers, the NRCS, and the TPWD provided input during the preparation of this EA to facilitate an interdisciplinary approach to comply with NEPA and agency mandates, policies, and regulations.

Based on the scope of this EA, the decisions to be made are: 1) should the TWSP conduct aquatic mammal damage management to alleviate damage when requested, 2) should the TWSP conduct disease surveillance and monitoring in aquatic mammal populations when requested, 3) should the TWSP implement an integrated methods approach, including technical assistance and direct operational assistance, to meet the need for action in Texas, 4) if not, should the TWSP attempt to implement one of the alternatives to an integrated methods strategy, and 5) would the proposed action or the other alternatives result in potential effects to the environment requiring the preparation of an EIS.

CHAPTER 2: AFFECTED ENVIRONMENT AND ISSUES

Chapter 2 contains a discussion of the issues, including issues that will receive detailed environmental impact analysis in Chapter 4 (Environmental Consequences), issues that have driven the development of SOPs, and issues that the TWSP did not consider in detail, with rationale. Pertinent portions of the affected environment will be included in this chapter in the discussion of issues. Additional descriptions of the affected environment occur during the discussion of the environmental effects in Chapter 4.

2.1 AFFECTED ENVIRONMENT

Beaver, nutria, muskrats, and otters are semi-aquatic species that are closely associated with aquatic habitats. Those aquatic mammal species addressed in this EA are capable of utilizing a variety of aquatic habitats in the State. Those aquatic mammals addressed in this EA occur throughout the year across the State where suitable aquatic habitat exists for foraging and shelter. Damage or threats of damage caused by those aquatic mammal species could occur statewide in Texas wherever those aquatic mammals occur. However, damage management would only be conducted by the TWSP when requested by a landowner or manager and only on properties where an MOU, work initiation document, or another comparable document were signed between the TWSP and a cooperating entity.

The ideal beaver habitat consists of ponds, small lakes with muddy bottoms, and meandering streams, but can consist of artificial ponds, reservoirs, and drainage ditches that contain nearby food sources (Novak 1987). Slough and Sadleir (1977) stated, "*Beavers prefer a seasonal stable water level. The most stable environment is one which they can control themselves by damming, thus low gradient (slow flowing), narrow streams, and lakes with dammable outlets are preferred (damming also creates new aquatic habitat…, and increases accessibility of onshore woody species)*". In mixed coniferous-deciduous forest habitat, Howard and Larson (1985) found the percentage of hardwood vegetation, watershed size, and stream width had positive effects on active beaver colony density, while an increase in stream gradient and progressively well-drained soils had negative effects on active colony density.

A model used by Curtis and Jensen (2004) found the percentage of roadside devoid of wood vegetation, stream gradient, and stream width were the primary factors for predicting beaver occupancy along roadsides. As the proportion of the roadside area devoid of vegetation and the stream gradient increased, the probability of beaver occupying a site along a roadside declined (Curtis and Jensen 2004). Curtis and Jensen (2004) stated, "*Roadside areas where stream gradients were >3% or where >50% of the roadside area was devoid of woody vegetation usually were not suitable beaver habitat in New York state*". In a study conducted by Jensen et al. (2001), beaver were also unlikely to colonize streams with gradients greater than 3%. In addition, Jensen et al. (2001) found the inlet opening of culverts under roads and stream gradient were the most important determinant of whether beaver would plug culverts. Jakes et al. (2007) found that beaver were more likely to impound streams crossed by roads in areas with a gradient of 0.6 to 1.2% and watershed sizes of approximately 6,200 acres. Therefore, the availability of woody vegetation, steam gradient, and stream depth appear to be major factors that influence the probability of beaver occupying a site. Beaver can eat a variety of woody vegetation. For example, the analysis of beaver stomach contents in Mississippi identified 42 species of trees, 36 genera of herbaceous plants, 4 types of woody vines, and many species of grass (Graminae) (Roberts and Arner 1984). Some of the common forbs eaten by beaver across the southern United States includes rice cutgrass (*Leersia oryzoides*), golden club (*Orontium aquaticum*), switchgrass (*Arundinaria tecta*), poison ivy (*Toxicodendron radicans*), soybean (*Glycine max*), and pondweed (*Potamogeton* spp.) (Novak 1987). In Texas, beaver occur throughout the State where suitable aquatic habitats are available.

The habitat requirements of muskrats are extremely flexible but they must have a source of permanent water and a protected area for shelter and raising young, such as a lodge built of vegetation or a den burrowed into banks (Boutin and Birkenholz 1987). In Texas, muskrats reside along the Gulf coast, northeast Texas, and in the panhandle region. They also occur along the Pecos and Rio Grande Rivers north and west of Big Bend National Park. They do not occur in much of central and west Texas (Wade and Ramsey 1986). They inhabit creeks, rivers, lakes, ponds, and drainage ditches with a steady water level feeding primarily on cattails (*Typha* spp.), bulrushes (*Scirpus* spp.), and aquatic grasses. It has historically been the most heavily exploited furbearer in North America with 6-20 million harvested annually since about 1935 (Boutin and Birkenholz 1998). Boutin and Birkenholz (1998) provide a comprehensive review of muskrat natural history and population dynamics.

Nutria and muskrats have similar habitat requirements and generally, consist of areas with a source of permanent water and sufficient aquatic plant communities. Nutria occur along rivers, lakes, lagoons, marshes, and swamp areas with freshwater and brackish plant communities (Kinler et al. 1987). Currently, nutria range throughout most of the eastern two-thirds of Texas. Their preferred habitat is swamps, marshes, lakes, rivers, and brackish waters where they feed on mostly aquatic and semi-aquatic vegetation, such as cattails and reeds. They also venture from these areas into croplands and golf courses, potentially causing considerable damage (LeBlanc 1994).

Otters primarily occur in the eastern third of Texas; however, historically their range has extended throughout the eastern half of Texas. River otters prefer to live near bodies of water such as lakes, large rivers, and streams. Along the Texas Gulf Coast region, otters also live in marshes, bayous, and brackish inlets. Melquist and Dronkert (1987) compiled a comprehensive review of river otter natural history and population dynamics.

Texas encompasses 268,596 square miles (171.9 million acres), which consists of 261,232 square miles (167.2 million acres) of land area and 7,365 square miles (4.7 million acres) of water (United States Census Bureau 2010). Upon receiving a request for assistance, the TWSP could conduct activities to reduce aquatic mammal damage or threats of damage on federal, state, tribal, municipal, and private properties in Texas. Areas where damage or threats of damage could occur include, but would not be limited to agricultural fields, vineyards, orchards, farmyards, dairies, ranches, livestock operations, aquaculture facilities, fish hatcheries, grain mills, grain handling areas, railroad yards, waste handling facilities, industrial sites, natural resource areas, park lands, and historic sites; state and interstate highways and roads; railroads, railroad beds, and their right-of-ways; property in or adjacent to subdivisions, businesses, and industrial parks; timberlands, croplands, and pastures; private and public property where burrowing aquatic mammals cause damage to structures, dams, dikes, ditches, ponds, and levees; public and private properties in rural/urban/suburban areas where aquatic mammals cause damage to landscaping and natural resources, property, and are a threat to human safety through the spread of disease. The area would also include airports and military airbases where aquatic mammals could be a threat to human safety and to property; areas where aquatic mammals negatively affect wildlife, including T&E species; and public property where aquatic mammals were negatively affecting historic structures, cultural landscapes, and natural resources. Chapter 4 also contains additional information on the affected environment.

Environmental Status Quo

As defined by the NEPA implementing regulations, the "*human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment*" (40 CFR 1508.14). Therefore, when a federal action agency analyzes their potential impacts on the "*human environment*", it is reasonable for that agency to compare not only the effects of the federal action, but also the potential impacts that occur or could occur in the absence of the federal action by a non-federal entity. This concept is applicable to situations involving federal assistance to reduce damage associated with wildlife species.

Neither state nor federal laws protect some wildlife species, such as most non-native invasive species. State authority or law manages most aquatic mammal species without any federal oversight or protection. In some situations, with the possible exception of restrictions on methods (*e.g*., firearms restrictions, pesticide regulations), unprotected wildlife species and certain resident wildlife species are managed with little or no restrictions, which allows anyone to lethally remove or take those species at any time when they are committing damage. In Texas, the TPWD has the authority to manage aquatic mammal populations in the State.

When a non-federal entity (*e.g*., agricultural producers, municipalities, counties, private companies, individuals, or any other non-federal entity) takes an action to alleviate aquatic mammal damage or threat, the action is not subject to compliance with the NEPA due to the lack of federal involvement in the action. Under such circumstances, the environmental baseline or status quo would be an environment that includes those resources as other non-federal entities manage or affect those resources in the absence of the federal action. Therefore, in those situations in which a non-federal entity has decided that a management action directed towards aquatic mammals should occur and even the particular methods that should be used, the involvement of the TWSP in the action would not affect the environmental status quo since the entity could take the action in the absence of involvement by the TWSP. Involvement by the TWSP would not change the environmental status quo if the requester had conducted the action in the absence of involvement by the TWSP in the action.

A non-federal entity could lethally remove aquatic mammals to alleviate damage without the need for a permit when those species are non-native or are unregulated by the TPWD. For example, landowners or their designees can remove beaver and nutria that are causing damage to their property without the need for a permit from the TPWD. In addition, other entities could remove aquatic mammals to alleviate damage during the hunting and/or trapping season, and/or through the issuance of permits by the TPWD. In addition, most methods available for resolving damage associated with aquatic mammals would also be available for use by other entities. Therefore, the decision-making ability of the TWSP would be restricted to one of three alternatives. The TWSP could take the action using the specific methods as decided upon by the non-federal entity, provide technical assistance only, or take no action. If the TWSP takes no action, another entity could take the action anyway using the same methods without the need for a permit, during the hunting or trapping season, or through the issuance of a permit by the TPWD. Under those circumstances, TWSP would have virtually no ability to affect the environmental status quo since the action would likely occur in the absence of TWSP direct involvement.

Based on the discussion above, it is clear that in those situations where a non-federal entity has obtained the appropriate permit or authority, and has already made the decision to remove or otherwise manage aquatic mammals to stop damage with or without the assistance of the TWSP, the participation of the TWSP in carrying out the action would not affect the environmental status quo.

2.2 ISSUES ASSOCIATED WITH AQUATIC MAMMAL DAMAGE MANAGEMENT

Issues are concerns regarding potential adverse effects that might occur from a proposed action. Federal agencies must consider such issues during the NEPA decision-making process. Initially, the TWSP developed the issues related to managing damage associated with aquatic mammals in Texas in consultation with the TPWD. In addition, the TWSP will invite the public to review and comment on the EA to identify additional issues.

Chapter 4 discusses the issues, as those issues relate to the possible implementation of the alternatives, including the proposed action. The TWSP evaluated, in detail, the following issues:

Issue 1 - Effects of Damage Management Activities on Target Aquatic Mammal Populations

A common issue when addressing damage caused by wildlife are the potential impacts of management actions on the populations of target species. Lethal and non-lethal methods would be available to resolve damage or threats to human safety.

Non-lethal methods could disperse or otherwise make an area unattractive to target species, which could reduce the presence of those species at the site and potentially the immediate area around the site where an entity employed those methods. Employing lethal methods could remove a single aquatic mammal or those aquatic mammals responsible for causing damage or posing threats to human safety. Therefore, the use of lethal methods could result in local population reductions in the area where damage or threats were occurring. The number of individual animals from a target species that the TWSP could remove from the population using lethal methods would be dependent on the number of requests for assistance received, the number of individual aquatic mammals involved with the associated damage or threat, and the efficacy of methods employed.

Another issue commonly identified is a concern that damage management activities conducted by TWSP would affect the ability of people to harvest those species during the regulated hunting and trapping seasons either by reducing local populations through the lethal removal of aquatic mammals or by reducing the number of aquatic mammals present in an area through dispersal techniques.

The analysis will measure the number of individual animals lethally removed in relation to that species abundance to determine the magnitude of impact to the populations of those species from the use of lethal methods. Magnitude may be determined either quantitatively or qualitatively. Determinations based on population estimates, allowable harvest levels, and actual harvest data would be quantitative. Determinations based on population trends and harvest trend data, when available, would be qualitative.

People can harvest beaver, muskrats, nutria, and otter in the State during annual hunting and/or trapping seasons and can be addressed using available methods by other entities in the State when those species cause damage or pose threats of damage when authorized by the TPWD, when authorization is required. Therefore, any damage management activities conducted by the TWSP under the alternatives would be occurring along with other natural processes and human-induced events, such as natural mortality, human-induced mortality from private damage management activities, damage management activities from other agencies, counties, or municipal governments, mortality from regulated harvest, and human-induced alterations of wildlife habitat.

Under certain alternatives, the TWSP could employ methods available to resolve damage and reduce threats to human safety that target an individual animal of an aquatic mammal species or a group of animals after applying the WS Decision Model (Slate et al. 1992; see WS Directive 2.201) to identify possible techniques. Chapter 4 analyzes the effects on the populations of target aquatic mammal populations in the State from implementation of the alternatives addressed in detail, including the proposed action. Information on aquatic mammal populations and trends are often available from several sources including the fur harvest reports, damage complaints, ground surveys, aerial surveys, and published literature.

Issue 2 - Effects on the Populations of Non-target Animals, Including T&E Species

The issue of non-target species effects, including effects on T&E species, arises from the use of non-lethal and lethal methods identified in the alternatives. The use of non-lethal and lethal methods has the potential to inadvertently disperse, capture, or kill non-target wildlife. Appendix B describes the methods available for use under the alternatives.

There are also concerns about the potential for adverse effects to occur to non-target animals from the use of chemical methods. Chemical methods that would be available for use to manage damage or threats associated with those aquatic mammal species addressed in this EA include immobilizing drugs, euthanasia chemicals, zinc phosphide (muskrats and nutria only)[7], and repellents. Chapter 4 and Appendix B further discuss those chemical methods available for use to manage damage and threats associated with aquatic mammals in Texas.

The ESA states that all federal agencies *"...shall seek to conserve endangered and threatened species and shall utilize their authorities in furtherance of the purposes of the Act"* [Sec. 7(a)(1)]. The TWSP conducts consultations with the USFWS pursuant to Section 7 of the Act to ensure compliance with the ESA. Consultations are also conducted to ensure that *"any action authorized, funded or carried out by such an agency...is not likely to jeopardize the continued existence of any endangered or threatened species…Each agency shall use the best scientific and commercial data available"* [Sec. 7(a)(2)].

As part of the scoping process for this EA, the TWSP consulted with the USFWS pursuant to Section 7 of the ESA to facilitate interagency cooperation between the TWSP and the USFWS. Chapter 4 discusses the

[7]EPA registration number 56228-06

potential effects of the alternatives on this issue.

Issue 3 - Effects of Damage Management Methods on Human Health and Safety

An additional issue often raised is the potential risks to human safety associated with employing methods to manage damage caused by target species. Both chemical and non-chemical methods have the potential to have adverse effects on human safety. Employees of the TWSP could use and recommend only those methods that were legally available under each of the alternatives. Still, some concerns exist regarding the safety of methods available despite their legality and selectivity. As a result, this EA will analyze the potential for proposed methods to pose a risk to members of the public. In addition to the potential risks to the public associated with the methods available under each of the alternatives, risks to employees of the TWSP would also be a concern. Injuries to employees of the TWSP could occur during the use of methods, as well as subject to workplace accidents. Selection of methods, under the alternatives, would include consideration for public and employee safety.

The issue of using chemical methods as part of managing damage associated with wildlife relates to the potential for human exposure either through direct contact with the chemical or exposure to the chemical from wildlife that have been exposed. Under the alternatives identified, the use or recommendation of chemical methods could include immobilizing drugs, euthanasia chemicals, repellents, and zinc phosphide. Zinc phosphide would only be available to manage damage caused by muskrats and nutria. The EPA through the FIFRA and the TDA through State laws would regulate pesticide use. The United States Drug Enforcement Administration and the United States Food and Drug Administration would regulate immobilizing drugs and euthanasia chemicals. In addition, the use of all chemical methods by the TWSP would be subject to Texas laws and WS' Directives.

Immobilizing drugs that could be available include Ketamine and Telazol, which are anesthetics (*i.e.*, general loss of pain and sensation) used during the capture of wildlife to eliminate pain, calm fear, and reduce anxiety in wildlife when handling and transporting wildlife. Xylazine is a sedative that wildlife professionals often use in combination with ketamine to calm nervousness, irritability, and excitement in wildlife during the handling and transporting of wildlife. Euthanasia chemicals could include sodium pentobarbital and potassium chloride, both of which the TWSP would administer after anesthetizing an animal.

Repellents often contain different active ingredients with most ingredients occurring naturally in the environment. The most common ingredients of repellents are coyote urine, capsaicin, or sand (Silica) mixed with a non-toxic carrier for application to surfaces. Repellents for animals are not generally restricted-use products; therefore, a person does not need a pesticide applicators license to purchase or apply those products. People generally apply repellents directly to affected resources, which elicits an adverse taste or texture response when the target animal ingests the treated resource or the ingestion of the repellent causes temporary sickness (*e.g.*, nausea). Products containing coyote urine or other odors associated with predatory wildlife are intended to elicit a fright response in target wildlife by imitating the presence of a predatory animal (*i.e.*, wildlife tend to avoid areas where predators are known to be present). If repellents were registered for use in the State to reduce damage caused by aquatic mammals, the TWSP could employ or recommend for use those repellents that were available (*i.e.*, registered with the EPA pursuant to the FIFRA and registered with the TDA).

Another concern would be the potential for immobilizing drugs used in animal capture and handling to cause adverse health effects in people that hunt or trap and consume the species involved. Among the species that the TWSP could capture and handle under the proposed action, this issue would be a primary concern for wildlife species that people hunt and consume as food.

The TWSP could also use binary explosives to remove or breach beaver dams in the State, when requested. Binary explosives require the mixing of two components for activation. Employees of the TWSP would keep the two components separated until ready for use at a beaver dam. The national WS program has formed an Explosives Safety Committee composed of qualified WS' personnel that are responsible for developing explosives safety and security for WS, conducting explosives training, and certifying WS' explosives specialists.

Most methods available to alleviate damage and threats associated with aquatic mammals would be non-chemical methods. Personnel of the TWSP could recommend limited habitat management in urban and suburban areas, such as at golf courses, city drainage ditches, and airports, where requesters can plant vegetation that is less palatable to beaver, muskrats, and nutria. WS' personnel could also recommend structural modifications, such as replacing culverts with a narrow opening with culverts that have a larger opening. Exclusion or barriers may involve the wrapping the trunks of desirable trees with woven wire or other material, barrier fencing, or electric fencing. Mechanical methods could include cage traps, foothold traps, body-gripping traps, cable devices, shooting, or the recommendation that hunters and/or trappers reduce a local population of aquatic mammals during the annual hunting and/or trapping seasons.

The primary safety risk of most non-chemical methods occurs directly to the applicator or those persons assisting the applicator. However, risks to others do exist when employing non-chemical methods, such as when using firearms or body-gripping traps. Most of the non-chemical methods available to address aquatic mammal damage in Texas would be available for use under any of the alternatives and by any entity, when permitted. Chapter 4 further discusses the risks to human safety from the use of non-chemical methods as this issue relates to the alternatives. Appendix B provides a complete list of non-chemical methods available to alleviate damage associated with aquatic mammals.

Another concern is the threat to human safety from not employing methods or not employing the most effective methods to reduce the threats that aquatic mammals can pose. The need for action in Chapter 1 addresses the risks to human safety from diseases associated with certain aquatic mammal populations. The low risk of disease transmission from aquatic mammals does not lessen the concerns of cooperators requesting assistance to reduce threats from zoonotic diseases. Increased public awareness of zoonotic events has only heightened the concern of direct or indirect exposure to zoonotic diseases. Not adequately addressing the threats associated with potential zoonotic diseases could lead to an increase in incidences of injury, illness, or loss of human life.

Additional concerns occur when inadequately addressing threats to human safety associated with aircraft striking aquatic mammals at airports in the State. Between 1990 and 2014, civil aircraft have struck at least 2 beaver and 25 muskrats at airports in the United States (Dolbeer et al. 2015). Although aircraft strikes involving aquatic mammals occur rarely, aquatic mammals have the potential to cause damage to aircraft, which can threaten the safety of passengers. Limiting or preventing the use of certain methods to address the potential for aircraft striking aquatic mammals could lead to higher risks to passenger safety. Chapter 4 further evaluates those concerns in relationship to the alternatives.

Issue 4 - Effects on the Aesthetic Values of Aquatic Mammals

One issue is the concern that the proposed action or the other alternatives would result in the loss of aesthetic benefits of target aquatic mammals to the public, resource owners, or neighboring residents. People generally regard wildlife as providing economic, recreational, and aesthetic benefits (Decker and Goff 1987), and the mere knowledge that wildlife exists is a positive benefit to many people. Aesthetics is the philosophy dealing with the nature of beauty, or the appreciation of beauty. Therefore, aesthetics is truly subjective in nature, dependent on what an observer regards as beautiful.

The human attraction to animals likely started when people began domesticating animals. The public today share a similar bond with animals and/or wildlife in general and in modern societies, a large percentage of households have indoor or outdoor pets. However, some people may consider individual wild animals and aquatic mammals as "*pets*" or exhibit affection toward those animals, especially people who enjoy viewing wildlife. Therefore, the public reaction can be variable and mixed to wildlife damage management because there are numerous philosophical, aesthetic, and personal attitudes, values, and opinions about the best ways to manage conflicts/problems between people and wildlife.

Wildlife populations provide a wide range of social and economic benefits (Decker and Goff 1987). Those include direct benefits related to consumptive and non-consumptive uses, indirect benefits derived from vicarious wildlife related experiences, and the personal enjoyment of knowing wildlife exists and contributes to the stability of natural ecosystems (Bishop 1987). Direct benefits are derived from a personal relationship with animals and may take the form of direct consumptive use (*i.e*., using parts of or the entire animal) or non-consumptive use (*e.g.*, viewing the animal in nature or in a zoo, photographing) (Decker and Goff 1987).

Indirect benefits or indirect exercised values arise without the user being in direct contact with the animal and originate from experiences, such as looking at photographs and films of wildlife, reading about wildlife, or benefiting from activities or contributions of animals (*e.g*., their use in research) (Decker and Goff 1987). Indirect benefits come in two forms: bequest and pure existence (Decker and Goff 1987). Bequest is providing for future generations and pure existence is merely knowledge that the animals exist (Decker and Goff 1987).

Public attitudes toward wildlife vary considerably. Some people believe that the TWSP should capture and translocate all animals to another area to alleviate damage or threats those animals pose. In some cases, people directly affected by wildlife strongly support removal. Individuals not directly affected by the harm or damage may be supportive, neutral, or totally opposed to any removal of wildlife from specific locations or sites. Some people totally opposed to wildlife damage management want the TWSP to teach tolerance for damage and threats caused by wildlife, and that people should never kill wildlife. Some of the people who oppose removal of wildlife do so because of human-affectionate bonds with individual wildlife. Those human-affectionate bonds are similar to attitudes of a pet owner and result in aesthetic enjoyment.

Issue 5 - Humaneness and Animal Welfare Concerns of Methods

The issue of humaneness and animal welfare, as it relates to the killing or capturing of wildlife is an important but very complex concept that people can interpret in a variety of ways. Schmidt (1989) indicated that vertebrate damage management for societal benefits could be compatible with animal welfare concerns, if "*…the reduction of pain, suffering, and unnecessary death is incorporated in the decision making process.*"

The American Veterinary Medical Association (1987) has previously described suffering as a "*…highly unpleasant emotional response usually associated with pain and distress*." However, suffering "*…can occur without pain…*" and "*…pain can occur without suffering…*". Because suffering carries with it the implication of a time frame, a case could be made for "*…little or no suffering where death comes immediately…*" (California Department of Fish and Game 1991). Pain and physical restraint can cause stress in animals and the inability of animals to effectively deal with those stressors can lead to distress. Suffering can occur when a person does not take action to alleviate conditions that cause pain or distress in animals.

Defining pain as a component in humaneness appears to be a greater challenge than that of suffering. Pain obviously occurs in animals. Altered physiology and behavior in animals can be indicators of pain. However, pain experienced by individual animals probably ranges from little or no pain to considerable pain (California Department of Fish and Game 1991).

The American Veterinary Medical Association has previously stated "...*euthanasia is the act of inducing humane death in an animal*" and "... *the technique should minimize any stress and anxiety experienced by the animal prior to unconsciousness*" (Beaver et al. 2001). Some people would prefer using American Veterinary Medical Association accepted methods of euthanasia when killing all animals, including wild and invasive animals. The American Veterinary Medical Association has stated, "[f]*or wild and feral animals, many of the recommended means of euthanasia for captive animals are not feasible. In field circumstances, wildlife biologists generally do not use the term euthanasia, but terms such as killing, collecting, or harvesting, recognizing that a distress-free death may not be possible*" (Beaver et al. 2001).

Pain and suffering, as it relates to methods available for use to manage aquatic mammals has both a professional and lay point of arbitration. Wildlife managers and the public must recognize the complexity of defining suffering, since *"…neither medical nor veterinary curricula explicitly address suffering or its relief"* (California Department of Fish and Game 1991). Research suggests that with some methods (*e.g.*, foothold trap) changes in the blood chemistry of trapped animals indicate the existence of some level of "*stress*" (Kreeger et al. 1990). However, such research has not yet progressed to the development of objective, quantitative measurements of pain or stress for use in evaluating humaneness (Bateson 1991, Sharp and Saunders 2008, Sharp and Saunders 2011).

The decision-making process involves tradeoffs between the above aspects of pain and humaneness. Therefore, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal, and people may perceive the humaneness of an action differently. The challenge in coping with this issue is how to achieve the least amount of animal suffering. Chapter 4 further discusses the issue of humaneness and animal welfare. Chapter 3 discusses SOPs intended to alleviate pain and suffering.

Issue 6 – Effects of Beaver Removal and Dam Manipulation on the Status of Wetlands in the State

Wetlands are a valuable component of land-based ecosystems that provide numerous direct and indirect benefits to people and wildlife (*e.g.*, see Costanza et al. 1997, Millennium Ecosystem Assessment 2005). Between the 1780s and the 1980s, Dahl (1990) estimated 53% of the original wetland acres in the lower 48 states were lost, primarily from human development. Beaver, through their building of dams and impounding water can have a unique role in establishing wetlands that not only provide benefit to the beaver, but to people and other wildlife. Wildlife professionals often consider beaver a "*keystone*" species for their ability to manipulate and create their own habitats, which can also provide benefits to other wildlife and people. Beaver may also be an inexpensive way of restoring wetlands or creating new wetlands (*e.g*., see Hey and Philippi 1995, Muller-Schwarze and Sun 2003, Buckley et al. 2011).

The issue of potential impacts to wetlands from activities conducted by the TWSP could occur from activities conducted to alleviate damage or threats of damage associated with beaver, primarily from the breaching or removal of beaver dams. Beaver dam breaching or removal during activities to manage damage caused by beaver sometimes occurs in areas inundated by water from water impounded by beaver dams. Dam material usually consists of mud, sticks, and other vegetative material. Beaver dams obstruct the normal flow of water, which can change the preexisting hydrology from flowing or circulating waters to slower, deeper, more expansive waters that accumulate bottom sediment over time. The depth of the bottom sediment behind a beaver dam depends on the length of time water covers an area and the amount of suspended sediment in the water.

Beaver dams, over time, can establish new wetlands. The regulatory definition of a wetland stated by the

United States Army Corps of Engineers and the EPA (40 CFR 232.2) is:

"Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Therefore, the breaching or removal of a beaver dam could result in the degrading or removal of a wetland, if wetland characteristics exist at a location where a beaver dam occurs. The preexisting habitat (prior to the building of the dam) and the altered habitat (areas flooded by impounded water) have different ecological values to the fish and wildlife native to the area. Some species may benefit by the addition of a beaver dam that creates a wetland, while the presence of some species of wildlife may decline. For example, some darter species listed as federally endangered require fast moving waters over gravel or cobble beds, which beaver dams can eliminate; thus, reducing the availability of habitat. In areas where bottomland forests were flooded by beaver dams, a change in species composition could occur over time as trees die. Flooding often kills hardwood trees, especially when flooding persists for extended periods, as soils become saturated. Conversely, beaver dams could be beneficial to some wildlife, such as river otter, Neotropical migratory birds, and waterfowl that require aquatic habitats.

If water impounded by a beaver dam persists for an extended period, hydric soils and hydrophytic vegetation could eventually form. This process could take anywhere from several months to years depending on preexisting conditions. Hydric soils are those soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions. In general, hydric soils form much easier where wetlands have preexisted. Hydrophytic vegetation includes those plants that grow in water or on a substrate that is at least periodically deficient in oxygen because of excessive water content. If those conditions exist, then a wetland has developed that would have different wildlife habitat values than an area of impounded water from more recent beaver activity.

In addition, people often raise concerns regarding the use of lethal methods to remove beaver to alleviate damage or threats. If the TWSP removed beaver from an area and removed or breached any associated beaver dam, the manipulation of water levels by removing/breaching the dam could prevent the establishment of wetlands by preventing water conditions to persist long enough to establish wetland characteristics. If the TWSP removed beaver but left the beaver dam undisturbed, the lack of maintenance to the dam by beaver would likely result in the eventual recession of the impounded water as weathering eroded the dam.

2.3 ISSUES CONSIDERED BUT NOT IN DETAIL WITH RATIONALE

The TWSP identified additional issues during the scoping process of this EA. TWSP considered those additional issues but a detailed analysis did not occur for the reasons provided. Discussion of those additional issues and the reasons for not analyzing those issues in detail occur below.

Appropriateness of Preparing an EA (instead of an EIS) for Such a Large Area

The appropriateness of preparing an EA instead of an EIS was a concern identified by the TWSP during the scoping process. Wildlife damage management falls within the category of actions in which the exact timing or location of individual activities can be difficult to predict well enough ahead of time to describe accurately such locations or times in an EA or even an EIS. Although the TWSP could predict some of the possible locations or types of situations and sites where some kinds of wildlife damage would occur, the program cannot predict the specific locations or times at which affected resource owners would determine a damage problem had become intolerable to the point that they request assistance from the TWSP. In addition, the TWSP would not be able to prevent such damage in all areas where it might occur without resorting to destruction of wild animal populations over broad areas at a much more intensive level than would be desired by most people, including the TWSP and other agencies. Such broad scale population management would also be impractical or impossible to achieve within the policies and professional philosophies of the TWSP.

Lead agencies have the discretion to determine the geographic scope of their analyses under the NEPA (Kleppe v Sierra Club, 427 U.S. 390, 414 (1976), CEQ 1508.25). Ordinarily, according to the APHIS procedures implementing the NEPA, WS' individual wildlife damage management actions could be categorically excluded (7 CFR 372.5(c)). The intent in developing this EA has been to determine if the proposed action or the other alternatives could potentially have significant individual and/or cumulative impacts on the quality of the human environment that would warrant the preparation of an EIS. This EA addresses impacts for managing damage and threats to human safety associated with aquatic mammals in the State to analyze individual and cumulative impacts and to provide a thorough analysis.

In terms of considering cumulative effects, one EA analyzing impacts for the entire State would provide a more comprehensive and less redundant analysis than multiple EAs covering smaller areas. If the TWSP made a determination through this EA that the proposed action or the other alternatives could have a significant impact on the quality of the human environment, then the WS program would publish a notice of intent to prepare an EIS and this EA would be the foundation for developing the EIS. Based on previous requests for assistance, the TWSP in Texas would continue to conduct damage management on a very small percentage of the land area in the State where damage was occurring or likely to occur.

Impact on Biodiversity from Activities Conducted by the TWSP

The TWSP does not attempt to eradicate any species of native wildlife in the State. The TWSP operates in accordance with federal and state laws and regulations enacted to ensure species viability. The TWSP would use available methods to target individual aquatic mammals or groups of aquatic mammals identified as causing damage or posing a threat of damage. Any reduction of a local population or group is frequently temporary because immigration from adjacent areas or reproduction replaces the animals removed. As stated previously, the TWSP would only provide assistance under the appropriate alternatives after receiving a request to manage damage or threats. Therefore, if the TWSP provided direct operational assistance under the alternatives, the TWSP would provide assistance on a small percentage of the land area of Texas. In addition, the TWSP would only target those aquatic mammals identified as causing damage or posing a threat.

The TWSP would not attempt to suppress wildlife populations across broad geographical areas at such intensity levels for prolonged durations that significant ecological effects would occur. The goal of the TWSP would not be to manage wildlife populations but to manage damage caused by specific individuals of a species.

Often of concern with the use of certain methods is that aquatic mammals that lethally removed by the TWSP would only be replaced by other aquatic mammals after the TWSP completes activities (*e.g.*, aquatic mammal that relocate into the area) or by aquatic mammals the following year (*e.g.*, increase in reproduction and survivability that could result from less competition). The ability of an animal population to sustain a certain level of removal and to return to pre-management levels demonstrates that limited, localized damage management methods have minimal impacts on species' populations.

Chapter 4 evaluates the environmental consequences of the alternatives on the populations of target and non-target species based on available quantitative and qualitative parameters. The permitting of lethal removal by the TPWD would ensure cumulative removal levels would occur within allowable levels to maintain species' populations and meet population objectives for each species. Therefore, activities conducted pursuant to any of the alternatives would not adversely affect biodiversity in the State.

A Loss Threshold Should Be Established Before Allowing Lethal Methods

One issue identified through the implementation of the NEPA processes by the TWSP is a concern that the TWSP or other entities should establish a threshold of loss before employing lethal methods to resolve damage and that wildlife damage should be a cost of doing business. In some cases, cooperators likely tolerate some damage and economic loss until the damage reaches a threshold where the damage becomes an economic burden. The appropriate level of allowed tolerance or threshold before employing lethal methods would differ among cooperators and damage situations. In addition, establishing a threshold would be difficult or inappropriate to apply to human health and safety situations. For example, aircraft striking aquatic mammals could lead to property damage and could threaten passenger safety if a catastrophic failure of the aircraft occurred because of the strike. Therefore, addressing the threats of wildlife strikes prior to an actual strike occurring would be appropriate.

In a ruling for Southern Utah Wilderness Alliance, et al. vs. Hugh Thompson, Forest Supervisor for the Dixie National Forest, et al., the United States District Court of Utah determined that a forest supervisor could establish a need for wildlife damage management if the supervisor could show that damage from wildlife was threatened (Civil No. 92-C-0052A January 20, 1993). Thus, there is judicial precedence indicating that it is not necessary to establish a criterion such as a percentage of loss of a particular resource to justify the need for damage management actions.

Aquatic Mammal Damage Management Should Not Occur at Taxpayer Expense

An issue identified is the concern that the TWSP should not provide assistance at the expense of the taxpayer or that activities should be fee-based. Funding for the TWSP activities could occur from federal appropriations, through state funding, and through cooperative funding. Cooperative service agreements with individual property owners or managers could also fund activities conducted by the TWSP. The TWSP receives a minimal federal appropriation for the maintenance of a TWSP program in Texas. The remainder of the TWSP would mostly be fee-based. The TWSP would provide technical assistance to requesters as part of the federally funded activities; however, the majority of funding to conduct direct operational assistance in which employees of the TWSP perform damage management activities associated with aquatic mammals would occur through cooperative service agreements between the requester and the TWSP.

Additionally, damage management activities are an appropriate sphere of activity for government programs, since managing wildlife is a government responsibility. Treves and Naughton-Treves (2005) and the International Association of Fish and Wildlife Agencies (2005) discuss the need for wildlife damage management and that an accountable government agency is best suited to take the lead in such activities because it increases the tolerance for wildlife by those people being impacted by their damage and has the least impacts on wildlife overall.

Cost Effectiveness of Management Methods

The CEQ does not require a formal, monetized cost benefit analysis to comply with the NEPA. Consideration of this issue is not essential to making a reasoned choice among the alternatives the TWSP is considering. However, the methods determined to be most effective to reduce damage and threats to human safety caused by aquatic mammals and that prove to be the most cost effective would likely receive the greatest application. As part of an integrated approach and as part of the WS Decision Model, evaluation of methods would continually occur to allow for those methods that were most effective at resolving damage or threats to be employed under similar circumstance where aquatic mammals were causing damage or posing a threat. Additionally, management operations may be constrained by cooperator funding and/or objectives and needs. Therefore, the cost of methods can often influence the availability of methods to resolve damage, which can influence the effectiveness of methods. Discussion of cost effectiveness as it relates to the effectiveness of methods occurs in Chapter 4.

Aquatic Mammal Damage Should be managed by Private Wildlife Control Agents or Trappers

People experiencing damage caused by aquatic mammals could contact wildlife control agents and private trappers to reduce aquatic mammal damage when deemed appropriate by the resource owner. In addition, the TWSP could refer persons requesting assistance to agents and/or private individuals under all of the alternatives fully evaluated in the EA.

WS Directive 3.101 provides guidance on establishing cooperative projects and interfacing with private businesses. The TWSP would only respond to requests for assistance received and would not respond to public bid notices. When responding to requests for assistance, the TWSP would inform requesters that other service providers, including private entities, might be available to provide assistance.

Effects from the Use of Lead Ammunition in Firearms

Questions have arisen about the deposition of lead into the environment from ammunition used in firearms to remove aquatic mammals. As described in Appendix B, the lethal removal of aquatic mammals with firearms by the TWSP to alleviate damage or threats could occur using a handgun, rifle, or shotgun. In an ecological risk assessment of lead shot exposure in non-waterfowl birds, ingestion of lead shot was identified as the concern rather than just contact with lead shot or lead leaching from shot in the environment (Kendall et al. 1996).

The removal of aquatic mammals by the TWSP using firearms in the State would occur primarily from the use of rifles. However, the TWSP could employ the use of shotguns to remove some target animals and could use handguns to euthanize live-captured target animals. When possible, personnel from the TWSP would retrieve aquatic mammal carcasses for disposal. With risks of lead exposure occurring primarily from ingestion of bullet fragments, the retrieval and proper disposal of aquatic mammal carcasses would greatly reduce the risk of scavengers ingesting lead that carcasses may contain.

Deposition of lead into soil could occur if, during the use of a firearm, the projectile passed through the target animal, if misses occurred, or if the retrieval of the carcass did not occur. Laidlaw et al. (2005) reported that, because of the low mobility of lead in soil, all of the lead that accumulates on the surface layer of the soil generally stays within the top 20 cm (about 8 inches). In addition, concerns occur that lead from bullets deposited in soil from shooting activities could contaminate ground water or surface water. Stansley et al. (1992) studied lead levels in water subject to high concentrations of lead shot accumulation because of intensive target shooting at several shooting ranges. Lead did not appear to "*transport*" readily in surface water when soils were neutral or slightly alkaline in pH (*i.e*., not acidic), but lead did transport more readily under slightly acidic conditions. Although Stansley et al. (1992) detected elevated lead levels in water in a stream and a marsh that were in the shot "*fall zones*" at a shooting range, the study did not find higher lead levels in a lake into which the stream drained, except for one sample collected near a parking lot. Stansley et al. (1992) believed the lead contamination near the parking lot was due to runoff from the lot, and not from the shooting range areas. The study also indicated that even when lead shot was highly accumulated in areas with permanent water bodies present, the lead did not necessarily cause elevated lead levels in water further downstream. Muscle samples from two species of fish collected in water bodies with high lead shot accumulations had lead levels that were well below the accepted threshold standard of safety for human consumption (Stansley et al. 1992).

Craig et al. (1999) reported that lead levels in water draining away from a shooting range with high accumulations of lead bullets in the soil around the impact areas were far below the "*action level*" of 15 parts per billion as defined by the EPA (*i.e.*, requiring action to treat the water to remove lead). The study found that the dissolution (*i.e*., capability of dissolving in water) of lead declines when lead oxides form on the surface areas of the spent bullets and fragments (Craig et al. 1999). Therefore, the lead oxide deposits that form on the surface of bullets and shot serves to reduce the potential for ground or surface water contamination (Craig et al. 1999). Those studies suggest that, given the very low amount of lead that the TWSP could deposit and the concentrations that would occur from the activities conducted by the TWSP to reduce aquatic mammal damage using firearms, as well as most other forms of dry land small game hunting in general, lead contamination of water from such sources would be minimal to nonexistent.

Since those aquatic mammals removed by the TWSP using firearms could be lethally removed by the entities experiencing damage using the same method in the absence of involvement by the TWSP, assistance with removing those aquatic mammals by the TWSP would not be additive to the environmental status quo. The proficiency training received by employees of the TWSP in firearm use and accuracy would increase the likelihood that aquatic mammals were lethally removed humanely in situations that ensure accuracy and that misses occur infrequently, which further reduces the potential for lead to be deposited in the soil from misses or from projectiles passing through carcasses. Based on current information, the risks associated with lead projectiles that the TWSP could contribute to the environment due to misses, the projectile passing through the carcass, or from aquatic mammal carcasses that may be irretrievable would be below any level that would pose any risk from exposure or significant contamination.

Effects of Activities on Soils, Water, and Air Quality

The implementation of those alternative approaches discussed in Section 3.1 by the TWSP would meet the requirements of applicable federal laws, regulations, and Executive Orders for the protection of the environment, including the Clean Air Act and Executive Order 13514[8]. The actions discussed in this EA do not involve major ground disturbance, construction, or habitat alteration. Chapter 3 discusses the SOPs to reduce risks to the environment that the TWSP would incorporate into activities when implementing applicable alternative approaches to managing damage. Activities that the TWSP could implement pursuant to those applicable alternative approaches discussed in Section 3.1 would not alter aquatic systems or cause changes in the flow, quantity, or storage of water resources. Personnel of the TWSP would use, store, and dispose of all chemical methods in accordance with applicable laws and regulations pursuant to WS Directive 2.210. The use, storage, and disposal of chemical methods by WS' personnel would also follow WS' directives, including WS Directive 2.401, WS Directive 2.405, WS Directive 2.415, WS Directive 2.430, WS Directive 2.455, and WS Directive 2.465.

Personnel of the TWSP would follow EPA-approved label directions for all pesticide use (see WS Directive 2.401). The intent of the registration process for chemical pesticides is to assure minimal adverse effects occur to the environment when people use the chemicals in accordance with label directions. The TWSP would properly dispose of any excess solid or hazardous waste in accordance with applicable federal, tribal, state, and local regulations.

[8]Executive Order 13514 mandates that at least 15 percent of existing federal buildings and leases meet Energy Efficiency Guiding Principles by 2015, and that annual progress be made toward 100 percent conformance of all federal buildings, with a goal of 100% of all new federal buildings achieving zero-net-energy by 2030. "*Zero-net-energy building*" is defined in Executive Order 13514 as "*a building that is designed, constructed, and operated to require a greatly reduced quantity of energy to operate, meet the balance of energy needs from sources of energy that do not produce greenhouse gases, and therefore result in no net emissions of greenhouse gases and be economically viable*".

Consequently, the TWSP does not expect the alternative approaches discussed in Section 3.1 to significantly impact soils, geology, minerals, water quality and quantity, floodplains, other aquatic resources, air quality, prime and unique farmlands, timber, and range. Therefore, the EA will not analyze those elements further.

Influence of Global Climate Change

The State of the Climate in 2012 report indicates that every year has been warmer than the long-term average since 1976 (Blunden and Arndt 2013). Impacts of this change will vary throughout the United States, but some areas will experience air and water temperature increases, alterations in precipitation, and increased severe weather events. Temperature and precipitation often influence the distribution and abundance of a plant or animal species. According to the EPA (2016), as temperatures continue to increase, the ranges of many species will likely expand into northern latitudes and higher altitudes. Species adapted to cold climates may struggle to adjust to changing climate conditions (*e.g.*, less snowfall, range expansions of other species).

The impact of climate change on wildlife and their habitats is of increasing concern to land managers, biologists, and members of the public. For example, climate change may alter the frequency and severity of habitat-altering events, such as wildfires, weather extremes, such as drought, presence of invasive species, and wildlife diseases. WS recognizes that climate change is an ongoing concern and may result in changes in species range and abundance. Over time, a combination of factors is likely to lead to changes in the scope and nature of human-wildlife conflicts in the State. Because these types of changes are an ongoing process, this EA has developed a dynamic system, including SOPs, and built in measures that allow agencies to monitor for and adjust to impacts of ongoing changes in the affected environment (see Section 3.3 and Section 3.4).

If the TWSP selected an alternative approach to meeting the need for action that allows the program to provide assistance (see Section 3.1), the TWSP would monitor activities, in context of the issues analyzed in detail, to determine if the need for action and the associated impacts remain with the parameters established and analyzed in this EA. Pursuant to SOPs discussed in Section 3.3 and Section 3.4, the TWSP would continue to coordinate activities to reduce and/or prevent aquatic mammal damage in the State with the TPWD. The mission of the TPWD is "…*To manage and conserve the natural and cultural resources of Texas and to provide hunting, fishing and outdoor recreation opportunities for the use and enjoyment of present and future generations*". Therefore, coordinating activities would ensure the TPWD had the opportunity to incorporate any activities the TWSP conducts into population objectives established for wildlife populations in the State. If the TWSP determines there to be a new need for action, changed conditions, new issues, or new alternatives having different environmental impacts, the TWSP would supplement this analysis or conduct a separate evaluation pursuant to the NEPA. Through monitoring, the TWSP can evaluate and adjust activities as changes occur over time.

Monitoring by the TWSP would also include reviewing the list of species the USFWS considers as threatened or endangered within the State pursuant to the ESA. As appropriate, the TWSP would consult with the USFWS pursuant to Section 7 of the ESA to ensure the activities conducted by the TWSP would not jeopardize the continued existence of threatened or endangered species or result in adverse modification to areas designated as critical habitat for a species within the State. Through the review of species listed as threatened or endangered and the consultation process with the USFWS, the TWSP can evaluate and adjust activities conducted pursuant to any alternative approach selected to meet the need for action. Accordingly, the TWSP could supplement this analysis or conduct a separate evaluation pursuant to the NEPA based on the review and consultation process. In this way, any actions conducted by the TWSP would be responsive to ongoing climate changes and the associated cumulative impacts of actions conducted in Texas in accordance with the NEPA.

Greenhouse Gas Emissions by the WS Program

Under the alternative approaches intended to meet the need for action discussed in Chapter 3, the TWSP could potentially produce criteria pollutants (*i.e*., pollutants for which maximum allowable emission levels and concentrations are enforced by state agencies). Those activities could include working in the office, travel from office to field locations, and travel at field locations (vehicles or ATV). During evaluations of the national program to manage feral swine (*Sus scrofa*), the WS program reviewed greenhouse gas emissions for the entire national WS program (USDA 2015). The analysis estimated effects of vehicle, aircraft, office, and ATV use by WS for FY 2013 and included the potential new vehicle purchases that could be associated with a national program to manage damaged caused by feral swine. The review concluded that the range of Carbon Dioxide Equivalents (includes CO_2, NO_x CO, and SO_x) for the entire national WS program would be below the reference point of 25,000 metric tons per year recommended by CEQ for actions requiring detailed review of impacts on greenhouse gas emissions. The activities that the TWSP could conduct under the alternative approaches discussed in Chapter 3 would have negligible cumulative effects on atmospheric conditions, including the global climate.

A Site Specific Analysis Should be made for Every Location Where Damage Management Would Occur

The underlying intent for preparing an EA is to determine if a proposed action might have a significant impact on the human environment. The EA development process is issue driven, meaning issues that were raised during the interdisciplinary process and through public involvement that were substantive, would be used to drive the analysis and determine the significance of the environmental impacts of the proposed action and the alternatives. Therefore, the level of site specificity must be appropriate to the issues listed.

The issues raised during the scoping process of this EA drove the analysis. In addition to the analysis contained in this EA, personnel of the TWSP use the WS Decision Model (Slate et al. 1992) described in Chapter 3 as a site-specific tool to develop the most appropriate strategy at each location. The WS Decision Model is an analytical thought process used by personnel of the TWSP for evaluating and responding to requests for assistance.

As discussed previously, one EA analyzing impacts for the entire State would provide a more comprehensive and less redundant analysis that allows for a better cumulative impact analysis. If a determination were made through this EA that the alternatives developed to meet the need for action could result in a significant impact on the quality of the human environment, then an EIS would be prepared.

CHAPTER 3: ALTERNATIVES

Chapter 3 contains a discussion of the alternatives that the TWSP developed to meet the need for action discussed in Chapter 1 and to address the identified issues discussed in Chapter 2. The TWSP developed the alternatives based on the need for action and the issues using the WS Decision model (Slate et al. 1992). The alternatives will receive detailed environmental impacts analysis in Chapter 4 (Environmental Consequences). Chapter 3 also discusses the rationale behind alternatives considered but not analyzed in detail as well as the SOPs that the TWSP would incorporate into the relevant alternatives.

3.1 DESCRIPTION OF THE ALTERNATIVES

The TWSP developed the following alternatives to meet the need for action and address the identified issues associated with managing damage caused by aquatic mammals in the State.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

This alternative would continue the current implementation of an adaptive integrated approach utilizing non-lethal and lethal techniques, when requested, as deemed appropriate using the WS Decision Model, to reduce damage and threats caused by aquatic mammals in Texas. A major goal of the program would be to resolve and prevent damage caused by aquatic mammals and to reduce threats to human safety. To meet this goal, the TWSP would continue to respond to requests for assistance with, at a minimum, technical assistance, or when funding was available, operational damage management. Funding could occur through federal appropriations, through state funding, or from cooperative funding. The adaptive approach to managing damage associated with aquatic mammals would integrate the use of the most practical and effective methods to resolve a request for damage management as determined by a site-specific evaluation to reduce damage or threats to human safety for each request. The TWSP would provide city/town managers, agricultural producers, property owners, and others requesting assistance with information regarding the use of appropriate non-lethal and lethal techniques.

Under this alternative, the TWSP could respond to requests for assistance by: 1) taking no action, if warranted, 2) providing only technical assistance to property owners or managers on actions they could take to reduce damages caused by aquatic mammals, or 3) providing technical assistance and direct operational assistance to a property owner or manager experiencing damage. To meet the need for action, the objectives of this alternative would be to assist all of the people requesting assistance from the TWSP, within the constraints of available funding and workforce.

The TWSP could provide property owners or managers requesting assistance with information regarding the use of effective and practical non-lethal and lethal techniques. The TWSP would give preference to non-lethal methods when practical and effective under this alternative (see WS Directive 2.101). Property owners or managers may choose to implement the recommendations of the TWSP on their own (*i.e*., technical assistance), use contractual services of private businesses, use volunteer services of private organizations, use the services of the TWSP (*i.e*., direct operational assistance), take the management action themselves, or take no further action.

The TWSP would work with those persons experiencing aquatic mammal damage to address those aquatic mammals responsible for causing damage as expeditiously as possible. To be most effective, damage management activities should occur as soon as aquatic mammals begin to cause damage. Once aquatic mammals become familiar with a particular location (*i.e*., conditioned to an area), dispersing those aquatic mammals or making the area unattractive can be difficult. The TWSP would work closely with those entities requesting assistance to identify situations where damage could occur and begin to implement damage management activities under this alternative as early as possible to increase the likelihood of those methods achieving the level of damage reduction requested by the cooperating entity.

The WS Decision Model would be the implementing mechanism for a damage management program under Alternative 1, which would be adapted to an individual damage situation. This alternative would allow the TWSP to use the broadest range of methods to address damage or the threat of damage. When the TWSP receives a request for direct operational assistance, the TWSP would conduct site visits to assess the damage or threats, would identify the cause of the damage, and would apply the Decision Model described by Slate et al. (1992) and WS Directive 2.201 to determine the appropriate methods to resolve or prevent damage. Discussion of the WS Decision Model and the use of the Model by the TWSP under Alternative 1 occur below. In addition, the TWSP would give preference to non-lethal methods when practical and effective (see WS Directive 2.101).

Non-lethal methods that would be available for use by the TWSP under this alternative include, but are not limited to minor habitat modification, behavior modification, live traps, translocation, exclusionary devices, water control devices for beaver, frightening devices, immobilizing drugs, and chemical repellents (see Appendix B for a complete list and description of potential methods). In addition, the TWSP could remove or breach beaver dams using binary explosives and hand tools. Once the determination was made that removing or breaching a beaver dam was appropriate and the beaver dam could be removed in accordance with the CWA (see Appendix D), the breaching or removal of the dam could be conducted manually using hand tools or when safe and appropriate, with use of binary explosives. Lethal methods that would be available to WS under this alternative include body-gripping traps, cable devices, the recommendation of harvest during the hunting and/or trapping seasons, euthanasia chemicals, zinc phosphide (muskrats and nutria only), and shooting. Target aquatic mammal species live-captured using non-lethal methods (*e.g.*, live-traps, immobilizing drugs) could be euthanized. In addition, the TWSP could use foothold traps and submersion rods or cables in drowning sets[9]. The lethal control of target aquatic mammals would comply with WS Directive 2.505.

Discussing methods does not imply that all methods would be used or recommended by the TWSP to resolve requests for assistance and does not imply that all methods would be used to resolve every request for assistance. The most appropriate response would often be a combination of non-lethal and lethal methods, or there could be instances where application of lethal methods alone would be the most appropriate strategy. For example, if an entity requesting assistance had already attempted to alleviate damage using non-lethal methods, the TWSP would not necessarily employ those same non-lethal methods, since the previous use of those methods were ineffective at reducing damage or threats to an acceptable level to the requester.

Many lethal and non-lethal methods are intended to be short-term attempts at reducing damage occurring at the time those methods were employed. Long-term solutions to managing aquatic mammal damage could include limited habitat manipulations and changes in cultural practices, which are techniques addressed further below and in Appendix B.

Non-lethal methods can disperse or otherwise make an area unattractive to aquatic mammals causing damage; thereby, reducing the presence of aquatic mammals at the site and potentially the immediate area around the site where non-lethal methods were employed. The TWSP would give preference to non-lethal methods when addressing requests for assistance (see WS Directive 2.101). However, the TWSP would not necessarily employ non-lethal methods to resolve every request for assistance if deemed inappropriate by personnel of the TWSP using the WS Decision Model, especially when the requesting entity had used non-lethal methods previously and found those methods to be inadequate to resolving the damage or threats of damage. Employees of the TWSP would use non-lethal methods to exclude, harass, and disperse target wildlife from areas where damage or threats were occurring. When effective, non-lethal methods would disperse aquatic mammals from an area resulting in a reduction in the presence of those aquatic mammals at the site where a person employed those methods. For any management methods employed, the proper timing would be essential in effectively dispersing those aquatic mammals causing damage. Employing methods soon after damage begins or soon after a property owner or manager identifies threats, increases the likelihood that those damage management activities would achieve success in addressing damage. Therefore, coordination and timing of methods would be necessary to be effective in achieving expedient resolution of aquatic mammal damage.

Under Alternative 1, the TWSP could employ only non-lethal methods when determined to be appropriate for each request for assistance to alleviate damage or reduce threats of damage using the WS Decision

[9]Section 4.1 and Appendix B provides additional information on the use of foothold traps and submersion cables or rods.

Model. In some situations, a cooperating entity has tried to employ non-lethal methods to resolve damage prior to contacting the TWSP for assistance. In those cases, the methods employed by the requester were either unsuccessful or the reduction in damage or threats had not reached a level that was tolerable to the requesting entity. In those situations, the TWSP could employ other non-lethal methods, attempt to apply the same non-lethal methods, or employ lethal methods. In many situations, the implementation of non-lethal methods, such as exclusion-type barriers, would be the responsibility of the requester, which means that, in those situations, the only function of the TWSP would be to implement lethal methods, if determined to be appropriate using the WS Decision Model.

The TWSP could employ lethal methods to resolve damage associated with those aquatic mammals identified by the TWSP as responsible for causing damage or threats to human safety under this alternative; however, the TWSP would only employ lethal methods after receiving a request for the use of those methods. Surveys in North Carolina and Alabama indicated the majority of landowners with beaver damage on their property that were surveyed desired damage management via beaver removal (Hill 1976, Woodward et al. 1985). Loker et al. (1999) found that suburban residents also might desire lethal management methods to resolve beaver damage conflicts. Such conflicts that occur between property owners and beaver can result in negative effects that often outweigh the benefits of having beaver on an owner's property (Miller and Yarrow 1994). The use of lethal methods could result in local population reductions in the area where damage or threats were occurring since people could remove individual aquatic mammals from the population. The TWSP and other entities often employ lethal methods to reinforce non-lethal methods and to remove aquatic mammals that the TWSP or other entities identify as causing damage or posing a threat to human safety. The number of aquatic mammals removed from the population using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of aquatic mammals involved with the associated damage or threat, and the efficacy of methods employed.

Often of concern with the use of lethal methods is that aquatic mammals that were lethally removed would only be replaced by other aquatic mammals either after the application of those methods (*e.g.*, aquatic mammals that relocate into the area) or by aquatic mammals the following year (*e.g.*, increase in reproduction and survivability that could result from less competition). As stated previously, the TWSP would not use lethal methods as population management tools over broad areas. The use of lethal methods would be intended to reduce the number of individuals of a target aquatic mammal species present at a specific location where damage was occurring by targeting those aquatic mammals causing damage or posing threats. The intent of lethal methods would be to manage damage caused by those individuals of an aquatic mammal species and not to manage entire aquatic mammal populations.

WS may recommend that people harvest aquatic mammal the regulated hunting and/or trapping season for those species in an attempt to reduce the number of aquatic mammals causing damage. Managing aquatic mammal populations over broad areas could lead to a decrease in the number of aquatic mammals causing damage. Establishing hunting or trapping seasons and the allowed harvest levels during those seasons is the responsibility of the TPWD. The TWSP does not have the authority to establish hunting or trapping seasons or to set allowed harvest numbers during those seasons.

Appendix B contains a complete list of methods available for use under this alternative. However, listing methods neither implies that all methods would be used by the TWSP to resolve requests for assistance nor does the listing of methods imply that all methods would be used to resolve every request for assistance. As part of an integrated approach, the TWSP may provide technical assistance and direct operational assistance to those people experiencing damage associated with aquatic mammals when those persons request assistance from the TWSP.

Technical Assistance Recommendations

Under Alternative 1, the TWSP would provide technical assistance to those persons requesting assistance with managing damage as part of an integrated approach. Technical assistance would occur as described in Alternative 2 of this EA. From FY 2013 through FY 2015, the TWSP conducted 1,441 technical assistance projects that involved aquatic mammal damage to agricultural resources, property, natural resources, and threats to human safety (see Table 1.1).

Direct Operational Assistance

Operational damage management assistance would include damage management activities that personnel of the TWSP conduct directly or activities that employees of the TWSP supervised. Initiation of operational damage management assistance could occur when the problem could not be effectively resolved through technical assistance alone and there was a written MOU, work initiation document, or other comparable document signed between the TWSP and the entity requesting assistance. The initial investigation by personnel of the TWSP would define the nature, history, and extent of the problem; species responsible for the damage; and methods available to resolve the problem. The professional skills of personnel of the TWSP could be required to resolve problems effectively, especially if chemical methods were necessary or if the problems were complex. To meet the need for action, the objective of the TWSP would be to provide direct operational assistance within two weeks of the TWSP receiving a request for such assistance.

Educational Efforts

Education is an important element of activities because wildlife damage management is about finding balance and coexistence between the needs of people and needs of wildlife. This is extremely challenging as nature has no balance, but rather is in continual flux. In addition to the routine dissemination of recommendations and information to individuals or organizations, the TWSP provides lectures, courses, and demonstrations to producers, homeowners, state and county agents, colleges and universities, and other interested groups. The TWSP frequently cooperates with other entities in education and public information efforts. Additionally, employees of the TWSP would continue to write technical papers and provide presentations at professional meetings and conferences so that other wildlife professionals and the public were aware of recent developments in damage management technology, programs, laws and regulations, and agency policies.

Research and Development

The National Wildlife Research Center (NWRC) functions as the research unit of WS by providing scientific information and the development of methods for wildlife damage management, which are effective and environmentally responsible. Research biologists with the NWRC work closely with wildlife managers, researchers, and others to develop and evaluate methods and techniques for managing wildlife damage. Research biologists with the NWRC have authored hundreds of scientific publications and reports based on research conducted involving animals and methods to manage damage.

WS' Decision Making Procedures

The WS Decision Model (see WS Directive 2.201) described by Slate et al. (1992) depicts how personnel from the TWSP would use a thought process for evaluating and responding to damage complaints. Personnel from the TWSP would assess the problem and then evaluate the appropriateness and availability (legal and administrative) of strategies and methods based on biological, economic, and social considerations. Following this evaluation, employees of the TWSP would incorporate methods deemed practical for the situation into a damage management strategy. After employees of the TWSP implemented this strategy, employees would continue to monitor and evaluate the strategy to assess effectiveness. If the strategy were effective, the need for further management would end. In terms of the WS Decision Model, most efforts to resolve animal damage consist of continuous feedback between receiving the request and monitoring the results of the damage management strategy. The Decision Model is not a written documented process, but a mental problem-solving process common to most, if not all, professions, including the TWSP.

The general thought process and procedures of the WS Decision Model would include the following steps.

1. **Receive Request for Assistance:** The TWSP would only provide assistance after receiving a request for such assistance. The TWSP would not respond to public bid notices.
2. **Assess Problem:** First, the TWSP would make a determination as to whether the assistance request was within the authority of the TWSP. If an assistance request were within the authority of the TWSP, employees of the TWSP would gather and analyze damage information to determine applicable factors, such as what species was responsible for the damage, the type of damage, the extent of damage, and the magnitude of damage. Other factors that employees of the TWSP could gather and analyze would include the current economic loss or current threat (*e.g.*, threat to human safety), the potential for future losses or damage, the local history of damage, and what management methods, if any, were used to reduce past damage and the results of those actions.
3. **Evaluate Management Methods:** Once a problem assessment was completed, an employee of the TWSP would conduct an evaluation of available management methods. The employee would evaluate available methods in the context of their legal and administrative availability and their acceptability based on biological, environmental, social, and cultural factors.
4. **Formulate Management Strategy:** An employee of the TWSP would formulate a management strategy using those methods that the employee determines to be practical for use. The employee would also consider factors essential to formulating each management strategy, such as available expertise, legal constraints on available methods, costs, and effectiveness.
5. **Provide Assistance:** After formulating a management strategy, an employee of the TWSP could provide technical assistance and/or direct operational assistance to the requester (see WS Directive 2.101).
6. **Monitor and Evaluate Results of Management Actions:** When providing direct operational assistance, it is necessary to monitor the results of the management strategy. Monitoring would be important for determining whether further assistance was required or whether the management strategy resolved the request for assistance. Through monitoring, an employee of the TWSP would continually evaluate the management strategy to determine whether additional techniques or modification of the strategy was necessary.
7. **End of Project:** When providing technical assistance, a project would normally end after an employee of the TWSP provided recommendations or advice to the requester. A direct operational assistance project would normally end when personnel of the TWSP stop or reduce the damage or threat to an acceptable level to the requester or to the extent possible. Some damage situations may require continuing or intermittent assistance from personnel of the TWSP and may have no well-defined termination point, such as aquatic mammals burrowing into levees where non-lethal methods (*e.g.*, rip-rap) were not possible or practical.

Community-based Decision Making

The TWSP could receive requests for assistance from community leaders and/or representatives. In those situations, the TWSP would follow the "*co-managerial approach*" to solve wildlife damage or conflicts as described by Decker and Chase (1997) under this alternative. Within this management model, the TWSP could provide technical assistance regarding the biology and ecology of aquatic mammals and effective, practical, and reasonable methods available to the local decision-maker(s) to reduce damage or threats. This could include non-lethal and lethal methods. The TWSP and other state and federal wildlife management agencies may facilitate discussions at local community meetings when resources were available. Under this approach, resource owners and others directly affected by aquatic mammal damage or conflicts would have direct input into the resolution of such problems. They may implement management recommendations provided by TWSP or others, or may request direct operational assistance from TWSP, other wildlife management agencies, local animal control agencies, or private businesses or organizations.

The community representative(s) and/or decision-maker(s) for the local community would be elected officials or representatives of the communities. The community representative(s) and/or decision-maker(s) who oversee the interests and business of the local community would generally be residents of the local community or appointees that other members of the community popularly elected. This person or persons would represent the local community's interest and make decisions for the local community or bring information back to a higher authority or the community for discussion and decision-making. Identifying the decision-maker for local business communities can be more complex because building owners may not indicate whether the business must manage wildlife damage themselves, or seek approval to manage wildlife from the property owner or manager, or from a governing board of representatives.

Under a community based decision-making process, the TWSP could provide information, demonstration, and discussion on available methods to the appropriate representative(s) of the community and/or community decision-maker(s) that requested assistance, which would help ensure that decisions made by representatives of the community and/or the decision-makers were based on community-based input. The TWSP would only provide direct operational assistance if the local community representative(s) and/or decision-maker(s) requested such assistance and only if the assistance requested was compatible with recommendations made by the TWSP.

By involving community representatives and/or community decision-makers in the process, the TWSP could present information that would allow decisions on damage management to involve those individuals that the representatives and/or decision-maker(s) represent. As addressed in this EA, the TWSP could provide technical assistance to the appropriate representative(s) and/or decision-maker(s), including demonstrations and presentation by the TWSP at public meetings to allow for involvement of the community. Requests for assistance to manage damage caused by aquatic mammals often originate from the decision-maker(s) based on community feedback or from concerns about damage or threats to human safety. As representatives of the community, the community representative(s) and/or decision-maker(s) would be able to provide the information to local interests either through technical assistance provided by the TWSP or through demonstrations and presentations by the TWSP on damage management activities. This process would allow the TWSP, the community representative(s), and/or decision-maker(s) to make decisions on damage management activities based on local input. The community leaders could implement management recommendations provided by the TWSP or others, or may request management assistance from the TWSP, other wildlife management agencies, local animal control agencies, or private businesses or organizations.

Decision-makers on Private Property

In the case of private property owners, the decision-maker is the individual that owns or manages the affected property. The decision-maker has the discretion to involve others as to what occurs or does not occur on property they own or manage. Therefore, in the case of an individual property owner or manager, the involvement of others and to what degree others were involved in the decision-making process would be a decision made by that individual. The TWSP could provide direct operational assistance when requested; however, the TWSP would only provide assistance if the requested management actions were in accordance with recommendations made by the TWSP.

Decision-makers on Public Property

The decision-maker for local, state, or federal property would be the official responsible for or authorized to manage the public land to meet interests, goals, and legal mandates for the property. The TWSP could provide technical assistance to this person and make recommendations to reduce damage. The TWSP could provide direct operational assistance when requested; however, the TWSP would only provide assistance if the requested management actions were in accordance with the recommendations made by the TWSP.

Alternative 2 – Aquatic Mammal Damage Management by the WS Program through Technical Assistance Only

Under this alternative, the federal WS program would continue to participate as part of the TWSP; however, when people contacted personnel with the WS program, WS' personnel would provide those people seeking assistance with technical assistance only. WS could also provide technical assistance to the Texas A&M AgriLife Extension Service and the TWDMA and refer people requesting assistance to the TWSP (Texas A&M AgriLife Extension Service and the TWDMA), the TPWD, and/or private entities. The Texas A&M AgriLife Extension Service and the TWDMA could continue to provide assistance as described in Alternative 1 or provide no assistance similar to Alternative 3.

Similar to the other alternatives, WS could receive requests for assistance from community representatives, private individuals/businesses, or from public entities. Technical assistance provided by the WS program would provide those people experiencing damage or threats caused by aquatic mammals with information, demonstrations, and recommendations on available and appropriate methods. The implementation of methods and techniques to resolve or prevent damage would be the responsibility of the requester with no direct involvement by the WS program; however, the TWSP could provide direct operational assistance. In some cases, WS may provide supplies or materials that were of limited availability for use by private entities (*e.g.*, loaning of traps). Technical assistance could be provided through a personal or telephone consultation, or during an on-site visit with the requester. Generally, WS' personnel would describe several management strategies to the requester for short and long-term solutions to managing damage. WS' personnel would base those strategies on the level of risk, need, and the practicality of their application. Personnel with the WS program would use the WS Decision Model to recommend those methods and techniques available to the requester to manage damage and threats of damage. Those people receiving technical assistance from the WS program could implement those methods recommended by WS, could employ other methods not recommended by WS, could seek assistance from the TWSP, could seek assistance from other entities, or take no further action.

Under Alternative 2, the WS program would recommend an integrated approach similar to Alternative 1 when receiving a request for assistance; however, the WS program would not provide direct operational assistance under this alternative. WS' personnel would give preference to non-lethal methods when practical and effective under this alternative (see WS Directive 2.101). WS' personnel would use the WS Decision Model and information provided by the individual seeking assistance as the basis for determining and recommending appropriate methods and techniques. In some instances, wildlife-related information provided to the requester by the WS program would result in tolerance/acceptance of the situation. In other instances, WS' personnel would discuss and recommend damage management options. WS' personnel would only recommend or loan those methods that were legally available for use by the appropriate individual. Similar to Alternative 1, those methods described in Appendix B would be available to those people experiencing damage or threats associated with aquatic mammals in the State;

however, immobilizing drugs and euthanasia chemicals would have limited availability to the public and other entities under this alternative and Alternative 3.

Immobilizing drugs and euthanasia chemicals would only be available to employees of the WS program, appropriately licensed veterinarians, or people under the supervision of a veterinarian. The EPA has designated zinc phosphide as a restricted use pesticide; therefore, only persons that have completed the requirements for obtaining a pesticide applicators license issued by the TDA could purchase zinc phosphide and only licensed pesticide applicators could use zinc phosphide or people under their supervision.

The TWSP, including the WS program, regularly provides technical assistance to individuals, organizations, and other federal, state, and local government agencies for managing aquatic mammal damage. Technical assistance would include collecting information about the species involved, the extent of the damage, and previous methods that the cooperator had attempted to resolve the problem. The WS program would then provide information on appropriate methods that the cooperator could consider to resolve the damage themselves. Types of technical assistance projects may include a visit to the affected property, written communication, telephone conversations, or presentations to groups, such as homeowner associations or civic leagues.

This alternative would place the immediate burden of operational damage management work on the resource owner, the Texas A&M AgriLife Extension Service, the TWDMA, other governmental agencies, and/or private businesses. Those persons experiencing damage or were concerned with threats posed by aquatic mammals could seek assistance from the TWSP, other governmental agencies, private entities, or conduct damage management on their own. Those people experiencing damage or threats could take action using those methods legally available to resolve or prevent aquatic mammal damage as permitted by federal, state, and local laws and regulations or those persons could take no action.

Alternative 3 – No Involvement with Managing Aquatic Mammal Damage by the WS Program

Under this alternative, the federal WS program would not provide any assistance with managing damage caused by aquatic mammals in the State. The WS program could continue to participate with the TWSP in other activities but would not provide assistance when receiving requests for assistance associated with aquatic mammals. WS' personnel would refer all requests for assistance associated with aquatic mammals to the TWSP (Texas A&M AgriLife Extension Service and the TWDMA), the TPWD, other governmental agencies, and/or private entities. The TWSP, consisting of the Texas A&M AgriLife Extension Service and the TWDMA, could continue to provide assistance as described in Alternative 1 or Alternative 2.

Despite no involvement by the WS program in resolving damage and threats associated with aquatic mammals in the State, those people experiencing damage caused by aquatic mammals could continue to resolve damage through assistance provided by the TWSP. In addition, those people experience damage or threats of damage caused by aquatic mammals could continue to employ those methods legally available to address aquatic mammal damage on their own. The removal of aquatic mammals by other entities could occur after authorization by the TPWD, when required, and during the hunting and/or trapping seasons. Landowners or their designees can remove beaver, otter, muskrat, and nutria that are causing damage to their property without the need for a permit from TPWD. In addition, property owners or managers experiencing damage could request assistance from other entities (*e.g.*, private trappers, private business).

Similar to Alternative 2, those methods described in Appendix B would generally be available to those people experiencing damage or threats associated with aquatic mammals in the State; however, immobilizing drugs and euthanasia chemicals would have limited availability to the public and other entities under this alternative. Under this alternative, appropriately licensed veterinarians or people under their supervision would be the only entities that could use immobilizing drugs and euthanasia chemicals. Zinc phosphide is a restricted use pesticide; therefore, only persons with a pesticide applicators license could purchase zinc phosphide and only licensed pesticide applicators could use zinc phosphide or people under their supervision.

Under this alternative, those people experiencing damage or threats of damage could contact the WS program; however, WS would immediately refer the requester to the TWSP, to the TPWD, and/or to other entities. The requester could contact other entities for information and assistance with managing damage, could take actions to alleviate damage without contacting any entity, or could take no further action.

3.2 ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

In addition to those alternatives analyzed in detail, the TWSP identified several additional alternatives. However, those alternatives will not receive detailed analyses for the reasons provided. Those alternatives considered but not analyzed in detail include:

Non-lethal Methods Implemented Before Lethal Methods

This alternative would require that the federal WS program apply non-lethal methods or techniques described in Appendix B to all requests for assistance to reduce damage and threats to safety from aquatic mammals in the State. If the use of non-lethal methods failed to resolve the damage situation or reduce threats to human safety at each damage situation, the WS program could employ lethal methods to resolve the request. The WS program would apply non-lethal methods to every request for assistance regardless of severity or intensity of the damage or threat until deemed inadequate to resolve the request. This alternative would not prevent the use of lethal methods by the TWSP (*i.e*., Texas A&M AgriLife Extension Service and the TWDMA), other entities, or by those persons experiencing aquatic mammal damage but would only prevent the use of those methods by the federal WS program until WS had employed non-lethal methods.

Those people experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting the WS program. Verification of the methods used would be the responsibility of the WS program. No standard exists to determine requester diligence in applying those methods, nor are there any standards to determine how many non-lethal applications are necessary before the initiation of lethal methods. Thus, the WS program could only evaluate the presence or absence of non-lethal methods. Alternative 1 and Alternative 2 would be similar to a non-lethal before lethal alternative because the WS program would give preference to the use of non-lethal methods before lethal methods (see WS Directive 2.101). Adding a non-lethal before lethal alternative and the associated analysis would not contribute additional information to the analyses in the EA.

Use of Non-lethal Methods Only by the WS Program

Under this alternative, the federal WS program would be required to implement non-lethal methods only to resolve damage caused by aquatic mammals in the State. The WS program would only employ those methods discussed in Appendix B that were non-lethal. No intentional lethal removal of aquatic mammals would occur by the WS program. The use of lethal methods could continue under this alternative by other entities or by those persons experiencing damage by aquatic mammals. The non-lethal methods used or recommended by the WS program under this alternative would be identical to those non-lethal methods identified in any of the alternatives.

In situations where non-lethal methods were impractical or ineffective to alleviate damages, the WS program could refer requests for information regarding lethal methods to the TWSP (*i.e.*, Texas A&M AgriLife Extension Service and the TWDMA), the TPWD, private businesses, or other entities.

Property owners or managers could conduct management using any method that was legal. Property owners or managers might choose to implement non-lethal recommendations made by the WS program, implement lethal methods, or request assistance from a private or public entity other than the WS program. Property owners/managers frustrated by the lack of assistance of the WS program with the full range of aquatic mammal damage management techniques may try methods not recommended by the WS program or use illegal methods (*e.g.*, poisons). In some cases, property owners or managers may misuse some methods or use some methods in excess of what was necessary, which could then become hazardous and pose threats to the safety of people and non-target species.

Using an integrated damage management approach, Alternative 1 incorporates the use of non-lethal methods when addressing requests for assistance. In those instances where non-lethal methods would effectively resolve damage from aquatic mammals, the WS program would use or recommend those methods under Alternative 1. Since non-lethal methods would be available for use under the alternatives analyzed in detail, this alternative would not add to the analyses. Those persons experiencing damage or threats of damage could lethally remove aquatic mammals under any of the alternatives even if the WS program was limited to using non-lethal methods only.

Use of Lethal Methods Only by the WS program

This alternative would require the use of lethal methods only to reduce threats and damage associated with aquatic mammals. However, non-lethal methods can be effective in preventing damage in certain instances. For example, Sheffels et al. (2014) found that placing plastic mesh tubes around newly planted woody vegetation at riparian restoration sites could prevent nutria from feeding on the vegetation. In addition, Sheffels et al. (2014) found that planting woody plant species that were less preferred by nutria might be another method to reduce damage to newly planted restoration sites. Under WS Directive 2.101, the WS program must consider the use of non-lethal methods before lethal methods. Non-lethal methods have been effective in alleviating aquatic mammal damage in some cases. For example, exclusion methods can be effective at preventing beaver from chewing on and felling trees. In those situations where damage could be alleviated effectively using non-lethal methods, the WS program would employ or recommend those methods as determined by the WS Decision Model. Therefore, the TWSP did not consider this alternative in detail.

Live-capture and Translocate Aquatic Mammals Only

Under this alternative, the WS program would address all requests for assistance using live-capture methods or the recommendation of live-capture methods and the WS program would translocate all aquatic mammals live-captured. The success of translocation efforts would depend on efficiently capturing the target aquatic mammals causing damage and the existence of an appropriate release site (Nielsen 1988). Aquatic mammals would be live-captured using live-traps to alleviate damage. The WS program would translocate all aquatic mammals live-captured through direct operational assistance under this alternative. Translocation sites would be identified and have to be approved by the TPWD and/or the property owner where the translocated aquatic mammals would be released prior to live-capture and translocation. Live-capture and translocation of aquatic mammals could be conducted as part of the alternatives analyzed in detail. However, the translocation of aquatic mammals could only occur under the authority of the TPWD. Therefore, the translocation of aquatic mammals by the WS program would only occur as directed by the TPWD. When requested by the TPWD, the WS program could translocate aquatic mammals or recommend translocation under any of the alternatives analyzed in detail, except under the no involvement by the WS program alternative (Alternative 3). However, other entities could translocate aquatic mammals under Alternative 3, if authorized by the TPWD.

Translocation may be appropriate in some situations when a species population is low. However, aquatic mammals are abundant in much of the suitable habitat in Texas, and translocation is not necessary for the maintenance of viable populations in the State. Because aquatic mammals are abundant in Texas, the aquatic mammals that the WS program translocated and released into suitable habitat would likely encounter other aquatic mammals with established territories. For example, if the WS program could translocate beaver, the release of beaver into suitable habitat would likely occur in areas where other beaver already occur. Beaver are territorial, and introducing translocated beaver into new areas often disorientates the beaver because they are unfamiliar with their surroundings. Therefore, translocated beaver are often at a disadvantage. Territorial beaver often viciously attack other beaver that people release or that wander into their territories and those injuries sustained during those attacks oftentimes causes the death of translocated beaver (McNeely 1995). Survival of translocated animals is generally very poor due to the stress of translocation, and in many cases, released animals suffer mortality in a new environment (Craven et al. 1998, Petro et al. 2015). Courcelles and Nault (1983) found that 50% (n=10) of radio-collared, relocated beaver died, probably from stress or predation resulting from the relocation. Of the 30 beaver radio-tagged by Petro et al. (2015) in Oregon, eight died within 30 days of release and four died within 90 days of release, with predation and disease/illness being the primary cause of death. Petro et al. (2015) found that most predation on relocated beaver occurred during the first week after release.

Relocated beaver also may disperse long distances from the release site (Novak 1987). Only 12% of beaver relocated in streams and 33% of beaver relocated in lake and pothole areas remained at the release site (Knudsen and Hale 1965). Hibbard (1958) recorded an average dispersal distance by 17 relocated beaver to be approximately 9 miles in North Dakota, and Denney (1952) reported an average dispersal of 10.4 miles and a maximum dispersal of 30 miles for 26 beaver transplanted in Colorado. Beaver relocated on streams and later recaptured (n=200) moved an average distance of 4.6 miles, and in lake and pothole relocations (n=272) moved an average of 2 miles (Knudsen and Hale 1965). Of 114 beaver relocated in Wyoming, McKinstry and Anderson (2002) found that 51% of the beaver moved more than 6.2 miles from their release site. Petro et al. (2015) found relocated beaver in Oregon traveled a mean distance of nearly 2.1 stream miles within 16 weeks post-release, with the longest dispersal distance being 18.1 stream miles from the release site.

Generally, translocating aquatic mammals that have caused damage to other areas following live-capture would not be effective or cost-effective. Translocation is generally ineffective because aquatic mammals are highly mobile and can easily return to damage sites from long distances, aquatic mammals generally already occupy habitats in other areas, and translocation could result in damage problems at the new location. For example, a property owner may give permission to relocate beaver to their property; however, since beaver are likely to disperse from their release site, they may cross several landowner boundaries during their dispersal, which entities must consider during efforts to translocate beaver (Petro et al. 2015). Live-trapping and translocating aquatic mammals is biologically unsound and not cost-efficient (Wade and Ramsey 1986). Translocation of wildlife is also discouraged by WS policy (see WS Directive 2.501) because of the stress to the translocated animal, poor survival rates, threat of spreading diseases, and the difficulties that translocated wildlife have with adapting to new locations or habitats (Nielsen 1988).

In addition, nutria are an invasive species; therefore, translocation of nutria would be inappropriate. Lastly, the WS program, the TPWD, and the property owner where the original capture took place could be liable for any property damage caused by translocated aquatic mammals. Therefore, the TWSP did not consider this alternative in detail.

Use of Non-lethal Methods and Approved Euthanasia Only

Under this alternative, the WS program would continue to employ an integrated approach but would only employ non-lethal methods to exclude, harass, or live-capture target aquatic mammals. When deemed appropriate, the WS program could continue to remove aquatic mammals lethally; however, under this alternative, the WS program would only use methods that captured target aquatic mammals alive. Once live-captured, target aquatic mammals would be euthanized using methods that meet the definition of euthanasia as defined by the American Veterinary Medical Association. Under this alternative, the only methods that would be available to live-capture beaver would be certain cable devices, foothold traps, suitcase traps, and cage traps. For muskrats and nutria, the only live-capture methods that would be available would be floating colony traps, foothold traps, and cage traps. Other non-lethal methods would also be available to resolve damage or threats of damage under this alternative and those methods would be similar to those non-lethal methods described under Alternative 1. The methods that would not be available under this alternative would be the use of foothold traps for submersion sets, the use of body-grip traps, zinc phosphide (for muskrats and nutria), and the use of firearms (except firearms could be used once target animals were live-captured).

Euthanasia methods would be restricted to those defined by the American Veterinary Medical Association (2013) as acceptable or conditionally acceptable, and would include sodium pentobarbital, potassium chloride, carbon dioxide, and firearms (once live-captured). This alternative would be similar to Alternative 1 since the WS program would give preference to the use of non-lethal methods when practical and effective (see WS Directive 2.101). In addition, WS' personnel would be familiar with the euthanasia methods described by the American Veterinary Medical Association and would use those methods to euthanize captured or restrained animals, whenever practicable (see WS Directive 2.430, WS Directive 2.505). Therefore, the TWSP did not consider this alternative in detail.

Reducing Damage by Managing Aquatic Mammal Populations through the Use of Reproductive Inhibitors

Under this alternative, the only method that would be available to resolve requests for assistance by the WS program would be the recommendation and the use of reproductive inhibitors to reduce or prevent reproduction in aquatic mammals responsible for causing damage. Wildlife professionals often consider reproductive inhibitors for use where wildlife populations are overabundant and where traditional hunting or lethal control programs are not publicly acceptable (Muller et al. 1997). Population dynamic characteristics (*e.g.*, longevity, age at onset of reproduction, population size, and biological/cultural carrying capacity), habitat and environmental factors (*e.g.*, isolation of target population, cover types, and access to target individuals), socioeconomic, and other factors often limit the use and effectiveness of reproductive control as a tool for wildlife population management.

Reproductive control for wildlife could occur through sterilization (permanent) or contraception (reversible). Sterilization could be accomplished through: 1) surgical sterilization (vasectomy, castration, and tubal ligation), 2) chemosterilization, and 3) through gene therapy. Contraception could be accomplished through: 1) hormone implantation (synthetic steroids such as progestins), 2) immunocontraception (contraceptive vaccines), and 3) oral contraception (progestin administered daily).

Population modeling indicates that reproductive control is more efficient than lethal control only for some rodent and small bird species with high reproductive rates and low survival rates (Dolbeer 1998). Additionally, the need to treat a sufficiently large number of target animals, multiple treatments, and population dynamics of free-ranging populations place considerable logistic and economic constraints on the adoption of reproduction control technologies as a wildlife management tool for some species.

Novak (1987) conducted a review of research evaluating chemically induced and surgically induced reproductive inhibition as a method for controlling beaver populations. Research on several reproductive inhibitors proposed for use in beaver population reduction has occurred, including research on quinestrol (17-alpha-ethynyl-estradiol-3-cyclopentylether) and mestranol (Gordon and Arner 1976, Wesley 1978). The use of chemosterilants as a means of managing the reproductive output of beaver has been successful in controlled experiments (Davis 1961, Arner 1964). However, while evidence suggests chemosterilants could reduce beaver reproduction in controlled experiments, no practical and effective method for distributing chemosterilants in a consistent way to wild, free ranging beaver populations has been developed or proven (Hill et al. 1978, Wesley 1978). Although those methods were effective in reducing beaver reproduction by up to 50%, those methods were not practical or too expensive for large-scale application. Inhibition of reproduction also may affect behavior, physiological mechanisms, and colony integrity (Brooks et al. 1980). Additionally, reproductive control does not alleviate current damage problems (Organ et al. 1996).

Currently, chemical reproductive inhibitors are not available for use to manage aquatic mammal populations. Given the costs associated with live-capturing and performing sterilization procedures on aquatic mammals and the lack of availability of chemical reproductive inhibitors for the management of most aquatic mammal populations, this alternative was not evaluated in detail. If reproductive inhibitors become available to manage aquatic mammal populations and are effective in reducing localized aquatic mammal populations, the WS program could evaluate the use of the inhibitor as a method available to manage damage. The use of reproductive inhibitors would require the approval of the TDA.

Compensation for Aquatic Mammal Damage

The compensation alternative would require the WS program to establish a system to reimburse persons impacted by aquatic mammal damage and to seek funding for the program. Under such an alternative, the WS program would continue to provide technical assistance to those persons seeking assistance with managing damage. In addition, the WS program would conduct site visits to verify damage. Evaluation of this alternative indicates that a compensation only alternative has many drawbacks. Compensation would require large expenditures of money and labor to investigate and validate all damage claims, and to determine and administer appropriate compensation. Compensation most likely would be below full market value and would give little incentive to resource owners to limit damage through improved cultural or other practices and management strategies. In addition, providing compensation would not be practical for reducing threats to human health and safety.

Short Term Eradication and Long Term Population Suppression

An eradication alternative would direct all the efforts of the WS program toward total long-term elimination of aquatic mammal populations wherever the WS program initiated a cooperative program in Texas. Eradication of native aquatic mammal species is not a desired population management goal of State agencies, the TWSP, or the WS program. The TWSP did not consider eradication as a general strategy for managing aquatic mammal damage because the Texas A&M AgriLife Extension Service, the TWDMA, the WS program, the TPWD, and other state or federal agencies with interest in, or jurisdiction over, wildlife oppose eradication of any native wildlife species and eradication is not acceptable to most people.

Suppression would direct the efforts of the WS program toward managed reduction of certain problem populations or groups. In areas where the WS program could attribute damage to localized populations of aquatic mammals, the WS program could decide to implement local population suppression using the WS Decision Model. However, large-scale population suppression would not be realistic or practical to consider as the basis of the WS program. Problems with the concept of suppression would be similar to those described above for eradication. Typically, the WS program would conduct activities on a very small portion of the sites or areas inhabited or frequented by target species in the State.

Bounties

Most wildlife professionals have not supported payment of funds (bounties) for removing animals suspected of causing damage, or posing threats of damage, for many years (Latham 1960). The TWSP concurs because of several inherent drawbacks and inadequacies in the payment of bounties. Bounties are often ineffective at controlling damage over a wide area, such as across the entire State. When a person claims a bounty, it is difficult or impossible to assure that people did not lethally remove animals outside an area where those species were causing damage. In addition, the WS program does not have the authority to establish a bounty program.

3.3 STANDARD OPERATING PROCEDURES FOR DAMAGE MANAGEMENT

SOPs improve the safety, selectivity, and efficacy of activities intended to resolve wildlife damage. The TWSP uses many such SOPs. Personnel of the TWSP would incorporate those SOPs into activities under the appropriate alternatives when addressing aquatic mammal damage and threats in the State.

Some key SOPs pertinent to resolving aquatic mammal damage in the State include the following:

- Personnel of the TWSP would consistently use and apply the WS Decision Model, which would identify effective strategies to managing damage and the potential effects of those strategies, when addressing aquatic mammal damage.

- Personnel of the TWSP would follow the EPA-approved label directions for all pesticide use. The intent of the registration process for chemical pesticides is to assure minimal adverse effects occur to the environment when entities use chemicals in accordance with label directions.

- Personnel of the TWSP would use immobilizing drugs and euthanasia chemicals according to the United States Drug Enforcement Administration and United States Food and Drug Administration guidelines, along with WS' directives and procedures.

- Personnel of the TWSP would only use controlled substances registered with the United States Drug Enforcement Administration or the United States Food and Drug Administration.

- Employees of the TWSP would follow approved procedures outlined in the WS' Field Manual for the Operational Use of Immobilizing and Euthanizing Drugs (Johnson et al. 2001).

- Employees of the TWSP that use controlled substances would receive training to use those substances and would receive certification to use controlled substances.

- Employees of the TWSP who use pesticides and controlled substances would participate in State-approved continuing education to keep current of developments and maintain their certifications.

- Pesticide and controlled substance use, storage, and disposal would conform to label instructions and other applicable laws and regulations, and Executive Order 12898.

- Personnel of the TWSP involved with specific damage management activities would receive appropriate Material Safety Data Sheets for pesticides and controlled substances.

- All personnel who use firearms would receive safety training according to WS' Directives.

- Employees of the TWSP would consider the use of non-lethal methods prior to the use of lethal methods when managing aquatic mammal damage.

- Employees of the TWSP would direct management actions toward localized populations, individuals, or groups of target species. TWSP would not conduct generalized population suppression across the entire State, or even across major portions of Texas.

- Employees of the TWSP would release non-target animals live-captured in traps unless it was determined that the animal would not survive and/or that the animal could not be released safely.

3.4 ADDITIONAL STANDARD OPERATING PROCEDURES SPECIFIC TO THE ISSUES

Several additional SOPs are applicable to the alternatives and the issues identified in Chapter 2 including the following:

Issue 1 - Effects of Damage Management Activities on Target Aquatic Mammal Populations

- The TWSP would monitor the lethal removal of aquatic mammals to evaluate population trends and to evaluate the magnitude of the TWSP removal of aquatic mammals in the State.

- The TWSP would provide the TPWD with information on the removal of aquatic mammals by the TWSP to alleviate damage, which would ensure the TPWD has the opportunity to consider any removal by the TWSP as part of management objectives for aquatic mammal species in the State.

- The TWSP would only target those individuals or groups of target species identified as causing damage or posing a threat to human safety.

- Personnel of the TWSP would use the WS Decision Model, designed to identify the most appropriate damage management strategies and their impacts, to determine strategies for resolving aquatic mammal damage.

- The TWSP would monitor activities to ensure those activities do not adversely affect aquatic mammal populations in the State.

- Personnel of the TWSP would give preference to non-lethal methods when practical and effective.

Issue 2 - Effects on the Populations of Non-target Animals, Including T&E Species

- When conducting removal operations via shooting, identification of the target would occur prior to application.

- As appropriate, personnel of the TWSP would use suppressed firearms to minimize noise.

- Personnel would use lures, trap placements, and capture devices that employees would strategically place at locations likely to capture a target animal and minimize the potential of non-target animal captures.

- Personnel of the TWSP would release any non-target animals live-captured in cage traps or any other restraining device whenever it was possible and safe to do so.

- Personnel would check live-capture methods in accordance with Texas laws and regulations. This would help ensure that TWSP personnel could release non-target species in a timely manner.

- Employees of the TWSP would dispose of aquatic mammal carcasses retrieved after conducting damage management activities in accordance with WS Directive 2.515.

- The TWSP has consulted with the USFWS and the TPWD to evaluate activities to resolve aquatic mammal damage and threats to ensure the protection of T&E species.

- The TWSP has evaluated potential effects to listed and candidate amphipods. The TWSP has not received any requests for damage management activities associated with aquatic mammals in the range of those species and does not anticipate any such requests. Since no activities are planned in these areas, the TWSP has made a "*no effect*" determination for those species. If requests are received, or if new species are listed, the TWSP will reevaluate the request and consult with the USFWS if proposed actions "*may affect*" the listed species.

- The TWSP has evaluated the potential for impacts to 20 listed and candidate mollusks and determined the program will have no effect on listed species. Many of the requests for management are received relative to artificial water sources (*e.g.*, stock ponds or drainage ditches). Additionally, the TWSP does no beaver damage management in the main stem of rivers or streams that would dewater the areas. The TWSP will coordinate with the USFWS if requests for beaver damage management is associated with known populations of endangered mollusks.

- The TWSP reviews current data from the USFWS on the range of the Houston toad (*Bufo houstonensis*) and, if activities are necessary in that range, the TWSP will conduct toad surveys using protocol established by the USFWS. If toads were determined not to be present, then the TWSP would conduct aquatic damage management activities within 6 months, consistent with the Section 7 consultation with the USFWS. Further, if potential habitat is determined to be occupied, the TWSP will consult with the USFWS on a case-by-case basis, if necessary.

- Within the range of the Texas trailing phlox (*Phlox nivalis* ssp. *texensis*), Texas prairie dawn-flower (*Hymenoxys texana*), and the Navasota ladies-tresses (*Spiranthes parksii*), access to sites where activities could be conducted will be restricted to existing roads and trails or via water to avoid adverse impacts to these species. If other plant species are listed, the TWSP will evaluate the occupied areas and the proposed project request to determine if access needs to be restricted to avoid negative impacts to the species.

- The TWSP would monitor activities conducted under the selected alternative, if activities were determined to have no significant impact on the environment and an EIS was not required, to ensure those activities do not negatively affect non-target species.

Issue 3 - Effects of Damage Management Methods on Human Health and Safety

- Employees of the TWSP would conduct damage management activities professionally and in the safest manner possible. Whenever possible, employees would conduct damage management activities away from areas of high human activity. If this were not possible, then employees would conduct activities during periods when human activity was low (*e.g.*, early morning).

- Personnel of the TWSP would conduct shooting during times when public activity and access to the control areas were restricted. Personnel involved in shooting operations receive training in the proper and safe application of this method.

- To provide procedures and accountability for the use of explosives to remove beaver dams by the TWSP, employees would adhere to WS Directive 2.435.

- All personnel employing chemical methods would receive proper training and certification in the use of those chemicals. All chemicals used by the TWSP would be securely stored and properly monitored to ensure the safety of the public. WS Directive 2.401 and WS Directive 2.430 outline how the TWSP would use chemicals and training requirements to use those chemicals.

- All chemical methods used by the TWSP or recommended by the TWSP would be registered with the EPA, the United States Drug Enforcement Administration, the United States Food and Drug Administration and/or the TDA, as appropriate.

- The TWSP would adhere to all established withdrawal times agreed up by the TWSP and veterinarian authorities for aquatic mammals when using immobilizing drugs for the capture of aquatic mammals. Although unlikely, in the event that the TWSP was requested to immobilize aquatic mammals, during a time when harvest of those aquatic mammal species was occurring or during a time where the withdrawal period could overlap with the start of a harvest season, the TWSP would euthanize the animal or mark the animal with a tag. Tags would be labeled with a "*do not eat*" warning and appropriate contact information.

- Personnel of the TWSP would dispose of aquatic mammal carcasses retrieved after damage management activities in accordance with WS Directive 2.515.

Issue 4 - Effects on the Aesthetic Values of Aquatic Mammals

- Personnel of the TWSP would direct management actions to reduce or prevent damage caused by aquatic mammals toward specific individuals identified as responsible for the damage, identified as posing a threat to human safety, or identified as posing a threat of damage.

- Those entities requesting assistance would agree upon all methods or techniques applied to resolve damage or threats to human safety by signing a work initiation document, MOU, or comparable document prior to the implementation of those methods.

- Personnel of the TWSP would give preference to non-lethal methods when practical and effective.

Issue 5 - Humaneness and Animal Welfare Concerns of Methods

- Personnel would receive training in the latest and most humane devices/methods for removing target aquatic mammals causing damage.

- Personnel of the TWSP would check methods in accordance with the laws and regulations in Texas to address those aquatic mammals live-captured in a timely manner, which would minimize the stress of the animal.

- When deemed appropriate using the WS Decision Model, the use of lethal methods by the TWSP would comply with WS' directives (*e.g.*, see WS Directive 2.401, WS Directive 2.430, WS Directive 2.505).

- The NWRC is continually conducting research to improve the selectivity and humaneness of wildlife damage management devices used by personnel in the field.

- Personnel of the TWSP would consider the use of non-lethal methods prior to the use of lethal methods when managing aquatic mammal damage.

Issue 6 – Effects of Beaver Removal and Dam Manipulation on the Status of Wetlands in the State

- Personnel of the TWSP would remove beaver dams in accordance with federal and state laws and regulations for environmental protection. The TWSP would conduct beaver dam removal to restore drainage or the stream channel for an area that has not become an established wetland.

- Upon receiving a request to remove beaver dams, the TWSP would visually inspect the dam and the associated water impoundment to determine if characteristics exist at the site that would meet the definition of a wetland under section 404 of the CWA (40 CFR 232.2; see Issue 6 in Section 2.2 of this EA). If wetland conditions were present at the site, the TWSP would proceed consistent with established protocols or guidance from the TCEQ or the United States Army Corps of Engineers.

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

Chapter 4 provides information needed for making informed decisions when selecting the appropriate alternative to address the need for action described in Chapter 1 and the issues described in Chapter 2. This chapter analyzes the environmental consequences of each alternative as that alternative relates to the issues identified. The following resource values in the State are not expected to be significantly impacted by any of the alternatives analyzed: soils, geology, minerals, water quality/quantity, flood plains, wetlands, critical habitats (areas listed in T&E species recovery plans), visual resources, air quality, prime and unique farmlands, aquatic resources, timber, and range. This EA will not consider those resources further.

The activities proposed in the alternatives would have a negligible effect on atmospheric conditions, including the global climate. Meaningful direct or indirect emissions of greenhouse gases would not occur because of any of the proposed alternatives. Those alternatives would meet the requirements of applicable laws, regulations, and Executive Orders, including the Clean Air Act and Executive Order 13514.

4.1 ENVIRONMENTAL CONSEQUENCES FOR ISSUES ANALYZED IN DETAIL

This section analyzes the environmental consequences of each alternative in comparison to determine the extent of actual or potential impacts on the issues. Therefore, the proposed action/no action alternative (Alternative 1) serves as the baseline for the analysis and the comparison of expected impacts among the alternatives. The analysis also takes into consideration mandates, directives, and the procedures of the TWSP.

Issue 1 - Effects of Damage Management Activities on Target Aquatic Mammal Populations

Methods available to address aquatic mammal damage or threats of damage in the State that would be available for use or recommendation under Alternative 1 (proposed action/no action alternative) and

Alternative 2 (technical assistance only alternative) would either be lethal methods or non-lethal methods. Many of the methods would also be available to other entities under Alternative 3 (no involvement by the TWSP alternative). The only methods that would have limited availability under Alternative 2 and Alternative 3 would be immobilizing drugs and euthanasia chemicals. Under Alternative 2, the TWSP could recommend lethal and non-lethal methods as part of an integrated approach to resolving requests for assistance. Alternative 1 would address requests for assistance received by the TWSP through technical and/or direct operational assistance where personnel of the TWSP would employ and/or recommend an integrated methods approach. Non-lethal methods that would be available to the TWSP under Alternative 1 would include water control devices for beaver, live traps, translocation, cable devices, exclusionary devices, immobilizing drugs, and chemical repellents (see Appendix B for a complete list and description of potential methods).

Non-lethal methods that would be available under all of the alternatives could disperse or otherwise make an area unattractive to aquatic mammals causing damage; thereby, reducing the presence of aquatic mammals at the site and potentially the immediate area around the site where WS' personnel employed the non-lethal methods. Employees of the TWSP would give preference to non-lethal methods when addressing requests for assistance under Alternative 1 and Alternative 2 (see WS Directive 2.101). However, employees would not necessarily employ or recommend non-lethal methods to resolve every request for assistance if an employee deemed those methods to be inappropriate using the WS Decision Model. For example, if a cooperator requesting assistance had already used non-lethal methods, the TWSP would not likely recommend or continue to employ those particular methods since their use had already been proven ineffective in adequately resolving the damage or threat.

The continued use of many non-lethal methods can often lead to the habituation of aquatic mammals to those methods, which can decrease the effectiveness of those methods. For any management methods employed, the proper timing would be essential in effectively dispersing those aquatic mammals causing damage. Employing methods soon after damage begins or soon after identifying threats would increase the likelihood those damage management activities would achieve success in addressing damage. Therefore, the coordination and timing of methods would be necessary to be effective in achieving expedient resolution of aquatic mammal damage.

Many non-lethal methods exclude, harass, and disperse target wildlife from areas where damage or threats were occurring. Harassment methods have generally proven ineffective in reducing beaver damage (Jackson and Decker 2004). When effective, non-lethal methods would disperse aquatic mammals from the area resulting in a reduction in the presence of those aquatic mammals at the site. However, aquatic mammals responsible for causing damage or threats could disperse to other areas with minimal impact on those species' populations. Personnel of the TWSP and other entities would not employ non-lethal methods over large geographical areas or apply those methods at such intensity that essential resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over such a wide geographical scope that long-term adverse effects would occur to a species' population. Non-lethal methods would generally have minimal impacts on overall populations of wildlife since individuals of those species were unharmed. The use of non-lethal methods would not have adverse impacts on aquatic mammal populations in the State under any of the alternatives.

A common issue is whether damage management actions would adversely affect the populations of target aquatic mammal species when using lethal methods. The TWSP would maintain ongoing contact with the TPWD to ensure activities occurred within management objectives for those species. Therefore, the TPWD would have the opportunity to monitor the total removal of aquatic mammals from all sources and would factor in survival rates from predation, disease, and other mortality data. Ongoing contact with the TPWD would assure the TPWD has the opportunity to consider local, state, and regional knowledge of wildlife population trends. As discussed previously, the analysis for magnitude of impact from lethal removal can be determined either quantitatively or qualitatively. Quantitative determinations can use information from population estimates, allowable harvest levels, and actual harvest data. Qualitative determinations can use information on population trends and harvest trend data. Several sources, including published literature and harvest data, can provide information on aquatic mammal populations and trends.

Lethal methods would also be available for use under all the alternatives by the TWSP and/or by other entities. Lethal methods that would be available to address aquatic mammal damage include live-capture followed by euthanasia, shooting, body-gripping traps, cable devices, zinc phosphide (muskrats and nutria only), and the recommendation of harvest during the hunting and/or trapping seasons, where appropriate. In addition, the TWSP could use foothold traps and submersion rods or cables for submersion sets. All of those methods would be available for use by the TWSP or for recommendation by the TWSP under Alternative 1. Personnel of the TWSP could employ lethal methods under Alternative 1 to resolve damage only after receiving a request for the use of those methods. Those same methods would also be available for the TWSP to recommend and for other entities to use under Alternative 2. Under Alternative 3, those same lethal methods would continue to be available for use by other entities despite the lack of involvement by the TWSP in damage management activities.

When personnel of the TWSP intend to remove live-captured target animals under Alternative 1, removal would occur pursuant to WS Directive 2.505 and WS Directive 2.430. Under alternative 2, the TWSP could recommend the use of methods to lethally remove live-captured or restrained target animals in accordance with WS Directive 2.505. Personnel of the TWSP would not provide assistance under Alternative 3; however, many of those methods available to lethally remove live-captured or restrained animals would continue to be available for use by other entities under Alternative 3.

The use of lethal methods by any entity could result in local population reductions in the area where damage or threats were occurring by removing individual target animals from a population. Personnel of the TWSP could employ or recommend lethal methods to remove target animals that employees identify as causing damage or posing a threat to human safety. Therefore, the use of lethal methods could result in local reductions of aquatic mammals in the area where damage or threats were occurring. The number of aquatic mammals removed from the population annually by the TWSP using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of aquatic mammals involved with the associated damage or threat, and the efficacy of methods employed. The number of aquatic mammals removed by other entities under Alternative 2 and Alternative 3 would be unknown but would likely be similar to the removal that could occur under Alternative 1.

Employees of the TWSP and other licensed entities could use the rodenticide zinc phosphide to target specific or localized populations of muskrats and/or nutria where damage or threats of damage were occurring. Products containing zinc phosphide require a restricted-use pesticide applicators license from the TDA to purchase and to apply those products. According to the EPA, zinc phosphide, when ingested, reacts with the acids in the gut, which releases phosphine gas. Phosphine gas, when inhaled, interferes with cell respiration, which leads to the death of the animal (EPA 1998). Rodenticides containing zinc phosphide are generally restricted-use pesticides, which, if available, could be purchased and applied by appropriately licensed people, and would not be products that were restricted to use by the TWSP only.

The intent of most lethal methods is to reduce the number of aquatic mammals present at a location since a reduction in the number of aquatic mammals at a location could lead to a reduction in damage, which would be applicable whether using lethal or non-lethal methods. The intent of many non-lethal methods would be to harass, exclude, or otherwise make an area unattractive to aquatic mammals, which may disperse or dissuade those aquatic mammals to other areas leading to a reduction in damage at the location. The intent of using lethal methods would be similar to the intent when using non-lethal methods, which would be to reduce the number of aquatic mammals in the area where damage was occurring; thereby, reducing the damage occurring at that location.

The use of firearms could reduce the number of aquatic mammals using a location (similar to dispersing aquatic mammals) by lethally removing those target animals causing damage or posing a threat of damage. WS' employees could also capture aquatic mammals using live-traps and subsequently euthanize those aquatic mammals to reduce the number of aquatic mammals using a particular area where damage was occurring. Similarly, the intent of recommending people harvest aquatic mammals during the regulated hunting and/or trapping season would be to manage those populations in the area where damage was occurring.

Often of concern with the use of lethal methods is that aquatic mammals that were lethally removed would only be replaced by other aquatic mammals either during the application of those methods (*e.g.*, aquatic mammals that relocate into the area) or by aquatic mammals the following year (*e.g.*, increase in reproduction and survivability that could result from less competition). As stated previously, WS would not use lethal methods during direct operational assistance as population management tools over broad areas. Under Alternative 1, personnel of the TWSP would use lethal methods to reduce the number of target animals present at a location where damage was occurring by targeting those animals causing damage or posing threats. The return of aquatic mammals to areas where personnel previously employed methods does not indicate the previous use of those methods was ineffective since the intent of those methods was to reduce the number of aquatic mammals present at a site at the time personnel of the TWSP employed those methods.

The intent when using most lethal methods is to reduce the number of aquatic mammals present at a location since a reduction in the number of aquatic mammals at a location could lead to a reduction in damage, which is applicable whether using lethal or non-lethal methods. The intent of many non-lethal methods would be to harass, exclude, or otherwise make an area unattractive to aquatic mammals, which could potentially disperse those aquatic mammals to other areas, which could potentially lead to a reduction in damage at the location. The intent of using lethal methods would be similar to the objective someone is trying to achieve when using non-lethal methods, which would be to reduce the number of aquatic mammals in the area where damage was occurring. Reducing the number of aquatic mammals in an area where damage is occurring can lead to a reduction in the damage occurring at that location.

Most lethal and non-lethal methods currently available provide only short-term benefits when addressing aquatic mammal damage. WS' personnel would employ those methods to reduce damage occurring at the time those methods were employed; however, short-term methods do not necessarily ensure aquatic mammals would not return once personnel discontinued using those methods or after the reproductive season (when young disperse and occupy vacant areas). Long-term solutions to resolving aquatic mammal damage can often be difficult to implement and can be costly. In some cases, long-term solutions involve exclusionary devices, such as fencing, or other practices, such as structural changes (*e.g.*, replacing existing culverts with culverts that have a wider opening). When addressing aquatic mammal damage, long-term solutions generally involve modifying existing characteristics of the site or making conditions less attractive to aquatic mammals. To ensure complete success, alternative sites in areas where damage was not likely to occur would often times be required to achieve complete success in reducing damage and to avoid moving the problem from one area to another. Modifying a site to be less attractive to aquatic mammals would likely result in the dispersal of those aquatic mammals to other areas where damage could occur or could result in multiple occurrences of damage situations.

The populations of beaver and muskrats are sufficient to allow for annual harvest seasons. Under Alternative 1 and Alternative 2, the TWSP may recommend that property owners or managers allow people to harvest aquatic mammals during the regulated hunting and/or trapping season for those species in an attempt to reduce the number of aquatic mammals causing damage on their properties. Managing localized aquatic mammal populations by allowing hunting and/or trapping could lead to a decrease in the number of aquatic mammals causing damage. Establishing hunting and trapping seasons and the allowed harvest during those seasons is the responsibility of the TPWD. The TWSP does not have the authority to establish hunting or trapping seasons or to set allowed harvest numbers during those seasons. However, the harvest of those aquatic mammals during hunting and/or trapping seasons in the State would be occurring in addition to any removal that could occur by the TWSP under the alternatives or recommended by the TWSP. In addition, other entities could lethally remove aquatic mammals to alleviate damage or threats of damage under all the alternatives. The total number of individuals from each species that other entities remove to alleviate damage or threats of damage is currently not available. A discussion of the potential impacts on the populations of target aquatic mammal species occurs below for each alternative.

The NEPA requires federal agencies to determine whether their actions have a "*significant impact on the quality of the human environment*". A declining population of a resident wildlife species on a local level does not necessarily equate to a "*significant impact*" as defined by the NEPA if the decline is collectively condoned or desired by the people that live in the affected human population. It is reasonable and proper to rely on the representative form of government within a state as the established mechanism for determining the "*collective*" desires or endorsements of the people of a state. The TWSP abides by this philosophy and defers to the collective desires of the people of the State of Texas by complying with State laws and regulations that govern the removal or capture of resident wildlife. Although the analysis herein indicates no negative impacts to aquatic mammal populations, should a decline occur in the future, it would not constitute a "*significant*" impact, as defined by the NEPA, if actions causing the decline are in accordance with State law, and concomitantly, the collective desires of the people of Texas.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

Under Alternative 1, the TWSP would continue to provide both technical assistance and direct operational assistance to those persons requesting assistance with managing damage and threats associated with aquatic mammals in the State. The TWSP could employ those methods described in Appendix B in an adaptive approach that would integrate methods to reduce damage and threats associated with aquatic mammals in the State.

The analysis for each of the species includes an estimate of annual removal by the TWSP as compared to statewide population estimates for the species. The estimated statewide population for each species uses the best available information. Frequently, current reliable information is not available for a species; therefore, population estimates often use conservative calculations based upon habitat availability and a species use of those habitats.

As discussed previously, the analysis to determine the magnitude of impact from lethal removal can occur either quantitatively or qualitatively. Population estimates, allowable harvest levels, and actual harvest data are quantitative examples. Population trends and harvest trend data are qualitative example. The removal that could occur by the TWSP to alleviate damage or threats of damage under Alternative 1 would be monitored by comparing numbers of animals killed with overall populations or trends in populations to assure the magnitude of removal was maintained below the level that would cause undesired adverse effects to the viability of native species' populations. The potential impacts on the populations of target aquatic mammal species from the implementation of the proposed action (Alternative 1) occur for each species below.

BEAVER POPULATION INFORMATION AND EFFECTS ANALYSIS

The North American beaver is a semi-aquatic mammal occurring in rivers, streams, lakes, reservoirs, and wetlands across North America. Beaver are large, bulky rodents whose most prominent features include a large scaly, paddle-shaped tail and nearly orange colored incisors (Hill 1982). Most adults weigh from 15.8 to 38.3 kg (35 to 50 lbs) with some occasionally reaching more than 45 kg (100 lbs), and are the largest North American rodents (Miller and Yarrow 1994). They range throughout most of Canada and the United States, with the exception of portions of Florida and the desert southwest. Beaver are active throughout most of the year and are primarily nocturnal, but they can be active during daylight hours. Beaver living along a river or large stream generally make bank burrows with multiple underwater entrances. Those in quiet streams, lakes, and ponds usually build dams and a lodge (National Audubon Society 2000). Signs that beaver are present in an area include gnawing around the bases of trees and trees that have fallen because of the gnawing. Beaver strip and eat bark, which is their primary source of food. Beaver are unique in their ability to create and modify their habitat by building dams (Boyles and Owens 2007).

Fur harvesters trapped beaver extensively during the 19th and part of the 20th century, and as a result, beaver disappeared from much of their range (Novak 1987). Through translocation efforts of state wildlife agencies and the regulation of harvest to protect from overexploitation, beaver currently occupy most of their former range and have exceeded the social carrying capacity in some areas. Dams built and maintained by beaver may flood stands of timber, roadways, and croplands. However, the dams also help reduce erosion, and the water impoundments formed by dams may create a favorable habitat for many forms of life (Hill 1982, Baker and Hill 2003).

Beaver often occur in family groups that consist of two adult parents with offspring from the current and/or the previous breeding season. The average family group ranges from 3.2 to 9.2 individuals (Novak 1987). Reports of beaver abundance often occur in terms of families per kilometer of stream or per square kilometer of habitat. Densities in terms of families per square kilometer have been reported to range from 0.15 to 4.6 families (Novak 1987), which is the same as 0.4 to 11.9 families per square mile. In streams, Novak (1987) summarized beaver abundance as ranging from 0.31 to 1.5 families per kilometer of stream, which converts to 0.8 to 3.9 families per mile of stream. Novak (1987) stated beaver populations are density dependent, which means that rates of increase generally occur as a population reduction occurs and become less as a population increases toward its carrying capacity[10]. This natural function of most wildlife populations helps to mitigate population reductions. Logan et al. (1996) indicated that wildlife populations held at a level below carrying capacity could sustain a higher level of harvest because of the compensatory mechanisms that cause higher rates of increase in such populations.

Beaver have a relatively low biotic potential due to their small litter size and a long juvenile development period. Population matrix models show that survival of kits (1st year juveniles) and yearlings (2nd year juveniles) is the most critical factor in population viability. Survival of those age classes is partly dependent on the ability of beaver to successfully disperse and re-colonize habitats. Beaver are strong dispersers, and populations can recover quickly from local reductions when dispersal corridors are maintained (Boyles and Owens 2007).

Coyotes, black bears, bobcats, fishers, red fox, river otters, mink, and large raptors, such as hawks and owls, can prey on beaver (Tesky 1993, Baker and Hill 2003, Jackson and Decker 2004). With the exception of coyote, bear, and bobcat predation, most predation likely occurs to kits, yearlings, and young

[10]Carrying capacity is the maximum number of animals that the environment can sustain and is determined by the availability of food, water, cover, and the tolerance of crowding by the species in question.

adults. With little exception, those predator species do not appear to exert significant predation pressure on beaver populations (Baker and Hill 2003).

The current population of beaver in the State is unknown; however, beaver are present in nearly all of the counties in Texas, and their population is not known to be declining. Since population estimates are not currently available, the analysis will derive a population estimate based on the best available information for beaver to provide an indication of the magnitude of removal proposed by the TWSP to alleviate damage and threats of damage. Beaver population estimates often use density data for beaver based on the number of beaver families per a linear unit of measure (*e.g.*, stream miles) or per unit of area (*e.g.*, habitat type) (Baker and Hill 2003). In addition, population estimates depend on the number of individual beaver per family (Novak 1987).

Beaver densities specific to Texas are currently not available. As discussed previously, beaver densities per unit of area calculated from other studies in the United States and Canada have ranged from 0.4 beaver families per square mile to a high of 11.9 beaver families per square mile (Novak 1987). Density estimates in the United States and Canada based only on stream miles (*i.e.*, per a linear unit of measure) have ranged from 0.8 beaver colonies per stream mile to 3.9 beaver colonies per stream mile (Novak 1987).

There are approximately 6.4 million acres of interior wetlands and 3.9 million acres of coastal wetlands in Texas (Thompson 2016). There are an estimated 80,000 miles of streams and rivers occur in Texas (Texas Almanac 2016). To evaluate a worst-case scenario, the estimated statewide beaver population will use the lowest beaver colony density per linear measure derived from other studies of 0.8 beaver colonies per stream mile. If 50% of the stream and river miles in Texas were suitable beaver habitat and if beaver colonies occupied all of those miles, approximately 32,000 beaver colonies would occur along the 80,000 miles of river and streams in the State, which would not include beaver colonies that inhabit wetlands, lakes, ponds, and other aquatic habitats.

The number of beaver per colony is also required to derive a population estimate. However, the average number of beaver per colony in Texas is unknown. In Alabama, Wilkinson (1962) estimated the average number of beaver per colony at 4.6 beaver, which is similar to the average of 5.3 beaver per colony in Georgia that Parrish (1960) estimated. From other studies, the average size of beaver colonies has ranged from 3.2 beaver to 9.2 beaver per colony (Novak 1987). Therefore, if there were 32,000 beaver colonies along the rivers and streams of the State and if there were 3.2 beaver per colony, the estimated statewide population of beaver inhabiting rivers and streams would be 102,400 beaver. The actual statewide population is likely much larger than 102,400 beaver. The statewide population is likely much larger because the calculated estimate used the lowest density information available for beaver. In addition, the population estimate did not include beaver that could inhabit other aquatic habitats or create their own habitats by impounding water in areas associated with water runoff or storage (*e.g.*, livestock ponds, drainage ditches, irrigation canals, storm water structures).

The authority for management of resident aquatic mammal species in Texas, including beaver, is the responsibility of the TPWD. The TPWD considers beaver to be a furbearer in the State that can be harvested annually during hunting and trapping seasons that have no limits on the number of beaver that people can harvest during the length of the season. When beaver are causing damage or about to cause damage on private property, the landowner or their designee can remove beaver without a permit anytime of the year (see Section 1.6).

Between FY 2013 and FY 2015, the TWSP received requests for assistance to manage damage or threats of damage caused by beaver in the State. Requests for assistance associated with beaver were primarily associated with flooding and burrowing damage, along with damage from beaver felling and girdling trees. Based on those requests for assistance to manage damage or threats of damage associated with beaver, the TWSP employed multiple methods to remove those beaver identified as causing damage or posing a threat of damage (see Table 4.1).

Table 4.1 - Analysis of beaver removal by the TWSP, FY 2013 – FY 2015

Fiscal Year	TWSP Removal*	Estimated Population†	Removal % Population‡	Sustainable Harvest∞	Removal % Harvest	Population Trend**
2013	1,621	**102,400**	1.6%	**30,720**	5.3%	Stable/Increasing
2014	1,521		1.5%		4.9%	Stable/Increasing
2015	1,307		1.3%		4.2%	Stable/Increasing
Ave.	**1,483**		**1.5%**		**4.8%**	**Stable/Increasing**

*Includes the unintentional removal of beaver as non-target animals (2 beaver in FY 2015)

†Based on a minimum statewide population estimate

‡The annual removal of beaver by the TWSP as a percentage of the minimum statewide population estimate

∞Based on a sustainable beaver harvest of 30% (Novak 1987) and a minimum population estimated at 102,400 beaver

**Based on consultation with the TPWD

The TWSP primarily employed body-gripping traps to remove beaver from FY 2013 through FY 2015. The TWSP also removed beaver using foothold traps, cable restraints, and firearms between FY 2013 and FY 2015. In addition, the TWSP breached or removed 755 beaver dams between FY 2013 and FY 2015, which is an average annual removal of 252 beaver dams. In total, the TWSP removed 19 dams using binary explosives and breached or removed 736 dams using hand tools.

If the beaver population has remained relatively stable at 102,400 beaver in Texas, the highest level of annual removal by the TWSP that occurred in FY 2013 would represent 1.6% of the estimated population. The number of beaver removed for damage management by other entities in Texas is unknown. An allowable harvest level for beaver may be as high as 30% of the population (Novak 1987). The total known removal of beaver in the State has not exceeded 30% of the estimated statewide population of beaver in Texas.

Based on previous requests for assistance and in anticipation of receiving additional requests for assistance with managing damage caused by beaver in Texas, the TWSP could lethally remove up to 2,000 beaver annually under Alternative 1. Based on a statewide population estimated at 102,400 beaver, the annual lethal removal by the TWSP of up to 2,000 beaver would represent 2.0% of the population. As stated previously, beaver inhabit many other types of aquatic habitats within the State besides rivers and streams and may occur at higher densities than the densities used to derive the estimate; therefore, the statewide beaver population likely exceeds 102,400 beaver. Therefore, the cumulative removal of beaver annually would likely be a much lower percentage of the actual statewide population. Although the number of beaver that property owners remove annually to alleviate damage or threats of damage is unknown, the actual number of beaver removed annually does not likely occur at a level that would increase cumulative effects. The unlimited harvest allowed by the TPWD also provides an indication that the statewide density of beaver is sufficient that overharvest is not likely to occur. Based on the limited removal proposed by the TWSP and the oversight by the TPWD, the TWSP removal of beaver annually would have no effect on the ability of those persons interested to harvest beaver during the regulated harvest season.

Under Alternative 1, people could also request the TWSP breach or remove beaver dams to alleviate or prevent flooding damage. Beaver dams are removed primarily from man-made structures, such as culverts, irrigation structures or drainage ditches. The TWSP could also receive requests to install devices to control the water flow through dams to alleviate flooding or install exclusion devices to prevent damming. When personnel breach or remove dams, the TWSP would primarily utilize manual methods (*e.g*., hands and hand tools). The TWSP could also use binary explosives in some cases. The TWSP anticipates breaching, removing, or installing flow control devices in up to 500 beaver dams annually as part of an integrated damage management program. When breaching or removing a dam, personnel of the TWSP would discard the building material used to create the dam (*e.g*., sticks, logs, and other vegetative matter) on the bank or would release those materials to flow downstream. Mud and small materials, such as bark and other plant debris, could also escape downstream and would tend to settle out within a short distance of the dam. Small to medium limbs, along with sediments, may drift further distances downstream. Dam breaching and removal would generally be conducted in conjunction with the removal of beaver responsible for constructing the dam since beaver would likely repair and/or rebuild dams quickly if dams were breached or removed prior to the beaver being removed. Therefore, the removal or breaching of beaver dams would not adversely affect beaver populations in the State since the TWSP would conduct those activities in association with removing beaver from the site; therefore, the removal would be included in the estimated annual removal levels of beaver addressed previously.

MUSKRAT POPULATION INFORMATION AND EFFECTS ANALYSIS

Muskrats build houses, or lodges of aquatic plants, especially cattails, up to 2.4 m (8 feet) in diameter and 1.5 m (5 feet) high. Muskrats usually build those structures atop piles of roots, mud, or similar support in marshy areas, streams, lakes, or along water banks. They also burrow in stream or pond banks with entrances often above the water line. Another sign of the presence of muskrat includes the presence of feeding platforms that muskrats build out of cut vegetation in water or on ice. These feeding platforms are marked by discarded or uneaten grasses or reed cuttings and floating blades of cattails, sedges, and similar vegetation located near the banks. This species is most active at dusk, dawn, and at night, but may be visible at any time of the day in all seasons, especially spring. Muskrats are excellent swimmers and spend much of their time in the water. They inhabit fresh, salt, and brackish waters throughout most of Canada and the United States, except for the Arctic regions (National Audubon Society 2000). They occur in marshes, ponds, sloughs, lakes, ditches, streams, and rivers (Boutin and Birkenholz 1987).

Muskrat are prolific and produce three to four litters per year that average five to eight young per litter (Wade and Ramsey 1986), which makes them relatively immune to overharvest (Boutin and Birkenholz 1987). Gestation period varies between 25 and 30 days. Young muskrats can reproduce the spring after their birth. Harvest rates of three to eight animals per acre may be sustainable in muskrat populations (Boutin and Birkenholz 1987). Muskrat home ranges vary from 529 square feet to 11,970 square feet (0.1 to 0.25 acres), with the size of home ranges occupied by muskrats dependent upon habitat quality and population density (Boutin and Birkenholz 1987).

Muskrats occur mainly in east Texas along the gulf coast, and in northeast Texas continuing into the panhandle region. They also occur along the Pecos River and the Rio Grande River north and west of Big Bend National Park. They do not occur in much of central and west Texas (Wade and Ramsey 1986). They reside in freshwater and brackish marshes, ponds, sloughs, lakes, ditches, streams, and rivers (Boutin and Birkenholz 1998).

Young muskrats are especially vulnerable to predation. Adult muskrats may also be subject to predation, but rarely in numbers that would lower populations. Predation alone does not appear to solve damage problems caused by muskrats (Miller 1994). Predators of muskrat include great horned and barred owls, red-tailed hawks, bald eagles, raccoons, mink, river otter, red fox, gray fox, coyotes, bobcat, Northern pike, largemouth bass, snapping turtles, and bullfrogs. Adult muskrats also occasionally kill young muskrats (Miller 1994).

No population estimates are available in Texas for muskrats; however, muskrats occur statewide in suitable habitat. As stated previously, there are an estimated 10.3 million acres of wetlands in Texas (Thompson 2016), including an estimated 80,000 miles of rivers and streams (Texas Almanac 2016). Since population estimates are not currently available, the analysis will derive a population estimate based on the best available information for muskrats to provide an indication of the magnitude of removal proposed by the TWSP to alleviate damage and threats of damage. Using the acreage of wetlands in Texas of 10.3 million acres and using a single muskrat home range of 0.25 acres and assuming only one muskrat occupies a home range with no overlap of ranges, a statewide population could be estimated at 41.2 million muskrats. However, not all wetlands in the State likely provide suitable habitat for muskrats. If only 10% of the wetland acreage in the State were suitable habitat for muskrats, the estimated population would be 4.1 million muskrats.

Muskrats are classified as regulated furbearers in Texas, and seasons and limits for harvest are set by the TPWD. People can harvest muskrats during annual hunting and trappings seasons in the State with no limit on the number of muskrats that can be harvested. The number of muskrats harvested annually during the hunting and trapping season is currently unknown.

The TWSP did not lethally remove any muskrats in the State during FY 2013 through FY 2015. Few muskrat conflicts exist and the TWSP estimates that it would remove no more than 50 muskrats annually under the Alternative 1. Using a population estimated at 4.1 million muskrats, the lethal removal of up to 50 muskrats annually would represent 0.001% of the statewide population. Although the number of muskrats harvested annually in the State during the hunting and trapping season is unknown, the cumulative removal is not likely to reach a magnitude where adverse effects would occur to the muskrat population. The unlimited removal allowed by the TPWD provides an indication that the statewide densities of muskrats are sufficient that overharvest is not likely to occur. In addition, most muskrats would probably be removed in habitats where little or no trapping by fur harvesters is done. Damage management activities associated with muskrats would target single animals or localized populations at sites where their presence was causing unacceptable damage to agriculture, human health and safety, natural resources, or property. Based on the limited removal proposed by WS and the oversight by the TPWD, the removal of muskrats annually by the TWSP would have no effect on the ability of those persons interested to harvest muskrats.

NUTRIA POPULATION INFORMATION AND EFFECTS ANALYSIS

The nutria is a large, dark colored, semi-aquatic mammal that is native to South America. People introduced nutria into the United States during the late 1930s (Whitaker, Jr. and Hamilton, Jr., 1998). The nutria is somewhat similar to the native muskrat in appearance. Nutria have small eyes and ears with a tail that is long, scaly, sparsely haired, and round (National Audubon Society 2000). On average, nutria weigh about 12 pounds (Whitaker, Jr. and Hamilton, Jr., 1998).

Nutria primarily inhabit brackish or freshwater marshes, but are also found in swamps, rivers, ponds, and lakes. They live in dense vegetation and in burrows along stream banks or shorelines (Wade and Ramsey 1986). The burrowing activity of nutria can severely damage levees, dikes, earthen dams, and other structures. Nutria feed on terrestrial or aquatic green plants, but also feed on crops adjacent to their habitat. Nutria will consume approximately 25% of their own weight in food each day (Whitaker, Jr. and Hamilton, Jr. 1998).

Female nutria begin breeding in their first year. Breeding can occur at any time during the year. In the right conditions, nutria can produce up to 15 young per year (Whitaker, Jr. and Hamilton, Jr. 1998). In the wild, the life expectancy of nutria is approximately two years. In Louisiana, fall densities of 18 nutria per acre have been found in floating freshwater marshes, while summer densities of nutria in Oregon along freshwater marshes may reach 56 nutria per acre (LeBlanc 1994). Whitaker, Jr. and Hamilton, Jr. (1998) found nutria densities can range up to 10 nutria per acre. Home ranges for nutria range from 12 to 445 acres (Whitaker, Jr. and Hamilton, Jr. 1998). In Louisiana, LeBlanc (1994) stated the home range of nutria was about 32 acres.

Pursuant to Executive Order 13112, the National Invasive Species Council has designated the nutria as meeting the definition of an invasive species. Lowe et al. (2000) ranked nutria as one of the 100 worst invasive species in the world. Nutria are not considered a native wildlife species in Texas. The current population of nutria in the State originated from nutria that people intentionally released to establish populations or from nutria that escaped captivity. Nutria are a furbearer that people can harvest annually during a trapping season.

Nutria are distributed along surface water streams, rivers, reservoirs and wetlands (both freshwater and brackish marshes) of the eastern two-thirds of the State (Wade and Ramsey 1986). Kinler et al. (1997) summarized reported density estimates that ranged from 0.6 to 138 nutria per hectare (0.3 to 56 per acre). The nutria population density is highest in freshwater marshes (Kinler et al. 1997). Nutria were introduced in the late 1930s to Louisiana (an earlier population was trapped out) and then expanded naturally and by trap and transplant by fur farmers. In the early 1940s, populations along the coast were substantially pushed inland by a hurricane (Wade and Ramsey 1986). Since that time, they have become firmly established in Texas.

Since population estimates are not currently available, the analysis will derive a population estimate using the best available information for nutria to provide an indication of the magnitude of removal proposed by the TWSP to alleviate damage and threats of damage. As stated previously, there are approximately 10.3 million acres of wetlands in Texas (Thompson 2016). If only 1% of the wetland acreage in the State were suitable habitat or were occupied by nutria and using a density estimate of 10 nutria per acre, a statewide population could be approximately one million nutria.

As shown in Table 4.2, the cumulative removal of nutria by the TWSP has not exceeded 0.02% of the estimated nutria population in the State. On average, the cumulative removal of nutria by the TWSP from FY 2013 through FY 2015 has represented 0.01% of the estimated population. The number of nutria that people lethally remove to alleviate damage annually or harvest annually during the harvest season in the State is unknown.

Table 4.2 - Analysis of nutria removal by the TWSP, FY 2013 – FY 2015

Fiscal Year	WS' Removal of Nutria		Cumulative Removal	% Removal of Population†
	Target	Non-target		
2013	211	2	231	0.02%
2014	113	1	114	0.01%
2015	87	1	88	0.01%
Average	**137**	**1**	**138**	**0.01%**

†Based on a statewide nutria population estimated at one million nutria

The number of nutria addressed by the TWSP each year would depend on the number of requests received, the number of nutria associated with causing damage or the threat of damage, and the efficacy of methods employed to resolve the damage. WS anticipates that personnel could lethally remove up to 1,000 nutria annually to resolve requests for assistance. In addition, WS' personnel could lethally remove nutria unintentionally during damage management activities that are targeting other aquatic mammal species, primarily activities associated with beaver. However, the cumulative removal by WS would not exceed 1,000 nutria annually in the State. If the TWSP lethally removed 1,000 nutria, the removal would represent 0.1% of a population estimated at one million nutria.

The unlimited removal allowed by the TPWD during the harvest season for nutria provides an indication that the statewide density of nutria is sufficient that overharvest is not likely to occur. Based on the limited removal proposed by WS and the oversight by the TPWD, the removal of nutria annually by the TWSP would have no effect on the ability of those persons interested to harvest nutria during the regulated harvest season.

Executive Order 13112 states that each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law; 1) reduce invasion of exotic species and the associated damages, 2) monitor invasive species populations, provide for restoration of native species and habitats, 3) conduct research on invasive species and develop technologies to prevent introduction, and 4) provide for environmentally sound control and promote public education on invasive species. The TWSP would conduct activities associated with nutria pursuant to Executive Order 13112.

RIVER OTTER POPULATION INFORMATION AND EFFECTS ANALYSIS

Historically, river otters inhabited aquatic ecosystems throughout much of North America, excluding the frozen Arctic and arid Southwest (Melquist et al. 2003). Information on historic numbers and distribution is limited. As its broad geographic distribution suggests, the river otter is able to adapt to diverse aquatic habitats. Otter occur in both marine and freshwater environments, ranging from coastal to high mountainous habitat. Riparian vegetation adjacent to lakes, streams, and other wetland areas is a key component of otter habitat.

Human encroachment, habitat destruction, and overharvest have eliminated river otters from marginal portions of their range. However, their present distribution spans the North American continent from east to west and extends from southern Florida to northern Alaska (Melquist and Dronkert 1987, Melquist et al. 2003). In southeast Alaska, Woolington (1984) found river otter densities in waterways were one otter per 0.7 miles. Melquist and Dronkert (1987) summarized studies estimating river otter densities, which showed that densities were about 1 per 175 to 262 acres in Texas coastal marshes, and ranged from 1 per 1.8 miles to 1 per 3.6 miles of waterway (stream or river), which is an average of 1 otter per 2.4 miles of waterway. Melquist and Hornocker (1983) found a population density range of 1 otter per 1.8 to 3.6 miles of waterway (primarily streams) in west central Idaho, with an average of 1 otter per 2.4 miles. Erickson et al. (1984) found one otter per 5.0 miles of linear waterways in Missouri and one otter per 1.5 square miles in wetland habitat. More recently, Mowry et al. (2011) found an average otter density of one otter per 2.6 miles along streams in Missouri using latrine surveys.

River otters are known to occur primarily in the eastern and southeastern counties of Texas, in both marine and freshwater environments. Population densities appear greatest in food-rich coastal regions, including estuaries, lower portions of streams, and coastal marshes, and they typically occur in inland areas where lowland marshes and swamps interconnect with meandering steams and small lakes (Melquist and Dronkert 1987).

There are an estimated 10.3 million acres of wetlands in Texas (Thompson 2016), including an estimated 80,000 miles of rivers and streams (Texas Almanac 2016). As was discussed previously, otter are closely associated with aquatic habitats where they forage and den along shorelines. Using 80,000 miles of streams in Texas and the range of one otter per 2.5 to 5.0 miles of waterway would result in a statewide population estimate ranging from 16,000 otter to 32,000 otter. If only 50% of those streams supported river otter, the minimum statewide river otter population could range from 8,000 to 16,000 otter in Texas. This would be a worst-case scenario since the otter population is likely to inhabit a much larger portion of the streams and rivers of Texas. In addition, otter also inhabit other aquatic habitats besides rivers and streams; therefore, the actual population is likely to be higher.

The TPWD considers river otter to be a furbearer in Texas that people can harvest in the State. During the harvest season, the TPWD places no limits on the number of otter that people can harvest. The number of river otters that people harvest in the State annually is unknown. In addition, the number of otter that people lethally remove to alleviate damage is unknown.

The TWSP responded to requests for assistance associated with river otter between FY 2013 and FY 2015. Resources damaged by river otter were primarily associated with predation to aquaculture. While providing assistance between FY 2013 through FY 2015, the TWSP lethally removed an average of 42 river otters in Texas (see Table 4.3). Of those otters removed by the TWSP from FY 2013 through FY 2015, the TWSP lethally removed an average of 25 otter unintentional as non-target animals during activities targeting other animals, primarily beaver and nutria. The highest unintentional removal occurred during FY 2015 when personnel from the TWSP lethally removed 34 otter unintentionally.

Based on previous requests for assistance and anticipating additional efforts to address damage, the TWSP could lethally remove up to 100 river otters annually in Texas, including otter that the TWSP could remove unintentional during other activities. The TWSP anticipates receiving requests for assistance primarily from aquaculture producers that were experiencing unacceptable predation of fish stock by river otters. In addition, WS could unintentionally remove river otters during activities targeting other animals, primarily beaver and nutria, despite efforts by the TWSP to minimize the unintentional removal of otters. Based upon the aforementioned population estimate, WS' lethal removal of up to 100 river otters annually under Alternative 1 would represent 1.3% of the otter population in Texas estimated at 8,000 otters and 0.6% of a statewide population estimated at 16,000 otters.

Table 4.3 - Analysis of river otter removal by the TWSP, FY 2013 – FY 2015

Fiscal Year	WS' Removal of Otter		Cumulative Removal	% Removal of Population†
	Target	Non-target		
2013	22	15	37	0.5%
2014	20	26	46	0.6%
2015	9	34	43	0.5%
Average	**17**	**25**	**42**	**0.5%**

†Based on a statewide nutria population estimated at 8,000 otter

As discussed previously, the number of otter that people harvest annually in the State is unknown. In addition, the number of otter that people lethally remove to alleviate damage is unknown. The TPWD continues to allow people to harvest an unlimited number of otter in the State during the annual harvest season, which provides an indication that lethal removal from harvest and from activities to alleviate damage are not likely to reach a magnitude annually that would result in a declining otter population. In addition, the statewide population is likely to be higher than the estimates used in this analysis; therefore, the removal of otter by the TWSP is likely to represent a smaller percentage of the actual population. The proposed intentional and the cumulative removal of otters in the State by the TWSP and the removal by other entities would be of low magnitude when compared to the actual statewide population estimates. Based on the low magnitude of removal proposed by the TWSP, the activities of the TWSP to alleviate otter damage or threats of damage would not limit the ability of people to harvest otters in the State.

WILDLIFE DISEASE SURVEILLANCE AND MONITORING

The ability to efficiently conduct surveillance for and detect diseases is dependent upon rapid detection of the introduced pathogen. Effective implementation of a surveillance system would facilitate planning and execution at regional and state levels, and coordination of surveillance data for risk assessment. It would also facilitate partnerships between public and private interests, including efforts by federal, state, and local governments as well as non-governmental organizations, universities, and other interest groups.

Implementation of disease sampling strategies by the TWSP to detect or monitor diseases in the United States would not adversely affect aquatic mammal populations in the State. Sampling strategies that the TWSP could employ would involve sampling live-captured that personnel of the TWSP could release on site after sampling occurs. The sampling (*e.g.*, drawing blood, tissue sample, collecting fecal samples) and the subsequent release of live-captured would not result in adverse effects since those aquatic mammals would be released unharmed on site. In addition, the sampling of that were sick, dying, or harvested by hunters would not result in the additive lethal removal of that would not have already occurred in the absence of disease sampling. Therefore, the sampling of aquatic mammals for diseases would not adversely affect the populations of any of the aquatic mammals addressed in this EA nor would sampling result in any lethal removal of aquatic mammals that would not have already occurred in the absence of disease sampling (*e.g.*, hunter harvest).

Alternative 2 – Aquatic Mammal Damage Management by the TWSP through Technical Assistance Only

Under this alternative, the WS program would only provide advice or guidance on damage management methods and activities; however, the Texas A&M AgriLife Extension Service and the TWDMA, along with other entities, could continue to provide assistance similar to Alternative 1. The WS program would not conduct any direct operational assistance to resolve damage or threats of damage, and therefore, would not have any impact on aquatic mammals in the State. The Texas A&M AgriLife Extension Service and the TWDMA would likely continue to conduct damage management activities similar to Alternative 1 with increased effort in proportion to those activities that would have been conducted by the WS program. In addition, other entities, including private entities, could provide assistance in the absence of any involvement by the WS program. In addition, persons experiencing damage or threats from aquatic mammals may implement methods based on recommendations of the WS program. Therefore, under this alternative the number of aquatic mammals lethally removed annually would likely be similar to the other alternatives since removal could occur by other entities or by those persons experiencing damage.

Removal of aquatic mammals to alleviate damage by other entities would likely be similar to the other alternatives since removal could occur through the issuance of a permit by the TPWD, when required. In addition, removal could continue to occur during the harvest season for those species. WS' participation in a management action would not be additive to an action that would occur in the absence of WS' participation. Recommendation of the use of lethal methods by the WS program under this alternative would not limit the ability of those persons interested in harvesting during the regulated season since the TPWD determines the number of that people may lethally remove during the hunting/trapping season and under permits.

With the oversight of the TPWD, it is unlikely that implementation of this alternatives would adversely affect aquatic mammal populations. Under this alternative, the TWSP would not provide any assistance with managing damage. However, other entities could provide direct operational assistance, such as the TPWD, or other State agencies, private entities, and/or private businesses. If direct operational assistance was not available from the WS program or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal removal, which could lead to real but unknown effects on other wildlife populations. People have resorted to the illegal use of chemicals and methods to resolve wildlife damage issues (*e.g*., see Bailey 1954, Allen et al. 1996, Jonker et al. 2006).

Alternative 3 – No Aquatic Mammal Damage Management Conducted by the TWSP

Under this alternative, the WS program would not provide assistance with managing damage associated with aquatic mammals; therefore, the WS program would not have any effect on target aquatic mammal populations in the State. However, similar to Alternative 2, Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service, and TPWD), and private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. In addition, those people experiencing damage or threats of damage could conduct activities themselves to resolve damage. While the WS program would provide no assistance under this alternative, the TWSP and other individuals or entities could conduct lethal damage management resulting in lethal removal levels similar to Alternative 1 and Alternative 2. Therefore, local aquatic mammal populations could decline, stay the same, or increase depending on actions taken by those persons experiencing aquatic mammal damage.

Since people could still lethally remove aquatic mammals if the WS program implemented this alternative, the potential effects on the populations of those aquatic mammal species in the State would be similar to the other alternatives for this issue. WS' involvement would not be additive to lethal removal that could occur since the cooperator requesting WS' assistance could conduct damage management activities themselves without WS' direct involvement or seek assistance from the TWSP, the TPWD, or other entities. Therefore, any actions to resolve damage or reduce threats associated with aquatic mammals could occur by other entities despite WS' lack of involvement under this alternative.

For the reasons discussed in the population impacts analysis under Alternative 1, it is highly unlikely that implementation of this alternative would affect aquatic mammal populations in the State. However, the potential for use of illegal chemical toxicants caused by frustration could lead to unknown, but potentially high impacts, on aquatic mammal populations. Some resource/property owners may take illegal, unsafe, or environmentally harmful action against local populations of aquatic mammals out of frustration or ignorance. If direct operational assistance was not available from WS or other entities, it is hypothetically possible that frustration caused by the inability to reduce damage and associated losses could lead to illegal take, which could lead to real but unknown effects on other wildlife populations. People have resorted to the illegal use of chemicals and methods to resolve wildlife damage issues (*e.g*., see Bailey 1954, Allen et al. 1996, Jonker et al. 2006). Additionally, if no agency, groups, or individuals were able to respond to damage complaints, much of the public could become intolerant of wildlife as a whole (International Association of Fish and Wildlife Agencies 2005).

Issue 2 - Effects on the Populations of Non-target Animals, Including T&E Species

As discussed previously, a concern would be the potential impacts to non-target species, including T&E species, from the use of methods to resolve damage caused by aquatic mammals. Discussion on the potential effects of the alternatives on the populations of non-target wildlife species, including T&E species, occurs below.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

The potential for adverse effects on non-target animal populations occurs from the employment of methods to address aquatic mammal damage. Under Alternative 1, the TWSP could provide both technical assistance and direct operational assistance to those people requesting assistance. The risks to non-target animals from the use of non-lethal methods as part of an integrated direct operational assistance program would be similar to those risks to non-target animals discussed in the other alternatives.

Personnel from the TWSP would be experienced with managing wildlife damage and would receive training in the employment of methods, which would allow employees to use the WS Decision Model to select the most appropriate methods to address damage caused by targeted animals and excluding non-target species. To reduce the likelihood of capturing non-target animals, the TWSP would employ the most selective methods for the target species, would employ the use of attractants, when applicable, that were as specific to target species as possible, and determine placement of methods to avoid exposure to non-target animals. Chapter 3 of this EA discusses the SOPs to prevent and reduce any potential adverse effects on non-target animals. Despite the best efforts to minimize non-target animal exposure to methods during program activities, the potential for the TWSP to disperse or lethally remove non-target animals exists when applying both non-lethal and lethal methods to manage damage or reduce threats to safety.

Non-lethal methods have the potential to cause adverse effects to non-target animals primarily through exclusion, harassment, and dispersal. Any exclusionary device erected to prevent access of target species also potentially excludes species that were not the primary reason for erecting the exclusion; therefore, exclusion methods potentially could adversely affect non-target species if the area excluded was large enough. The use of auditory and visual dispersal methods to reduce damage or threats caused by aquatic mammals would also likely disperse non-target animals in the immediate area the methods were employed. Therefore, non-target animals may disperse permanently from an area while employing non-lethal dispersal techniques. However, like target species, the potential impacts on non-target species would likely be temporary with target and non-target species often returning after the cessation of dispersal methods.

Non-lethal methods that use auditory and visual stimuli to reduce or prevent damage elicit fright responses in wildlife. When employing those methods to disperse or harass target species, any non- target animals nearby when employing those methods would also likely disperse from the area. Similarly, any exclusionary device constructed to prevent access by target species could also exclude access to some non-target species. The persistent use of those non-lethal methods could result in the dispersal or abandonment of those areas where non-lethal methods were employed by both target and non-target species. Therefore, any use of those non-lethal methods would likely elicit a similar response from both non-target and target species. Although exclusion and dispersal methods do not result in the lethal removal of non-target animals, the use of those methods could restrict or prevent access of non-target animals to beneficial resources. However, long-term adverse effects would not occur to a species' population since the TWSP would not employ those methods over large geographical areas or at such intensity levels that resources (*e.g.*, food sources, habitat) would be unavailable for extended durations or over a wide geographical scope. Exclusion and dispersal methods would generally have minimal impacts on overall populations of wildlife since individuals of those species would be unharmed. Overall, the use of non-lethal methods would not adversely affect populations of animals since those methods would often be temporary.

Other non-lethal methods available for use under this alternative would include live traps, water control devices, repellents, and immobilizing drugs. Live traps restrain wildlife once captured; therefore, those methods are live-capture methods. Live traps would have the potential to capture non- target species. Trap placement in areas where target species were active and the use of target-specific attractants would likely minimize the capture of non-target animals. Attending to traps appropriately would allow the release of any non-target animals captured unharmed. Water control devices are systems that allow the passage of water through a beaver dam to manage the level of impounded water. Taylor and Singleton (2014) provide a comprehensive summary of the evolution of water control devices to reduce flooding by beaver. The use or recommendation of water control devices would not adversely affect non-target animals.

Chemical repellents could also be available to reduce aquatic mammal damage. The TWSP has not used repellents to reduce aquatic mammal damage in the State. However, the TWSP may recommend or employ commercially available repellents when providing technical assistance and direct operational assistance. The TWSP would only use or recommend those products registered with the EPA pursuant to the FIFRA and registered with TDA under this alternative. The active ingredients in many commercially available repellents are naturally occurring substances (*e.g.*, capsaicin, whole egg solids), which are often used in food preparation (EPA 2001). When used according to label instructions, most repellents would be safe since 1) they are not toxic to animals, if ingested; 2) there is normally little to no contact between animals and the active ingredient, and 3) the active ingredients are found in the environment and degrade quickly (EPA 2001). Therefore, the use and recommendation of repellents would not have negative impacts on non-target species when used according to label requirements. Most repellents for aquatic mammals pose a very low risk to non-target animals when exposed to or when ingested.

The TWSP could employ immobilizing drugs to handle and transport target aquatic mammal species. Personnel of the TWSP would apply immobilizing drugs directly to target animals through hand injection. Therefore, no direct effects to non-target animals would be likely since identification would occur prior to application. Animals anesthetized using immobilizing drugs recover once the animal's body has fully metabolized the drug. Therefore, non-target animals that may consume animals that recover are unlikely to receive a dosage that would cause any impairment. When using immobilizing drugs to handle or transport target animals, the TWSP would monitor anesthetized animals until that animal recovers sufficiently to leave the site.

Potential impacts to non-target animals from the use of non-lethal methods would be similar to the use of non-lethal methods under any of the alternatives. Non-target animals would generally be unharmed from the use of non-lethal methods under any of the alternatives since no lethal removal would occur. Non-lethal methods would be available under all the alternatives analyzed. Involvement in the use of or recommendation of non-lethal methods by the TWSP would ensure employees considered the potential impacts to non-target animals when using the WS Decision Model. Potential impacts to non-target animals under this alternative from the use of and/or the recommendation of non-lethal methods are likely to be low.

The TWSP could also employ and/or recommend lethal methods under Alternative 1 to alleviate damage, when the TWSP personnel deemed those methods appropriate for use using the WS Decision Model. Lethal methods available for use to manage damage caused by aquatic mammals under this alternative would include the recommendation of harvest during hunting and/or trapping seasons, shooting, body-gripping traps, cable devices, zinc phosphide (muskrats and nutria only), and euthanasia chemicals, including euthanasia after live-capture. The TWSP could also use foothold traps and submersion cables or rods as a submersion set. Available methods and the application of those methods to resolve aquatic mammal damage is further discussed in Appendix B.

Zinc phosphide is a toxicant used to kill small rodents, lagomorphs, muskrats, and nutria. Zinc phosphide is two to 15 times more toxic to rodents than to carnivores (Hill and Carpenter 1982). Secondary risks appear to be minimal to predators and scavengers that scavenge carcasses of animals killed with zinc phosphide (Tietjen 1976, Hegdal and Gatz 1977, Hegdal et al. 1980, Hill and Carpenter 1982, Johnson and Fagerstone 1994). Risks would be minimal since the digestive tract detoxifies 90% of the zinc phosphide ingested by rodents (Hegdal et al. 1980) and 99% of the zinc phosphide residues occur in the digestive tracts, with none occurring in the muscle. In addition, the amount of zinc phosphide required to kill target rodents is not enough to kill most other predatory animals that consume tissue (Johnson and Fagerstone 1994).

In addition, zinc phosphide has a strong emetic action (*i.e.*, causes vomiting) and most non-target animals in research tests regurgitated bait or tissues contaminated with zinc phosphide without succumbing to the toxicant (Hegdal and Gatz 1977, Hegdal et al. 1980, Johnson and Fagerstone 1994). Furthermore, predators tend to eviscerate zinc phosphide-poisoned rodents before eating them or otherwise avoid the digestive tract and generally do not eat the stomach and intestines (Hegdal et al. 1980, Johnson and Fagerstone 1994). Although zinc phosphide baits have a strong, pungent, phosphorous-like odor (garlic like), this characteristic seems to attract rodents, particularly rats, and apparently makes the bait unattractive to some other animals. Many birds appear capable of distinguishing treated from untreated baits and they prefer untreated grain when given a choice (Siegfried 1968, Johnson and Fagerstone 1994). Birds appear particularly susceptible to the emetic effects of zinc phosphide, which would tend to offer an extra degree of protection against bird species dying from the consumption of grain treated with zinc phosphide or, for scavenging bird species, from eating poisoned rodents. Use of rolled oats instead of whole grain also appears to reduce bird acceptance of bait. Uresk et al. (1988) reported on the effects of zinc phosphide on six non-target rodent populations. Uresk et al. (1988) observed no differences in populations of eastern cottontail rabbits and white-tailed jackrabbits (*Lepus townsendii*) between areas treated with zinc phosphide (ground application) and untreated areas eight months after applying treated bait for black-tailed prairie dogs (*Cynomys ludovicianus*). However, primary consumption of bait by non-target wildlife could occur and potentially cause mortality. Uresk et al. (1988) reported a 79% reduction in deer mouse populations in areas treated with zinc phosphide; however, the effect was not statistically significant because of high variability in densities and the reduction was not long-term (Deisch et al. 1990).

Five weeks after treatment, Ramey et al. (2000) reported that zinc phosphide baiting did not kill any ring-necked pheasants (*Phasianus colchicus*). In addition, Hegdal and Gatz (1977) determined that zinc phosphide did not affect non-target populations and that predators killed more radio-tracked animals than died from zinc phosphide intoxication (Hegdal and Gatz 1977, Ramey et al. 2000). Tietjen (1976) observed horned larks (*Eremophila alpestris*) and mourning doves (*Zenaida macroura*) on zinc phosphide-treated prairie dog colonies, but observations after treatment did not locate any sick or dead birds, a finding similar to Apa et al. (1991). Uresk et al. (1988) reported that ground-feeding birds showed no difference in numbers between control and treated sites. Apa et al. (1991) further stated that horned larks did not consume zinc phosphide because: 1) poisoned grain remaining for their consumption was low (*i.e*., prairie dogs consumed the bait before larks could consume it), 2) birds have an aversion to black-colored foods, and 3) birds have a negative sensory response to zinc phosphide.

Tietjen and Matschke (1982) have also reported minimal impacts on birds associated with the use of zinc phosphide. Deisch et al. (1989) reported on the effect zinc phosphide has on invertebrates. Deisch et al. (1989) determined that zinc phosphide bait reduced ant densities; however, bait did not affect spider mites, crickets, wolf spiders, ground beetles, darkling beetles, and dung beetles. Wolf spiders and ground beetles showed increases after one year on zinc phosphide treated areas (Deisch 1986). Generally, direct long-term impacts from rodenticide treatments were minimal for the population of insects that were sampled (Deisch et al. 1989). Long-term effects were not directly related to rodenticides, but more to habitat changes (Deisch 1986) as vegetative cover and prey diversity increased without prairie dogs grazing and clipping the vegetation (Deisch et al. 1989).

Use of zinc phosphide on various types of fruit, vegetable, or cereal baits (*e.g*., apples, carrots, sweet potatoes, oats, barley) has proven to be effective at suppressing target wildlife populations. Specific bait applications can also minimize non-target hazards. Personnel of the TWSP would use zinc phosphide in accordance with the requirements of the product label that the EPA and the TDA have approved. Personnel of the TWSP that use chemical methods would be certified as pesticide applicators by the TDA and would adhere to all certification requirements set forth in the FIFRA and the Texas pesticide control laws and regulations. Personnel of the TWSP would not use zinc phosphide without authorization from the property owner or manager.

The use of firearms would essentially be selective for target species since personnel of the TWSP would identify animals prior to application; therefore, adverse effects are not likely to occur from use of this method. Similarly, the use of euthanasia methods would not result in non-target animal removal since identification would occur prior to euthanizing an animal.

Personnel of the TWSP would take precautions to safeguard against dispersing, capturing, or lethally removing non-target animals during operational use of methods and techniques for resolving damage and reducing threats caused by aquatic mammals; however, the use of such methods could result in the incidental lethal removal of unintended species. The unintentional removal and capture of wildlife species during damage management activities conducted under Alternative 1 would primarily be associated with the use of body-gripping traps and in some situations, with live-capture methods, such as foothold traps, cage traps, and devices.

The unintentional removal of non-target animals by the TWSP occurs primarily during activities targeting beaver. Since FY 2013, the unintentional removal of non-target animals by the TWSP during activities targeting aquatic mammal included 23 raccoons (*Procyon lotor*), 1 bobcat (*Lynx rufus*), 1 great blue heron (*Ardea herodias*), 1 largemouth bass (*Micropterus salmoides*), 1 Virginia opossum (*Didelphis virginiana*), 4 nutria, 75 river otters, 52 turtles[11], and 2 alligators (*Alligator mississippiensis*) in the State. Because they are invasive species, personnel of the TWSP consider nutria to be target animals if encountered during beaver damage management activities.

Similar to the analyses of lethal removal on the populations of target species addressed under Issue 1, of primary concern with the unintended removal of non-target animals is the magnitude of removal on those species' populations. The lethal removal of any single species of non-target animals by the TWSP since FY 2013 has not exceeded one or two individuals annually, except for river otters, raccoons, and turtles. For those species in which the TWSP unintentional removal did not exceed one or two individuals annually from FY 2013 through FY 2015, the TWSP removal did not adversely affect those species' populations based on the limited removal that occurred. During regulated hunting and/or trapping seasons, hunters and trappers can harvest many of the species that the TWSP lethally removed unintentionally. There are annual harvest seasons for raccoons, bobcats, Virginia opossum, river otters, turtles, and alligators in Texas. Impacts associated with the removal of otter and nutria unintentionally occurred previously during the analysis conducted in Issue 1. The unintentional removal of those species by TWSP when compared to the harvest level of those species would be of low magnitude. Activities of the TWSP did not limit the ability to harvest those species during the regulated season given the limited removal that occurred by the TWSP.

The previous non-target animals lethally removed unintentionally by the TWSP are representative of non-target animals that the TWSP could lethally remove under Alternative 1. Although personnel of the TWSP could lethally remove additional species of non-target animals unintentionally, the removal of individuals from any additional species would not be likely to increase substantively above the number of non-target animals removed annually by the TWSP during previous damage management activities.

The unintentional removal of non-target animals annually would likely be minimal with removal not exceeding one or two individuals per year of most species. Although the TWSP could lethally remove non-target animals, removal of individuals from any species is not likely to increase substantively. In addition, the level of removal analyzed for otter, nutria, and muskrats that could be lethally removed or live-captured as non-target animals was addressed under Issue 1 and the annual anticipated lethal removal of those species included non-target removal that could occur by the TWSP. Therefore, Issue 1 evaluated the cumulative removal of otter, nutria, and muskrats, including removal that could occur when an

[11] The information tracking systems used by the TWSP does not distinguish between all species of turtles.

employee from the TWSP lethally removes these species as a target or non-target species. The TWSP would continue to monitor activities, including non-target animal removal, to ensure the annual removal of non-target animals would not result in adverse effects to a species' population. The TWSP has not captured or adversely affected any T&E species during previous activities conducted in Texas. For those wildlife species where the unintentional removal has or could exceeded one or two individuals per year, the potential impacts to those species populations from the unintentional removal occurs by species below.

ALLIGATOR POPULATION IMPACT ANALYSIS

Currently, the USFWS protects the American alligator pursuant to the ESA under the "*threatened due to similarity of appearance*" classification. American alligators are similar in appearance with several species of crocodiles and caimans that the USFWS consider threatened or endangered. Therefore, the USFWS regulates the harvest of alligators and the legal trade in the alligators, their skins, and products made from alligators, as part of efforts to prevent the illegal removal and trafficking of threatened and endangered crocodiles and caimans that appear similar to the American alligator. However, American alligator populations are currently not threatened or endangered with extinction and populations are often sufficient to allow annual harvest seasons.

American alligators occur in the eastern part of Texas wherever suitable habitat exists, which consists of aquatic habitats similar to those described for beaver, muskrats, and nutria. The TWSP allows residents to harvest alligators during a regulated harvest season each year and properly licensed nuisance alligator trappers may remove alligators that the TPWD considers a threat to people, pets, and other resources. The current alligator population in Texas is unknown. Although the USFWS classifies alligators as "*threatened due to similarity of appearance*", the harvest and removal of alligators can occur under special rules for alligators (see 50 CFR 17.42). The TWSP reports any removal of alligators to the TPWD including any biological data gathered by the TWSP for scientific research purposes, which the TPWD can use to monitor and establish management objectives for alligators in the State.

The TPWD provides landowner permits to landowners with suitable habitat and alligator populations along the gulf coast and even provides public alligator hunting opportunities. The number of public and private landowner permits varies depending on habitat quality and alligator survey results. In calendar year 2016, the TPWD offered permits to remove 248 alligators through the public hunting program.

The limited removal of two alligators by the TWSP between FY 2013 and FY 2015 has not adversely affected alligator populations nor has the unintentional removal of alligators by the TWSP limited the ability to harvest alligators. Based on activities conducted to alleviate aquatic mammal damage, the potential unintentional removal of alligators by the TWSP is not likely to increase substantively above the number of alligators removed unintentionally by the TWSP during previous damage management activities. The TWSP would continue to release alligators live-captured during activities targeting aquatic mammals unless directed by the TPWD to euthanize those alligators.

RACCOON POPULATION IMPACT ANALYSIS

Raccoons occur statewide in Texas and often occur around aquatic habitats where beaver, muskrats, nutria, and otter occur. The current raccoon population in Texas is unknown. However, the population is sufficient statewide to allow annual hunting and trapping seasons. The TPWD allows hunters and trappers to harvest raccoons during regulated trapping and hunting seasons each year with no limit on the number of raccoons that hunters and trappers can harvest during the length of those seasons. The highest annual removal of raccoons by the TWSP occurred in FY 2015 when the TWSP removed 12 raccoons unintentionally during activities targeting aquatic mammals. Between FY 2013 and FY 2015, the unintentional removal of raccoons by the TWSP during activities targeting aquatic mammals has averaged less than eight raccoons per year.

The magnitude of non-target removal of raccoons by the TWSP during activities targeting aquatic mammals in the State would be low when compared to the number of raccoons that people harvest in the State annually and when compared to the statewide population. The limited removal of raccoons by the TWSP has not limited the ability of people to harvest raccoons during the regulated season.

VIRGINIA OPOSSUM POPULATION IMPACT ANALYSIS

Opossum occur statewide in Texas wherever suitable habitat exists and often occur around aquatic habitats where beaver, muskrats, nutria, and otter occur. The TPWD allows hunters and trappers to harvest opossum during annual trapping seasons and a continuously open hunting season with no limit on the number of opossum that people can harvest during those seasons. The current opossum population in Texas is unknown.

Between FY 2013 and FY 2015, the TWSP lethally remove one opossum unintentionally during activities targeting aquatic mammals. The TWSP anticipates the unintentional removal of opossum from activities targeting aquatic mammals to remain low when compared to the number of opossum harvested annually in the State and when compared to the statewide population. The limited removal of opossum by the TWSP would not limit the ability to harvest opossum during the regulated season.

TURTLE POPULATION IMPACT ANALYSIS

Between FY 2013 and FY 2015, the TWSP lethally removed an average of 17 turtles unintentionally during activities that targeted aquatic mammals. The species of turtles that the TWSP has lethally removed unintentional include common snapping turtles (*Chelydra serpentina*), red-eared turtles (*Trachemys scripta*), river cooters (*Pseudemys concinna*), smooth softshell turtles (*Apalone mutica*), and spiny softshell turtles (*A. spinifera*). The TWSP has not captured or lethally removed any threatened or endangered turtle species during activities targeting aquatic mammals.

Except for threatened or endangered turtles, the TPWD allows people to harvest turtles on private property in the State, including the commercial harvest of turtles. The number of turtles that people harvest in the State is unknown. Similarly, the statewide populations of turtle species that occur in the State are unknown. However, the annual removal of turtles by the TWSP since FY 2013 has not reached a magnitude that would adversely affect the populations of any turtle species in Texas. The TWSP would take precautions to avoid the capture of turtles during activities to alleviate damage caused by aquatic mammals. Given the limited removal of turtles of any given species by the TWSP, activities conducted by the TWSP did not adversely affect turtle populations in Texas. In addition, the unintentional removal of turtles by the TWSP would not limit the ability to harvest turtles in the State based on the low magnitude of removal occurring by the TWSP. In addition, the magnitude of unintentional removal by the TWSP would be low when compared to the actual statewide populations of those turtles.

T&E SPECIES EFFECTS

The TWSP would make special efforts to avoid jeopardizing T&E species through biological evaluations of potential effects and the establishment of special restrictions or minimization measures through consultation with the USFWS. Chapter 3 of this EA describes several SOPs to avoid effects to T&E species.

Under Alternative 1, the activities that the TWSP could conduct to alleviate damage or threats of damage associated aquatic mammals would have minimal potential impacts on T&E species or their designated critical habitats. A review of federally listed T&E species in Texas confirms those species discussed in Section 3.4 are the only species potentially affected by the activities that the TWSP could conduct to alleviate damage and threats of damage caused by aquatic mammals. Appendix C contains a list of species currently designated as threatened or endangered in the State. In 1998, the TWSP prepared a biological assessment that the TWSP submitted to USFWS in conjunction with an informal Section 7 consultation request. The USFWS concurred that the activities of the TWSP were not likely to adversely affect any listed T&E species, with the possible exceptions of the ocelot (*Leopardus pardalis*), jaguarondi (*Herpailurus yaguarondi*), and Houston toad. The USFWS provided reasonable and prudent measures to avoid impacts to those species, which the TWSP would incorporate as SOPs if the TWSP implements this alternative (see Section 3.4). The TWSP consulted nationally with the USFWS on the ocelot and received a new biological opinion in 2010. Based on the biological opinion, the TWSP has incorporated the reasonable and prudent measures and terms and conditions for incidental take to minimize the potential for taking an ocelot. Following the reasonable and prudent measures along with terms and conditions, the TWSP does not anticipate taking an ocelot. The TWSP has not taken any T&E species in the State, and does not anticipate take under this alternative. The USFWS and the TPWD concurred that the activities conducted by the TWSP to manage damage caused by aquatic mammals would have no effect or would not likely adversely affect any federal or state listed T&E species in Texas.

Alternative 2 – Aquatic Mammal Damage Management by the WS Program through Technical Assistance Only

Under this alternative, WS would have no direct impact on non-target species, including T&E species. People seeking technical assistance from the WS program could employ those methods that employees of WS recommend or provide through loaning of equipment. WS' personnel would base recommendations on the WS Decision Model using information provided by the person requesting assistance or through site visits. Recommendations would include methods or techniques to minimize non-target impacts associated with the methods that employees recommend or loan. Methods recommended could include non-lethal and lethal methods as deemed appropriate by the WS Decision Model and as permitted by laws and regulations.

The potential impacts to non-target animals under this alternative would be variable and based on several factors. If people requesting assistance employed methods as recommended by the WS program, the potential impacts to non-target animals would likely be similar to Alternative 1. If people did not follow the recommendations made on methods and techniques or if other methods were employed that were not recommended, the potential impacts on non-target species, including T&E species, would likely be higher compared to Alternative 1.

The potential impacts of harassment and exclusion methods on non-target species would be similar to those described under Alternative 1. Harassment and exclusion methods would be easily obtainable and simple to employ. Since identification of target animals would occur when employing shooting as a method, the potential impacts to non-target species would likely be low under this alternative; however, the impacts would likely be low only if people had the knowledge and experience to recognize and correctly identify a target animal.

Those persons experiencing damage from aquatic mammals may implement methods and techniques based on the recommendations of the WS program. Therefore, the knowledge and skill of those persons implementing recommended methods would influence the potential for impacts to occur. If those persons experiencing damage do not implement methods or techniques correctly, the potential impacts from providing only technical assistance could be greater than Alternative 1. The incorrect implementation of methods or techniques recommended by the WS program could lead to an increase in non-target animal removal when compared to the non-target animal removal that could occur by the TWSP under Alternative 1.

If requesters were provided technical assistance but do not implement any of the recommended actions and conducted no further action, the potential to remove non-target animals would be lower when compared to Alternative 1. If those persons requesting assistance implement recommended methods appropriately and as instructed or demonstrated, the potential impacts to non-target animals would be similar to the Alternative 1. If WS made recommendations on the use of methods to alleviate damage but those methods were not implemented as recommended by WS or if those methods recommended by WS were used inappropriately, the potential for lethal removal of non-target animals would likely increase under this alternative. Therefore, the potential impacts to non-target animals, including T&E species, would be variable under this alternative.

If those people requesting assistance deemed non-lethal methods recommended by the WS program ineffective under this alternative, those people could employ lethal methods. Those people requesting assistance would likely be those persons that would use lethal methods since the damage had reached a threshold for that individual requester that triggered the requester to seek assistance to reduce damage. The potential impacts on non-target animals by those people experiencing damage would be highly variable. People whose aquatic mammal damage problems were not effectively resolved by non-lethal control methods would likely resort to other means of legal or illegal lethal control. This could result in less experienced persons implementing control methods and could lead to greater removal of non-target animals than would occur under Alternative 1. When those persons experiencing damage caused by wildlife reach a level where assistance does not adequately reduce damage or where no assistance is available, people have resorted to illegal actions (*e.g*., see Bailey 1954, Allen et al. 1996, Jonker et al. 2006). Illegal actions could result in losses of both target and non-target wildlife. Illegal actions by those persons frustrated with the lack of assistance or assistance that inadequately reduces damage to an acceptable level can often result in the indiscriminate removal of wildlife species.

The ability to reduce negative effects caused by aquatic mammals to wildlife species and their habitats, including T&E species, would be variable under this alternative. The skills and abilities of the people implementing damage management actions would determine their ability to reduce risks. Similar to Alternative 3, the Texas A&M AgriLife Extension Service and the TPWD along with private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of direct assistance provided by the WS program. Risks to non-target animals and T&E species would continue to occur from activities conducted by Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service, and TPWD), and private entities or organizations (*e.g*., TWDMA), including from those people who implement damage management activities on their own. Those risks to non-target animals and T&E species from activities conducted by Texas state agencies and private entities or organizations would likely be similar to those discussed when implementing Alternative 1.

Alternative 3 – No Involvement with Managing Aquatic Mammal Damage by the WS Program

Under this alternative, the federal WS program in the State would not conduct damage management activities associated with aquatic mammals. Therefore, no direct impacts to non-target animals or T&E species would occur by the WS program under this alternative. However, Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service and TPWD) and private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. Risks to non-target animals and T&E species would continue to occur from activities conducted by Texas state agencies and private entities or organizations, including from those people who implement damage management activities on their own.

The Texas A&M AgriLife Extension Services, the TWDMA, and the TPWD would likely provide some level of assistance, but without assistance by the WS program. Those entities would likely continue to lethal removal minimal numbers of non-target animals similar to Alternative 1, since similar methods would continue to be available for use. If the assistance provided by those entities increased in proportion to assistance that the WS program would have provided, the effects on non-target animals would likely be similar to Alternative 1 and Alternative 2. If those entities did not increase assistance in proportion to the assistance that the WS program would have provided, those activities conducted by private entities could increase. This could result in less experienced persons implementing methods and could lead to greater lethal removal of non-target animals than Alternative 1. Other entities could use methods where the personnel of the WS program may not because WS' personnel would follow those SOPs outlined in Section 3.3 and Section 3.4. Therefore, the risks of capturing or removing a non-target animal unintentionally could be greater under this alternative.

SOPs that would be followed by the TWSP, if the WS program were involved, to avoid T&E impacts were described in Section 3.3 and Section 3.4. Whereas the TWSP would adhere to those measures, private citizens might or might not be required to act in accordance with them. This could lead to a much greater impact on T&E species than under Alternative 1. The TWSP anticipates that private efforts to lethal removal target aquatic mammals could result in potential adverse impacts for T&E and sensitive species. This potential could be much higher than Alternative 1. The illegal use of methods often results in loss of both target and non-target wildlife (*e.g.*, see Bailey 1954, Allen et al. 1996, Jonker et al. 2006). The use of illegal toxicants by those persons frustrated with the lack of assistance or assistance that inadequately reduces damage to an acceptable level can often result in the indiscriminate lethal removal of animal species. Therefore, the potential for effects on non-target animals could be higher under this alternative than Alternative 1.

Issue 3 - Effects of Damage Management Methods on Human Health and Safety

A common concern is the potential adverse effects that methods available could have on human health and safety. Each of the alternatives evaluates the threats to human safety of methods available under the alternatives below.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

The cooperator requesting assistance would be made aware through a MOU, work initiation document, or a similar document that those methods agreed upon could potentially be used on property owned or managed by the cooperator. Therefore, the cooperator would be made aware of the possible use of those methods on property they own or manage to identify any risks to human safety associated with the use of those methods. Cooperators would be made aware by signing a MOU, work initiation document, or another similar document, which would assist the TWSP and the cooperating entity with identifying any risks to human safety associated with methods at a particular location.

Under Alternative 1, the TWSP could use or recommend those methods discussed in Appendix B singularly or in combination to resolve and prevent damage associated with aquatic mammals in the State. The TWSP would use the Decision Model to determine the appropriate method or methods that would effectively resolve the request for assistance. Those methods would be continually evaluated for effectiveness and if necessary, additional methods could be employed. Non-lethal and lethal methods could be used under this alternative. The TWSP would continue to provide technical assistance and/or direct operational assistance to those persons seeking assistance with managing damage or threats from aquatic mammals. Risks to human safety from technical assistance conducted by the TWSP would be similar to those risks addressed under Alternative 2. Those non-lethal methods that could be used as part of an integrated approach to managing damage, that would be available for use by the TWSP as part of direct operational assistance, would be similar to those risks associated with the use of those methods under the other alternatives.

Lethal methods available under this alternative would include the use of body-gripping traps, cable devices, the recommendation of harvest during hunting and/or trapping seasons, shooting, zinc phosphide, and euthanasia chemicals. In addition, target aquatic mammal species live-captured using non- lethal methods (*e.g.*, live-traps, immobilizing drugs) could be euthanized. The TWSP could also use foothold traps and submersion rods or cables for drowning sets. Those lethal methods available under this alternative (or similar products) would also be available under the other alternatives. None of the lethal methods available would be restricted to use by the TWSP only. Euthanasia chemicals would not be available to the public but those aquatic mammals live-captured could be killed using other methods. Other entities (*e.g.*, veterinarians) could be available to euthanize animals using euthanasia chemicals. Zinc phosphide would only be available to persons with a pesticide applicators license issued by TDA.

Employees of the TWSP who conduct activities to manage damage caused by aquatic mammals would be knowledgeable in the use of those methods available, the wildlife species responsible for causing damage or threats, and WS' directives. That knowledge would be incorporated into the decision-making process inherent with the WS Decision Model that would be applied when addressing threats and damage caused by aquatic mammals. When employing lethal methods, employees of the TWSP would consider risks to human safety when employing those methods based on location and method. For example, risks to human safety from the use of methods would likely be lower in rural areas that are less densely populated. Consideration would also be given to the location where damage management activities would be conducted based on property ownership. If locations where methods would be employed occur on private property in rural areas where access to the property could be controlled and monitored, the risks to human safety from the use of methods would likely be less. If damage management activities occurred at public parks or near other public use areas, then risks of the public encountering damage management methods and the corresponding risk to human safety would increase. Activities would generally be conducted when human activity was minimal (*e.g.*, early mornings, at night) or in areas where human activities were minimal (*e.g.*, in areas closed to the public).

The use of live-capture traps, restraining devices (*e.g.*, foothold traps, some cable devices), and body-gripping traps have been identified as a potential issue. Live-capture traps available for aquatic mammals would typically be walk-in style traps where aquatic mammals enter but are unable to exit. Live-traps, restraining devices, and body-gripping traps would typically be set in situations where human activity was minimal to ensure public safety. Those methods rarely cause serious injury and would only be triggered through direct activation of the device. Therefore, human safety concerns associated with live-traps, restraining devices, and body-gripping traps used to capture wildlife, including aquatic mammals, would require direct contact to cause bodily harm. Therefore, if left undisturbed, risks to human safety would be minimal. Signs warning of the use of those tools in the area could be posted for public view at access points to increase awareness that those devices were being used and to avoid the area, especially pet owners.

Safety issues related to the misuse of firearms and the potential human hazards associated with the use of firearms were issues identified. To help ensure the safe use of firearms and to increase awareness of those risks, employees of the TWSP who use firearms during official duties would be required to attend an approved firearm safety-training course and to remain certified for firearm use must attend a safety-training course in accordance with WS Directive 2.615. As a condition of employment, the TWSP employees who carry and use firearms are subject to the Lautenberg Domestic Confiscation Law, which prohibits firearm possession by anyone who has been convicted of a misdemeanor crime of domestic violence (18 USC § 922(g)(9)). A safety assessment based on site evaluations, coordination with cooperating and local agencies (if applicable), and consultation with cooperators would be conducted before firearms were deemed appropriate to alleviate or reduce damage and threats to human safety when conducting activities. The TWSP would work closely with cooperators requesting assistance to ensure all safety issues were considered before firearms would be deemed appropriate for use. The use of all methods, including firearms, would be agreed upon with the cooperator to ensure the safe use of those methods. The security of firearms would also occur pursuant to WS Directive 2.615.

The recommendation by the TWSP that aquatic mammals be harvested during the regulated hunting and/or trapping season that are established by the TPWD would not increase risks to human safety above those risks already inherent with hunting or trapping those species. Recommendations of allowing hunting and/or trapping on property owned or managed by a cooperator to reduce aquatic mammal populations, which could then reduce damage or threats, would not increase risks to human safety. Safety requirements established by the TPWD for the regulated hunting and trapping season would further minimize risks associated with hunting and trapping. Although hunting and trapping accidents do occur, the recommendation of allowing hunting or trapping to reduce localized populations of aquatic mammals would not increase those risks.

The issue of using chemical methods as part of managing damage associated with wildlife relates to the potential for human exposure either through direct contact with the chemical or exposure to the chemical from wildlife that have been exposed. Under the alternatives identified, the use of chemical methods could include immobilizing drugs, euthanasia chemicals, zinc phosphide, binary explosives, and repellents.

Employees of the TWSP would only administer immobilizing drugs to aquatic mammals that have been live-captured using other methods. Employees of the TWSP would use immobilizing drugs to sedate target animals for temporarily handling and/or to transport target animals. Sedating target animals can lessen the distress to the animal from the experience. Drug delivery would occur on site with close monitoring of the animal to ensure proper care of the animal. Immobilizing drugs would be reversible with a full recovery of sedated animals occurring. Drugs used in capturing and handling wildlife that would be available include Ketamine, a mixture of Ketamine/Xylazine, and Telazol. Appendix B contains a list and description of immobilizing drugs available for use under the identified alternatives.

If aquatic mammals were immobilized for sampling or translocation and released, risks could occur to human safety if harvest and consumption occurred. SOPs employed by the TWSP to reduce risks are discussed in Chapter 3 and in Appendix B. SOPs that would be part of the activities conducted include:

- All immobilizing drugs used in capturing and handling wildlife would be under the direction and authority of state veterinary authorities, either directly or through procedures agreed upon between those authorities and the TWSP.
- As determined on a state-level basis by those veterinary authorities (as allowed by AMDUCA), wildlife hazard management programs may choose to avoid capture and handling activities that utilize immobilizing drugs within a specified number of days prior to the hunting or trapping season for the target species. This practice would avoid release of animals that may be consumed by hunters and/or trappers prior to the end of established withdrawal periods for the particular drugs used. Ear tagging or other marking of animals drugged and released to alert hunters and trappers that they should contact state officials before consuming the animal.
- Most animals administered immobilizing drugs would be released well before hunting/trapping seasons, which would give the drug time to metabolize completely out of the animals' systems before they might be harvested and consumed by people. In some instances, animals collected for control purposes would be euthanized when they were captured within a certain specified time period prior to the legal hunting or trapping season to avoid the chance that they would be

consumed as food while still potentially having immobilizing drugs in their systems.

Meeting the requirements of the AMDUCA should prevent any adverse effects to human health with regard to this issue.

Euthanizing chemicals would be administered under similar circumstances to immobilizing drugs and would be administered to animals live-captured using other methods. Euthanasia chemicals would include sodium pentobarbital and potassium chloride. Euthanized animals would be disposed of in accordance with WS Directive 2.515; therefore, would not be available for harvest and consumption. Euthanasia of target animals would occur in the absence of the public to minimize risks, whenever possible.

The recommendation of repellents or the use of those repellents registered for use to disperse aquatic mammals in the State could occur under Alternative 1 as part of an integrated approach to managing aquatic mammal damage. Those chemical repellents that would be available to recommend for use or that could be directly used by the TWSP under this alternative would also likely be available under any of the alternatives. Therefore, risks to human safety from the recommendation of repellents or the direct use of repellents would be similar across all the alternatives. Risks to human safety associated with the use of repellents by the TWSP or the recommendation of repellents by the TWSP is addressed under the technical assistance only alternative (Alternative 2). Risks to human safety would be similar across all the alternatives. The involvement of the TWSP, either through recommending the use of repellents or the direct use of repellents, would ensure that label requirements of those repellents were discussed with those persons requesting assistance when recommended through technical assistance or would be specifically adhered to by personnel of the TWSP when using those chemical methods. Therefore, the risks to human safety associated with the recommendation of or direct use of repellents could be lessened through participation by the TWSP.

When the TWSP received a request to remove a beaver dam, employees of the TWSP would assess the potential for downstream flooding to determine the appropriate removal method. The TWSP would generally breach or remove beaver dams by hand with a rake or power tools (*e.g.*, a winch). The TWSP would normally breach or remove dams through incremental stages of debris removal from the dam that allows water levels to be gradually lowered. Breaching of dams would normally occur to limit the potential for flooding downstream by gradually allowing water levels to lower as more of the dam was breached over time. Depending on the size of the impoundment, water levels could be slowly lowered over several hours or days when breaching dams. When breaching dams, only that portion of the dam blocking the stream or ditch channel would be altered or breached, with the intent of returning water levels and flow rates to historical levels or to a level that eliminates damage threats that would be acceptable to the property owner or resource manager. Similar to breaching dams, the removal of the dam removes the debris impounding water and restores the normal flow of water. The TWSP could also use explosives to breach or remove beaver dams. Employees of the TWSP would generally use explosives to remove beaver dams that were too large to remove by hand.

Personnel of the TWSP responsible for the use of explosives would be required to complete in-depth training and must demonstrate competence and safety with use of explosives pursuant to the WS Explosives Safety Manual (see WS Directive 2.435). Employees would adhere to WS' policies as well as regulations promulgated by the Bureau of Alcohol, Tobacco, and Firearms, the Occupational Safety and Health Administration, the United States Department of Transportation, and the Texas State Police concerning explosives use, storage, safety, and transportation. The TWSP would use binary explosives that require the mixing of two components for activation. Binary explosives reduce the hazard of accidental detonation during storage and transportation since the two components are stored separately. Storage and transportation of mixed binary explosives is prohibited. When explosives were being used by the TWSP, warning signs would be posted to restrict public entry. The TWSP would also contact the appropriate utility resources to identify and mark underground utilities before removing dams with explosives. When beaver dams were near roads or highways, police or other road officials would be used to help stop traffic and restrict public entry.

The TWSP would use only legal, effective, and environmentally safe damage management methods, tools, and approaches. The EPA through the FIFRA, the TDA, the United States Drug Enforcement Administration, MOUs with land managing agencies, and the directives of the TWSP would regulate chemical methods that could be available for use by the TWSP pursuant to the alternatives. The TWSP would properly dispose of any excess solid or hazardous waste. No adverse effects to human safety have occurred from the use of methods by the TWSP to alleviate aquatic mammal damage in the State from FY 2013 through FY 2015. The risks to human safety from the use of non-lethal and lethal methods, when used appropriately and by trained personnel, would be low. The TWSP does not anticipate the alternatives would result in any adverse or disproportionate environmental impacts to minority and low-income persons or populations. In contrast, the alternatives may benefit minority or low-income populations by reducing threats to public health and safety and property damage.

In addition, the TWSP has considered the impacts that Alternative 1 might have on children. The proposed activities would occur by using only legally available and approved methods where it is highly unlikely that activities conducted pursuant to the alternatives would adversely affect children. For these reasons, the TWSP concludes that it would not create an environmental health or safety risk to children from implementing Alternative 1. Additionally, the need for action identified a need to reduce threats to human safety, including risks to children; therefore, cooperators could request the assistance of the TWSP with reducing threats to the health and safety of children posed by aquatic mammals. Based on the use patterns of methods available to address damage caused by aquatic mammals, this alternative would comply with Executive Order 12898 and Executive Order 13045.

Alternative 2 – Aquatic Mammal Damage Management by the WS Program through Technical Assistance Only

Under this alternative, the federal WS program would be restricted to making recommendations on the use of methods and the demonstration of methods to resolve damage. WS' personnel would only provide technical assistance to those people requesting assistance with aquatic mammal damage and threats. WS' personnel would base technical assistance recommendations on information provided by the person requesting assistance or through site visits. Therefore, those persons requesting assistance could use the methods that WS' personnel recommend or provide through loaning of equipment. WS' personnel would make the cooperator requesting assistance aware of threats to human safety associated with the use of those methods recommended by the WS program. Risks to human safety from activities and methods recommended under this alternative would be similar to the other alternatives since the same methods would be available.

Methods recommended could include non-lethal and lethal methods as deemed appropriate by WS' Decision Model and as permitted by laws and regulations. The Texas A&M AgriLife Extension Service and the TPWD along with private entities or organizations (*e.g.*, TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of direct assistance provided by the WS program. Threats to human safety would continue to occur from activities conducted by Texas state agencies and private entities or organizations, including from those people who implement damage management activities on their own similar to Alternative 3.

Although hazards to human safety from non-lethal methods exist, those methods are generally safe when used by trained individuals who are experienced in their use. Risks to human safety associated with non-chemical methods would be low based on their use profile for alleviating damage associated with wildlife.

Under this alternative, the availability of immobilizing drugs and euthanasia chemicals would be limited. Immobilizing drugs used in capturing and handling wildlife could be administered under the direction and authority of state veterinary authorities, either directly or through procedures agreed upon between those authorities and other entities, such as the TWSP and/or the TPWD. Without access to immobilizing drugs or euthanizing chemicals, those persons capturing aquatic mammals using live-traps or other live-capture methods would be responsible for euthanizing or handling live-captured captive animals. Since the availability of immobilizing drugs and euthanizing chemicals would be limited under this alternative, a gunshot would likely be the primary method of euthanasia.

The use of chemical methods that are considered non-lethal could continue to be available under this alternative. Chemical methods available would include repellents. There are few chemical repellents registered for use to manage damage caused by aquatic mammals in the State. Most repellents require ingestion of the chemical to achieve the desired effects on target species. Repellents that require ingestion are intended to discourage foraging on vulnerable resources and to disperse aquatic mammals from areas where the repellents were applied. Repellents, when used according to label directions, are generally regarded as safe especially when the ingredients are considered naturally occurring. Some risk of exposure to the chemical would occur to the applicator, as well as others, as the product was applied due to the potential for drift. Some repellents also have restrictions on whether application can occur on edible plants with some restricting harvest for a designated period after application. All restrictions on harvest and required personal protective equipment would be included on the label and if followed, would minimize risks to human safety associated with the use of those products.

The recommendation by the WS program that aquatic mammals be harvested during the regulated hunting and/or trapping season, which would be established by the TPWD, would not increase risks to human safety above those risks already inherent with hunting and trapping aquatic mammals. Recommendations of allowing hunting or trapping on property owned or managed by a cooperator to reduce local aquatic mammal populations that could then reduce aquatic mammal damage or threats would not increase risks to human safety. Safety requirements established by the TPWD for the regulated hunting and trapping season would further minimize risks associated with those activities. Although hunting and trapping accidents do occur, the recommendation of allowing hunting or trapping to reduce localized aquatic mammal populations would not increase those risks.

The recommendation of shooting with firearms as a method of direct lethal removal could occur under this alternative. Safety issues do arise related to misusing firearms and the potential human hazards associated with firearms use when employed to reduce damage and threats. When used appropriately and with consideration for human safety, risks associated with firearms would be minimal. If firearms were employed inappropriately or without regard to human safety, serious injuries could occur. Under this alternative, recommendations of the use of firearms by the WS program would include human safety considerations. Since the use of firearms to alleviate aquatic mammal damage would be available under any of the alternatives and the use of firearms by those persons experiencing aquatic mammal damage could occur whether the WS program was consulted or contacted, the risks to human safety from the use of firearms would be similar among all the alternatives.

If non-chemical methods were employed according to recommendations and as demonstrated by the TWSP, the potential risks to human safety would be similar to Alternative 1. If methods were employed without guidance or applied inappropriately, the risks to human safety could increase. The extent of the increased risk would be unknown and variable. Non-chemical methods inherently pose minimal risks to human safety given the design and the extent of the use of those methods.

The cooperator requesting assistance would also be made aware of threats to human safety associated with the use of those methods. Section 3.3 and Section 3.4 discuss the SOPs that the WS program would incorporate in the appropriate alternatives. Risks to human safety from activities and methods recommended under this alternative would be similar to the other alternatives since the same methods would be available. If people misuse or apply those methods inappropriately, any of the methods available to alleviate aquatic mammal damage could threaten human safety. However, when used appropriately, methods available to alleviate damage would not threaten human safety. The recommendation of methods by the WS program to people requesting assistance and the pattern of use recommended by the WS program would comply with Executive Order 12898 and Executive Order 13045.

The ability to reduce negative effects caused by aquatic mammals to human safety, including T&E species, would be variable under this alternative. The skills and abilities of the people implementing damage management actions would determine their ability to reduce risks. Similar to Alternative 3, the Texas A&M AgriLife Extension Service and the TPWD along with private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of direct assistance provided by the WS program. Risks to human health and safety would continue to occur from activities conducted by Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service and TPWD), and private entities or organizations (*e.g*., TWDMA), including from those people who implement damage management activities on their own. Those risks to human health and safety from activities conducted by Texas state agencies and private entities or organizations would likely be similar to those discussed when implementing Alternative 1.

Alternative 3 – No Involvement with Managing Aquatic Mammal Damage by the WS Program

Under this alternative, the WS program would not be directly involved with damage management activities in the State. Therefore, no direct impacts to human safety from methods would occur by WS under this alternative. However, like Alternative 2, Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service and TPWD), and private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. Threats to human safety would continue to occur from methods used by Texas state agencies and private entities or organizations, including from those people who implement damage management activities on their own.

The ability to reduce threats to human safety posed by available methods would be variable based upon the skills and abilities of the person implementing damage management actions under this alternative. The Texas A&M AgriLife Extension Services, the TWDMA, and the TPWD would likely still provide some level of assistance, but without assistance by the WS program. Those entities would likely continue to employ those methods discussed in Appendix B. Similar to Alternative 2, immobilizing drugs and euthanasia chemicals would have limited availability under this alternative to the public. Zinc phosphide would continue to be available to those persons with the appropriate pesticide applicators license. Since most methods available to resolve or prevent aquatic mammal damage or threats would be available to anyone, the threats to human safety from the use of those methods would be similar between the alternatives. However, methods employed by those persons not experienced in the use of methods or were not trained in their proper use, could increase threats to human safety.

If the assistance provided by those entities increased in proportion to assistance that the WS program would have provided, the potential threats to human safety from methods available would be similar to Alternative 1. If those entities did not increase assistance in proportion to the assistance that the WS program would have provided, those activities conducted by private entities could increase. This could result in less experienced persons implementing methods and could lead to greater risks to human safety than Alternative 1 and Alternative 2. Other entities could use methods where the personnel of the WS program may not because WS' personnel would follow those SOPs outlined in Section 3.3 and Section 3.4 to reduce threats to human safety. Methods employed by those persons not experienced in the use of methods or are not trained in their proper use, could increase threats to human safety.

SOPs that could be followed by the TWSP, if the WS program were involved, to reduce threats to human safety were described in Section 3.3 and Section 3.4. Whereas the TWSP could adhere to these measures, private citizens might or might not be required to act in accordance with them. This could lead to a higher risk to human safety than under Alternative 1 and Alternative 2.

Issue 4 - Effects on the Aesthetic Values of Aquatic Mammals

Another concern often raised is the potential impact the alternatives could have on the aesthetic value that people often regard for aquatic mammals. The effects of the alternatives on this issue are analyzed below by alternative.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

Under this alternative, methods would be employed that would result in the dispersal, exclusion, or removal of individuals or small groups of aquatic mammals to resolve damage and threats. In some instances where aquatic mammals were dispersed or removed, the ability of interested persons to observe and enjoy those aquatic mammals would likely temporarily decline.

Even the use of exclusionary devices can lead to the dispersal of wildlife if the resource being damaged was acting as an attractant. Thus, once the attractant was removed or made unavailable, the wildlife would likely disperse to other areas where resources would be more vulnerable.

The use of lethal methods would result in temporary declines in local populations resulting from the removal of aquatic mammals to address or prevent damage and threats. The goal of Alternative 1 would be to respond to requests for assistance and to manage those aquatic mammals responsible for the resulting damage. Therefore, the ability to view and enjoy aquatic mammals would remain if a reasonable effort were made to locate aquatic mammals outside the area in which damage management activities were occurring. In most cases, the aquatic mammals removed by the TWSP could be removed by the person experiencing damage or removed by other entities if no assistance was provided by the TWSP.

All activities would be conducted where a request for assistance was received and only after the cooperator and the TWSP had signed a MOU, work initiation document, or similar document. Some aesthetic value would be gained by the removal of aquatic mammals and the return of a more natural environment, including the return of native wildlife and plant species that may be suppressed or displaced by high aquatic mammal densities.

Since those aquatic mammals that could be removed by the TWSP under this alternative could be removed by other entities, the TWSP involvement in removing those aquatic mammals would not likely be additive to the number of aquatic mammals that could be removed in the absence of the TWSP involvement. Other entities could remove aquatic mammals when the TPWD authorizes the removal, without the need for a permit, if the species was unregulated (*e.g.*, beaver and nutria), or during the regulated hunting or trapping seasons. In addition, entities could request the assistance of other state and federal agencies or seek assistance from private entities to manage damage.

The removal of aquatic mammals by the TWSP from FY 2013 through FY 2015 has been of low magnitude compared to the total mortality and populations of those species. The activities of the TWSP would not likely be additive to the aquatic mammals that could be lethally removed in the absence of involvement by the TWSP. Although aquatic mammals removed by the TWSP would no longer be present for viewing or enjoying, those aquatic mammals would likely be removed by the property owner or manager if the TWSP were not involved in the action. Removal by the property owner or manager could occur under a permit, during the regulated hunting and trapping seasons, or if the aquatic mammals were unregulated, removal could occur without the need for a permit.

Given the limited removal proposed by the TWSP under this alternative when compared to the known sources of mortality of aquatic mammals and the population estimates of those species, aquatic mammal damage management activities conducted by the TWSP pursuant to Alternative 1 would not adversely affect the aesthetic value of aquatic mammals. The impact on the aesthetic value of aquatic mammals and the ability of the public to view and enjoy aquatic mammals under Alternative 1 would be similar to the other alternatives and would likely be low.

Alternative 2 – Aquatic Mammal Damage Management by the WS Program through Technical Assistance Only

If those persons seeking assistance from the WS program were those persons likely to conduct damage management activities in the absence of involvement by the WS program or sought assistance from other entities, then technical assistance provided by the WS program would not adversely affect the aesthetic value of aquatic mammals in the State similar to Alternative 1. Aquatic mammals could be lethally removed under this alternative by those entities experiencing aquatic mammal damage or threats, which could result in localized reductions in the presence of aquatic mammals at the location where damage was occurring. The presence of aquatic mammals where damage was occurring could be reduced where damage management activities were conducted under any of the alternatives. Even the recommendation of non-lethal methods would likely result in the dispersal of aquatic mammals from the area if those non-lethal methods recommended were employed by those persons receiving technical assistance. Therefore, technical assistance provided by the WS program would not prevent the aesthetic enjoyment of aquatic mammals since any activities conducted to alleviate aquatic mammal damage could occur in the absence of participation by the WS program in the action, either directly or indirectly.

Under this alternative, the effects on the aesthetic values of aquatic mammals would be similar to those addressed for Alternative 1. When people seek assistance with managing damage from either the WS program or another entity, the damage level has often reached an unacceptable threshold for that particular person. Therefore, in the case of aquatic mammal damage, the social acceptance level of those aquatic mammals causing damage has reached a level where assistance has been requested and those persons would likely apply methods or seek those entities that would apply those methods based on recommendations provided by the WS program or by other entities. Based on those recommendations, methods could be employed by the requester that could result in the dispersal and/or removal of aquatic mammals responsible for damage or threatening safety. If those aquatic mammals causing damage were dispersed or removed by those persons experiencing damage based on recommendations by the WS program or by other entities, the potential effects on the aesthetic value of those aquatic mammals would be similar to Alternative 1. In addition, those persons could contact other entities to provide direct assistance with dispersing or removing those aquatic mammals causing damage.

The potential impacts on aesthetics from a technical assistance program would only be lower than Alternative 1 if those individuals experiencing damage were not as diligent in employing those methods as the WS program would be if conducting an operational program or if the requester took no further action. If those persons experiencing damage abandoned the use of those methods or conducted no further actions, then aquatic mammals would likely remain in the area and available for viewing and enjoying for those persons interested in doing so. Similar to the other alternatives, the geographical area in which damage management activities could occur would not be such that aquatic mammals would be dispersed or removed from such large areas that opportunities to view and enjoy aquatic mammals would be severely limited.

Alternative 3 – No Involvement with Managing Aquatic Mammal Damage by the WS Program

Under the no aquatic mammal damage management by the WS program alternative, the actions of the WS program would have no impact on the aesthetic value of aquatic mammals in the State. Those people experiencing damage or threats from aquatic mammals would be responsible for researching, obtaining, and using all methods as permitted by federal, state, and local laws and regulations or seeking assistance from other entities. Aquatic mammals could continue to be dispersed and lethally removed under this alternative in the State. Like Alternative 2, Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service and TPWD), and private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. Potential impacts to aesthetics would continue to occur from methods used by Texas state agencies and private entities or organizations, including from those people who implement damage management activities on their own.

Since aquatic mammals would continue to be lethally removed under this alternative, despite the lack of involvement by the WS program, the ability to view and enjoy aquatic mammals would likely be similar to the other alternatives. The lack of involvement by the WS program would not lead to a reduction in the number of aquatic mammals dispersed or removed. The TPWD with management authority over aquatic mammals could continue to adjust all removal levels based on population objectives for those aquatic mammal species in the State. Therefore, the number of aquatic mammals lethally removed annually through harvest and under permits would be regulated and adjusted by the TPWD.

Those people experiencing damage or threats could continue to use those methods they feel appropriate to resolve aquatic mammal damage or threats, including lethal removal or could seek the direct assistance of other entities. Therefore, WS' involvement in managing damage would not be additive to the aquatic mammals that could be dispersed or removed. The impacts to the aesthetic value of aquatic mammals would be similar to the other alternatives.

Issue 5 - Humaneness and Animal Welfare Concerns of Methods

As discussed previously, a common issue often raised is concerns about the humaneness of methods available under the alternatives for resolving aquatic mammal damage and threats. The issues of method humaneness relating to the alternatives are discussed below.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

Under this alternative, the TWSP would integrate methods using the WS Decision Model as part of technical assistance and direct operational assistance. Methods available under this alternative could include non-lethal and lethal methods integrated into direct operational assistance conducted by WS. Under this alternative, non-lethal methods would be used by WS that were generally regarded as humane. Non-lethal methods that would be available include translocation, exclusion devices, frightening devices, cage traps, foothold traps, immobilizing drugs, and repellents.

As discussed previously, humaneness, in part, appears to be a person's perception of harm or pain inflicted on an animal. People may perceive the humaneness of an action differently. The challenge in coping with this issue is how to achieve the least amount of animal suffering.

Some individuals believe any use of lethal methods to resolve damage associated with wildlife is inhumane because the resulting fate is the death of the animal. Others believe that certain lethal methods can lead to a humane death. Others believe most non-lethal methods of capturing wildlife to be humane because the animal is generally unharmed and alive. Still others believe that any disruption in the behavior of wildlife is inhumane. With the multitude of attitudes on the meaning of humaneness and the varying perspectives on the most effective way to address damage and threats in a humane manner, agencies are challenged with conducting activities and employing methods that are perceived to be humane while assisting those persons requesting assistance to manage damage and threats associated with wildlife. The goal of the TWSP would be to use methods as humanely as possible to resolve requests for assistance to reduce damage and threats to human safety. The TWSP would continue to evaluate methods and activities to minimize the pain and suffering of animals addressed when attempting to resolve requests for assistance.

Some methods have been stereotyped as "*humane*" or "*inhumane*". However, many "*humane*" methods can be inhumane if not used appropriately. For instance, a cage trap would generally be considered by most members of the public as "*humane*", since the animal would be alive and generally unharmed. Yet, without proper care, live-captured wildlife in a cage trap could be treated inhumanely if not attended to appropriately.

Therefore, the goal would be to address requests for assistance effectively using methods in the most humane way possible that minimizes the stress and pain to the animal. Overall, the use of exclusion and live-capture devices would be regarded as humane when used appropriately. Although some concern arises from the use of live-capture methods, the stress of animals is likely temporary.

Although some issues of humaneness could occur from the use of cage traps, foothold traps, translocation, immobilizing drugs, and repellents, those methods, when used appropriately and by trained personnel, would not result in the inhumane treatment of wildlife. Concerns from the use of those non-lethal methods would be from injuries to animals while those animals were restrained and from the stress of the animal while being restrained or during the application of the method. Pain and physical restraint can cause stress in animals and the inability of animals to effectively deal with those stressors can lead to distress. Suffering occurs when action is not taken to alleviate conditions that cause pain or distress in animals.

If aquatic mammals were to be live-captured by the TWSP, personnel would be present on-site during capture events or capture devices would be checked frequently to ensure aquatic mammals captured were addressed in a timely manner and to prevent injury. Although stress could occur from being restrained, timely attention to live-captured wildlife would alleviate suffering. Stress would likely be temporary.

Under this alternative, the TWSP could employ lethal methods to alleviate or prevent aquatic mammal damage and threats, when requested. Lethal methods would include shooting, body-gripping traps, cable devices, euthanasia chemicals, zinc phosphide (muskrats and nutria only), and the recommendation of harvest during hunting and/or trapping seasons. The TWSP could also use foothold traps and submersion cables or rods with drowning sets. In addition, target species live-captured using non-lethal methods could be euthanized by the TWSP. The use of lethal control methods by the TWSP under this alternative would follow those required by WS' directives (see WS Directive 2.430, WS Directive 2.505).

The euthanasia methods that the TWSP is considering for use under this alternative for live-captured aquatic mammals are carbon dioxide, carbon monoxide, gunshot, and barbiturates or potassium chloride in conjunction with general anesthesia. When used appropriately, the American Veterinary Medical Association (2013) considers those methods to be acceptable forms of euthanasia. The use of carbon dioxide, carbon monoxide, barbiturates, and potassium chloride for euthanasia would occur after the animal was live-captured and would occur away from public view. Although the American Veterinary Medical Association guideline also lists gunshot as a conditionally acceptable method of euthanasia for free-ranging wildlife, there is greater potential the method may not consistently produce a humane death (American Veterinary Medical Association 2013). Personnel of the TWSP that employ firearms to address aquatic mammal damage or threats to human safety would be trained in the proper placement of shots to ensure a timely and quick death.

An issue when dealing with aquatic mammal species is the use of foothold traps to create drowning sets and the humaneness of drowning. There is considerable debate and disagreement among animal interest groups, veterinarians, wildlife professionals, fur trappers, and nuisance wildlife agents on this issue. The debate centers on an uncertainty as to whether the drowning animals are rapidly rendered unconscious by high levels of carbon dioxide and therefore, insensitive to distress and pain (Ludders et al. 1999). The inhalation of carbon dioxide at concentrations of 7.5% can increase the pain threshold and higher concentrations can have a rapid anesthetic effect on animals (American Veterinary Medical Association 2013). For comparison, room air contains approximately 0.04% carbon dioxide (American Veterinary Medical Association 2007).

The American Veterinary Medical Association considers drowning to be an unacceptable method of euthanasia because the death of the animal does not meet their definition of euthanasia (Beaver et al. 2001, American Veterinary Medical Association 2007, American Veterinary Medical Association 2013). Ludders et al. (1999) concluded animals that drowned were distressed because of the presence of high levels of the stress related hormones epinephrine and norepinephrine that were present in their bloodstreams. Ludders et al. (1999) showed death during drowning occurred from hypoxia and anoxia; thus, animals experienced hypoxemia. Ludders et al. (1999) reported carbon dioxide narcosis did not occur in drowning animals until the mercury levels in the arterial blood of animals exceeded 95 millimeters. Therefore, Ludders et al. (1999) also concluded drowning did not meet the definition of euthanasia. This conclusion was based on animals not dying rapidly from carbon dioxide narcosis (Ludders et al. 1999).

Death by drowning in the classical sense is caused by the inhalation of fluid into the lungs and is referred to as "*wet*" drowning (Gilbert and Gofton 1982, Noonan 1998). Gilbert and Gofton (1982) reported that all submerged beaver do not die from wet drowning, but die of narcosis induced by carbon dioxide, and the American Veterinary Medical Association has stated the use of carbon dioxide is acceptable (Gilbert and Gofton 1982, Noonan 1998, American Veterinary Medical Association 2013). Gilbert and Gofton (1982) reported that after beaver were trapped and they entered the water, the beaver struggled for two to five minutes, followed by a period of reflexive responses. Andrews et al. (1993) stated that with some techniques that induce hypoxia, some animals have reflex motor activity followed by unconsciousness that is not perceived by the animal. Gilbert and Gofton (1982) stated it is unknown how much conscious control actually existed at this stage and they stated anoxia might have removed much of the sensory perception by five to seven minutes post submersion.

However, Gilbert and Gofton (1982) have been criticized because levels of carbon dioxide in the blood were not reported (Ludders et al. 1999) and there was insufficient evidence that the beaver in their study were under a state of carbon dioxide narcosis when they died (letter from V. Nettles, D.V.M., Ph.D., Southeastern Cooperative Wildlife Disease Study, to W. MacCallum, MDFW, June 15, 1998). Adding to the controversy, Clausen and Ersland (1970) did measure carbon dioxide in the blood for submersed restrained beaver; yet, none of the beaver in their study died, so Clausen and Ersland (1970) could not determine if beaver died of carbon dioxide narcosis. Clausen and Ersland (1970) demonstrated that carbon dioxide increased in arterial blood while beaver were submersed and carbon dioxide was retained in the tissues. While Clausen and Ersland (1970) did measure the amounts of carbon dioxide in the blood of submersed beaver, they did not attempt to measure the analgesic effect of carbon dioxide buildup to the beaver (letter from V. Nettles, D.V.M., Ph.D., Southeastern Cooperative Wildlife Disease Study, to W. MacCallum, MDFW, June 15, 1998). When beaver were trapped using foothold traps with intent to "*drown*", the beaver exhibit a flight response. Gracely and Sternberg (1999) reported that there is stress-induced analgesia resulting in reduced pain sensitivity during fight or flight responses. Environmental stressors that animals experience during flight or fight activate the same stress-induced analgesia (Gracely and Sternberg 1999).

The use of drowning trap sets has been a traditional wildlife management technique in trapping aquatic mammals, such as beaver and muskrat. Trapper education manuals and other manuals written by wildlife biologists recommend drowning sets for foothold traps set for beaver (Howard et al. 1980, Randolph 1988, Bromley et al. 1994, Dolbeer et al. 1994, Miller and Yarrow 1994). In some situations, drowning trap sets are the most appropriate and efficient method available to capture beaver and muskrat. For example, a drowning set attachment should be used with foothold traps when capturing beaver to prevent the animals from injuring themselves while restrained, or from escaping (Miller and Yarrow 1994).

Animals that drown die relatively quickly (*e.g.*, within minutes) versus the possible stress of being restrained and harassed by people, dogs, and other wildlife before being euthanized. Drowning sets make the captured animal, along with the trap, less visible and prevents injury from the trapped animal (*i.e.*, bites and scratches) to people who may otherwise approach a restrained animal. Furthermore, the sight of dead animals may offend some people. Drowning places the dead animal out of public view. Some sites may be unsuitable for body-gripping traps or cable devices because of unstable banks, deep water, or a pond with a soft bottom, but those sites would be suitable for foothold traps.

Although rarely used by the TWSP, the TWSP concludes that using drowning trap sets are acceptable and recognizes that some people disagree. The TWSP based those conclusions on the short time period of a drowning event, the possible analgesic effect of carbon dioxide buildup, the minimal, if any, pain or distress on drowning animals, the American Veterinary Medical Association acceptance of hypoxemia as euthanasia, and the American Veterinary Medical Association acceptance of a minimum of pain and distress during euthanasia. In addition, the best management practice trapping standards for beaver and muskrat allow for the use of submersion sets (Association of Fish and Wildlife Agencies 2014*a*, Association of Fish and Wildlife Agencies 2014*b*) and the current acceptance of catching and drowning muskrats and beaver approved by International Humane Trapping Standards (Fur Institute of Canada 2009).

Research and development by the NWRC has improved the selectivity and humaneness of management techniques. Research is continuing to bring new findings and products into practical use. Until new findings and products were found practical, a certain amount of animal suffering could occur when some methods were used in situations where non-lethal damage management methods were not practical or effective. As stated previously, research suggests that some methods, such as restraint in foothold traps or changes in the blood chemistry of trapped animals, indicate "*stress*" (Kreeger et al. 1990). However, such research has not yet progressed to the development of objective, quantitative measurements of pain or stress for use in evaluating humaneness (Bateson 1991, Sharp and Saunders 2008, Sharp and Saunders 2011).

Personnel from the TWSP would be experienced and professional in their use of management methods. Consequently, management methods would be implemented in the most humane manner possible. Many of the methods discussed in Appendix B to alleviate aquatic mammal damage and/or threats in the State could be used under any of the alternatives by those persons experiencing damage regardless of WS' direct involvement. The only methods that may have limited availability to those people experiencing damage associated with aquatic mammals would be zinc phosphide, immobilizing drugs, and euthanasia chemicals. Therefore, the issue of humaneness associated with methods would be similar across any of the alternatives since those methods could be employed by other entities in the absence of involvement by the TWSP. Those persons who view a particular method as humane or inhumane would likely continue to view those methods as humane or inhumane under any of the alternatives. SOPs that would be incorporated into activities of the TWSP to ensure methods were used by the TWSP as humanely as possible are listed in Chapter 3.

Alternative 2 – Aquatic Mammal Damage Management by the WS Program through Technical Assistance Only

The issue of humaneness and the animal welfare of methods under this alternative would be similar to the humaneness issues discussed under Alternative 1. This similarity would be derived from WS' recommendation of methods that some people may consider inhumane. WS would not be involved directly with damage management activities under this alternative. However, the recommendation of the use of methods would likely result in the requester employing those methods. Therefore, by recommending methods and thus a requester employing those methods, the issue of humaneness would be similar to Alternative 1. Under Alternative 2, WS would recommend the use of euthanasia methods pursuant to WS Directive 2.505. However, the person requesting assistance would determine what methods to use to euthanize or kill a live-captured animal under Alternative 2.

WS would instruct and demonstrate the proper use and placement of methodologies to increase effectiveness in capturing target aquatic mammal species and to ensure methods were used in such a way as to minimize pain and suffering. However, the efficacy of methods employed by a cooperator would be based on the skill and knowledge of the requester in resolving the threat to safety or damage situation despite demonstration by WS. Therefore, a lack of understanding of the behavior of aquatic mammals or improperly identifying the damage caused by aquatic mammals along with inadequate knowledge and skill in using methodologies to resolve the damage or threat could lead to incidents with a greater probability of being perceived as inhumane. In those situations, the potential for pain and suffering would likely be regarded as greater than discussed for Alternative 1.

In addition, the issue of humaneness and animal welfare would continue to occur from methods used by Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service, and TPWD), and private entities or organizations (*e.g*., TWDMA), including from those people who implement damage management activities on their own. Those entities and people experiencing damage or threats associated with aquatic mammals could continue to use those methods legally available.

Alternative 3 – No Involvement with Managing Aquatic Mammal Damage by the WS Program

Under this alternative, the WS program would not be involved with any aspect of aquatic mammal damage management in the State. Like Alternative 2, Texas state agencies (*e.g*., Texas A&M AgriLife Extension Service, and TPWD), and private entities or organizations (*e.g*., TWDMA) could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. The issue of humaneness and animal welfare would continue to occur from methods used by Texas state agencies and private entities or organizations, including from those people who implement damage management activities on their own. Those entities and people experiencing damage or threats associated with aquatic mammals could continue to use those methods legally available.

Those methods would likely be considered inhumane by those persons who would consider methods proposed under any alternative as inhumane. The issue of humaneness would likely be directly linked to the methods legally available to the public since methods are often labeled as inhumane by segments of society no matter the entity employing those methods. The humaneness of methods would be based on the skill and knowledge of the person employing those methods. A lack of understanding of the target species or methods used could lead to an increase in situations perceived as being inhumane to wildlife despite the method used. Despite the lack of involvement by the WS program under this alternative, those methods perceived as inhumane by certain individuals and groups would still be available to use to resolve damage and threats caused by aquatic mammals. Under this alternative, euthanasia or killing of live-captured animals would also be determined by those persons employing methods to live-captured wildlife.

In addition, the WS program would be accountable to the public. The WS program makes information available to the public on the activities of the program. The public would be less aware of methods and activities that private individuals use and conduct to alleviate damage because there would be no reporting of activities. The people that perceive some methods as inhumane would be less informed about the activities being conducted by private individuals because private individuals would not be required to provide information under any policies or regulations similar to those of the WS program. Therefore, the perception of inhumane activities could be reduced because the activities of private individuals would not be publicly available, although the actual occurrence of activities may increase because private individuals would likely increase damage management activities in the absence of assistance.

Issue 6 – Effects of Beaver Removal and Dam Manipulation on the Status of Wetlands in the State

Generally, people consider beaver to be beneficial where their activities do not compete with human land use or human health and safety (Wade and Ramsey 1986). The opinions and attitudes of individuals, organizations, and communities vary greatly and are primarily influenced and formed by the benefits and/or damage directly experienced by each individual (Hill 1982, Baker and Hill 2003). Woodward et al. (1976) found that 24% of landowners who reported beaver activity on their property indicated benefits to having beaver ponds on their land and desired assistance with beaver pond management (Hill 1976, Woodward et al. 1985). In some situations, the damage and threats caused by beaver outweigh the benefits (Grasse and Putnam 1955, Woodward et al. 1985, Novak 1987).

Concern has been expressed regarding the potential effects of Alternative 1 and the alternatives on wetland ecosystems associated with activities that could be conducted to address beaver damage or threats. Concerns have been raised that removing and/or modifying beaver dams in an area would result in the loss of wetland habitat and the plant and animal species associated with those wetlands. In addition, concerns are often raised regarding the use of lethal methods to remove beaver to alleviate damage or threats. If beaver were lethally removed from an area and any associated beaver dam was removed or breached, the manipulation of water levels by removing/breaching the dam could prevent the establishment of wetlands in areas where water has been impounded by beaver dams for an extended period.

Over time, the impounding of water associated with beaver dams can establish new wetlands. Because beaver dams may involve waters of the United States, the removal of a beaver dam is regulated under Section 404 of the CWA. The United States Army Corps Of Engineers and the EPA regulatory definition of a wetland (40 CFR 232.2) is "[t]*hose areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas*."

Although beaver can cause damage to resources, there can be many benefits associated with beaver and beaver activities. Beaver can provide ecological benefits associated with the creation of wetland habitats (*e.g*., see Munther 1982, Wright et al. 2002, Rosell et al. 2005, Pollock et al. 2007, Fouty 2003, Fouty 2008, Hood and Bayley 2008, Taylor et al. 2009, Pollock et al. 2012, Pollock et al. 2014). Beaver can also provide aesthetic and recreational opportunities for wildlife observation (Wade and Ramsey 1986, Ringleman 1991), improve water quality (Muller-Schwarze and Sun 2003), and provide cultural and economic gains from fur harvest (Hill 1976, McNeely 1995, Lisle 1996, Lisle 2003).

Beaver impoundments can increase surface and groundwater storage, which can help reduce problems with flooding by slowing the downstream movement of water during high-flow events and help to mitigate the adverse effects of drought (Wade and Ramsey 1986, Naiman et al. 1988, Hey and Philippi 1995, Fouty 2003, Westbrook et al. 2006, Fouty 2008). Hood and Bayley (2008) determined that the presence of beaver could help reduce the loss of open water wetlands during warm, dry years. The presence of beaver impoundments in riverine systems of the Rocky Mountains could affect groundwater recharge and the ability of the water table to withstand drought effects (Westbrook et al. 2006). The presence of active beaver lodges accounted for over 80% of the variability in the amount of open water present in the mixed-wood boreal region of east-central Alberta (Hood and Bayley 2008). Hood and Bayley (2008) also found temperature and rainfall influenced the amount of open-water wetlands, but to a much lesser extent than the presence of beaver. During wet and dry years, the presence of beaver was associated with a 9-fold increase in open water area over the same areas when beaver were absent. Hood and Bayley (2008) noted that beaver could mitigate some of the adverse effects of global warming through their ability to create and maintain areas of open water. Beaver ponds and associated wetlands can provide a potential water source for livestock, serve as basins for the entrapment of streambed silt and eroding soil (Hill 1982), and help to filter nutrients from the water; thereby, maintaining the quality of nearby water systems (Arner and Hepp 1989).

Beaver may increase habitat diversity by opening forest habitats via dam building and tree cutting, which can result in a greater mix of plant species, and different-aged plant communities (Hill 1982, Arner and Hepp 1989). The creation of standing water, edge habitat, and plant diversity, all in close proximity, can result in excellent habitat for many wildlife species (Jenkins and Busher 1979, Arner and DuBose 1982, Hill 1982, Arner and Hepp 1989, Medin and Clary 1990, Medin and Clary 1991, Edwards and Otis 1999). The wetland habitat that beaver ponds might create can be beneficial to some fish (primarily warm water species), reptiles, amphibians, waterfowl, shorebirds, and furbearers, such as muskrats, otter, and mink (Arner and DuBose 1982, Naiman et al. 1986, Miller and Yarrow 1994, Metts et al. 2001, Cunningham et al. 2007). For example, in Mississippi, beaver ponds over three years in age were found to have developed plant communities valuable as nesting and brood rearing habitat for wood ducks (Arner and DuBose 1982). Reese and Hair (1976) found that beaver pond habitats were highly attractive to a large number of birds throughout the year and that the value of beaver pond habitat to waterfowl was minor when compared to other species of birds (Novak 1987). During the winter, Lochmiller (1979) found that woodpeckers spent more time at beaver ponds than areas upstream of beaver ponds. Edwards and Otis (1999) found that six established beaver ponds (10 to 35 years old) were attractive to several bird species seasonally, with the average species richness during all seasons ranging from 23.3 to 30.3 bird species. Metts et al. (2001) found that the abundance, species richness, and species diversity of reptiles was higher at beaver impoundments when compared to unimpounded streams. However, the species richness, species diversity, and evenness of amphibians were higher at unimpounded streams compared to beaver impoundments (Metts et al. 2001). Beaver ponds could be beneficial to some T&E species. The USFWS estimates that up to 43% of T&E species rely directly or indirectly on wetlands for their survival (EPA 1995).

Under Alternative 1, the TWSP could recommend and/or implement methods to manipulate water levels associated with water impounded by beaver dams to alleviate flooding damage. If the technical assistance alternative was selected, the TWSP could recommend methods to people requesting assistance that could result in the manipulation of water levels associated with water impounded by beaver dams. The TWSP would not be involved with any aspect of activities associated with beaver dams under this alternative. Methods that would generally be available under all the alternatives would include exclusion devices, explosives, and water flow devices (see Appendix B for additional information). However, the availability to breach or remove beaver dams using explosives would be limited under Alternative 2 and Alternative 3, since the property owner or manager seeking to remove or breach a dam would be required to locate a person certified to use explosives to conduct the work. In addition, the property owner or manager could use backhoes or other mechanical methods to remove or breach beaver dams under any of the alternatives; however, the TWSP would not operationally employ backhoes or other large machinery to remove or breach dams.

Exclusion devices and water control systems have been used for many years to manipulate the level of water impounded by beaver dams with varying degrees of success (United States General Accounting Office 2001, Taylor and Singleton 2014). Taylor and Singleton (2014) provide a comprehensive summary of the evolution of flow devices to reduce flooding by beaver. Landowner management objectives play a role in how the efficacy of a level system is perceived (Nolte et al. 2001). Nolte et al. (2001) found that survey respondents classified pond levelers installed to manage wetlands for waterfowl habitat more successful than levelers installed to provide relief from flooding. Langlois and Decker (2004) reported that "*...very few beaver problems...can actually be solved with a water level control device*" with a 4.5% success rate in Massachusetts and a 3% success rate in New York. Nolte et al. (2001) reported only 50% of installed pond levelers in Mississippi met landowner objectives and found that pond levelers placed in sites with high beaver activity more frequently failed if installed without implementing population control measures. Taylor and Singleton (2014) recommended, "*…that natural resource managers avoid using fence systems or pipe systems alone, unless they can be used in areas where maintenance requirements and expected damage are extremely low. Flow devices are not intended to replace lethal control*." Taylor and Singleton (2014) also recommended that flow devices be used "*…as part of integrated management plans where beaver flooding conflicts are expected and where local conditions allow flow-device installation and maintenance*".

Higher success rates have been reported for newer exclusion and water control systems ranging from 87% to 93% (Callahan 2005, Boyles 2006, Simon 2006, Boyles and Owens 2007). Lisle (2003) reported the use of water control devices or a combination of a Beaver Deceiver™ and flow management device virtually eliminated the need for maintenance and beaver removal at 20 sites where clogged culverts and flooded roads had previously been a routine issue.

When using exclusion and water control systems, those methods must be specifically designed to meet the needs of each site (Langlois and Decker 2004). Consequently, devices installed by inexperienced individuals may have a higher failure rate than those installed by a professional (Lisle 1996, Callahan 2003, Boyles 2006, Simon 2006, Spock 2006). Higher success rates reported for newer exclusion and water control devices may be indicative of increased understanding of the kinds of situations where those devices work best. For example, Callahan (2005) noted that exclusion and water control systems installed at culvert sites were more successful than similar systems installed at freestanding dams. Callahan (2003) and Callahan (2005) also provided a list of sites that were not well suited to the use of exclusion or water control devices. Boyles (2006) and Boyles and Owens (2007) reported some of the highest success rates for newer exclusion and water control systems; however, those devices were only tested at culvert sites.

Beaver build dams to raise water levels to meet their needs for security and access to forage. While pond levelers allow for the retention of some water, if the water level does not meet the needs of the beaver, they may move a short distance upstream or downstream and build a new dam, or abandon the area (Callahan 2003, Langlois and Decker 2004). This may merely result in moving the problem to a new landowner or, depending upon site characteristics, the resulting pond may result in new or increased damage problems for the original landowner. McNeely (1995) reported the most common reasons cited for lack of success of water flow devices were clogging caused by debris or silt and beaver construction of additional dams upstream or downstream of the management device. In a study by Callahan (2005), construction of a new dam upstream or downstream of a pond leveler device was the most common cause of failure for free-standing dams (*e.g.*, dams not associated with a culvert or other similar constriction in water flow, 11 of 156 sites). Callahan (2005) also found that insufficient pipe capacity (six sites), dammed fencing (two sites), and lack of maintenance (two sites) were causes for pond leveler failures. Nolte et al. (2001) also reported the need to address problems with dams upstream or downstream of a device. At culvert sites, Callahan (2005) found a lack of maintenance was the primary cause of failure with culvert exclusion devices (4 of 227 sites). Callahan (2005) also found vandalism resulted in the failure of a culvert device at one of the sites. At two culvert sites, Callahan (2005) found dammed fencing reduced or completely impeded the operation of exclusion devices.

Most pond levelers and exclusion devices require maintenance. The amount of maintenance required can vary considerably among sites, depending on site conditions and the type of device (Nolte et al. 2001, Callahan 2005, Boyles 2006, Spock 2006). Stream flow, leaf fall, floods, and beaver activity can continuously bring debris to the intake of a water control device. Ice damage and damage from debris washed downstream during high water events may also trigger the need for maintenance (*e.g.*, cleaning out the intake pipe). Although most exclusion and water control devices generally require some level of maintenance, there are reports of devices that have remained effective for a period of years with no maintenance (Nolte et al. 2001). Nolte et al. (2001) reported that post-installation maintenance had been performed by property owners or managers on 70% of the 20 successfully operating Clemson pond levels installed by WS in Mississippi. The most common action was to adjust the riser on the pipe to manipulate water levels. Other maintenance included removal of vegetation and secondary dams built after the installation of the devices. In a survey of individuals who had received assistance with exclusion and water control devices, Simon (2006) found 18 of 36 survey respondents reported maintaining their devices, while installation program staff monitored an additional 10 devices. Of those survey respondents, Simon (2006) found that 61% reported that routine maintenance took 15 minutes or less while 93% reported that maintenance took a half hour or less. Boyles (2006) reported that time spent on device maintenance ranged from one to 4.75 hours per year.

Installation and upkeep of water control devices vary from site to site. For example, transporting materials over long distances in difficult terrain to install devices in remote locations where road access is not available could increase costs compared to the ability to transport materials for installation at a culvert site along a roadway. Callahan (2005) reported that the average cost for an exclusion fence at a culvert was $750 with an average annual maintenance cost of approximately $200. Flexible leveler pipe systems cost an average of $1,000 to install and $100 per year in maintenance, while the average cost to install a combination fence and leveler was $1,400 with approximately $150 per year in maintenance (Callahan 2005). Over a ten-year period, Callahan (2005) estimated the cost of installation and annual maintenance would range from $200 to $290 per year depending on the device installed. Spock (2006) reported that exclusion and/or water control device installation cost ranged from < $600 to over $3,000 dollars, with slightly more than half the systems (58.2%) ranging between $600 and $1,000 to install. In many cases, Spock (2006) found the cost included the first year of maintenance. The more expensive installations tended to be extensive fence and leveler systems or systems with numerous leveler pipes (Spock 2006). Boyles (2006) reported that device installation cost an average of $1,349 per device and $3,180 per site with subsequent annual maintenance cost averaging $19.75 per site per year (Boyles 2006). However, unlike the study by Callahan (2005) the devices evaluated by Boyles (2006) had only been in place for a relatively short time (average time in place 15 months, range 6 to 22 months versus average time in place 36.6 months, range 3 to 75 months). The cost of maintenance may vary over time as site conditions change.

Alternative 1 – The TWSP Would Continue the Current Adaptive Integrated Methods Approach to Managing Damage Caused by Aquatic Mammal in Texas (No Action/Proposed Action)

Under this alternative, the TWSP could manipulate water levels associated with water impoundments caused by beaver dams using either dam breaching, dam removal, or the installation of water flow devices, including exclusion devices. Breaching or removing beaver dams would maintain the normal flow of water. Personnel of the TWSP would not use heavy equipment, such as backhoes or bulldozers, to breach, remove, or install water flow devices. However, cooperators or their agents could utilize heavy machinery to breach a dam, remove a dam, or to install water flow devices in a dam. The TWSP may utilize small all-terrain or amphibious vehicles and/or watercraft for transporting personnel, equipment, and supplies to worksites. The TWSP would only remove or breach that portion of the beaver dam blocking the stream or ditch channel.

The breaching or removal of dams could occur by hand. Breaching would normally occur through incremental stages of debris removal from the dam, which would allow water levels to lower gradually. Breaching of dams would normally occur to limit the potential for flooding downstream by gradually allowing water levels to lower as personnel of the TWSP breached more of the dam over time. Breaching also minimizes the release of debris and sediment downstream by allowing water to move slowly over or through the dam. Depending on the size of the impoundment, personnel of the TWSP could lower water levels slowly over several hours or days when breaching dams. When breaching dams, personnel of the TWSP would only alter or breach that portion of the dam blocking the stream or ditch channel, with the intent of returning water levels and flow rates to historical levels or to a level that eliminates damage threats that would be acceptable to the property owner or resource manager. Similar to breaching dams, the removal of the dam removes the debris impounding water and restores the normal flow of water.

Personnel of the TWSP would generally breach or remove beaver dams by hand with a rake or the use of power tools (*e.g.*, a winch). However, explosives would also be available to remove beaver dams. Explosives could potentially be utilized by the personnel of the TWSP that are specially trained and certified to conduct such activities. Explosives are defined as any chemical mixture or device that serves as a blasting agent or detonator. Explosives would generally be used to remove beaver dams that were too large to remove by hand. After a blast, the majority of materials are lifted up and out of the drainage area, away from the water flow. Any remaining fill material still obstructing the channel would normally be washed downstream by water current. The only noticeable side effects from this activity are diluted mud, water, and small amounts of debris from the dam scattered around the blasting site. Considerably less than 10 cubic yards of material would be moved in each of those project activities. Explosives would only be used after beaver were removed from the site.

Personnel of the TWSP would only utilize binary explosives (*i.e.*, explosives comprised of two parts that must be mixed at the site before they can be detonated as an explosive material) for beaver dam removal, when requested. Binary explosives consist of ammonium nitrate and nitro-methane; however, those two components separated are not classified as explosives until mixed. Therefore, binary explosives would be subject to fewer regulations and controls. However, once mixed, binary explosives would be considered high explosives and subject to all applicable federal and state regulations. Detonating cord and detonators would also be considered explosives and the TWSP would adhere to all applicable state and federal regulations for storage, transportation, and handling. The TWSP use of explosives and safety procedures would occur in accordance with WS Directive 2.435.

In addition to dam breaching and removal, water flow devices and exclusion methods would also be available for the TWSP to employ during direct operational assistance or to recommend during technical assistance. Several different designs of water flow devices and exclusion methods would be available; however, the intent of all those methods would be to lower water levels by allowing water to flow through the beaver dam using pipes and wire mesh. After installation, beaver dams would be left intact with water levels maintained at desired levels by adjusting the water flow device. Water flow devices and exclusion methods allow beaver to remain at the site and maintain the beaver dam.

Although dams could be breached/removed manually or with binary explosives, those methods can be ineffective because beaver could quickly repair or replace the dam if the beaver were not removed prior to breaching or removing the dam (McNeely 1995). Damage may be effectively reduced in some situations by installing exclusion and water control devices. Exclusion and water control devices can be designed so that the level of the beaver-created water impoundment can be managed to eliminate or minimize damage from flooding while retaining the ecological and recreational benefits derived from beaver impounding water over time. For example, the TWSP may recommend modifications to site and culvert design (Jensen et al. 1999) as a non-lethal way of reducing problems with beaver dams at culverts.

Manipulating water levels impounded by beaver dams under this alternative would generally be conducted to maintain existing stream channels and drainage patterns, and to reduce water levels to alleviate flooding. The TWSP could be requested to assist with manipulation of a beaver dam to alleviate flooding to agricultural crops, timber resources, public property, such as roads and bridges, private property, and water management structures, such as culverts. The intent of breaching or removing beaver dams would not be to drain established wetlands. With few exceptions, requests for assistance received by the TWSP from public and private entities would involve breaching or removing dams to return an area to the condition that existed before the dam had been built, or before the impounded water had been affecting the area long enough for wetland characteristics to become established.

Most activities conducted by the TWSP in Texas do not have the potential to affect wetlands, since those activities would not be conducted near or in wetlands. Under this alternative, water levels would be manipulated to return streams, channels, dikes, culverts, and canals to their original function. Most requests to alleviate flooding from impounded water would be associated roads, crops, merchantable timber, pastures, and other types of property or resources that were not previously flooded. Most dams removed would have been created because of recent beaver activity. Personnel of the TWSP receive most requests for assistance associated with beaver dams soon after affected resource owners discover damage.

As stated previously, the TWSP could install water control devices, breach, or remove up to 500 beaver dams annually under this alternative. Upon receiving a request to manipulate the water levels in impoundments caused by beaver dams, the TWSP would visually inspect the dam and the associated water impoundment to determine if characteristics exist at the site that would meet the definition of a wetland under section 404 of the CWA (see 40 CFR 232.2). If wetland conditions were present at the site, the entities requesting assistance from the TWSP would be notified that a permit might be required to manipulate the water levels impounded by the dam and to seek guidance from the TCEQ, the EPA, and/or the United States Army Corps of Engineers pursuant to State laws and the CWA. If the area does not already have hydric soils, it usually takes several years for them to develop and a wetland to become established. This process often takes more than 5 years as indicated by the Swampbuster provision of the Food Security Act. Most beaver dam removal by the TWSP would occur under exemptions stated in 33 CFR parts 323 and 330 of Section 404 of the CWA or parts 3821 and 3822 of the Food Security Act. However, manipulating water levels associated with some beaver dams could trigger certain portions of Section 404 that require landowners to obtain permits from the United States Army Corps of Engineers prior to removing a blockage. Personnel of the TWSP would determine the proper course of action upon inspecting a beaver dam impoundment. Appendix D describes the procedures used by the TWSP to assure compliance with the pertinent laws and regulations.

The manipulation of water impoundment levels by the TWSP through dam breaching, dam removal, or installation of water flow devices would typically be associated with dams constructed from recent beaver activity and would not have occurred long enough to take on the qualities of a true wetland (*i.e.* hydric soils, hydrophytic vegetation, and hydrological function). Activities of the TWSP associated with beaver dam breaching, beaver dam removal, or the installation of flow control device would only be conducted to restore the normal flow of water through drainages, streams, creeks, canals, and other watercourses where flooding damage was occurring or would occur. Activities most often take place on small watershed streams, tributary drainages, and ditches and those activities can best be described as small, one-time projects conducted to restore water flow through previously existing channels. Beaver dam breaching or removal would not affect substrate or the natural course of streams since only the dam would be breached or removed.

In the majority of instances, beaver dam removal would be accomplished by manual methods (*i.e.*, hand tools). Personnel of the TWSP would not utilize heavy equipment, such as trackhoes or backhoes, for beaver dam removal. In some cases, small explosive charges may be used by certified, trained personnel. These explosives would be placed in a manner to remove only that portion of the dam necessary to alleviate flooding. In addition, explosives are placed to lift and remove debris out from the drainage, stream, or creek flow to prevent unnecessary sediment or debris downstream. In all cases, only the portion of the dam blocking the stream or ditch channel would be breached or removed. In some instances, the TWSP would install water flow devices to manage water levels at the site of a breached beaver dam. From FY 2009 through FY 2014, the TWSP breached or removed 1,143 beaver dams (517 by hand and 626 by using explosives) during damage management activities associated with beaver. The TWSP would use hand tools to breach or remove dams. Dams could be breached or removed in accordance with exemptions from Section 404 permit requirements established by regulation or as allowed under NWPs granted under Section 404 of the CWA (see Appendix D). The majority of impoundments that the TWSP would remove would only be in existence for a few months. Therefore, those impoundments would generally not be considered wetlands as defined by 40 CFR 232.2 and those impoundments would not possess the same wildlife habitat values as established wetlands.

In those situations where a non-federal cooperator had already made the decision to breach or remove a beaver dam to manipulate water levels with or without the assistance of the TWSP, participation in carrying out the action by the TWSP would not affect the environmental status quo.

Additional concern has been raised relating to the lethal removal of beaver by the TWSP or the recommendation of lethal methods to alleviate damage or threats of damage under this alternative. Beaver lethally removed could be replaced by other beaver requiring additional assistance later. Houston et al. (1995) indicated that beaver tend to reoccupy vacant habitats. The likelihood that a site would be recolonized by beaver varies depending on many factors. For example, removal of beaver and a beaver dam from a relatively uniform section of irrigation canal may resolve the problem for an extended period because the relatively uniform nature of the canal does not predispose a site to repeat problems. Re-colonization would also depend on the proximity and density of the beaver population in the surrounding area. Isolated areas or areas with a lower density of beaver would normally take longer for beaver to recolonize than areas with higher beaver densities. Activities conducted under Alternative 1 would be directed at specific beaver and/or beaver colonies and would not be conducted to suppress the overall beaver population in the State.

In accordance with WS Directive 2.101, preference would be given to non-lethal methods where practical and effective. Although use of exclusion and water control devices could greatly reduce the need for lethal beaver removal, beaver removal may still be needed in some situations even though a flow device or water control system had been installed (Wood et al. 1994, Nolte et al. 2001, Simon 2006, Spock 2006). Callahan (2005) states the trapping of beaver to alleviate damage should occur "*...where a flow device is either not feasible or fails, the water level needs to be drastically lowered, or the landowner wants no beavers or ponds on their property*". Spock (2006) reported that beaver had to be trapped out of one site when an exclusion system was augmented by the installation of a water control device. Lisle (1996) noted that it might be necessary to remove beaver that have learned to dam around exclusion and water control devices. In some instances, trapping during the annual trapping season for beaver continued to occur at or near the area where water control devices were installed but was not prompted by the failure of the devices

(Lisle 1996, Simon 2006, Spock 2006).

Exclusion and water control devices may not be the most effective method in specific types of terrain and are not suitable for every site (Wood et al. 1994, Nolte et al. 2001, Langlois and Decker 2004, Callahan 2005). Exclusion devices and water control devices may not be suitable for man-made, uniform channels, such as agricultural drainage ditches and irrigation canals. In addition, exclusion devices and water control devices may not be suitable for reservoirs, areas where human health, property or safety would be threatened with even minor elevation in water level, and areas where the landowner has expressed zero tolerance for beaver activity on their property (Callahan 2003, Callahan 2005, Simon 2006). Water control devices may be ineffective in beaver ponds in broad, low-lying areas because even a slight increase in water depth can result in a substantial increase in the area flooded (Organ et al. 1996).

Exclusion and water control systems would not resolve problems related to beaver construction of bank dens. Depending upon site characteristics, beaver may build bank dens instead of lodges by burrowing into banks, levees, and other earthen impoundments. When bank dens are built in earthen levees or in banks supporting roadways or railroad tracks, they can greatly weaken the earthen structure. Burrowing into embankments can weaken the integrity of impoundments. Burrows allow water to infiltrate embankments, which can allow water to seep through the embankments causing erosion and weakening water impoundments. In those situations, removal of the beaver (either by translocation or by lethal methods) could be the only practical solution to resolve the potential for damage.

Water control devices may also be inappropriate in areas that are managed for aquatic species that need free-flowing water conditions and gravel substrate to survive. The still water and silt that accumulates behind beaver dams can be detrimental to some species. In addition, beaver dams could impede the movement of fish upstream. Avery (2004) found the removal of beaver dams resulted in substantial increases in the stream area where trout could be found. For example, a 9.8-mile treatment zone on the North Branch of the Pemebonwon River in Wisconsin and an additional 17.9 miles of seven tributaries to the treatment section of the river were maintained free of beaver dams since 1986. In 1982, prior to dam removal, wild brook trout were found in only four of the seven tributaries within the treatment zone and at only four of the 12 survey stations. In the spring of 2000, wild brook trout were present in all seven tributaries and at all 12 survey stations (Avery 2004). In some cases, water control devices could be modified to improve fish passage (Close 2003). Although the presence of beaver dams could be detrimental to some species of fish, some fish species may benefit from the presence of a beaver dam (Rosell et al. 2005, Pollock et al. 2007, Taylor et al. 2009, Pollock et al. 2012, Pollock et al. 2014).

Although beaver can serve a valuable role in wetland ecology, the presence of beaver dams in existing wetlands that property owners or managers manage intensively could be a concern to those entities. In those wetlands, property owners or managers often use man-made water control structures to manage the water level in the wetland area in order to maximize habitat value for waterfowl and specific types of wetland-dependent wildlife. Therefore, the presence of beaver dams can impede the use of those structures or cause elevated water levels that are contrary to the objectives of the wetland. While general elevations or reductions in water levels might conceivably be achieved by installing pipe systems through beaver dams in managed wetlands, the devices tend to be more difficult to adjust than man-made water control structures. More importantly, the primary difficulty associated with pipe systems in those situations comes when property owners or managers use drawdowns to achieve wetland management objectives. Drawdowns generally involve reducing the water level until large sections of mudflat are exposed. Many plant species valuable to waterfowl and other wetland bird species need exposed mudflats to sprout. Shorebirds can also use the mudflats to forage for invertebrates. The extent of the water level reduction conflicts with the beaver's desire for water deep enough to provide protection, and water area of sufficient extent to provide relatively easy access to foraging sites. The extent of the water level reduction during a drawdown would likely increase the risk of new dam creation in other locations that may cause new problems (Callahan 2003).

Alternative 2 – Aquatic Mammal Damage Management by the WS Program through Technical Assistance Only

The issues regarding the effects on wetlands under this alternative would likely be similar to those issues discussed under Alternative 1. This similarity would be based on the recommendation of methods by the WS program to manage damage caused by beaver and the recommendation of methods to manage the water impounded by beaver dams. Based on information provided by the person requesting assistance or based on site visits, the WS program could recommend that a landowner or manager manipulate beaver dams to reduce flooding damage or threats of damage. The WS program would not be directly involved with conducting activities associated with the manipulation of beaver dams under this alternative. However, the recommendation of the use of methods would likely result in the requester employing those methods or employing an agent to employ them. Therefore, by recommending methods and thus a requester employing those methods, the potential for those methods to reduce the presence of impounded water would be similar to Alternative 1.

The WS program could instruct and demonstrate the proper use and placement of flow control and exclusionary devices, as well as recommend the breaching or removal of beaver dams, when appropriate. The WS program would also assist requesters by providing information on permit requirements and which state and/or federal agencies need to be contacted by the requester to obtain appropriate permits to manipulate the levels of water impounded by beaver dams.

The efficacy of methods employed by a cooperator would be based on the skill and knowledge of the requester or their agent despite recommendations or demonstration by the WS program. Therefore, a lack of understanding of the behavior of beaver along with inadequate knowledge and skill in using methodologies to resolve flooding could lead to incidents with a greater probability of unforeseen impacts to wetlands. In those situations, the potential for dam manipulation to affect the status of wetlands adversely would likely be regarded as greater than those affects discussed under Alternative 1.

The WS program would recommend the landowner or manager seek and obtain the proper permits to manipulate water levels impounded by beaver dams under this alternative; however, the WS program would not be responsible for ensuring that appropriate permits were obtained, proper methods were implemented for manipulating water levels, or for reviewing sites for the presence of T&E species. The requester would incur those responsibilities and they may or may not properly follow recommendations of the WS program.

In addition, the TWSP, the TPWD, and/or private entities or organizations could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. If other entities continued to provide assistance at a level similar to WS' involvement, the potential effects on this issue would be similar to Alternative 1.

Alternative 3 – No Involvement with Managing Aquatic Mammal Damage by the WS Program

Under this alternative, the WS program would not be involved with any aspect of managing water levels associated with beaver dam impoundments. Under this alternative, the WS program would not be involved with any aspect of managing damage associated with beaver in the State, including technical assistance. Due to the lack of involvement in managing damage caused by beaver, no impacts to wetlands would occur directly from the WS program. This alternative would not prevent those entities experiencing threats or damage due to flooding from manipulating water levels associated with beaver dams in the absence of assistance by the WS program or seeking the assistance of other entities. Those methods described previously would be available to other entities to breach or remove dams, including explosives and water flow devices. However, the use of explosives to remove dams under this alternative would be limited to those persons trained and licensed to use explosives. A property owner or manager could seek the services of an entity trained and licensed to use explosives to remove beaver dams under this alternative. The direct burden of implementing permitted methods would be placed on those persons experiencing damage. Like Alternative 2, the TWSP, the TPWD, and/or private entities or organizations could and would likely continue to conduct damage management activities and those activities could increase in proportion to the reduction of assistance provided by the WS program. If other entities continued to provide assistance at a level similar to WS' involvement, the potential effects on this issue would be similar to Alternative 1.

Since the same methods would be available to resolve or prevent beaver damage or threats related to beaver dams, effects on the status of wetlands in the State from the use of those methods would be similar between the alternatives. However, manipulating water levels by those persons not experienced in identifying wetland characteristics or unaware of the requirement to seek appropriate permits to alter areas considered as a wetland, could increase threats to wetlands and the associated flora and fauna.

4.2 CUMULATIVE IMPACTS OF ALTERNATIVE 1 BY ISSUE

Cumulative impacts, as defined by the CEQ (40 CFR 1508.7), are impacts to the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts may result from individually minor, but collectively significant, actions taking place over time.

Under Alternative 1 and Alternative 2, the TWSP would address damage associated with aquatic mammals either by providing technical assistance only (Alternative 2) or by providing technical assistance and direct operational assistance (Alternative 1) in the State. The TWSP would be the primary federal agency conducting direct operational aquatic mammal damage management in the State under Alternative 1. However, other federal, state, and private entities could also be conducting aquatic mammal damage management in the State.

The TWSP does not normally conduct direct damage management activities concurrently with such agencies or other entities in the same area, but may conduct damage management activities at adjacent sites within the same period. In addition, commercial companies may conduct damage management activities in the same area. The potential cumulative impacts could occur from either damage management program activities by the TWSP over time or from the aggregate effects of those activities combined with the activities of other agencies and private entities. Through ongoing coordination and collaboration between the TWSP and the TPWD, activities of each agency and the removal of aquatic mammals would be available. Damage management activities in the State would be monitored to evaluate and analyze activities to ensure they were within the scope of analysis of this EA.

The activities proposed in the alternatives would have a negligible effect on atmospheric conditions including the global climate. Meaningful direct or indirect emissions of greenhouse gases would not occur because of any of the proposed alternatives. Those alternatives would meet the requirements of applicable laws, regulations, and Executive Orders including the Clean Air Act and Executive Order 13514.

Issue 1 - Effects of Damage Management Activities on Target Aquatic Mammal Populations

The issue of the effects on target aquatic mammal species arises from the use of non-lethal and lethal methods to address the need for reducing damage and threats. As part of an integrated methods approach to managing damage and threats, the TWSP could apply both lethal and non-lethal methods when requested by those persons experiencing damage.

Non-lethal methods could exclude, disperse, or otherwise make an area unattractive to aquatic mammals causing damage; thereby, reducing the presence of aquatic mammals at the site and potentially the immediate area around the site where non-lethal methods were employed. Employees of the TWSP would give non-lethal methods priority when addressing requests for assistance (see WS Directive 2.101). However, the TWSP would not necessarily employ non-lethal methods to resolve every request for assistance if deemed inappropriate by personnel of the TWSP using the WS Decision Model. For example, if a cooperator requesting assistance, had already attempted to disperse aquatic mammals using non-lethal harassment methods, the TWSP would not necessarily employ those methods again during direct operational assistance since those methods had already been proven to be ineffective in that particular situation. The TWSP and other entities could use non-lethal methods to exclude, harass, and disperse target wildlife from areas where damage or threats were occurring. When effective, non-lethal methods would disperse aquatic mammals from an area resulting in a reduction in the presence of those aquatic mammals at the site where the TWSP or other entities employed those methods. However, aquatic mammals responsible for causing damage or threats would likely disperse to other areas with minimal impacts occurring to those species' populations. The TWSP would not employ non-lethal methods over large geographical areas or apply those methods at such intensity that essential resources (*e.g*., food sources, habitat) would be unavailable for extended durations or over a wide geographical scope that long-term adverse effects would occur to a species' population. The TWSP and most people generally regard non-lethal methods as having minimal impacts on overall populations of wildlife since individuals of those species would be unharmed. Therefore, the use of non-lethal methods would not have cumulative effects on aquatic mammal populations in the State.

Employees of the TWSP could employ lethal methods to resolve damage associated with those target aquatic mammal species identified by the TWSP as responsible for causing damage or threats to human safety. However, lethal removal by the TWSP would only occur after receiving a request for such assistance. Therefore, the use of lethal methods could result in local reductions in the number of target animals in the area where damage or threats were occurring since the TWSP would remove those target individuals from the population. The TWSP would often employ lethal methods to reinforce non-lethal methods and to remove aquatic mammals that have been identified as causing damage or posing a threat to human safety. The use of lethal methods could therefore result in local reductions of aquatic mammals in the area where damage or threats were occurring. The number of aquatic mammals removed from a species' population using lethal methods under Alternative 1 would be dependent on the number of requests for assistance received, the number of aquatic mammals involved with the associated damage or threat, and the efficacy of methods employed.

The TWSP would monitor removal by comparing numbers of animals killed with overall populations or trends in populations to assure the magnitude of removal was below the level that would cause undesired adverse effects to the viability of native species populations. This EA analyzed the potential cumulative impacts on the populations of target aquatic mammal species from the implementation of Alternative 1 in Section 4.1.

Evaluation of activities relative to target species indicated that program activities would likely have no cumulative adverse effects on aquatic mammal populations when targeting those species responsible for damage at the levels addressed in this EA. The actions of the TWSP would be occurring simultaneously, over time, with other natural processes and human generated changes that are currently taking place. These activities include, but would not be limited to:

- Natural mortality of aquatic mammals
- Mortality through vehicle strikes, aircraft strikes, and illegal harvest
- Human-induced mortality of aquatic mammals through annual hunting and trapping seasons
- Human-induced mortality of aquatic mammals through private damage management activities
- Human and naturally induced alterations of wildlife habitat
- Annual and perennial cycles in wildlife population densities
- Precipitation levels

All those factors play a role in the dynamics of aquatic mammal populations. In many circumstances, requests for assistance arise when some or all of those elements have contrived to elevate target species populations or place target species at a juncture to cause damage to resources. The actions taken to minimize or eliminate damage would be constrained as to scope, duration, and intensity for the purpose of minimizing or avoiding impacts to the environment. The TWSP would use the Decision Model to evaluate the damage occurring, including other affected elements and the dynamics of the damaging species, to determine appropriate strategies to minimize effects on environmental elements. The Model would allow the TWSP to implement damage management actions and to monitor those actions to adjust/cease damage management actions, which would allow the TWSP to take into consideration other influences in the environment, such as those listed above, in order to avoid cumulative effects on target species (Slate et al. 1992).

The populations of beaver, muskrats, nutria, and otter are sufficient to allow for annual harvest seasons that typically occur during the fall and winter. The TPWD is responsible for establishing hunting and trapping seasons in the State for aquatic mammals. The removal of aquatic mammals by the TWSP in Texas from FY 2013 through FY 2015 was of a low magnitude when compared to the total known removal of those species and the populations of those species. The anticipated annual removal of aquatic mammals would also be of low magnitude when compared to estimated populations and the annual harvest of those species. Therefore, the proposed activities would not limit the ability of people to harvest aquatic mammals in the State. No cumulative adverse effects on target and non-target wildlife would be expected from the TWSP damage management activities based on the following considerations:

Historical outcomes of the damage management activities conducted by the TWSP on populations

The TWSP would conduct damage management activities associated with aquatic mammals only at the request of a cooperator to reduce damage that was occurring or to prevent damage from occurring and only after methods to be used were agreed upon by all parties involved. The TWSP would monitor activities to ensure any potential impacts were identified and addressed. The TWSP would work closely with resource agencies to ensure damage management activities would not adversely affect aquatic mammal populations and that the TWSP activities were considered as part of management goals established by those agencies. Historically, the TWSP activities to manage damage caused by aquatic mammals in Texas have not reached a magnitude that would cause adverse effects to aquatic mammal populations in the State.

SOPs built into the TWSP

SOPs are designed to reduce the potential negative effects of the actions by the TWSP on aquatic mammals, and have been tailored to respond to changes in wildlife populations that could result from unforeseen environmental changes. This would include those changes occurring from sources other than the TWSP. Alteration of activities would be defined through SOPs, and implementation would be insured through monitoring, in accordance with the WS Decision Model (see WS Directive 2.201; Slate et al. 1992).

Issue 2 - Effects on the Populations of Non-target Animals, Including T&E Species

Potential effects on non-target species from conducting aquatic mammal damage management arise from the use of non-lethal and lethal methods to alleviate or prevent those damages. The use of non-lethal methods during activities to reduce or prevent damage caused by aquatic mammals has the potential to exclude, disperse, or capture non-target wildlife. However, the effects of non-lethal methods are often temporary and often do not involve the removal (killing) of non-target wildlife species. When using exclusion devices and/or repellents, both target and non-target wildlife can be prevented from accessing the resource being damaged. Since exclusion and repellents do not involve lethal removal, cumulative impacts on non-target species from the use of exclusionary methods or repellents would not occur, but would likely disperse those individuals to other areas. Exclusionary methods and repellents can require constant maintenance to ensure effectiveness. Therefore, the use of exclusionary devices and repellents would be somewhat limited to small, high-value areas and not used to the extent that non- targets would be excluded from large areas that would cumulatively impact populations from the inability to access a resource, such as potential food sources or shelter. The use of visual and auditory harassment and dispersion methods would generally be temporary with non-target species returning after the cessation of those activities. Dispersal and harassment do not involve the removal (killing) of non-target species and similar to exclusionary methods would not be used to the extent or at a constant level that would prevent non-target animals from accessing critical resources that would threaten survival of a population.

The use of lethal methods or those methods used to live-capture target species followed by euthanasia also have the potential to affect non-target wildlife through the removal (killing) or capture of non-target species. Capture methods used are often methods that would be set to confine or restrain target wildlife after being triggered by a target individual. Capture methods would be employed in such a manner as to minimize the threat to non-target species by placement in those areas frequently used by target wildlife, using baits or lures that are as species specific as possible, and modification of individual methods to exclude non-target animals from capture. Most methods described in Appendix B are methods that would be employed to confine or restrain wildlife that would be subsequently euthanized using humane methods. With all live-capture devices, non-target wildlife captured could be released on site if determined to be able to survive following release. SOPs are intended to ensure removal of non-target wildlife is minimal during the use of methods to capture target wildlife.

The use of firearms and euthanasia methods would essentially be selective for target species since identification of an individual would be made prior to the application of the method. Euthanasia methods would be applied through direct application to target wildlife. Therefore, the use of those methods would not affect non-target species.

The TWSP would track and record chemical methods to ensure proper accounting of used and unused chemicals occur. All chemicals would be stored and transported according with WS' Directives and relevant federal, state, and local regulations. Appendix B describes the chemical methods available for use under Alternative 1. Personnel of the TWSP would apply repellents directly to the affected resource. Similarly, employees of the TWSP would apply immobilizing drugs or euthanasia chemicals directly to target animals. When using zinc phosphide for muskrats or nutria, WS would pre-bait areas with untreated bait during an acclimation period so target animals would become acclimated to feeding at the location. The acclimation period also allows WS' personnel to observe for non-target activity at the site. If personnel of the TWSP observed non-target animals feeding on untreated bait during the acclimation period, personnel of the TWSP would abandon those locations. Per label requirements, baits would consist of apples, carrots, pears, and/or sweet potatoes, which are highly attractive to muskrat and nutria. Personnel of the TWSP would place treated baits in areas where non-target exposure would be minimal (*e.g.*, on floating raft) or in areas (*e*.g., beside a den entrance) in accordance with the label requirements.

Personnel of the TWSP would use all chemical methods according to product labels, which would ensure that proper use would minimize non-target threats. The adherence of the TWSP to Directives and SOPs governing the use of chemicals would also ensure non-target hazards would be minimal.

Repellents may be used or recommended by the TWSP in Texas to manage aquatic mammal damage. The active ingredients in numerous commercial repellents are capsaicin, pepper oil, and carnivore urine. Characteristics of these chemicals and potential use patterns indicate that no cumulative impacts related to environmental fate would be expected from their use in WS' programs in Texas when used according to label requirements.

The amount of chemicals used or stored by the TWSP would be minimal to ensure human safety. All label requirements of repellents and toxicants would be followed to minimize non-target hazards. Based on this information, WS' use of chemical methods, as part of Alternative 1, would not have cumulative impacts on non-target animals.

The methods described in Appendix B have a high level of selectivity and could be employed using SOPs to ensure minimal impacts to non-target species. The unintentional removal of wildlife would likely be limited and would not reach a magnitude where adverse effects would occur. Based on the methods available to resolve aquatic mammal damage and/or threats, the TWSP does not anticipate the number of non-target animals lethally removed to reach a magnitude where declines in those species' populations would occur. Therefore, removal under Alternative 1 of non-target animals would not cumulatively affect non-target species. The TWSP has reviewed the T&E species listed by the TPWD, the USFWS, and the National Marine Fisheries Service, and has determined that damage management activities proposed by the TWSP would not likely adversely affect T&E species. Cumulative impacts would be minimal on non-target animals from any of the alternatives discussed**.**

Issue 3 - Effects of Damage Management Methods on Human Health and Safety

Non-chemical methods described in Appendix B would be used within a limited period, would not be residual, and do not possess properties capable of inducing cumulative effects on human health and safety. Non-chemical methods would be used after careful consideration of the safety of those persons employing methods and to the public. When possible, capture methods would be employed where human activity was minimal to ensure the safety of the public. Capture methods also require direct contact to trigger ensuring that those methods, when left undisturbed, would have no effect on human safety. All methods would be agreed upon by the requesting entities, which would be made aware of the safety issues of those methods when entering into a MOU, work initiation document, or another comparable document between WS and the cooperating entity. SOPs would also ensure the safety of the public from those methods used to capture or remove wildlife. Firearms used to alleviate or prevent damage, though hazards do exist, would be employed to ensure the safety of employees and the public.

Personnel employing non-chemical methods would continue to be trained to be proficient in the use of those methods to ensure the safety of the applicator and to the public. Based on the use patterns of non-chemical methods, those methods would not cumulatively affect human safety.

Repellents to disperse aquatic mammals from areas of application would be available. Repellents must be registered with the EPA according to the FIFRA and registered with the TDA. Many of the repellents currently available for use have active ingredients that are naturally occurring and are generally regarded as safe. Although some hazards exist from the use of repellents, hazards occur primarily to the handler and applicator. When repellents were applied according to label requirements, no effects to human safety would be expected. Given the use patterns of repellents, no cumulative effects would occur to human safety.

When using explosives to remove beaver dams, the TWSP would only use binary explosives (see Appendix B). Employees of the TWSP who conduct activities using binary explosives would receive training in accordance with WS Directive 2.435. Personnel of the TWSP who use explosives undergo extensive training and are certified to safely use explosives. Employees must adhere to the safe storage, transportation, use policies, and regulations of TWSP, the Bureau of Alcohol, Tobacco and Firearms, the Occupational Safety and Health Administration, and the Department of Transportation.

The TWSP has received no reports or documented any effects to human safety from activities to manage damage caused by aquatic mammals conducted by the TWSP from FY 2013 through FY 2015. No cumulative effects from the use of those methods discussed in Appendix B would be expected given the use patterns of those methods for resolving aquatic mammal damage in the State.

Issue 4 - Effects on the Aesthetic Values of Aquatic Mammals

The activities of the TWSP would result in the removal of aquatic mammals from those areas where damage or threats were occurring. Therefore, the aesthetic value of aquatic mammals in those areas where damage management activities were being conducted would be reduced. However, for some people, the aesthetic value of a more natural environment would be gained by reducing aquatic mammal densities, including the return of native species that may be suppressed or dispersed by non-native species.

Some people experience a decrease in aesthetic enjoyment of wildlife because they feel that overabundant species are objectionable and interfere with their enjoyment of wildlife in general. Continued increases in numbers of individuals or the continued presence of aquatic mammals may lead to further degradation of some people's enjoyment of any wildlife or the natural environment. The actions of the TWSP could positively affect the aesthetic enjoyment of wildlife for those people that were being adversely affected by the target species identified in this EA.

Aquatic mammal population objectives would be established and enforced by the TPWD by regulating harvest during the statewide hunting and trapping seasons after consideration of other known mortality factors. Since those persons seeking assistance could remove aquatic mammals from areas where damage was occurring when permitted by the TPWD, the TWSP involvement would have no effect on the aesthetic value of aquatic mammals in the area where damage was occurring. When damage caused by aquatic mammals has occurred, any removal of aquatic mammals by the property or resource owner would likely occur whether the TWSP was involved with taking the aquatic mammals or not.

In the wild, few animals in the United States have life spans approaching that of people. Mortality is high among wildlife populations and specific individuals among a species may experience death early in life. Mortality in wildlife populations is a natural occurrence and people who form affectionate bonds with animals experience loss of those animals over time in most instances. A number of professionals in the field of psychology have studied human behavior in response to attachment to pet animals (Gerwolls and Labott 1994, Marks et al. 1994, Zasloff 1996, Archer 1999, Ross and Baron-Sorensen 1998, Meyers 2000). Similar observations were probably applicable to close bonds that could exist between people and wild animals. As observed by researchers in human behavior, normal human responses to loss of loved ones proceed through phases of shock or emotional numbness, sense of loss, grief, acceptance of the loss or what cannot be changed, healing, and acceptance and rebuilding which leads to resumption of normal lives (Lefrancois 1999). Those who lose companion animals, or animals for which they may have developed a bond and affection, are observed to proceed through the same phases as with the loss of human companions (Gerwolls and Labott 1994, Boyce 1998, Meyers 2000). However, they usually establish a bond with other individual animals after such losses. Although they may lose the sense of enjoyment and meaning from the association with those animals that die or are no longer accessible, they usually find a similar meaningfulness by establishing an association with new individual animals or through other relational activities (Weisman 1991). Through this process of coping with the loss and establishing new affectionate bonds, people may avoid compounding emotional effects resulting from such losses (Lefrancois 1999).

Some aquatic mammals with which people have established affectionate bonds may be removed from some project sites by the TWSP. However, other individuals of the same species would likely continue to be present in the affected area and people would tend to establish new bonds with those remaining animals. In addition, human behavior processes usually result in individuals ultimately returning to normalcy after experiencing the loss of association with a wild animal that might be removed from a specific location. Activities of the TWSP would not be expected to have any cumulative effects on this element of the human environment.

Issue 5 - Humaneness and Animal Welfare Concerns of Methods

The TWSP would continue to seek new methods and ways to improve current technology to improve the humaneness of methods used to manage damage caused by wildlife. Cooperation with individuals and organizations involved in animal welfare continues to be an agency priority for the purpose of evaluating strategies and defining research aimed at developing humane methods.

All methods not requiring direct supervision during employment (*e.g.*, live traps) would be checked in accordance with Texas laws and regulations to ensure any wildlife confined or restrained were addressed in a timely manner to minimize distress of the animal. All euthanasia methods used for live- captured aquatic mammals would be applied according to WS' directives. Shooting would occur in some situations and personnel would be trained in the proper use of firearms to minimize pain and suffering of aquatic mammals removed by this method.

The TWSP would employ methods as humanely as possible by applying SOPs to minimize pain and that allow wildlife captured to be addressed in a timely manner to minimize distress. Through the establishment of SOPs that guide WS in the use of methods to address damage and threats associated with aquatic mammals in the State, the cumulative impacts on the issue of method humaneness would be minimal. All methods would be evaluated to ensure SOPs were adequate and that wildlife captured were addressed in a timely manner to minimize distress.

Issue 6 – Effects of Beaver Removal and Dam Manipulation on the Status of Wetlands in the State

Beaver build dams primarily in smaller riverine streams (intermittent and perennial brooks, streams, and small rivers) and in drainage areas with dams consisting of mud, sticks and other vegetative materials. Their dams obstruct the normal flow of water and typically change the pre-existing hydrology from flowing or circulating waters to slower, deeper, more expansive waters that accumulate bottom sediment behind the dam. The depth of bottom sediment depends on the length of time an area is covered by water and the amount of suspended sediment in the water.

The pre-existing habitat and the altered habitat have different ecological values to the fish and wildlife native to an area. Some species would abound by the addition of a beaver dam, while others would diminish. For example, some fish species require fast moving waters over gravel or cobble beds, which beaver dams can eliminate, thus reducing the habitat's value for these species. In general, it has been found that wildlife habitat values decline around bottomland beaver impoundments because trees are killed from flooding and mast production declines. On the other hand, beaver dams can potentially be beneficial to some species of fish and wildlife such as river otter, Neotropical birds, and waterfowl.

If a beaver dam is not breached and water is allowed to stand, hydric soils and hydrophytic vegetation may eventually form. This process can take anywhere from several months to years depending on pre-existing conditions. Hydric soils are those soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions. In general, hydric soils form much easier where wetlands have preexisted. Hydrophytic vegetation includes those plants that grow in water or on a substrate that is at least periodically deficient in oxygen because of excessive water content. If these conditions are met, then a wetland has developed that would have different wildlife habitat values than an area that has been more recently impounded by beaver dam activity. For example, Russell et al. (1999) found that the species richness and the total abundance of reptiles were statistically higher at beaver ponds greater than 10 years old when compared to beaver ponds that were less than 5 years old.

The intent of most dam breaching is not to drain established wetlands. With few exceptions, requests from public and private individuals and entities that the TWSP receives involve dam breaching to return an area back to its pre-existing condition within a few years after beaver create the dam. If the area does not have hydric soils, it usually takes many years for them to develop and a wetland to become established. This often takes greater than five years as recognized by the Swampbuster provisions. Most beaver dam removal by the TWSP is either exempt from regulation under Section 404 of the CWA as stated in 33 CFR Part 323 or may be authorized under the United States Army Corps of Engineers Nationwide Permit System in 33 CFR Part 330.

The Corps District Engineer is responsible for determining whether or not beaver dam removals in their District have the "*effect of fill*" in waters of the United States. Most of the Corps' regulatory Districts in Texas are in the Southwestern Division. The TWSP consulted with the Southwestern Division and determined that beaver dam removal by hand generally does not have the "*effect of fill*" on waters of the United States and can often be removed without a permit per CWA.

It should also be noted that beaver created wetlands are dynamic and do not remain in one state for indefinite periods. Large beaver ponds may eventually fill with sediment and create a beaver meadow. Beaver may be removed from an area due to natural predation or they may abandon an area due to lack of food. Once a dam is abandoned, it is subject to natural decay and damage due to weather. The dam would eventually fail and the wetland would return to a flowing stream or brook. The TWSP beaver management activities may accelerate or modify these natural processes by removing beaver and restoring or increasing water flow; however, they are generally processes that would occur naturally over time.

Muskrat management would usually be intended to maintain or protect existing wetlands by reducing threats to natural and man-made wetlands and associated floral, faunal and T&E communities. Wetlands are often created by natural or man-made dams, dikes, levees and berms that contain standing water or control drainage, particularly after precipitation events that could result in flooding. Muskrat burrowing activity can degrade the integrity of these structures by allowing water infiltration or by causing erosion by feeding on vegetation intended to stabilize dirt structures. Muskrats are omnivores and feed on a variety of aquatic and terrestrial plants and aquatic animals. At high population densities, they may disrupt or damage natural wetland floral and faunal communities or they may feed on T&E species. The activities of the TWSP would be intended to protect existing wetlands from damage caused by muskrats.

Therefore, the activities of the TWSP to manage flooding damage by manipulating beaver dams would not be expected to have any cumulative adverse effects on wetlands in Texas when conducted in accordance with the CWA and the Swampbuster provision of the Food Security Act.

CHAPTER 5: LIST OF PREPARERS AND PERSONS CONSULTED

5.1 LIST OF PREPARERS

Michael Bodenchuk, State Director	USDA-APHIS-Wildlife Services
Ryan Wimberly, Staff Wildlife Biologist	USDA-APHIS-Wildlife Services
Vivian Prothro, Staff Wildlife Biologist	USDA-APHIS-Wildlife Services

5.2 LIST OF AGENCIES CONSULTED

Texas Parks and Wildlife Department
Texas A&M AgriLife Extension Service
Texas Wildlife Damage Management Association
United States Fish and Wildlife Service

APPENDIX A

LITERATURE CITED

Allen, G. T., J. K. Veatch, R. K. Stroud, C. G. Vendel, R. H. Poppenga, L. Thompson, J. Shafer, and W. E. Braselton. 1996. Winter poisoning of coyotes and raptors with Furadan-laced carcass baits. Journal of Wildlife Diseases 32:385-389.

American Veterinary Medical Association. 1987. Panel report on the colloquium on recognition and alleviation of animal pain and distress. Journal of the American Veterinary Medical Association 191:1186-1189.

American Veterinary Medical Association. 2007. American Veterinary Medical Association guidelines on euthanasia. American Veterinary Medical Association. Schaumburg, Illinois.

American Veterinary Medical Association. 2013. American Veterinary Medical Association guidelines on euthanasia. American Veterinary Medical Association. http://www.avma.org/issues/animal_welfare/euthanasia.pdf. Accessed on March 6, 2013.

Andrews, E. J., B. T. Bennett, J. D. Clark, K. A. Houpt, P. J. Pascoe, G. W. Robinson, and J. R. Boyce. 1993. Report on the American Veterinary Medical Association panel on euthanasia. Journal of the American Veterinary Medical Association 202:229-249.

Apa, A. D., D. W. Uresk, and R. L. Linder. 1991. Impacts of black-tailed prairie dog rodenticides on nontarget passerines. Great Basin Naturalist 51:301-309.

Archer, J. 1999. The nature of grief: The evolution and psychology of reactions to loss. Taylor & Francis/Routledge, Florence, Kentucky.

Arner, D. H. 1964. Research and a practical approach needed in management of beaver and beaver habitat in the Southeastern United States. Transactions of the North American Wildlife Conference 29:150-158.

Arner, D. H., J. Baker, D. Wesley, and B. Herring. 1967*a*. An inventory and study of beaver impounded water in Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi.

Arner, D. H., D. Wesley, and B. Herring. 1967*b*. Possibilities for recreational development in beaver impounded waters. Transactions of the Third Annual Water Resources Conference, San Francisco, California.

Arner, D. H., and J. S. Dubose. 1978*a*. The economic impact of increased forest and farmland beaver damage in Mississippi. Water Resources Research Institute, Mississippi State University, Mississippi State, Mississippi. 41pp.

Arner, D. H., and J. S. Dubose. 1978*b*. Increase in beaver impounded water in Mississippi over a ten year period. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 32:150–153.

Arner, D. H., and J. S. DuBose. 1982. The impact of the beaver on the environment and economics in the southeastern United States. International Congress of Game Biologists 14:241-247.

Arner, D. H., and G. R. Hepp. 1989. Beaver pond wetlands: A southern perspective. Pp 117-128 *in* L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. Habitat management for migrating and wintering waterfowl in North America. Texas Tech University Press, Lubbock, Texas.

Association of Fish and Wildlife Agencies. 2014*a*. Best management practices for trapping beaver in the United States. http://jjcdev.com/~fishwild/?section=best_management_practices. Accessed November 3, 2014.

Association of Fish and Wildlife Agencies. 2014*b*. Best management practices for trapping muskrats in the United States. http://jjcdev.com/~fishwild/?section=best_management_practices. Accessed November 3, 2014.

Avery, E. L. 1992. Effects of removing beaver dams upon a northern Wisconsin brook trout stream. Wisconsin Department of Natural Resources Final D-J Project Report, F-83R. 185 pp.

Avery, E. L. 2004. A compendium of 58 trout stream habitat development evaluations in Wisconsin – 1985-2000. Wisconsin Department of Natural Resources Research Report 187. 96 pp.

Bailey, R. W. 1954. Status of beaver in West Virginia. Journal of Wildlife Management 18:184-190.

Baker, B. W., and E. P. Hill. 2003. Beaver (*Castor canadensis*). Pages 288-310 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild mammals of North America: Biology, management, and conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Bateson, P. 1991. Assessment of pain in animals. Animal Behaviour, 42:827-839.

Beaver, B. V., W. Reed, S. Leary, B. McKiernan, F. Bain, R. Schultz, B. T. Bennett, P. Pascoe, E. Schull, L. C. Cork, R. Francis-Floyd, K. D. Amass, R. Johnson, R. H. Schmidt, W. Underwood, G. W. Thorton, and B. Kohn. 2001. 2000 Report of the AVMA panel on euthanasia. Journal of the American Veterinary Medical Association 218:669-696.

Beach, R., and W. F. McCulloch. 1985. Incidence and significance of *Giardia Lamblia* (Lambl) in Texas beaver populations. Proc. Great Plains Wildl. Damage Cont. Work. 7:152-164.

Berryman, J. H. 1991. Animal damage management: Responsibilities of various agencies and the need for coordination and support. Proc. East. Wildl. Damage Control Conf. 5:12-14.

Bishop, R. C. 1987. Economic values defined. Pp. 24-33 *in* D. J. Decker and G. R. Goff, eds. Valuing wildlife: Economic and social perspectives. Westview Press, Boulder, Colorado.

Blanton, J. D., D. Palmer, and C. E. Rupprecht. 2010. Rabies surveillance in the United States during 2009. Journal of the American Veterinary Medical Association 237:646-657.

Blanton, J. D., D. Palmer, J. Dyer, and C. E. Rupprecht. 2011. Rabies surveillance in the United States during 2010. Journal of the American Veterinary Medical Association 239:773-783.

Blanton, J. D., J. Dyer, J. McBrayer, and C. E. Rupprecht. 2012. Rabies surveillance in the United States during 2011. Journal of the American Veterinary Medical Association 241:712-722.

Blanton, J. D., K. Robertson, D. Plamer, and C. E. Rupprecht. 2009. Rabies surveillance in the United States during 2008. Journal of the American Veterinary Medical Association 235:676-689.

Blundell, G. M., J. W. Kern, R. T. Bowyer, and L. K. Duffy. 1999. Capturing river otters: a comparison of Hancock and leg-hold traps. Wildlife Society Bulletin 27:184-192.

Blunden, J., and D. S. Arndt, Eds. 2013. State of the climate in 2012. Bulletin of the American Meteorological Society 94:S1-S238.

Boutin, S., and D. E. Birkenholz. 1987. Muskrat and round-tailed muskrat. Pp. 314-325 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. The Ontario Trappers Association, Ontario Ministry of Natural Resources, Toronto, Canada.

Boyce, P. S. 1998. The social construction of bereavement: An application to pet loss. Thesis, City University of New York. 154 pp.

Boyles, S. L. 2006. Report on the efficacy and comparative costs of using flow devices to resolve conflicts with North American beavers along roadways in the Coastal Plain of Virginia. M.S. Thesis, Christopher Newport University, Newport News, Virginia. 48 pp.

Boyles, S., and S. Owens. 2007. North American Beaver (*Castor canadensis*): A technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. http://www.fs.fed.us/r2/projects/scp/assessments/northamericanbeaver.pdf. Accessed on November 3, 2014.

Brakhage, G. K., and F. W. Sampson. 1952. Rabies in beaver. Journal of Wildlife Management 16:226.

Bromley, P. T., J. F. Heisterberg, W. T. Sullivan, Jr., P. Sumner, J. C. Turner, R. D. Wickline, and D. K. Woodward. 1994. Wildlife damage management: beavers. North Carolina Cooperative Extension Service.

Brooks, R. P., M. W. Fleming, and J. J. Kennelly. 1980. Beaver colony response to fertility control: Evaluating a concept. Journal of Wildlife Management 44:568-575.

Brown, S. T., and J. W. Brown. 1999. How to control beaver flooding. Beavers Wetlands and Wildlife, Dolgeville, New York 13329.

Brown, S., D. Shafer, and S. Anderson. 2001. Control of beaver flooding at restoration projects. WRAP Technical Notes Collection (ERDC TN-WRAP-01-01), U.S. Army Engineer Research and Development Center, Vicksburg Mississippi. http://www.beaversww.org/assets/PDFs/US-ACE-paper.pdf. Accessed November 3, 2014.

Buckley, M., T. Souhlas, E. Niemi, E. Warren, and S. Reich. 2011. The economic value of beaver ecosystem services: Escalante River Basin, Utah. ECONorthwest, Eugene, Oregon. 66 pp.

California Department of Fish and Game. 1991. Final environmental document - bear hunting. Title 14 Calif. Code of Regs. Calif. Dept. of Fish and Game, State of California, April 25, 1991. 337 pp.

Callahan, M. 2003. Beaver management study. Association of Massachusetts Wetland Scientists Newsletter 44:12-15.

Callahan, M. 2005. Best management practices for beaver problems. Association of Massachusetts Wetland Scientists Newsletter 53:12-14.

Caudell, J. N. 2008. In the news. Human-Wildlife Interactions 2:141-143.

Caudell, J. N. 2012. In the news. Human-Wildlife Interactions 6:179-180.

CDC. 2000. Notice to Readers: Update: West Nile Virus Isolated from Mosquitoes – New York, 2000. Morbidity and Mortality Weekly Report 49:211.

CDC. 2002. Rabies in a beaver – Florida, 2001. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report. 51:481-482.

CDC. 2015. Giardia. < http://www.cdc.gov/parasites/giardia/index.html>. Accessed December 4, 2015.

Chapman, F. B. 1949. The beaver in Ohio. Journal of Mammalogy 30:174-179.

Clausen, G., and A. Ersland. 1970. Blood O_2 and acid-base changes in the beaver during submersion. Respiration Physiology 11:104-112.

Close, T. L. 2003. Modifications to the Clemson pond leveler to facilitate brook trout passage. Minnesota Department of Natural Resources Special Publication 158. 9 pp.

Cooke, H. A., and S. Zack. 2008. Influence of beaver dam density on riparian areas and riparian birds in shrubsteppe of Wyoming. Western North American Naturalist 68:365-373.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K.Limburg, S. Naeem, R. V. O'Neill, J.Paruelo, R G. Raskin, P. Sutton, and M.van den Belt. 1997. The value of the world's ecosystem services and natural capital. Nature 387:253-260.

Courcelles, R., and R. Nault. 1983. Beaver programs in the James Bay area, Quebec, Canada. Acta Zool. Fenn. 174:129-131.

Craig, J. R., J. D. Rimstidt, C. A. Bonnaffon, T. K. Collins, and P. F. Scalon. 1999. Surface water transport of lead at a shooting range. Bulletin of Environmental Contamination and Toxicology 63:312-319.

Craven, S.R., T. Barnes, and G. Kania. 1998. Toward a professional position on the translocation of problem wildlife. Wildlife Society Bulletin 26:171-177.

Cunningham, J. M., A. J. K. Calhoun, and W. E. Glanz. 2007. Pond-breeding amphibian species richness and habitat selection in a beaver-modified landscape. Journal of Wildlife Management 71:2517-2526.

Curtis, P. D., and P. G. Jensen. 2004. Habitat features affecting beaver occupancy along roadsides in New York State. Journal of Wildlife Management 68:278-287.

Dahl, T. E. 1990. Wetland losses in the United States, 1780s to 1980s. United States Department of Interior, United States Fish and Wildlife Service, Washington, D.C. 21 pp.

Dams, J. R., J. A. Barnes, G. E. Ward, D. van Leak, D. C. Guynn, Jr., C. A. Dolloff, and M. Hijdy. 1995. Beaver impacts on timber on the Chauga River drainage in South Carolina. Proceedings of the Eastern Wildlife Damage Management Conference 7:177-186.

Davis, D. S. 1961. Principles for population control by gametocides. Transactions of the North American Wildlife Conference 26:160-166.

DeAlmeida, M. H. 1987. Nuisance furbearer damage control in urban and suburban areas. Pp. 996-1006 *in* Novak, J. A. Baker, M. E. Obbard, and B. Malloch, Eds., Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Decker, D. J., and G. R. Goff. 1987. Valuing wildlife: economic and social perspectives. Westview Press, Boulder, Colorado.

Decker, D. J., and K. G. Purdy. 1988. Toward a concept of wildlife acceptance capacity in wildlife management. Wildlife Society Bulletin 16:53-57.

Decker, D. J., and L. C. Chase. 1997. Human dimensions of living with wildlife – a management challenge for the 21st century. Wildlife Society Bulletin 28:4-15.

Deems, E. F., and D. Pursley. 1978. North American Furbearers: their management, research, and harvest status in 1976. University of Maryland, College Park, Maryland.

Deisch, M. S. 1986. The effects of three rodenticides on nontarget small mammals and invertebrates. Thesis, South Dakota State University, Brookings, South Dakota.

Deisch, M. S., D. W. Uresk, and R. L. Linder. 1989. Effects of two prairie dog rodenticides on ground-dwelling invertebrates in western South Dakota. Pp. 166-170 *in* A. J. Bjugstad, D. W. Uresk, and R. H. Hamre, eds. Ninth Great Plains wildlife damage control workshop proceedings. USDA Forest Service General Technical Report RM-171. Fort Collins, Colorado.

Deisch, M. S., D. W. Uresk, and R. L. Linder. 1990. Effects of prairie dog rodenticides on deer mice in western South Dakota. Great Basin Naturalist 50:347-353.

Denney, R. N. 1952. A summary of North American beaver management, 1946-1948. Colorado Game and Fish Dep., Curr. Rep. 28. 58 pp.

D'Eon, R. G., R. LaPinte, N. Bosnick, J. C. Davies, B. MacLean, W. R. Watt, and R. G. Wilson. 1995. The beaver handbook: A guide to understanding and coping with beaver activity. Ontario Ministry of Natural Resources, Northeast Science and Technology, FG-006, Queen's Printer for Ontario, Canada.

Dickson, J. G. 2001. Early History. Pp. 20–30 *in* J. Dickson, ed. Wildlife of the Southern Forests: Habitat and management. Hancock House, Blaine, Washington.

Dolbeer, R. A. 1998. Population dynamics: The foundation of wildlife damage management for the 21st century. Pp. 2-11 *in* Barker, R. O. and Crabb, A. C., Eds. Eighteenth Vertebrate Pest Conference (March 2-5, 1998, Costa Mesa, California). University of California at Davis, Davis, California.

Dolbeer, R. A., N. R. Holler, and D. W. Hawthorne. 1994. Identification and control of wildlife damage. Pp. 474-506 *in* T. A. Bookhout, ed. Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, Maryland.

Dolbeer, R. A., S. E. Wright, J. R. Weller, A. L. Anderson, and M. J. Begier. 2015. Wildlife strikes to civil aircraft in the United States 1990–2014, Serial report 21. U.S. Department of Transportation, Federal Aviation Administration, Office of Airport Safety and Standards, Washington, D.C.

Dyer, J. L., R. Wallace, L. Orciari, D. Hightower, P. Yager, and J. D. Blanton. 2013. Rabies surveillance in the United States during 2012. Journal of the American Veterinary Medical Association 243:805-815.

Dyer, J. L., P. Yager, L. Orciari, L. Greenberg, R. Wallace, C. A. Hanlong, and J. D. Blanton. 2014. Rabies surveillance in the United States during 2013. Journal of the American Veterinary Medical Association 245:1111-1123.

Edwards, N. T., and D. L. Otis. 1999. Avian communities and habitat relationships in South Carolina Piedmont beaver ponds. American Midland Naturalist 141:158-171.

EPA. 1995. Facts about wetlands. United States Environmental Protection Agency. Office of water, wetlands, oceans, and watersheds (4502F), Environmental Protection Agency 843-F-95-00le.

EPA. 1998. Reregistration Eligibility Decision (RED): Zinc phosphide. United States Environmental Protection Agency, Office of Pesticide Programs Special Review and Reregistration Division, Washington, D.C. 207 pp.

EPA. 2001. Selected mammal and bird repellents fact sheet. http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-112_01-Mar-01.pdf. Accessed November 3, 2014.

EPA. 2016. Climate change on ecosystems. https://www.epa.gov/climate-impacts/climate-impacts-ecosystems. Accessed October 11, 2016.

Erb, J., and H. R. Perry, Jr. 2003. Muskrats (*Ondatra zibethicus* and *Neofiber alleni*). Pages 311-348 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild mammals of North America: Biology, management, and conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Erickson, D. W., C. R. McCullough, and W. R. Poranth. 1984. Evaluation of experimental river otter reintroducutions. Final Report of Missouri Department of Conservation. Federal Aid Project. No. W-13-R-38. 47.

Federal Emergency Management Agency. 2005. Dam Owner's Guide to Animal Impacts on Earthen Dams. FEMA L-264.

Fouty, S. 2008. Climate change and beaver activity: How restoring nature's engineers can alleviate problems. Beaversprite, Spring. 3 pp.

Fouty, S. C. 2003. Current and historic stream channel response to changes in cattle and elk grazing pressure and beaver activity: southwest Montana and east-central Arizona. Ph.D. Dissertation, Department of Geography, University of Oregon, Corvallis, Oregon.

Fur Institute of Canada. 2009. Update on implementation of agreement on international humane trapping standards. http://www.fur.ca/files/AIHTS_update_17Feb09.pdf. Accessed November 3, 2014.

Gerwolls, M. K., and S. M. Labott. 1994. Adjustment to the death of a companion animal. Anthrozoos 7:172-187.

Gilbert, F. F., and N. Gofton. 1982. Terminal dives in mink, muskrat, and beaver. Physiology and Behavior 28:835-840.

Godbee, J., and T. Price. 1975. Beaver damage survey. Georgia Forestry Commission, Macon, Georgia.

Gordon, K. L. and D. H. Arner. 1976. Preliminary study using chemosterilants for control of nuisance beaver. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 30:463-465.

Gracely, R. H., and W. F. Sternberg. 1999. Athletes: pain and pain inhibition. American Pain Society 9:1-8.

Grasse, J. E., and E. F. Putnam. 1955. Beaver management and ecology in Wyoming. Wyoming Game and Fish Comm., Cheyenne, Wyoming.

Hanson, W. D., and R. S. Campbell. 1963. The effects of pool size and beaver activity on distribution and abundance of warm-water fishes in a north Missouri stream. American Midland Naturalist 69:136-149.

Haramis, M. 1997. The effect of nutria (*Myocastor coypus*) on marsh loss in the lower Eastern Shore of Maryland: an exclosure study. U.S. Geological Survey, Biological Resource Division, Patuxent Wildlife Research Center, 11410 American Holly Drive, Laurel, Maryland 20708-4015. Unpubl. Progress Rep.- 1997, Study Plan No. 80039.01.

Haramis, M. 1999. Nutria study progress report. U.S. Geological Survey, Biological Resource Division, Patuxent Wildlife Research Center, 11410 American Holly Drive, Laurel, Maryland 20708-4015. Unpubl. Nutria Study Progress Rep. 1998.

Hegdahl, P. L., T. A. Gatz, and E. C. Fite. 1980. Secondary effects of rodenticides on mammalian predators. Worldwide Furbearer Conference Proceedings, Volume III. August 3-11, 1980, Frostburg, Maryland.

Hegdal, P. O., and T. L. Gatz. 1977. Hazards to seedeating birds and other wildlife associated with surface strychnine baiting for Richardson's ground squirrels. EPA report under Interagency Agreement EPA-IAG-D4-0449.

Hey, D. L., and N. S. Philippi. 1995. Flood reduction through wetland restoration: The Upper Mississippi River Basin as a case study. Restoration Ecology 3:4-17.

Hibbard, E. A. 1958. Movements of beaver transplanted in North Dakota. Journal of Wildlife Management 22:209-211.

Hill, E. P. 1976. Control methods for nuisance beaver in the southeastern United States. Proceedings of the Vertebrate Pest Conference 7:85-98.

Hill, E. P. 1982. Beaver. Pp. 256-281 *in* J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America: Biology, management, and economics. Johns Hopkins University Press, Baltimore, Maryland.

Hill, E. P. 1994. River otters. Pp. C-109-C-112 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds., Prevention and Control of Wildlife Damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Hill, E. P., and J. W. Carpenter. 1982. Responses of Siberian ferrets to secondary zinc phosphide poisoning. Journal of Wildlife Management 46:678-685.

Hill, E. P., D. N. Lasher, and R. B. Roper. 1978. A review of techniques for minimizing beaver and white-tailed deer damage in southern hardwoods. Proceedings of the Symposium on Southeastern Hardwoods 2:79-93.

Hood, G. A., and D. G. Larson. 2014. Beaver-created habitat heterogeneity influences aquatic invertebrate assemblages in boreal Canada. Wetlands 34:19-29.

Hood, G. A., and D. G. Larson. 2015. Ecological engineering and aquatic connectivity: a new perspective from beaver-modified wetlands. Freshwater Biology 60:198-208.

Hood, G. A., and S.E. Bayley. 2008. Beaver (*Castor canadensis*) mitigate the effects of climate on the area of open water in boreal wetlands in western Canada. Biological Conservation 141:556-567.

Houston, A. E, M. R. Pelton, and R. Henry. 1995. Beaver immigration into a control area. Southern Journal of Applied Forestry 19:127-130.

Howard, R., L. Berchielli, G. Parsons, and M. Brown. 1980. Trapping furbearers: Student manual. New York State Department of Conservation, New York.

Howard, R. J., and J. S. Larson. 1985. A stream habitat classification system for beaver. Journal of Wildlife Management 49:19-25.

International Association of Fish and Wildlife Agencies. 2005. The potential costs of losing hunting and trapping as wildlife management tools. Animal Use Committee, International Association of Fish and Wildlife Agencies, Washington, D.C. 55 pp.

Jackson, S., and T. Decker. 2004. Beavers in Massachusetts natural history, benefits, and ways to resolve conflicts between people and beavers. UMass Extension, USDA and Massachusetts Department of Fish and Wildlife. 14 pp.

Jakes, A. F., J. W. Snodgrass, and J. Burger. 2007. *Castor canadensis* (beaver) impoundment associated with Geomorphology of southeastern streams. Southern Naturalist 6:271-282.

Jenkins, S. H., and P. E. Busher. 1979. *Castor canadensis*. Mammalian Species 120:1-8.

Jensen, P. G., P. D. Curtis, and D. L. Hamelin. 1999. Managing nuisance beavers at roadsides: A guide for highway departments. Cornell Cooperative Extension Publication #147BEAV.

Jensen, P. G., P. D. Curtis, M. E. Lehnert, and D. L. Hamelin. 2001. Habitat and structural factors influencing beaver interference with highway culverts. Wildlife Society Bulletin 29:654-664.

Johnson, G. D., and K. A. Fagerstone. 1994. Primary and secondary hazards of zinc phosphide to nontarget wildlife – a review of the literature. Denver Wildlife Research Report No. 11-55-005, U.S. Department of Agriculture, Denver, Colorado.

Johnson, M. R., R. G. McLean, and D. Slate. 2001. Field operations manual for the use of immobilizing and euthanizing drugs. USDA, APHIS, WS Operational Support Staff, Riverdale, Maryland.

Jonker, S. A., R. M. Muth, J. F. Organ, R. R. Zwick, and W. F. Siemer. 2006. Experiences with beaver damage and attitudes of Massachusetts residents toward beaver. Wildlife Society Bulletin 34:1009-1021.

Kendall, R. J., T. E. Lacher Jr., C. Bunck, F. B. Daniel, C. Driver, C. E. Grue, F. Leighton, W. Stansley, P. G. Watanabe, and M. Whitworth. 1996. An ecological risk assessment of lead shot exposure in non-waterfowl avian species: Upland game birds and raptors. Environmental Toxicology and Chemistry 15:4-20.

Kinler, N. W., G. Linscombe, and P. R. Ramsey. 1987. Nutria. Pp. 326-343 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. The Ontario Trappers Association, Ontario Ministry of Natural Resources, Toronto, Canada.

Knudsen, G. J. 1962. Relationship of beaver to forests, trout and wildlife in Wisconsin. Wisconsin Conservation Department, Technical Bulletin Number 25, Madison, Wisconsin.

Knudsen, G. J., and J. B. Hale. 1965. Movements of transplanted beavers in Wisconsin. Journal of Wildlife Management 29:685-688.

Kreeger, T.J., P. J. White, U.S. Seal, and J. R. Tester, 1990. Pathological responses of red fox to foothold traps. Journal of Wildlife Management 54:147-160.

Laidlaw, M. A., H. W. Mielke, G. M. Filippelli, D. L. Johnson, and C. R. Gonzales. 2005. Seasonality and children's blood lead levels: developing a predictive model using climatic variables and blood lead data from Indianapolis, Indiana, Syracuse, New York, and New Orleans, Louisiana (USA). Environmental Health Perspectives 113:793-800.

Langlois, S. A., and L. A. Decker. 2004. The use of water flow devices and flooding problems caused by beaver in Massachusetts. Massachusetts Division of Fisheries and Wildlife. 13 pp.

Laramie, H. A., Jr., and S. W. Knowles. 1985. Beavers and their control. University of New Hampshire Cooperative Extension Service, Durham, New Hampshire.

Latham, R. M. 1960. Bounties are bunk. National Wildlife Federation, Washington, D.C. 10 pp.

LeBlanc, D. J. 1994. Nutria. Pp. B71-B80 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and control of wildlife damage. University of Nebraska-Lincoln, Lincoln, Nebraska.

Lefrancois, G. R. 1999. The Lifespan. Sixth edition. Wadsworth Publishing Company, Belmont, California.

Linzey, A. V., and NatureServe (Hammerson, G. & Cannings, S.). 2013. *Castor canadensis*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>. Accessed January 22, 2015.

Linzey, D. W. 1998. The Mammals of Virginia. McDonald and Woodward, Blacksburg, Virginia.

Lisle, S. 1996. Beaver Deceivers. Wildlife Control Technology. September-October 42-44.

Lisle, S. 1999. Wildlife Programs at the Penobscot Nation. Transactions of the North American Wildlife and Natural Resource Conference 65:466-477.

Lisle, S. 2003. Use and potential of flow devices in beaver management. Lutra 46:211-216.

Lochmiller, R. L. 1979. Use of beaver ponds by southeastern woodpeckers in winter. Journal of Wildlife Management 43:263-266.

Loeb , B. F., Jr. 1994. The beaver of the old north state. Popular Government 59:18-23.

Logan, K. A., L. L. Sweanor, T. K. Ruth, and M. G. Hornocker. 1996. Cougars of the San Andred Mountains, New Mexico. Federal Aid in Wildlife Restoration Project W-128-R, Hornocker Wildlife Institute, Moscow, Idaho.

Loker, C. A., D. J. Decker, and S. J. Schwager. 1999. Social acceptability of wildlife management actions in suburban areas: 3 cases from New York. Wildlife Society Bulletin 27:152-159.

Lowe, S., M. Browne, S. Boudjelas, and M. De Poorter. 2000. 100 of the World's Worst Invasive Alien Species A selection from the Global Invasive Species Database. Published by The Invasive Species Specialist Group (ISSG**)** a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN). 12 pp. First published as special lift-out in *Aliens 12*, December 2000. Updated and reprinted version: November 2004.

Lowery, G. H., Jr. 1974. The mammals of Louisiana and its adjacent waters. Louisiana State University Press, Baton Rouge, Louisiana. 565 pp.

Ludders, J. W., R. H. Schmidt, F. J. Dein, and P. N. Klein. 1999. Drowning is not euthanasia. Wildlife Society Bulletin 27:666-670.

Lynch, J. J., T. O'Neil, and D. W. Lay. 1947. Management significance of damage by geese and muskrats to Gulf Coast Marshes. Journal of Wildlife Management 1:50-76.

Mallis, A. 1982. Handbook of pest control, 6th ed. Franzak & Foster Co., Cleveland. 1101 pp.

Marks, S. G., J. E. Koepke, and C. L. Bradley. 1994. Pet attachment and generativity among young adults. Journal of Psychology 128:641-650.

McKinstry, M. C., and S. H. Anderson. 2002. Survival, fates, and success of transplanted beavers, *Castor canadensis*, in Wyoming. Canadian Field-Naturalist 116:60-68.

McNeely, R. 1995. Missouri's Beaver: A guide to management, nuisance prevention, and damage control. Missouri Department of Conservation, Jefferson City, Missouri.

Medin, D. E., and W. P. Clary. 1990. Bird populations in and adjacent to a beaver pond ecosystem in Idaho. USDA-Forest Service, Intermountain Research Station, 432.

Medin, D. E., and W. P. Clary. 1991. Small mammals of a beaver pond ecosystem and adjacent riparian habitat in Idaho. USDA-Forest Service, Intermountain Research Station, 445.

Melquist, W. E., and A. E. Dronkert. 1987. River otter. Pp 626-641 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild furbearer management and conservation in North America. Ministry of Natural Resources, Ontario, Canada.

Melquist, W. E., and M. G. Hornocker. 1983. Ecology of river otters in west central Idaho. Wildlife Monographs 83:3-60.

Melquist, W. E., P. J. Polechla, Jr., and D. Toweill. 2003. River otter. Pp 708-734 *in* G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Conservation. Second edition. The Johns Hopkins University Press, Baltimore, Maryland.

Metts, B. S., J. D. Lanham, and K. R. Russell. 2001. Evaluation of herpetofaunal communities on upland streams and beaver-impounded streams in the Upper Piedmont of South Carolina. American Midland Naturalist 145:54-65.

Meyers, B. 2000. Anticipatory mourning and the human-animal bond. Pp. 537-564 *in* T. A. Rando, ed. Clinical dimensions of anticipatory mourning: Theory and practice in working with the dying, their loved ones, and their caregivers. Research Press, Champaign, Illinois.

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Wetlands and water. World Resources Institute, Washington, D.C.

Miller, J. E. 1994. Muskrats. Pp. B-61-B-69 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and Control of Wildlife Damage. Univ. Nebr. Coop. Ext., USDA-APHIS-ADC and Great Plains Agric. Council Wildl. Comm., Lincoln, Nebraska.

Miller, J. E. 1983. Control of beaver damage. Proc. East. Wildl. Damage Control Conf. 1:177-183.

Miller, J. E., and G. K. Yarrow. 1994. Beaver. Pp. B-1-B-11 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, eds. Prevention and Control of Wildlife Damage. Univ. Nebr. Coop. Ext., USDA-APHIS-ADC and Great Plains Agric. Council Wildl. Comm., Lincoln, Nebraska.

Mowry, R. A., M. E. Gompper, J. Beringer, and L. S. Eggert. 2011. River otter population size estimation using noninvasive latrine surveys. Journal of Wildlife Management 75:1625-1636.

Muller, L. I., R. J. Warren, and D. L. Evans. 1997. Theory and practice of immunocontraception in wild animals. Wildlife Society Bulletin 25:504-514.

Muller-Schwarze, D., and L. Sun. 2003. The beaver: Natural history of a wetlands engineer. Cornell University Press, Ithaca, New York.

Munther, G. L. 1982. Beaver management in grazed riparian ecosystems. Wildlife Livestock Relationships Symposium 10:234-241.

Naiman, R. J., J. M. Melillo, and J. E. Hobbie. 1986. Ecosystem alteration of boreal forest streams by beaver (*Castor canadensis*). Ecology 67:1254-1269.

Naiman, R. J., C. A. Johnston, and J. C. Kelley. 1988. Alteration of North American streams by beaver. BioScience 38:753-762.

National Audubon Society. 2000. Field guide to North American mammals. J. O. Whitaker, Jr., editor. Alfred A. Knopf Publishing, New York City, New York.

Neves, R.J., and M.C. Odom. 1989. Muskrat predation on endangered freshwater mussels in Virginia. Journal of Wildlife Management 53:934-941.

Nielsen, L. 1988. Definitions, considerations, and guidelines for translocation of wild animals. Pp. 12-49 *in* L. Nielsen and R. D. Brown, eds. Translocation of wild animals. Wisconsin Humane Society, Milwaukee, Wisconsin, and Caesar Kleberg Wildlife Research Institute, Kingsville, Texas.

Nolte, D. M., S. R. Swafford, and C. A. Sloan. 2001. Survey of factors affecting the success of Clemson beaver pond levelers installed in Mississippi by Wildlife Services. Pp. 120-125 *in* M C. Brittingham, J. Kays, and R. McPeake eds. Proceedings of the Ninth Wildlife Damage Management Conference. Pennsylvania State University, University Park, Pennsylvania.

Noonan, B. 1998. The Canadian terminal dive study. Wildlife Control Techniques. May-June.

Novak, M. 1987. Beaver. Pp. 282-312 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild Furbearer management and conservation in North America. The Ontario Trappers Association, Ontario Ministry of Natural Resources, Toronto, Canada.

O’Neil, T. 1949. The muskrat in the Louisiana Coastal Marshes. Louisiana Department of Wildlife and Fisheries, New Orleans. 152 pp.

Organ, J. F., T. Decker, J. DiStefano, K. Elowe, P. Rego, and P. G. Mirick. 1996. Trapping and furbearer management: Perspectives from the Northeast. USDI-Fish and Wildlife Service, Hadley, Massachusetts.

Parrish, W. F., Jr. 1960. Status of the beaver (*Castor canadensis carolinensis*) in Georgia. Thesis, University of Georgia, Athens, Georgia.

Partington, M. 2002. Preventing beaver dams from blocking culverts. Advantage 3:1-4.

Petro, V. M., J. D. Taylor, and D. M. Sanchez. 2015. Evaluating landowner-based beaver relocation as a tool to restore salmon habitat. Global Ecology and Conservation 3:477-486.

Phillips, R. L. 1996. Evaluation of 3 types of snares for capturing coyotes. Wildlife Society Bulletin 24: 107-110.

Pollock, M. M., T. MG. R. Pess, T. J. Beechie, and D. R. Montgomery. 2004. The importance of beaver ponds to Coho salmon production in the Stillaguamish River Basin, Washington, USA. North American Journal of Fisheries Management 24:749-760.

Pollock, M. M., J. M. Wheaton, N. Bouwes, C. Volk, N. Weber, and C. E. Jordan. 2012. Working with beaver to restore salmon habitat in the Bridge Creek intensively monitored watershed: Design rationale and hypotheses. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-120. 47 pp.

Pollock, M. M., T. J. Beechie, and C. E. Jordan. 2007. Geomorphic changes upstream of beaver dams in Bridge Creek, an incised stream channel in the interior Columbia River basin, eastern Oregon. Earth Surface Processes and Landforms 32:1174-1185.

Pollock, M. M., T. J. Beechie, J. M. Wheaton, C. E. Jordan, N. Bouwes, N. Weber, and C. Volk. 2014. Using beaver dams to restore incised stream ecosystems. BioScience 64:279-290.

Price, J. M., and J. G. Nickum. 1995. Aquaculture and Birds: the Context for Controversy. Colonial Waterbirds 18 (Special Publication 1):33-45.

Pullen, T. M., Jr. 1967. Some effects of beaver (*Castor canadensis*) and beaver pond management on the ecology and utilization of fish populations along warm-water streams in Georgia and South Carolina. Ph.D. Dissertation. University of Georgia, Athens, Georgia. 84 pp.

Ramey, C. A., J. B. Bourassa, and J. E. Brooks. 2000. Potential risks to ring-necked pheasants in California agricultural areas using zinc phosphide. International Biodeterioration & Biodegradation 45:223-230.

Randolph, J. P. 1988. Virginia trapper's manual. Department of Game and Inland Fisheries, Richmond, Virginia.

Reese, K. P., and J. D. Hair. 1976. Avian species diversity in relation to beaver pond habitats in the Piedmont region of South Carolina. Proceeding of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 30:437-447.

Ringleman, J. K. 1991. Managing beaver to benefit waterfowl. Waterfowl Management Handbook. United States Department of the Interior, Fish and Wildlife Service, Fish and Wildlife Leaflet 13.4.7.

Roberts, T. H., and D. H. Arner. 1984. Food habits of beaver in East-Central Mississippi. Journal of Wildlife Management 48:1414-1419.

Roblee, K. J. 1983. A wire mesh culvert for use in controlling water levels at nuisance beaver sites. Proc. East. Wildl. Dam. Control Conf. 1:167-168.

Roblee, K. J. 1984. Use of corrugated plastic drainage tubing for controlling water levels at nuisance beaver sites. New York Fish and Game Journal 31:63-80.

Roblee, K. J. 1987. The use of T-culvert guard to protect road culverts from plugging damage by beavers. Proc. East. Wildl. Damage Control Conf. 3:25-33.

Ross, C. B., and J. Baron-Sorensen. 1998. Pet loss and human emotion: guiding clients through grief. Accelerated Development, Incorporation, Philadelphia, Pennsylvania.

Rossell, R. O. Bozsér, P. Collen, and H. Parker. 2005. Ecological impact of beavers Castor fiber and Castor Canadensis and their ability to modify ecosystems. Mammal Review 35:248-276.

Russell, K. R., C. E. Moorman, J. K. Edwards, B. S. Metts, and D. C. Guynn, Jr. 1999. Amphibian and reptile communities associated with beaver (*Castor canadensis*) ponds and unimpounded streams in the Piedmont of South Carolina. Journal of Freshwater Ecology 14:149-158.

Salyer II, J. C. 1946. The Carolina beaver: A vanishing species? Journal of Mammalogy 27:331-335.

Schmidt, R. 1989. Animal welfare and wildlife management. Transcripts of the North American Wildlife and Natural Resources Conference 54:468-475.

Schobert, E. 1987. Telazol use in wild and exotic animals. Veterinary Medicine 82:1080–1088.

Schwartz, C. W., and E. R. Schwartz. 1959. The wild mammals of Missouri. University of Missouri and Missouri Conservation Committee, Columbia, Missouri.

Sharp, T., and G. Saunders. 2008. A model for assessing the relative humaneness of pest animal control methods. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Sharp, T., and G. Saunders. 2011. A model for assessing the relatives humaneness of pest animal control methods. 2nd Edition. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, ACT.

Sheffels, T. R., M. D. Sytsma, J. Carter, and J. D. Taylor. 2014. Efficacy of plastic mesh tubes in reducing herbivory damage by the invasive nutria (*Myocastor coypus*) in an urban restoration site. Northwest Science 88:269-279.

Shwiff, S. A., K. N. Kirkpatrick, and K. Godwin. 2011. Economic evaluation of beaver management to protect timber resources in Mississippi. Human-Wildlife Interactions 5:306-314.

Siegfried, W. R. 1968. The reaction of certain birds to rodent baits treated with zinc phosphide. Ostrich 39:197-198.

Simon, L. 2006. Solving beaver flooding problems through the use of water flow control devices. Proceedings of the Vertebrate Pest Conference 22:174-180.

Skinner, Q. D., J. E. Speck Jr., M. Smith, and J. C. Adams. 1984. Stream water quality as influenced by beaver within grazing systems in Wyoming. J. Range. Manage. 37:142-146.

Slate, D.A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Transcripts of the North American Wildlife and Natural Resources 57:51-62.

Slough, B. G., and R. M. F. S. Sadleir. 1977. A land capability classification system for beaver (*Castor canadensis* Kuhl). Canadian Journal of Zoology 55:1324-1335.

Snodgrass, J. W. 1997. Temporal and spatial dynamics of beaver-created patches as influenced by management practices in a south-eastern North American landscape. Journal of Applied Ecology 34:1043-1056.

Snodgrass, J. W., and G. K. Meffe. 1998. Influence of beavers on stream fish assemblages: Effects of pond age and watershed position. Ecology 79:928-942.

Snodgrass, J. W., and G. K. Meffe. 1999. Habitat use and temporal dynamics of blackwater stream fishes in and adjacent to beaver ponds. Copeia 1999:628-639.

Southwick Associates. 2004. Potential Economic Losses Associated With Uncontrolled Nutria Populations in Maryland's Portion of the Chesapeake Bay. Prepared for the: Wildlife and Heritage Service, 580 Taylor Avenue, Annapolis, Maryland 21401 by Southwick Associates, P.O. Box 6435, Fernandina Beach, Florida 32035.

Spock, M. 2006. Effectiveness of water flow devices as beaver conflict resolution tools: A satisfaction survey of Massachusetts clients. Center for Animals and Public Policy, Tufts University Cummings School of Veterinary Medicine. 50 pp.

Stansley, W., L. Widjeskog, and D. E. Roscoe. 1992. Lead contamination and mobility in surface water at trap and skeet ranges. Bulletin of Environmental Contamination and Toxicology 49:640-647.

Stevens, C. E., C. A. Paszkowski, and A. Lee Foote. 2007. Beaver (*Castor canadensis*) as a surrogate species for conserving anuran amphibians on boreal streams in Alberta, Canada. Biological Conservation 134:1-13.

Taylor, J., D. Bergman, and D. Nolte. 2009. An overview of the international beaver ecology and management workshop. Pp. 225-234 *in* J. R. Boulanger, ed. Proceedings of the 13th Wildlife Damage Management Conference.

Taylor, J. D., and R. D. Singleton. 2014. The evolution of flow devices used to reduce flooding by beavers: a review. Wildlife Society Bulletin 38:127-133.

Texas Almanac. 2016. Environment. http://texasalmanac.com/topics/environment/rivers. Access October 14, 2016.

Tesky, J. L. 1993. *Castor canadensis*. In: Fire Effects Information System, [Online]. USDA, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/. Accessed November 3, 2014.

The Wildlife Society. 2015. Standing position statement: wildlife damage management. The Wildlife Society, Washington., D.C. 2 pp.

Thompson, C. 2016. Wetland Loss. http://www.tarleton.edu/Faculty/cthompson/WETLANDS1/Loss.html. Accessed October 16, 2016.

Tietjen, H. P. 1976. Zinc phosphide – its development as a control agent for black-tailed prairie dogs. U.S. Fish and Wildlife Service, Special Report on Wildlife 195.

Tietjen, H. P., and G. H. Matschke. 1982. Aerial pre-baiting for the management of prairie dogs with zinc phosphide. Journal of Wildlife Management 46:1108-1112.

Treves, A., and L. Naughton-Treves. 2005. Evaluating lethal control in the management of human-wildlife conflict. Pp. 86-106 in R. Woodroffe, S. Thirgood, A. Rabinowitz, eds., People and Wildlife: Conflict or Coexistence, University of Cambridge Press, United Kingdom.

United States Census Bureau. 2010. 2010 census state area measurements and internal point coordinates. United State Census Bureau. http://www.census.gov/geo/reference/state-area.html. Accessed September 29, 2014.

USDA. 2015. Final Environmental Impact Statement: Feral swine damage management: A national approach. USDA/APHIS/WS, Riverdale, Maryland.

United States General Accounting Office. 2001. Wildlife Services Program: Information on activities to manage wildlife damage. Report to Congressional Committees. GOA-02-138. 71 pp.

Uresk, D. W., R. M. King, A. D. Apa, M. S. Deisch, and R. L. Linder. 1988. Rodenticidal effects of zinc phosphide and strychnine on notarget species. Pages 57-63 *in* D. W. Uresk, G. L. Schenbeck, and R. Cefkin, tech. coordinators. Eighth Great Plains Wildlife Damage Control Workshop Proceedings, Fort Collins, Colorado, USA. GTR RM-154. USDA Forest Service Rocky Mountain Forest and Range Experiment Station.

Valentine, J. M., J. R. Walther, K. M. McCartney, and L. M. Ivy. 1972. Alligator diets on the Sabine National Wildlife Refuge. Journal of Wildlife Management 36:809-815.

Wade, D. E., and C. W. Ramsey. 1986. Identifying and managing aquatic rodents in Texas: beaver, nutria and muskrat. Texas Agricultural Extension Service and Texas Agriculture Experimental Station. Texas A&M University in cooperation with USDI-USFWS Pub. B-1556, College Station, Texas.

Weisman, A. D. 1991. Bereavement and companion animals. Omega: Journal of Death and Dying 22: 241-248.

Wesley, D. E. 1978. Beaver control in the Southeastern United States. Proceedings of the Symposium of Southeastern Hardwoods 6:84-91.

Westbrook, C. J., D. J. Cooper, and B. W. Baker. 2006. Beaver dams and overbank floods influence groundwater-surface water interactions of a Rocky Mountain riparian area. Water Resources Research 42, W06404, doi:10.1029/2005WR004560.

Whitaker, Jr., J.O., and W.L.J. Hamilton, Jr. 1998. Mammals of the Eastern United States. Cornell University Press, Ithaca, New York. 583 pp.

Wilkinson, P. M. 1962. A life history study of the beaver in east-central Alabama. Thesis, Auburn University, Auburn, Alabama.

Wolfe, J. L., D. K. Bradshaw, and R. H. Chabreck. 1987. Alligator feeding habits: new data and a review. Northeast Gulf Science 9:1-8.

Wood, G. W., L. A. Woodward, and G. K. Yarrow. 1994. The Clemson beaver pond leveler. Clemson Cooperative Extension Service, Clemson, South Carolina.

Woodward, D. K. 1983. Beaver management in the southeastern United States: a review and update. Proc. East. Wildl. Damage Contr. Conf. 1:163-165.

Woodward, D. K., J. D. Hair, and B. P. Gaffney. 1976. Status of beaver in South Carolina as determined by a postal survey of landowners. Proceedings of the Annual Conference of Southeast Fish and Wildlife Agencies 30:448-54.

Woodward, D. K., R. B. Hazel, and B. P. Gaffney. 1985. Economic and environmental impacts of beavers in North Carolina. Proceedings of the Eastern Wildlife Damage Management Conference 2:89-96.

Woolington, J. D. 1984. Habitat use and movements of river otters at Kelp Bay, Baranof Island, Alaska. M.S. Thesis, University of Alaska, Fairbanks, Alaska.

Wright, J. V. 1987. Archeological evidence for the use of furbearers in North America. Pp. 3 - 12 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Mallock, eds. Wild Furbearer management and conservation in North America. The Ontario Trappers Association, Ontario Ministry of Natural Resources, Toronto, Canada.

Wright, J. P., C. G. Jones, and A. S. Flecker. 2002. An ecosystem engineer, the beaver, increases species richness on a landscape scale. Oecologia 132:96-101.

Zasloff, R. L. 1996. Measuring attachment to companion animals: a dog is not a cat is not a bird. Applied Animal Behaviour Science 47:43-48.

APPENDIX B

METHODS AVAILABLE FOR RESOLVING OR PREVENTING AQUATIC MAMMAL DAMAGE IN TEXAS

The most effective approach to resolving wildlife damage problems would be to integrate the use of several methods, either simultaneously or sequentially. An adaptive plan would integrate and apply practical methods of prevention and reduce damage by aquatic mammals while minimizing harmful effects of damage reduction measures on people, other species, and the environment. An adaptive plan allows for the modification of strategies, depending on the characteristics of specific damage problems.

In selecting damage management techniques for specific damage situations, consideration would be given to the responsible species and the magnitude, geographic extent, duration and frequency, and likelihood of wildlife damage. Consideration would also be given to the status of target and potential non-target species, local environmental conditions and impacts, social and legal aspects, and relative costs of damage reduction options. The cost of damage reduction may sometimes be a secondary concern because of the overriding environmental, legal, and animal welfare considerations. Those factors would be evaluated in formulating damage management strategies that incorporate the application of one or more techniques.

A variety of methods would potentially be available to the TWSP in Texas relative to the management or reduction of damage from aquatic mammals. Various federal, state, and local statutes and regulations would govern the TWSP use of methods, including WS' directives. The TWSP would develop and recommend or implement strategies for each request for assistance. Within each approach there may be available a number of specific methods or techniques. The following methods could be recommended or used by the TWSP. Many of the methods described would also be available to other entities in the absence of any involvement by the TWSP.

Non-chemical Wildlife Damage Management Methods

Non-chemical methods consist primarily of tools or devices used to exclude, capture, or kill a particular animal or local population of wildlife to alleviate damage and conflicts. Methods may be non-lethal (*e.g.*, fencing, cage traps) or lethal (*e.g.*, firearms, body-grip traps). The TWSP and the entity requesting assistance would agree upon all methods or techniques applied by WS to resolve damage or threats to human safety by signing a work initiation document, MOU, or another comparable document prior to the implementation of those methods. Non-chemical methods that personnel of the TWSP could use or recommend include:

Structural changes could be methods that WS' employees recommend when providing technical assistance. For example, Jensen et al. (2001) recommended that highway departments install over-sized culverts in areas where beaver may be present. Jensen et al. (2001) stated, "*Due to the effects of stream gradients, culverts should be oversized to at least 2.1 m^2 (inlet opening area) for a 0% gradient stream and at least 0.8 m^2 for streams with gradients up to 3% to reduce the probability of plugging to 50%*". In addition, Jensen et al. (2001) stated, "*These recommendations should be considered minimum sizes, because culverts should be enlarged to at least a size that maintains the natural stream width*." Structural changes would be methods the requester implements without any direct involvement by WS' personnel. Over the service life of a culvert, Jensen et al. (2001) speculated that installing oversized culverts by highway departments would be more cost-effective than trapping, debris removal, or other short-term options to manage damage to roads associated with beaver.

Exclusion pertains to preventing access to resources through fencing or other barriers. Fencing of small critical areas can sometimes prevent animals that cannot climb from entering areas of protected resources. Fencing of culverts, drainpipes, and other water control structures can sometimes prevent beaver from building dams that plug those devices. Using hardware cloth or other metal barriers can sometimes prevent girdling and gnawing of valuable trees. Construction of concrete spillways may reduce or prevent damage to dams by aquatic mammal species that burrow into embankments. Riprap used on dams and levees can sometimes deter aquatic mammals from burrowing. Using electric fences of various constructions can sometimes effectively reduce damage to various crops. Sheffels et al. (2014) found that placing plastic mesh tubes around newly planted woody vegetation at riparian restoration sites could prevent nutria from feeding on the vegetation. In many cases, WS could recommend the use of exclusion but the implementation of specific methods would be the responsibility of the property owner or manager (*e.g.*, constructing concrete spillways, using riprap on dams and levees).

The TWSP could recommend or implement beaver exclusion and the use of water control devices to alleviate flooding damage without removing beaver. Although beaver dams could be breached/removed manually or with binary explosives, those methods are usually ineffective because beaver quickly repair or replace the dam (McNeely 1995). In some situations installing exclusion and water control devices can effectively reduce damage. WS could design exclusion and water control devices to maintain the beaver-created impoundment at a level that eliminates or minimizes damage while retaining the ecological and recreational benefits derived from beaver impoundments. The TWSP could also recommend that modifications occur to culvert design (Jensen et al. 1999) as a non-lethal way of reducing problems with beaver dams at culverts.

Beaver exclusion generally involves the placement of fencing to prevent beaver from accessing water intake areas, such as culverts. Personnel of the TWSP could recommend or implement a variety of exclusion systems, including the Beaver Deceiver™, Beaver Bafflers™, and pre-dams (Lisle 1996, Brown and Brown 1999, Lisle 1999, Brown et al. 2001, Partington 2002, Lisle 2003). The Beaver Deceiver™ is a fencing system that people can install to prevent beaver blockage of culverts by minimizing environmental cues that stimulate beaver to construct dams, and by making culverts less attractive as dam construction sites (Lisle 1996, Lisle 1999, Lisle 2003). Blocking culverts by installing a fence on the upstream end of the culvert can sometimes deter beaver from building dams at the entrance to or inside the culvert. Installation of a fence increases the length of the area that must be dammed to impound water, and if beaver build along the fence, may increase the distance between the beaver and the source of the cues that stimulate damming behavior (*e.g.*, water moving through culvert) (Lisle 1996, Lisle 1999, Lisle 2003, Callahan 2005). Beaver prefer to build dams perpendicular to water flow, so fences can be oriented at odd angles to water flow and can be set so that they do not block the stream channel. WS may also use fencing to cover the up and downstream ends of the culverts to prevent beaver from entering the deceiver from the downstream side of the culvert and to prevent any beaver that might make it past the outer fence from plugging the interior of the culvert. Efforts can also be made to reduce the sound of water flowing through the culvert by raising the water level on the down-stream side of the culvert with dam boards or beaver-made dams, by constructing flumes to replace waterfalls, or, in extreme cases, by resetting the culvert (Lisle 1996). Using Beaver Deceivers™ in combination with water control devices can ensure sufficient water flow through the culvert (see discussion on Beaver Deceivers™ below).

Attaching cylindrical exclusion devices, like Beaver Bafflers™, to culvert openings can reduce the likelihood that beaver plug a culvert by spreading the water intake over a larger area (Brown et al. 2001). While cylindrical exclusion devices can be effective in some situations (Partington 2002), in a study of beaver exclusion and water control devices, cylindrical shapes attached in-line with a culvert had a higher failure rate (40%) than trapezoidal shapes (*e.g.*, Beaver Deceivers™; 3% failure rate) and use of the cylindrical devices was discontinued in favor of trapezoidal fences (Callahan 2005).

Unlike Beaver Deceivers™ and cylindrical fences, pre-dam fences (*e.g.*, deep-water fences, diversion dams) (Brown and Brown 1999) can be designed with the specific intention that the beaver build the dam along the fence. Pre-dam fences can be short semicircular or circular fences built in an arc around a water inlet. The fence serves as a dam construction platform that allows beaver to build a dam at the site but prevents beaver from plugging the water intake. If the size of the upstream impoundment created from the impounded water were not a concern, no further modifications of the pre-dam would be needed. However, in most cases, pre-dams would be used in combination with water control devices to manage the size of the upstream pond to alleviate flooding concerns.

Fence mesh size can be selected to minimize risks to beaver and non-target species. Brown et al. (2001) noted that beaver occasionally became stuck in 6-inch mesh and that the risk of beaver entrapment was lower with 5-inch mesh. Lisle (1999) noted that the size of the mesh on the fence of the Beaver Deceivers™ (6-inch mesh) was such that it allowed most species to pass through the fence except beaver and big turtles. In some remote areas where vehicular traffic is infrequent, it may be acceptable for animals that cannot pass through the fence mesh to travel across the road. However, for culverts under busy roads, it may be necessary to design special "*doors*" that allow the passage of beaver, large turtles, and other non-target animals through the device. For example, T-joints 30 centimeters in diameter have been used to allow access through Beaver Deceiver™ fences. The T-shape reduces the likelihood that beaver can haul woody debris for dam construction inside the device (Lisle 2003). Fence caps would not be attached to the up and down-stream ends of a culvert when it is necessary to allow passage of species like large turtles and beavers through a culvert. Fence caps would not be attached to the up and down-stream ends of a culvert when it is necessary to allow passage of species like large turtles and beavers through a culvert.

Water control devices (*e.g.*, pond levelers) are systems that allow the passage of water through a beaver dam. The devices could be used in situations where the presence of impounded water is desired but it is necessary to manage the level of water in the pond. Various types of water control devices have been described (Arner 1964, Roblee 1984, Laramie and Knowles 1985, Miller and Yarrow 1994, Wood et al. 1994, Lisle 1996, Organ et al. 1996, Brown and Brown 1999, Lisle 1999, Brown et al. 2001, Close 2003, Lisle 2003, Simon 2006, Spock 2006, Taylor and Singleton 2014). Water control devices such as the corrugated plastic drainage tubing (Roblee 1984), the T-culvert guard (Roblee 1987), wire mesh culvert (Roblee 1983), and the Clemson beaver pond leveler (Miller and Yarrow 1994) can sometimes be used to control the water in beaver impoundment to desirable levels that do not cause damage. Taylor and Singleton (2014) provide a comprehensive summary of the evolution of flow devices to reduce flooding by beaver. The devices generally involve the use of one or more pipes installed through the beaver dam to increase the flow of water through the dam. Height and placement of pipes can be adjusted to achieve the desired water level in the beaver pond. Beaver generally only check the dam for leaks, so, when site conditions permit, the inlet of the pipe is placed away from the dam to make the source of the water flow more difficult to detect and decrease the likelihood that beaver will attempt to plug the device. To minimize the sound/sensation of water movement and the associated beaver damming behavior, the end of the pipe may be capped with a series of holes or notches cut in the pipe, which allows water to flow into the pipe. Holes and notches may be placed on the underside of the pipe to reduce the sound of water movement. Alternatively, 90-degree elbow joints can be placed facing downward on the upstream end of the pipes to prevent the noise of running water and attracting beaver. A protective cage can be placed around the upstream end of the inlet pipe to prevent beaver from blocking the pipe and to reduce problems with debris blocking the pipe. As noted above, water control systems can be combined with exclusion devices to prevent beaver from blocking culverts while still maintaining a water impoundment at an acceptable level.

Beaver dam breaching/removal would involve the removal of debris deposited by beaver that impedes the flow of water. Removing or breaching a dam is generally conducted to maintain existing stream channels and drainage patterns, and reduce floodwaters behind the dam. Beaver dams are made from natural debris such as logs, sticks and mud that beaver take from the immediate area and impound water, creating habitat that they utilize to build lodges and bank dens to raise their young and/or provide protection from predators. The impoundments that the TWSP removes or breaches would typically be created by recent beaver activity and would not have been in place long enough to take on the qualities of a true wetland (*e.g*., hydric soils, aquatic vegetation, pre-existing function). Unwanted beaver dams could be removed by hand with a rake or power tools (*e.g.*, a winch), or with explosives. Explosives would be used only by the TWSP personnel specially trained and certified to conduct such activities, and only binary explosives would be used (*i.e*., they are comprised of two parts that must be mixed at the site before they can be detonated as an explosive material). Beaver dam removal or breaching by hand or with binary explosives would not affect the substrate or the natural course of the stream. Removing or breaching dams would return the area back to its pre-existing condition with similar flows and circulations. Because beaver dams involve waters of the United States, removal is regulated under Section 404 of the CWA (see Appendix D).

Most beaver dam breaching, if considered discharge, would be covered under exemptions in 33 CFR 323 or under a NWP issued pursuant to 33 CFR 330 and do not require a permit. A permit would be required if the beaver dam breaching activity was not covered by a Section 404 permitting exemption or a NWP and the area affected by the beaver dam was considered a true wetland. The State of Texas may require additional permits (see Appendix D). Personnel of the TWSP would survey the site or impoundment to determine if conditions exist for classifying the site as a true wetland. If the site appears to have conditions over 3 years old or appeared to meet the definition of a true wetland, the landowner or cooperator would be required to obtain a permit before proceeding (see Appendix D for information that explains Section 404 permit exemptions and conditions for breaching/removing beaver dams).

Live Capture and Translocation can be accomplished using hand capture, catch poles, cage traps, suitcase type traps, cable devices, or with foothold traps to capture some aquatic mammal species for the purpose of translocating them for release in other areas. The TWSP could employ those methods in Texas when the target animal(s) can legally be translocated or can be captured and handled with relative safety by personnel of the TWSP. Live capture and handling of aquatic mammals poses an additional level of human health and safety threat if target animals are aggressive, large, or extremely sensitive to the close proximity of people. For that reason, the TWSP may limit this method to specific situations and certain species. In addition, moving damage-causing individuals to other locations can typically result in damage at the new location, or the translocated individuals can move from the relocation site to areas where they are unwanted. In addition, translocation can facilitate the spread of diseases from one area to another. Although translocation is not necessarily precluded in all cases, it would be logistically impractical, in most cases, and biologically unwise in Texas due to the risk of disease transmission. High population densities of some animals may make this a poor wildlife management strategy for those species. Translocation would be evaluated by the TWSP on a case-by-case basis.

Trapping can utilize a number of devices, including foothold traps, cage-type traps, body-gripping traps, and cable devices. Capture methods are often methods that would be set to confine or restrain target animals after they trigger the trap. Personnel would strategically place traps at locations likely to capture a target aquatic mammal and minimize the threat to non-target species by placement in those areas frequently used by the target aquatic mammal species, using baits or lures that are as species specific as possible, and modification of individual methods to exclude non-target animals from capture.

WS' personnel would check methods in accordance with WS Directive 2.210 and WS Directive 2.450. Checking live-traps frequently would help ensure that personnel of the TWSP could release live-captured non-target species in a timely manner. WS would monitor activities to ensure those activities do not negatively affect non-target species.

While personnel of the TWSP would take precautions to safeguard against taking non-target animals during operational use of trapping methods and techniques for resolving damage and reducing threats caused by aquatic mammals, the use of such methods could result in the incidental lethal removal of unintended species. The unintentional removal and capture of animals during damage management activities conducted under the proposed activities would primarily be associated with the use of body-gripping traps and in some situations, with live-capture methods, such as foothold traps, cage traps, and cable devices. However, WS' personnel have not captured or killed any threatened, endangered, or candidate species in Texas previously using trapping methods

Foothold Traps can be effectively used to capture aquatic mammals. Foothold traps can be placed in travel ways being actively used by the target species. Placement of traps is contingent upon the habits of the respective target species, habitat conditions, and presence of non-target animals. Effective trap placement and adjustment, and the use and placement of appropriate baits and lures by trained personnel of the TWSP also contribute to the selectivity of foothold traps. An additional advantage is that foothold traps can allow for the on-site release of non-target animals since animals are captured alive. For aquatic mammals, foothold traps are often placed just under the surface of the water in travel ways and are intended to capture the target aquatic mammal as they exit or enter the water. The use of foothold traps requires more skill than some methods. Foothold traps would generally be available for use by the public and other state or federal agencies.

The TWSP could also attach a foothold trap to a submersion cable or rod that the TWSP anchors at the trap set and in deep water. Attaching the trap to the cable or rod with a locking mechanism allows the trap to slide down the cable or rod into deeper water, but prevents a captured animal from returning to the surface.

Cable Devices are typically made of wire or cable, and can be set to capture an animal by the neck or body. Cable devices may be used as either lethal or live-capture devices depending on how or where they are set. Cable devices set to capture an animal by the neck are usually lethal but stops can be attached to the cable to increase the probability of a live capture depending on the trap check interval. Cable devices positioned to capture the animal around the body can be a useful live-capture device, but are more often used as a lethal control technique. Cable devices can incorporate a breakaway feature to release non-target wildlife and livestock where the target animal is smaller than potential non-target animals (Phillips 1996). Cable devices can be effectively used wherever a target animal moves through a restricted travel lane (*e.g.*, trails through vegetation). When an animal moves forward into the loop formed by the cable, the noose tightens and the animal is held. Cable devices must be set in locations where the likelihood of capturing non-target animals would be minimized.

Cage-type traps come in a variety of styles to live-capture animals. The most commonly known cage traps for aquatic mammals are box traps and suitcase traps. Box traps are usually rectangular and are made from various materials, including metal, wire mesh, plastic, and wood. Box traps are generally portable and easy to set-up.

The disadvantages of using cage traps are: 1) some individual target animals may avoid cage traps; 2) some non-target animals may associate the traps with available food and purposely get captured to eat the bait, making the trap unavailable to catch target animals; 3) cage traps must be checked frequently to ensure that captured animals are not subjected to extreme environmental conditions; 4) some animals will fight to escape and may become injured; and 5) expense of purchasing traps.

Trap monitors are devices that send a radio signal to a receiver if a set trap is disturbed and alerts field personnel that an animal may be captured. Trap monitors can be attached directly to the trap or attached to a string or wire and then placed away from the trap in a tree or shrub. When the monitor is hung above the ground, it can be detected from several miles away, depending on the terrain in the area. There are many benefits to using trap monitors, such as saving considerable time when checking traps, decreasing fuel usage, prioritizing trap checks, and decreasing the need for human presence in the area. Trap monitors could be used when using cage traps. Trap monitors do not exempt the TWSP from mandatory physical trap checks. Wireless trail (game) cameras could also be used to monitor traps where cell service is available. Some trail cameras allow images to be sent to cellular phones, which permits for fewer site visits and reduced cost associated with travel.

Trap monitoring devices could be employed, when applicable, that indicate when a trap has been activated. Trap monitoring devices would allow personnel to prioritize trap checks and decrease the amount of time required to check traps, which decreases the amount of time captured target or non-target animals would be restrained. By reducing the amount of time targets and non-target animals are restrained, pain and stress can be minimized and captured wildlife can be addressed in a timely manner, which could allow non-target animals to be released unharmed. Trap monitoring devices could be employed where applicable to facilitate monitoring of the status of traps in remote locations to ensure any captured wildlife was removed promptly to minimize distress and to increase the likelihood non-target animals could be released unharmed.

Hancock/Bailey Traps (suitcase/basket type cage traps) are designed to live-capture beaver. The trap is constructed of a metal frame that is hinged with springs attached and covered with chain- link fence. The trap's appearance is similar to a large suitcase when closed. When set, the trap is generally baited and opened to allow an animal to enter. When tripped, the panels of the trap close around the animal capturing the animal. One advantage of using the Hancock or Bailey trap is the ease of release of beaver or non-target animals. Beaver caught in Hancock or Bailey traps could also be humanely euthanized. Disadvantages are that those traps can be expensive, cumbersome, and difficult to set (Miller and Yarrow 1994). The trap weighs about 25 pounds and is relatively bulky to carry and maneuver. Hancock and Bailey traps can also be dangerous to set (*i.e.*, hardhats are recommended when setting suitcase traps), are less cost and time-efficient than cable devices, foothold traps, or body-grip traps, and may cause serious and debilitating injury to river otters (Blundell et al. 1999).

Body-grip Traps are designed to cause the quick death of the animal that activates the trap. Body-grip traps consists of a pair of rectangular wire frames that close like scissors when triggered, killing the captured animal with a quick body blow. For body-grip traps, the traps should be placed to ensure the rotating jaws close on either side of the neck of the animal to ensure a quick death. Body-grip traps are lightweight and easily set. Safety hazards and risks to people are usually related to setting, placing, checking, or removing the traps. Selectivity of body-grip traps can be enhanced by placement, trap size, trigger configurations, and baits. When using body-gripping traps, risks of non-target capture can be minimized by using recessed sets (placing trap inside a cubby, cage, or burrow) or restricting openings. For example, body-grip traps set to capture beaver can be placed underwater to minimize risks to non-target animals. Choosing appropriately sized traps for the target species can also exclude non-target animals by preventing larger non-target animals from entering and triggering the trap. The trigger configurations of traps can be modified to minimize non-target capture. For example, offsetting the trigger can allow non-target animals to pass through body-grip traps without capture. Body-grip traps would be available for use by all entities.

Shooting with firearms is very selective for the target species and could be conducted with rifles, handguns, and shotguns. Methods and approaches used by the TWSP may include use of illuminating devices, bait, firearm suppressors, and night vision/thermal equipment. Shooting can be an effective method in some circumstances, and can often provide immediate relief from the problem. Shooting may at times be one of the only methods available to effectively and efficiently resolve damage. Shooting would be limited to locations where it is legal and safe to discharge a weapon. In addition, WS' personnel could use firearms to euthanize live-captured animals.

Shooting can also be used in conjunction with an illumination device at night, which is especially useful for nocturnal aquatic mammals. Spotlights may or may not be covered with a red lens, which nocturnal animals may not be able to see, making it easier to locate them undisturbed. Night shooting may be conducted in sensitive areas that have high public use or other activity during the day, which would make daytime shooting unsafe. The use of night vision and Forward Looking Infrared (FLIR) devices can also be used to detect and shoot aquatic mammals at night, and is often the preferred equipment due to the ability to detect and identify animals in complete darkness. Night vision and FLIR equipment aid in locating wildlife at night when wildlife may be more active. Night vision and FLIR equipment could be used during surveys and in combination with shooting to remove target aquatic mammals at night. The TWSP personnel most often use this technology to target aquatic mammals in the act of causing damage or likely responsible for causing damage. Those methods aid in the use of other methods or allow other methods to be applied more selectively and efficiently. Night vision and FLIR equipment allow for the identification of target species during night activities, which reduces the risks to non-target animals and reduces human safety risks. Night vision equipment and FLIR devices only aid in the identification of wildlife and are not actual methods of removal. The use of FLIR and night vision equipment to remove target aquatic mammals would increase the selectivity of direct management activities by targeting those aquatic mammals most likely responsible for causing damage or posing threats.

Hunting/Trapping is sometimes recommended by the TWSP to resource owners. The TWSP could recommend resource owners consider legal hunting and trapping as an option for reducing aquatic mammal damage. Although legal hunting/trapping is impractical and/or prohibited in many urban-suburban areas, it can be used to reduce some local populations of aquatic mammals.

Chemical Wildlife Damage Management Methods

All pesticides used by the TWSP would be registered under the FIFRA and administered by the EPA and TDA. All personnel of the TWSP who apply restricted-use pesticides would be certified pesticide applicators by TDA and have specific training by the TWSP for pesticide application. The EPA and the TDA require pesticide applicators to adhere to all certification requirements set forth in the FIFRA. Pharmaceutical drugs, including those used in wildlife capture and handling, are administrated by the United States Food and Drug Administration and/or the United States Drug Enforcement Administration.

Chemicals would not be used by the TWSP on public or private lands without authorization from the property owner or manager. The following chemical methods have been proven selective and effective in reducing damage by aquatic mammals.

Ketamine (Ketamine HCl) is a dissociative anesthetic that is used to capture wildlife. It is used to eliminate pain, calm fear, and allay anxiety. Ketamine is possibly the most versatile drug for chemical capture, and it has a wide safety margin (Johnson et al. 2001). When used alone, this drug may produce muscle tension, resulting in shaking, staring, increased body heat, and, on occasion, seizures. Usually, ketamine is combined with other drugs, such as Xylazine. The combination of such drugs is used to control an animal, maximize the reduction of stress and pain, and increase human and animal safety.

Telazol is a more powerful anesthetic and usually used for larger animals. Telazol is a combination of equal parts of tiletamine hydrochloride and zolazepam hydrochloride (a tranquilizer). Telazol produces a state of unconsciousness in which protective reflexes, such as coughing and swallowing, are maintained during anesthesia. Schobert (1987) listed the dosage rates for many wild and exotic animals. Before using Telazol, the size, age, temperament, and health of the animal are considered. Following a deep intramuscular injection of Telazol, onset of anesthetic effect usually occurs within 5 to 12 minutes. Muscle relaxation is optimum for about the first 20 to 25 minutes after the administration, and then diminishes. Recovery varies with the age and physical condition of the animal and the dose of Telazol administered, but usually requires several hours.

Xylazine is a sedative (analgesic) that calms nervousness, irritability, and excitement, usually by depressing the central nervous system. Xylazine is commonly used with ketamine to produce a relaxed anesthesia. It can also be used alone to facilitate physical restraint. Because Xylazine is not an anesthetic, sedated animals are usually responsive to stimuli. Therefore, personnel should be even more attentive to minimizing sight, sound, and touch. When using ketamine/Xylazine combinations, Xylazine will usually overcome the tension produced by ketamine, resulting in a relaxed, anesthetized animal (Johnson et al. 2001). This reduces heat production from muscle tension, but can lead to lower body temperatures when working in cold conditions.

Sodium Pentobarbital is a barbiturate that rapidly depresses the central nervous system to the point of respiratory arrest. Barbiturates are a recommended euthanasia drug for free-ranging wildlife (American Veterinary Medical Association 2013). Sodium pentobarbital would only be administered after target animals were live-captured and properly immobilized to allow for direct injection. There are United States Drug Enforcement Administration restrictions on who can possess and administer this drug. Certified personnel of the TWSP are authorized to use sodium pentobarbital and dilutions for euthanasia in accordance with United States Drug Enforcement Administration and state regulations. All animals euthanized using sodium pentobarbital and all of its dilutions (*e.g.* Beuthanasia-D, Fatal-Plus) are disposed of through incineration or deep burial to prevent secondary poisoning of scavenging animals and introduction of these chemicals to non-target animals.

Potassium Chloride used in conjunction with prior general anesthesia is used as a euthanasia agent for animals, and is considered acceptable and humane by the American Veterinary Medical Association (2013). Animals that have been euthanized with this chemical experience cardiac arrest followed by death, and are not toxic to predators or scavengers.

Beuthanasia®-D combines pentobarbital with another substance to hasten cardiac arrest. Intravenous (IV) and intracardiac (IC) are the only acceptable routes of injection. As with pure sodium pentobarbital, IC injections with Beuthanasia®-D are only acceptable for animals that are unconscious or deeply anesthetized. With other injection routes, there are concerns that the cardiotoxic properties may cause cardiac arrest before the animal is unconscious. It is a Schedule III drug, which means it can be obtained directly from the manufacturer by anyone with a United States Drug Enforcement Administration registration. However, Schedule III drugs are subject to the same security and record-keeping requirements as Schedule II drugs.

Fatal-Plus® combines pentobarbital with other substances to hasten cardiac arrest. IV is the preferred route of injection; however, IC is acceptable as part of the two-step procedure used by the TWSP. Animals are first anesthetized and sedated using a combination of ketamine/Xylazine and once completely unresponsive to stimuli and thoroughly sedated, Fatal-Plus® is administered. Like Beuthanasia®-D, it is a Schedule III drug requiring a United States Drug Enforcement Administration registration for purchase and is subject to the security and record-keeping requirements of Schedule II drugs.

Carbon dioxide is sometimes used to euthanize aquatic mammals that are captured in live traps and when relocation is not a feasible option. Live aquatic mammals would be placed in a sealed chamber. Carbon dioxide gas is released into the chamber and the animal quickly dies after inhaling the gas. The American Veterinary Medical Association (2013) approves this method as a euthanizing agent. Carbon dioxide gas is a byproduct of animal respiration, is common in the atmosphere, and is required by plants for photosynthesis. It is used to carbonate beverages for human consumption and is the gas released by dry ice. The use of carbon dioxide by WS for euthanasia purposes is exceedingly minor and inconsequential to the amounts used for other purposes by society.

Zinc phosphide is an inorganic compound used to control rats, mice, voles, ground squirrels, prairie dogs, nutria, muskrats, feral rabbits, and gophers. Zinc phosphide is a heavy, finely ground gray- black powder that is partially insoluble in water and alcohol. When exposed to moisture, it decomposes slowly and releases phosphine gas (PH_3). When zinc phosphide treated bait encounters acids in the stomach, phosphate (PH_3) gas is released, which may account in a large part for observed toxicity. Animals that ingest lethal amounts of bait usually succumb overnight with terminal symptoms of convulsions, paralysis, coma, and death from asphyxia. If death is prolonged for several days, intoxication that occurs is similar to intoxication with yellow phosphorous, in which the liver is heavily damaged. Prolonged exposure to phosphine can produce chronic phosphorous poisoning.

Although zinc phosphide baits have a strong, pungent, phosphorous-like odor (garlic like), this characteristic seems to attract rodents, particularly rats, and apparently makes the bait unattractive to some other animals. For many uses of zinc phosphide formulated on grain or grain-based baits, pre-baiting is recommended or necessary for achieving good bait acceptance. Primary toxicity risks to non-target species from the direct consumption of treated bait can be minimized by using bait stations to prevent access by non-target species such as birds.

Because zinc phosphide is not stored in muscle or other tissues of poisoned animals, there is no secondary poisoning with this rodenticide. The bait however, remains toxic up to several days in the gut of the dead rodent. Other animals can be poisoned if they eat enough of the gut content of rodents recently killed with zinc phosphide.

Repellents are usually naturally occurring substances or chemicals formulated to be distasteful or to elicit pain or discomfort for target animals when they are smelled, tasted, or contacted. Repellents are variably effective and depend largely on resource to be protected, time and length of application, and sensitivity of the species causing damage. Again, acceptable levels of damage control would usually not be realized unless repellents were used in conjunction with other techniques. Repellents often contain different active ingredients with most ingredients occurring naturally in the environment. The most common ingredients of repellents are coyote urine, capsaicin, or sand (Silica) mixed with a non-toxic carrier for application to surfaces. Repellents for animals are not generally restricted-use products; therefore, a person does not need a pesticide applicators license to purchase or apply those products. People generally apply repellents directly to affected resources, which elicits an adverse taste or texture response when the target animal ingests the treated resource or the ingestion of the repellent causes temporary sickness (*e.g.*, nausea). Products containing coyote urine or other odors associated with predatory wildlife are intended to elicit a fright response in target wildlife by imitating the presence of a predatory animal (*i.e.*, wildlife tend to avoid areas where predators are known to be present). If repellents were registered for use in the State to reduce damage caused by aquatic mammals, the TWSP could employ or recommend for use those repellents that were available.

Explosives are defined as any chemical mixture or device that serves as a blasting agent or detonator. The procedures and accountability for WS' use of explosives for removing beaver dams and training requirements for explosives certification would adhere to WS Directive 2.435. Explosives are generally used to breach beaver dams that are too large to remove by digging using hand tools. Explosives would be used to remove dams after the beaver were removed using other methods. The TWSP would only use binary explosives to remove beaver dams. Binary explosives consist of two components that are contained separately. The two components of binary explosives are ammonium nitrate and nitro-methane or nitro-methane and aluminum powder, which are not classified as explosives until the two components are mixed. Therefore, binary explosives are subject to fewer regulations and controls because they are packaged separately. However, once mixed, binary explosives are considered high explosives and subject to all applicable federal and state requirements. When used to remove beaver dams, the two components would not be mixed until ready for use at the site where the dam was located. Detonating cord and detonators are also considered explosives and the TWSP must adhere to all applicable state and federal regulations for storage, transportation, and handling. All explosive specialists in the TWSP are required to attend extensive explosive safety training and spend time with a certified explosive specialist in the field prior to obtaining certification. Only well-trained, certified employees of the TWSP and closely supervised personnel would use explosives in accordance with WS Directive 2.435. Explosive handling and use procedures follow the rules and guidelines set forth by the Institute of Makers of Explosives, which is the safety arm of the commercial explosive industry in the United States and Canada. The TWSP also adheres to transportation and storage regulations from state and federal agencies, such as Occupational Safety and Health Association, Bureau of Alcohol, Tobacco, and Firearms, and the Department of Transportation.

APPENDIX C

FEDERAL AND STATE LIST
OF THREATENED OR ENDANGERED SPECIES IN TEXAS

Common Name	Scientific Name	Group	State Status	Federal Status	†Determination
Austin Blind Salamander	*Eurycea waterlooensis*	Amphibian	Endangered	Endangered	NE
Barton Springs Salamander	*Eurycea sosorum*	Amphibian	Endangered	Endangered	NE
Black-spotted Newt	*Notophthalmus meridionalis*	Amphibian	Threatened		NE
Blanco Blind Salamander	*Eurycea robusta*	Amphibian	Threatened		NE
Cascade Caverns Salamander	*Eurycea latitans*	Amphibian	Threatened		NE
Comal Blind Salamander	*Eurycea tridentifera*	Amphibian	Threatened		NE
Georgetown Salamander	*Eurycea naufragia*	Amphibian		Threatened	NE
Houston Toad	*Anaxyrus houstonensis*	Amphibian	Endangered	Endangered	NE
Jollyville Salamander	*Eurycea tonkawae*	Amphibian		Threatened	NE
Mexican Burrowing Toad	*Rhinophrynus dorsalis*	Amphibian	Threatened		NE
Mexican Treefrog	*Smilisca baudinii*	Amphibian	Threatened		NE
Salado Salamander	*Eurycea chisholmensis*	Amphibian		Threatened	NE
San Marcos Salamander	*Eurycea nana*	Amphibian	Threatened	Threatened	NE
Sheep Frog	*Hypopachus variolosus*	Amphibian	Threatened		NE
South Texas Siren (large form)	*Siren* sp. 1	Amphibian	Threatened		NE
Texas Blind Salamander	*Eurycea rathbuni*	Amphibian	Endangered	Endangered	NE
White-lipped Frog	*Leptodactylus fragilis*	Amphibian	Threatened		NE
Arizona Botteri's Sparrow	*Peucaea botterii arizonae*	Bird	Threatened		NE
Attwater's Greater Prairie Chicken	*Tympanuchus cupido attwateri*	Bird	Endangered	Endangered	NE
Bachman's Sparrow	*Aimophila aestivalis*	Bird	Threatened		NE
Bald Eagle	*Haliaeetus leucocephalus*	Bird	Threatened		NE
Black-capped Vireo	*Vireo atricapilla*	Bird	Endangered	Endangered	NE
Cactus Ferruginous Pygmy-owl	*Glaucidium brasilianum cactorum*	Bird	Threatened		NE
Common Black Hawk	*Buteogallus anthracinus*	Bird	Threatened		NE
Eskimo Curlew	*Numenius borealis*	Bird	Endangered	Endangered	NE

Golden-cheeked Warbler	*Dendroica chrysoparia*	Bird	Endangered	Endangered	NE
Gray Hawk	*Buteo plagiatus*	Bird	Threatened		NE
Interior Least Tern	*Sterna antillarum athalassos*	Bird	Endangered	Endangered	NE
Mexican Spotted Owl	*Strix occidentalis lucida*	Bird	Threatened	Threatened	NE
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	Bird	Endangered	Endangered	NE
Northern Beardless-tyrannulet	*Camptostoma imberbe*	Bird	Threatened		NE
Peregrine Falcon	*Falco peregrinus anatum*	Bird	Threatened		NE
Piping Plover	*Charadrius melodus*	Bird	Threatened	Threatened	NE
Red-cockaded Woodpecker	*Picoides borealis*	Bird	Endangered	Endangered	NE
Red-crowned Parrot	*Amazona viridigenalis*	Bird		Candidate	NE
Reddish Egret	*Egretta rufescens*	Bird	Threatened		NE
Rose-throated Becard	*Pachyramphus aglaiae*	Bird	Threatened		NE
Rufa Red Knot	*Calidris canutus rufa*	Bird		Threatened	NE
Sooty Tern	*Sterna fuscata*	Bird	Threatened		NE
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	Bird	Endangered	Endangered	NE
Swallow-tailed Kite	*Elanoides forficatus*	Bird	Threatened		NE
Texas Botteri's Sparrow	*Aimophila botterii texana*	Bird	Threatened		NE
Tropical Parula	*Parula pitiayumi*	Bird	Threatened		NE
Western Yellow-billed Cuckoo	*Coccyzus americanus occidentails*	Bird		Threatened	NE
White-faced Ibis	*Plegadis chihi*	Bird	Threatened		NE
White-tailed Hawk	*Buteo albicaudatus*	Bird	Threatened		NE
Whooping Crane	*Grus americana*	Bird	Endangered	Endangered	NE
Wood Stork	*Mycteria americana*	Bird	Threatened		NE
Zone-tailed Hawk	*Buteo albonotatus*	Bird	Threatened		NE
Arkansas River Shiner	*Notropis girardi*	Fish	Threatened	Threatened	NE
Big Bend Gambusia	*Gambusia gaigei*	Fish	Endangered	Endangered	NE
Blackside Darter	*Percina maculata*	Fish	Threatened		NE
Blotched Gambusia	*Gambusia senilis*	Fish	Threatened		NE
Blue Sucker	*Cycleptus elongatus*	Fish	Threatened		NE
Bluehead Shiner	*Pteronotropis hubbsi*	Fish	Threatened		NE
Bluntnose Shiner	*Notropis simus*	Fish	Threatened		NE

Chihuahua Shiner	*Notropis chihuahua*	Fish	Threatened		NE
Clear Creek Gambusia	*Gambusia heterochir*	Fish	Endangered	Endangered	NE
Comanche Springs Pupfish	*Cyprinodon elegans*	Fish	Endangered	Endangered	NE
Conchos Pupfish	*Cyprinodon eximius*	Fish	Threatened		NE
Creek Chubsucker	*Erimyzon oblongus*	Fish	Threatened		NE
Devils River Minnow	*Dionda diaboli*	Fish	Threatened	Threatened	NE
Fountain Darter	*Etheostoma fonticola*	Fish	Endangered	Endangered	NE
Leon Springs Pupfish	*Cyprinodon bovinus*	Fish	Endangered	Endangered	NE
Mexican Goby	*Ctenogobius claytonii*	Fish	Threatened		NE
Mexican Stoneroller	*Campostoma ornatum*	Fish	Threatened		NE
Opossum Pipefish	*Microphis brachyurus*	Fish	Threatened		NE
Paddlefish	*Polyodon spathula*	Fish	Threatened		NE
Pecos Gambusia	*Gambusia nobilis*	Fish	Endangered	Endangered	NE
Pecos Pupfish	*Cyprinodon pecosensis*	Fish	Threatened		NE
Proserpine Shiner	*Cyprinella proserpina*	Fish	Threatened		NE
Rio Grande Chub	*Gila pandora*	Fish	Threatened		NE
Rio Grande Darter	*Etheostoma grahami*	Fish	Threatened		NE
Rio Grande Silvery Minnow	*Hybognathus amarus*	Fish	Endangered	Endangered	NE
River Goby	*Awaous banana*	Fish	Threatened		NE
San Felipe Gambusia	*Gambusia clarkhubbsi*	Fish	Threatened		NE
San Marcos Gambusia	*Gambusia georgei*	Fish	Endangered	Endangered	NE
Sharpnose Shiner	*Notropis oxyrhynchus*	Fish		Endangered	NE
Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	Fish	Threatened		NE
Smalleye Shiner	*Notropis buccula*	Fish		Endangered	NE
Smalltooth Sawfish	*Pristis pectinata*	Fish	Endangered	Endangered	NE
Toothless Blindcat	*Trogloglanis pattersoni*	Fish	Threatened		NE
Widemouth Blindcat	*Satan eurystomus*	Fish	Threatened		NE
A Ground Beetle	*Rhadine exilis*	Invertebrate		Endangered	NE
A Ground Beetle	*Rhadine infernalis*	Invertebrate		Endangered	NE
American Burying Beetle	*Nicrophorus americanus*	Invertebrate		Endangered	NE
Bone Cave Harvestman	*Texella reyesi*	Invertebrate		Endangered	NE

Bracken Bat Cave Meshweaver	Cicurina venii	Invertebrate		Endangered	NE
Coffin Cave Mold Beetle	*Batrisodes texanus*	Invertebrate		Endangered	NE
Cokendolpher Cave Harvestman	*Texella cokendolpheri*	Invertebrate		Endangered	NE
Comal Springs Dryopid Beetle	*Stygoparnus comalensis*	Invertebrate	Endangered	Endangered	NE
Comal Springs Riffle Beetle	*Heterelmis comalensis*	Invertebrate	Endangered	Endangered	NE
Diamond Y Spring Snail	*Pseudotryonia adamantina*	Invertebrate	Endangered	Endangered	NE
Diminuitie Amphipod	*Gammarus hyalleloides*	Invertebrate	Endangered	Endangered	NE
False Spike	*Quadrula mitchelli*	Invertebrate	Threatened		NE
Golden Orb	*Quadrula aurea*	Invertebrate	Threatened	Candidate	NE
Gonzales Springsnail	*Tryonia circumstriata*	Invertebrate	Endangered	Endangered	NE
Government Canyon Bat Cave Meshweaver	*Cicurina vespera*	Invertebrate		Endangered	NE
Government Canyon Bat Cave Spider	*Tayshaneta microps*	Invertebrate		Endangered	NE
Helotes Mold Beetle	*Batrisodes venyivi*	Invertebrate		Endangered	NE
Kretschmarr Cave Mold Beetle	*Texamaurops reddelli*	Invertebrate		Endangered	NE
Louisiana Pigtoe	*Pleurobema riddellii*	Invertebrate	Threatened		NE
Madla Cave Meshweaver	*Cicurina madla*	Invertebrate		Endangered	NE
Mexican Fawnsfoot	*Truncilla cognata*	Invertebrate	Threatened		NE
Peck's Cave Amphipod	*Stygobromus pecki*	Invertebrate	Endangered	Endangered	NE
Pecos Amphipod	*Gammarus pecos*	Invertebrate	Endangered	Endangered	NE
Pecos Assiminea	*Assiminea pecos*	Invertebrate	Endangered	Endangered	NE
Phantom Cave Snail	*Pyrgulopsis texana*	Invertebrate	Endangered	Endangered	NE
Phantom Spring Snail	*Tryonia cheatumi*	Invertebrate	Endangered	Endangered	NE
Reddell Harvestman	*Texella reddelli*	Invertebrate		Endangered	NE
Robber Baron Cave Meshweaver	*Cicurina baronia*	Invertebrate		Endangered	NE
Salina Mucket	*Potamilus metnecktayi*	Invertebrate	Threatened		NE
Sandbank Pocketbook	*Lampsilis satura*	Invertebrate	Threatened		NE
Smooth Pimpleback	*Quadrula houstonensis*	Invertebrate	Threatened	Candidate	NE
Southern Hickorynut	*Obovaria jacksoniana*	Invertebrate	Threatened		NE
Texas Fatmucket	*Lampsilis bracteata*	Invertebrate	Threatened	Candidate	NE
Texas Fawnsfoot	*Truncilla macrodon*	Invertebrate	Threatened	Candidate	NE
Texas Heelsplitter	*Potamilus amphichaenus*	Invertebrate	Threatened		NE

Texas Hornshell	*Popenaias popeii*	Invertebrate	Threatened	Candidate	NE
Texas Pigtoe	*Fusconaia askewi*	Invertebrate	Threatened		NE
Texas Pimpleback	*Quadrula petrina*	Invertebrate	Threatened	Candidate	NE
Tooth Cave Ground Beetle	*Rhadine persephone*	Invertebrate		Endangered	NE
Tooth Cave Pseudoscorpion	*Tartarocreagris texana*	Invertebrate		Endangered	NE
Tooth Cave Spider	*Tayshaneta myopica*	Invertebrate		Endangered	NE
Triangle Pigtoe	*Fusconaia lananensis*	Invertebrate	Threatened		NE
Warton Cave Meshweaver	*Cicurina wartoni*	Invertebrate		Candidate	NE
Atlantic Spotted Dolphin	*Stenella frontalis*	Mammal	Threatened		NE
Black Bear	*Ursus americanus*	Mammal	Threatened		NE
Coues' Rice Rat	*Oryzomys couesi*	Mammal	Threatened		NE
Dwarf Sperm Whale	*Kogia simus*	Mammal	Threatened		NE
False Killer Whale	*Pseudorca crassidens*	Mammal	Threatened		NE
Finback Whale	*Balaenoptera physalus*	Mammal	Endangered	Endangered	NE
Gervais' Beaked Whale	*Mesoplodon europaeus*	Mammal	Threatened		NE
Goose-beaked Whale	*Ziphius cavirostris*	Mammal	Threatened		NE
Gray Wolf	*Canis lupus*	Mammal	Endangered	Endangered	NE
Humpback Whale	*Megaptera novaeangliae*	Mammal	Endangered	Endangered	NE
Jaguar	*Panthera onca*	Mammal	Endangered	Endangered	NE
Jaguarundi	*Herpailurus yaguarondi*	Mammal	Endangered	Endangered	NE
Killer Whale	*Orcinus orca*	Mammal	Threatened		NE
Louisiana Black Bear	*Ursus americanus luteolus*	Mammal	Threatened		NE
Mexican Long-nosed Bat	*Leptonycteris nivalis*	Mammal	Endangered	Endangered	NE
Ocelot	*Leopardus pardalis*	Mammal	Endangered	Endangered	NE
Palo Duro Mouse	*Peromyscus truei comanche*	Mammal	Threatened		NE
Pygmy Killer Whale	*Feresa attenuata*	Mammal	Threatened		NE
Pygmy Sperm Whale	*Kogia breviceps*	Mammal	Threatened		NE
Rafinesque's Big-eared Bat	*Corynorhinus rafinesquii*	Mammal	Threatened		NE
Red Wolf	*Canis rufus*	Mammal	Endangered	Endangered	NE
Rough-toothed Dolphin	*Steno bredanensis*	Mammal	Threatened		NE
Short-finned Pilot Whale	*Globicephala macrorhynchus*	Mammal	Threatened		NE

Southern Yellow Bat	*Lasiurus ega*	Mammal	Threatened		NE
Spotted Bat	*Euderma maculatum*	Mammal	Threatened		NE
Texas Kangaroo Rat	*Dipodomys elator*	Mammal	Threatened		NE
West Indian Manatee	*Trichechus manatus*	Mammal	Endangered	Endangered	NE
White-nosed Coati	*Nasua narica*	Mammal	Threatened		NE
Ashy Dogweed	*Thymophylla tephroleuca*	Plant	Endangered	Endangered	NE
Black Lace Cactus	*Echinocereus reichenbachii* var. *albertii*	Plant	Endangered	Endangered	NE
Bracted Twistflower	*Streptanthus bracteatus*	Plant		Candidate	NE
Bunched Cory Cactus	*Coryphantha ramillosa ssp. ramillosa*	Plant	Threatened	Threatened	NE
Chisos Mountains Hedgehog Cactus	*Echinocereus chisoensis* var. *chisoensis*	Plant	Threatened	Threatened	NE
Davis' Green Pitaya	*Echinocereus davisii*	Plant	Endangered	Endangered	NE
Earth Fruit	*Geocarpon minimum*	Plant	Threatened	Threatened	NE
Guadalupe Fescue	*Festuca ligulata*	Plant		Candidate	NE
Johnston's Frankenia	*Frankenia johnstonii*	Plant	Endangered		NE
Hinckley's Oak	*Quercus hinckleyi*	Plant	Threatened	Threatened	NE
Large-fruited Sand-verbena	*Abronia macrocarpa*	Plant	Endangered	Endangered	NE
Little Aguja Pondweed	*Potamogeton clystocarpus*	Plant	Endangered	Endangered	NE
Lloyd's Mariposa Cactus	*Sclerocactus mariposensis*	Plant	Threatened	Threatened	NE
Navasota Ladies'-tresses	*Spiranthes parksii*	Plant	Endangered	Endangered	NE
Neches River Rose-mallow	*Hibiscus dasycalyx*	Plant		Threatened	NE
Nellie's Cory Cactus	*Escobaria minima*	Plant	Endangered	Endangered	NE
Pecos Sunflower	*Helianthus paradoxus*	Plant	Threatened	Threatened	NE
Slender Rushpea	*Hoffmannseggia tenella*	Plant	Endangered	Endangered	NE
Sneed's Pincushion Cactus	*Escobaria sneedii* var. *sneedii*	Plant	Endangered	Endangered	NE
South Texas Ambrosia	*Ambrosia cheiranthifolia*	Plant	Endangered	Endangered	NE
Star Cactus	*Astrophytum asterias*	Plant	Endangered	Endangered	NE
Terlingua Creek Cat's-eye	*Cryptantha crassipes*	Plant	Endangered	Endangered	NE
Texas Ayenia	*Ayenia limitaris*	Plant	Endangered	Endangered	NE
Texas Golden Gladecress	*Leavenworthia texana*	Plant	Endangered	Endangered	NE
Texas Poppy-mallow	*Callirhoe scabriuscula*	Plant	Endangered	Endangered	NE

Texas Prairie Dawn	*Hymenoxys texana*	Plant	Endangered	Endangered	NE
Texas Snowbells	*Styrax platanifolius* spp. *texanus*	Plant	Endangered	Endangered	NE
Texas Trailing Phlox	*Phlox nivalis ssp. texensis*	Plant	Endangered	Endangered	NE
Texas Wild Rice	*Zizania texana*	Plant	Endangered	Endangered	NE
Tobusch Fishhook Cactus	*Sclerocactus brevihamatus* ssp. *tobuschii*	Plant	Endangered	Endangered	NE
Walker's Manioc	*Manihot walkerae*	Plant	Endangered	Endangered	NE
White Bladderpod	*Physaria pallida*	Plant	Endangered	Endangered	NE
Zapata Bladderpod	*Physaria thamnophila*	Plant	Endangered	Endangered	NE
Alligator Snapping Turtle	*Macrochelys temminckii*	Reptile	Threatened		NE
Black-striped Snake	*Coniophanes imperialis*	Reptile	Threatened		NE
Brazos Water Snake	*Nerodia harteri*	Reptile	Threatened		NE
Cagle's Map Turtle	*Graptemys caglei*	Reptile	Threatened		NE
Chihuahuan Desert Lyre Snake	*Trimorphodon vilkinsonii*	Reptile	Threatened		NE
Chihuahuan Mud Turtle	*Kinosternon hirtipes murrayi*	Reptile	Threatened		NE
Green Sea Turtle	*Chelonia mydas*	Reptile	Threatened	Threatened	NE
Hawksbill Sea Turtle	*Eretmochelys imbricata*	Reptile	Endangered	Endangered	NE
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Reptile	Endangered	Endangered	NE
Leatherback Sea Turtle	*Dermochelys coriacea*	Reptile	Endangered	Endangered	NE
Loggerhead Sea Turtle	*Caretta caretta*	Reptile	Threatened	Threatened	NE
Louisiana Pine Snake	*Pituophis ruthveni*	Reptile	Threatened	Candidate	NE
Mountain Short-horned Lizard	*Phrynosoma hernandesi*	Reptile	Threatened		NE
Northern Cat-eyed Snake	*Leptodeira septentrionalis*	Reptile	Threatened		NE
Northern Scarlet Snake	*Cemophora coccinea copei*	Reptile	Threatened		NE
Reticulate Collared Lizard	*Crotaphytus reticulatus*	Reptile	Threatened		NE
Reticulated Gecko	*Coleonyx reticulatus*	Reptile	Threatened		NE
Smooth Green Snake	*Liochlorophis vernalis*	Reptile	Threatened		NE
Speckled Racer	*Drymobius margaritiferus*	Reptile	Threatened		NE
Texas Horned Lizard	*Phrynosoma cornutum*	Reptile	Threatened		NE
Texas Indigo Snake	*Drymarchon melanurus erebennus*	Reptile	Threatened		NE
Texas Scarlet Snake	*Cemophora coccinea lineri*	Reptile	Threatened		NE

Texas Tortoise	*Gopherus berlandieri*	Reptile	Threatened	NE
Timber Rattlesnake	*Crotalus horridus*	Reptile	Threatened	NE
Trans-Pecos Black-headed Snake	*Tantilla cucullata*	Reptile	Threatened	NE

†NE=No effect; MANLAA=May affect, not likely to adversely affect

APPENDIX D

CRITERIA FOR BEAVER DAM BREACHING/REMOVAL

Beaver dam breaching is generally conducted to maintain existing stream channels and drainage patterns, and reduce flooding. Beaver dams are made from natural debris such as logs, sticks, and mud that beaver take from the area. This portion would be dislodged during a beaver dam breaching operation. The impoundments that the TWSP could remove would normally be from recent beaver activity and would not have been in place long enough to take on the qualities of a true wetland (*i.e*., hydric soils, aquatic vegetation, pre-existing function). Beaver dam breaching and removal by hand does not affect the substrate or the natural course of the stream and returns the area back to its preexisting condition with similar flows and circulations since the impounded water can be released slowly over time.

Wetlands are recognized by three characteristics: hydric soils, hydrophytic vegetation, and general hydrology. Hydric soils either are composed of, or have a thick surface layer of, decomposed plant materials (muck); sandy soils have dark stains or streaks from organic material in the upper layer where plant material has attached to soil particles. In addition, hydric soils may be bluish gray or gray below the surface or brownish black to black and have the smell of rotten eggs. Wetlands also have hydrophytic vegetation present such as cattails, bulrushes, willows, sedges, and water plantains. The final indicator is general hydrology which includes standing and flowing water or waterlogged soils during the growing season; high water marks are present on trees and drift lines of small piles of debris are usually present. Beaver dams usually will develop a layer of organic material at the surface because siltation can occur rapidly, but aquatic vegetation and high water marks (a new high water mark is created by the beaver dam) are usually not present. However, cattails and willows can show up rapidly if they are in the vicinity, but most hydrophytic vegetation takes time to establish.

When a dam is removed or breached, debris could be discharged into the water. The debris that ends up in the water would be considered "*incidental fallback*" or discharge fill. However, in most beaver dam removal or breaching operations, the material that would be displaced, if considered to be discharge, would be exempt from permit requirements under exemptions in 33 CFR 323 or under the NWP discussed in 33 CFR 330. If beaver dams could not be breached or removed under exemptions in 33 CFR 323 or pursuant to a NWP, then the property owner or manager would be responsible for seeking the necessary permit under Section 401 and Section 404 of the CWA. WS' personnel would survey the beaver dam site and impoundment and determine whether conditions exist suggesting that the area may be a wetland as defined above. In addition, WS' personnel would work to estimate the age of the beaver dam (*e.g.*, asking the landowner, using aerial photos). The characteristics of the impoundment and the age of the dam would be used to determine whether Swampbuster, Section 404 permit exemptions, or NWPs allow removal of the dam. If not, the landowner would be required to obtain a Section 404 permit before the dam could be removed. In those cases, the EPA and/or the United States Army Corps of Engineers would be responsible for determining if the beaver dam and associated areas were actual wetlands and if so, whether to issue a permit to remove the dam.

Federal Regulations - United States Army Corps of Engineers

Under Section 404 of the CWA, the Corps of Engineers regulates all waters of the United States. Because beaver dams involve waters of the United States, dam breaching is regulated under Section 404 of the CWA. In most beaver dam breaching operations, the material that is displaced would be exempt from permitting or included in a NWP in accordance with Section 404 of the CWA (see 33 CFR Part 323, 33 CFR 330). A permit would be required if the impoundment caused by a beaver dam was not covered under a NWP or permitting exemption and was considered jurisdictional based on the Corps of Engineers 1987 Delineation Manual.

The following explains Section 404 exemptions and conditions that pertain to the breaching of beaver dams and are interpretation of the NWPs by the TWSP.

33 CFR 323 - Permits For Discharges of Dredged or Fill Material into Waters of the United States. This regulation provides guidance to determine whether certain activities require permits under Section 404.

Part 323.4 Discharges not requiring permits. This section establishes exemptions for discharging certain types of fill into waters of the United States without a permit. Certain minor drainage activities connected with normal farming, ranching, and silviculture activities where they have been established do not require a permit as long as these drainages do not include the immediate or gradual conversion of a wetland to a non-wetland. Specifically, part (a)(1)(iii)(C)(i) states, "*...fill material incidental to connecting upland drainage facilities (e.g., drainage ditches) to waters of the United States, adequate to effect the removal of excess soil moisture from upland croplands*...". This indicates that beaver dams that block ditches, canals, or other structures designed to drain water from upland crop fields can be breached without a permit.

Moreover, (a)(1)(iii)(C)(iv) states the following types of activities do not require a permit "*The discharges of dredged or fill materials incidental to the emergency removal of sandbars, gravel bars, or other similar blockages which are formed during flood flows or other events, where such blockages close or constrict previously existing drainage ways and, if not promptly removed, would result in damage to or loss of existing crops or would impair or prevent the plowing, seeding, harvesting or cultivating of crops on land in established use for crop production. Such removal does not include enlarging or extending the dimensions of, or changing the bottom elevations of, the affected drainage way as it existed prior to the formation of the blockage. Removal must be accomplished within one year of discovery of such blockages in order to be eligible for exemption*."; this allows the breaching of beaver dams in natural streams to restore drainage of agricultural lands within one year of discovery.

Part 323.4 (a) (2) allows "*Maintenance, including emergency reconstruction of recently damaged parts, of currently serviceable structures such as dikes, dams, levees, groins, riprap, breakwaters, causeways, bridge abutments or approaches, and transportation structures. Maintenance does not include any modification that changes the character, scope, or size of the original fill design. Emergency reconstruction must occur within a reasonable period of time after damage occurs in order to qualify for this exemption*"; this allows beaver dams to be breached without a permit where they have resulted in damage to roads, culverts, bridges, or levees if it is done in a reasonable amount of time.

33 CFR 330 - Nationwide Permit Program. The United States Army Corps of Engineers, Chief of Engineers is authorized to grant certain dredge and fill activities on a nationwide basis if they have minimal impact on the environment. The NWPs are listed in Appendix A of 33 CFR 330 and permittees must satisfy all terms and conditions established to qualify for their use. Individual beaver dam breaching by the TWSP may be covered by any of the following NWPs if not already exempted from permit requirements by the regulations discussed above. WS complies with all conditions and restrictions placed on NWPs for any instance of beaver dam breaching done under a specific NWP.

NWPs can be used except in any component of the National Wild and Scenic River System such as waterways listed as an "*Outstanding Water Resource*", or any waterbody, which is part of an area designated for "*Recreational or Ecological Significance*".

The United States Army Corps of Engineers reissue the NWPs every 5 years with some modifications to the NWPs and their general conditions. The effective date of the current NWPs is March 19, 2012. These NWPs will expire on March 18, 2017.

NWP 18 - Minor Discharges: This NWP authorizes minor discharges of dredged and fill material into all waters of the United States provided the activity meets specific criteria. One of the criteria is that the quantity of discharge and the volume of excavated area does not exceed 10 cubic yards below the plane of the ordinary high water mark (this is normally well below the level of the beaver dam) or is in a "*special aquatic site*" (wetlands, mudflats, vegetated shallows, riffle and pool complexes, sanctuaries, and refuges). The District Engineer must be "*notified*"(general conditions for notification apply), if the discharge is between 10-25 cubic yards for a single project or the project is in a special aquatic site and less than 1/10 of an acre is expected to be lost. If the values are greater than those given, a permit is required. Beaver dams rarely would exceed 5 cubic yards of backfill into the waters of the United States. Beaver dams periodically may be breached in a special aquatic area, but normally the aquatic site will be returned to normal. However, if beaver dam breaching is going to exceed the noted impact to waters of the United States for the NWP, including wetlands, then an Individual Permit must be obtained from the District Engineer.

NWP 27 - Aquatic Habitat Restoration, Establishment, and Enhancement Activity: This NWP allows for the discharge of dredge and fill in waters of the United States for activities associated with the restoration of wetland and riparian areas with certain restrictions. On non-federal public and private lands, the owner must have: a binding agreement with the USFWS or the USDA-Natural Resources Conservation Service to conduct restoration; a voluntary wetland restoration project documented by Natural Resources Conservation Service; or notify the District Engineer according to "*notification*" procedures. On federal lands, including United States Army Corps of Engineers and USFWS, wetland restoration can take place without any contract or notification. This NWP "*...applies to restoration projects that serve the purpose of restoring "natural" wetland hydrology, vegetation, and function to altered and degraded non-tidal wetlands and "natural" functions of riparian areas. This NWP does not authorize the conversion of natural wetlands to another aquatic use...*". If operating under this permit, the breaching of a beaver dam would be allowed as long as it was not a true wetland, and for non-federal public and private lands the appropriate agreement, project documentation, or notification is in place.

A quick response immediately resulting from permitting requirements can be critical to the success of minimizing or preventing damage. Exemptions contained in the above regulations or NWPs provide for the breaching of the majority of beaver dams that the TWSP encounters. The primary determination that must be made by personnel of the TWSP is whether a beaver impounded area has become a true wetland or is just a flooded area. The flexibility allowed by these exemptions and NWPs is important for the efficient and effective resolution of many beaver damage problems because damage escalates rapidly in many cases the longer an area remains flooded.