DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[FWS–R2–ES–2011–0079; MO 92210–0–0008 B2]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List Texas Fatmucket, Golden Orb, Smooth Pimpleback, Texas Pimpleback, and Texas Fawnsfoot as Threatened or Endangered

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on a petition to list five mussel species in Texas as threatened or endangered and to designate critical habitat under the Endangered Species Act of 1973, as amended (Act). The five species are Texas fatmucket (*Lampsilis bracteata*), golden orb (*Quadrula aurea*), smooth pimpleback (*Q. houstonensis*), Texas pimpleback (*Q. petrina*), and Texas fawnsfoot (*Truncilla macrodon*). After review of all available scientific and commercial information, we find that listing these five mussel species is warranted. Currently, however, listing of these species is precluded by higher priority actions to amend the Federal Lists of Endangered and Threatened Wildlife and Plants. Upon publication of this 12-month petition finding, we will add these five species to our candidate species list. We will develop a proposed rule to list these species as our priorities allow. We will make any determination on critical habitat during development of the proposed listing rule. In any interim period, we will address the status of the candidate taxa through our annual Candidate Notice of Review.

DATES: The finding announced in this document was made on October 6, 2011.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number FWS–R2–ES–2011–0079. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, 1505 Ferguson Lane, Austin, TX 78754. Please submit any new information, materials, comments, or questions concerning this finding to the above address.

FOR FURTHER INFORMATION CONTACT: Gary Mowad, Texas State Administrator, U.S. Fish and Wildlife Service (see **ADDRESSES**); by telephone at 512–927–3557; or by facsimile at 512–927–3592. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*) requires that, for any petition to revise the Federal Lists of Endangered and Threatened Wildlife and Plants that contains substantial scientific or commercial information that listing the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In this finding, we will determine that the petitioned action is: (1) Not warranted, (2) warranted, or (3) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are threatened or endangered, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register.**

Previous Federal Actions

This 12-month petition finding covers five species of mussels that are grouped together because of their overlapping or proximate ranges within the river basins of central Texas. The petitions for listing these five species were parts of two multi-species petitions, dated June 18, 2007, and October 9, 2008. The other species from those petitions, including other Texas mussels, will be considered in separate petition findings.

On June 25, 2007, we received a formal petition dated June 18, 2007, from Forest Guardians (now WildEarth Guardians), requesting that we: (1) Consider all full species in our Southwest Region ranked as G1 or G1G2 by the organization NatureServe, except those that are currently listed, proposed for listing, or candidates for listing; and (2) List each species as either threatened or endangered with critical habitat. The petitioned group of species included four Texas mussels, two of which are included in this finding: the Texas fatmucket and golden orb. Two additional mussels from eastern Texas, the Texas heelsplitter (*Potamilus amphichaenus*) and Salina mucket (*P. metnecktayi*), were also included in this petition. The petition incorporated all analyses, references, and documentation provided by NatureServe in its online database at *http://www.natureserve.org/* into the petition. Included in NatureServe was supporting information regarding the species' taxonomy and ecology, historical and current distribution, present status, and actual and potential causes of decline. We sent a letter dated July 11, 2007, to Forest Guardians acknowledging receipt of the petition and stating that the petition was under review by staff in our Southwest Regional Office.

On October 15, 2008, we received a petition dated October 9, 2008, from WildEarth Guardians, requesting that the Service list as threatened or endangered and designate critical habitat for six species of freshwater mussels, including the smooth pimpleback, Texas pimpleback, and Texas fawnsfoot. Two additional mussels from the Rio Grande basin, the false spike (*Quincuncina mitchelli*) and Mexican fawnsfoot (*Truncilla congata*), were also included in this petition. In addition to other information, the petition incorporated all analyses, references, and documentation provided by NatureServe in its online database at *http://www.natureserve.org/.* In a November 26, 2008, letter to the petitioner, we acknowledged receipt of the second petition and stated that the petition for the six mussel species was under review by staff in our Southwest (Region 2) and Southeast (Region 4) Regional Offices. The southern hickorynut (*Obovaria jacksoniana*) was also included in this 2008 petition, and on March 23, 2010 (75 FR 13717), we found that the petition did not present substantial information supporting that that species may be endanagered or threatened.

On December 15, 2009, we published our 90-day finding that the petitions presented substantial scientific information indicating that listing nine Texas mussels may be warranted (74 FR 66260). As a result of the finding, we initiated a status review for all nine species. This notice constitutes the 12-month finding on the June 18, 2007, petition to list the Texas fatmucket and golden orb and the October 9, 2008, petition to list the smooth pimpleback, Texas pimpleback, and Texas fawnsfoot as threatened or endangered. Our petition findings for the remaining Texas mussel species will be published at a later time.

Summary of Procedures for Determining the Listing Status of Species

Review of Status Based on Five Factors

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

In making these findings, we discuss below information pertaining to each species in relation to the five factors provided in section 4(a)(1) of the Act. In considering what factors might constitute threats to a species, we must look beyond the exposure of the species to a particular factor to evaluate whether the species may respond to the factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat, and during the status review, we attempt to determine how significant a threat it is. The threat is significant if it drives or contributes to the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined by the Act. However, the identification of factors that could impact a species negatively may not be sufficient to compel a finding that the species warrants listing. The information must include evidence sufficient to suggest that the potential threat has the capacity (*i.e.,* it should be of sufficient magnitude and extent) to affect the species' status such that it meets the definition of endangered or threatened under the Act.

Evaluation of the Status of Each of the Five Mussel Species

In this finding, we first provide a description of general mussel biology. Then, for each of the five species, we describe the species, its life history, and habitat; evaluate listing factors for that species; and present our finding that the petitioned action is warranted or not for that species. We follow these descriptions, evaluations, and findings with a discussion of the priority and progress of our listing actions.

General Mussel Biology

All five species are freshwater mussels in the family Unionidae and occur only in Texas, in portions of the Colorado, Guadalupe, Nueces-Frio, and Brazos River systems (Howells *et al.* 1996, p. 1). Adult freshwater mussels are suspension feeders, drawing in food and oxygen through their incurrent siphon (tube that draws water into the shell). They may also feed on organic particles in sediment using the large, muscular foot (an organ used to anchor the mussel in the substrate or for locomotion) (Raikow and Hamilton 2001, p. 520). Adults feed on algae, bacteria, detritus (dead organic material), microscopic animals, and dissolved organic matter (Fuller 1974, pp. 221–222; Silverman *et al.* 1997, p. 1862; Nichols and Garling 2000, pp. 874–876; Christian *et al.* 2004, p. 109). For their first several months, as they inhabit interstitial spaces (small spaces between sediment particles) within the substrate, juvenile mussels feed using cilia (fine hairs) on the foot to capture suspended as well as depositional material, such as algae and detritus (Yeager *et al.* 1994, pp. 253–259). Mussels tend to grow relatively rapidly for the first few years, and then slow appreciably at sexual maturity, when energy presumably is being diverted from growth to reproductive activities (Baird 2000, pp. 66–67).

As a group, mussels are extremely long lived, living from two to several decades (Rogers *et al.* 2001, p. 592), and possibly up to 200 years in extreme instances (Bauer 1992, p. 427). Most mussel species, including the five in this finding, have distinct forms of males and females. During reproduction, males release clouds of sperm into the water column, which females draw in through their siphons. Fertilization takes place internally, and the resulting eggs develop into specialized larvae (called glochidia) within the female gills. The females release matured glochidia individually, in small groups, or embedded in larger mucus structures called conglutinates.

The glochidia of freshwater mussels are obligate parasites (cannot live independently of their hosts) on the gills or fins of fishes (Vaughn and Taylor 1999, p. 913). Glochidia die if they fail to find a host fish, attach to a fish that has developed immunity from prior infestations, or attach to the wrong location on a host fish (Neves 1991, p. 254; Bogan 1993, p. 299). Glochidia encyst (enclose in a cyst-like structure) on the host's tissue and develop into juvenile mussels weeks or months after attachment (Arey 1932, pp. 214–215). Mussels experience their primary opportunity for dispersal and movement within the stream as glochidia attached to a host fish (Smith 1985, p. 105). Upon release from the host, newly transformed juveniles drop to the substrate on the bottom of the stream. Those juveniles that drop in unsuitable substrates die because their immobility prevents them from relocating to more favorable habitat. Juvenile freshwater mussels burrow into interstitial substrates and grow to a larger size that is less susceptible to predation and displacement from high flow events (Yeager *et al.* 1994, p. 220). Throughout the rest of their life cycle, mussels generally remain within the same small area where they released from the host fish.

Species Information for Texas Fatmucket

Species Description

The Texas fatmucket is a large, elongated mussel that reaches a maximum length of 100 millimeters (mm) (3.94 inches (in)) (Howells 2010c, p. 2). The shell is oval to elliptical or somewhat rhomboidal and tan to greenish-yellow with numerous irregular, wavy, and broad and narrow dark brown rays, with broad rays widening noticeably as they approach the ventral (underside) margin. The nacre (inside of the shell) is white with occasional yellow or salmon coloration and iridescent posteriorly (Howells 2010c, p. 2). Females have mantle flaps (extensions of the tissue that covers the visceral mass) that often resemble minnows, including eye spots, lateral line, and fins (Howells 2010c, p. 2).

Taxonomy

The Texas fatmucket was first described in 1855 by Gould as *Unio bracteatus* and later moved to the genus *Lampsilis* by Simpson (1900, p. 543). Some forms found in headwater streams were historically split into a different species, *L. elongatus,* but they have since been determined to be ecophenotypes (individuals whose shape is determined by their environment) of *L. bracteata* (Howells 2010c, p. 5). The Texas fatmucket is recognized by the Committee on Scientific and Vernacular Names of Mollusks of the Council of Systematic Malacologists, American Malacological Union (Turgeon *et al.* 1998, p. 34), and we recognize it as a valid species.

Biology and Life History

Although there is no specific information on age and size of maturity of the Texas fatmucket, it is likely similar to a related species, the Louisiana fatmucket (*L. hydiana*), which reaches sexual maturity around 36 mm (1.4 in) (Howells 2000b, pp. 35–48; Howells 2010c, p. 3). Texas fatmucket females have been found gravid (with glochidia in the gill pouch) from July through October, although brooding may continue throughout much of the year (Howells 2010c, p. 3). Texas fatmucket females display a mantle lure to attract host fish, releasing glochidia when the lure is bitten or struck by the fish. Bluegill (*Lepomis macrochirus*) and green sunfish (*L. cyanellus*) have been successful hosts in laboratory studies (Howells 1997b, p. 257). Hosts such as these sunfishes are common, widely distributed species in Texas that occur in an array of habitat types (Hubbs *et al.* 2008, p. 45) and would not generally be expected to be a limiting factor in Texas fatmucket reproduction and distribution (Howells 2010c, p. 3).

Habitat

The Texas fatmucket occurs in moderately sized rivers in mud, sand, or gravel, or mixtures of these substrates (Howells 2010c, p. 4) and sometimes in narrow crevices between bedrock slabs (Howells 1995, p. 21). Live individuals have been found in relatively shallow water, rarely more than 1.5 meters (m) (4.9 feet (ft)) deep, and usually less. Remaining populations typically occur at sites where one or both banks are relatively low, allowing floodwaters to spread out over land and thereby reducing damage from scouring (Howells 2010c, p. 4). The species does not occur in ponds, lakes, or reservoirs, suggesting that it is intolerant of deep, low-velocity water created by artificial impoundments.

Distribution and Abundance

Historical Distribution

The Texas fatmucket historically had populations in at least 18 rivers in the upper Colorado, Guadalupe, and San Antonio River systems in the Texas Hill Country and east-central Edwards Plateau region of central Texas. In the Colorado River, it ranged from Travis County upstream approximately 320 kilometers (km) (200 miles (mi)) to Runnels County in the Colorado River. It was also found in many tributaries, including the Pedernales, Llano, San Saba, and Concho Rivers, and Jim Ned, Elm, and Onion Creeks (Howells *et al.* 1996, p. 61).

In the Guadalupe-San Antonio River basin, the Texas fatmucket occupied approximately 240 km (150 mi) of the Guadalupe River, from Gonzales County upstream to Kerr County, including the North Guadalupe River, Johnson Creek, and the Blanco River. In the San Antonio River, it ranged from its confluence with the Medina River in Bexar County upstream to the City of San Antonio, as well as in the Medina River and Cibolo Creek (Howells *et al.* 1996, p. 61; Howells 2010c, p. 6). Strecker (1931, pp. 66–68) reported Texas fatmucket from a lake in Victoria County in the lower Guadalupe River drainage (Howells 2010c, p. 6), but this is probably a misidentified Louisiana fatmucket, which occurs in lakes or impoundments. A Salado Creek record from Bell County (Strecker 1931, pp. 62–63) is also probably a misidentified Louisiana fatmucket, since the Texas fatmucket is not known to occur in the Brazos River basin or its western tributaries (Howells *et al.* 1996, p. 61; Howells 2010c, p. 6).

Current Distribution

Based on historical and current data, the Texas fatmucket has declined significantly rangewide and is now known from only nine streams in the Colorado and Guadalupe River systems in very limited numbers. All existing populations are represented by only one or two individuals and are likely not stable or recruiting (juvenile mussels joining the adult population). In the streams where the species is extant (surviving), populations are highly fragmented and restricted to short reaches with few exceptions. The Texas fatmucket has been considered a species of special concern by some malacologists for several decades (Athearn 1970, p. 28).

Colorado River System

The Texas fatmucket was historically known to occur throughout the Colorado River and numerous tributaries (Randklev *et al.* 2010c, p. 4). However, in the mainstem Colorado River, the Texas fatmucket has not been found, live or dead, in several decades despite numerous surveys (Howells 1994, p. 4; 1995, pp. 20–21, 25, 29; 1996, pp. 20, 23; 1997a, pp. 27, 31, 34–35; 1998, p. 10; 1999, p. 18; 2000a, pp. 25–27; 2002a, pp. 6–7; 2004, pp. 7, 10–11; 2005, p. 6; Johnson 2009, p. 1; Burlakova and Karatayev 2010a, p. 12), and thus is considered extirpated (eliminated from) from the Colorado River mainstem. Within this system, the species is only known from sparse populations in Colorado River tributaries, including the South Concho River, Spring Creek, Llano River (including Threadgill Creek), Pedernales River (including Live Oak Creek), Onion Creek, Jim Ned Creek, Elm Creek, and the San Saba River.

Evidence of persisting Texas fatmucket populations has been found in Spring Creek, a tributary to the Middle Concho River, which flows into the Concho River, a large tributary of the Colorado River. Historically, Spring Creek harbored Texas fatmucket in Irion and Tom Green Counties (Randklev *et al.* 2010c, p. 1). In 1993, discovery of shell material prompted additional surveys, and in 1997, one live individual was found in Irion County (Howells 1998, p. 13). Farther downstream, in Tom Green County, two live individuals were recorded in 1997, upstream of Twin Buttes Reservoir (Howells 1998, pp. 13–14), but no evidence of this population was found in 2008 (Burlakova and Karatayev 2010a, p. 12). Spring Creek was reported to have dried in 1999 and 2000, which may have eliminated the population there (Howells *et al.* 2003, p. 5).

In the Llano River, there are three areas that are currently known to contain Texas fatmucket populations. The species occurred throughout the length of the river historically (Ohio State University Museum (OSUM) 2011a, p. 1). A single shell was collected in Llano County in 1992 (Howells 1994, p. 6), and eight live individuals were found in 2011 (Burlakova and Karatayev 2011, p. 1). Individuals were small in size, indicating a potentially reproducing population. The species also persists in Mason County, where two shell fragments of recently dead Texas fatmucket were found in 1995 (Howells 1996, p. 22), and two live individuals were collected at the same site in 2009 (Burlakova and Karatayev 2010a, pp. 12–13). The species also appears to persist in Kimble County, where one live Texas fatmucket was recorded in 2009 (Burlakova and Karatayev 2010a, pp. 12–13).

In 2004, four live Texas fatmucket were recorded from Threadgill Creek, a tributary to the Llano River in Gillespie and Mason Counties (Howells 2005, pp. 6–7). This population is on private land, which limits survey access, but Howells (2009, p. 5) indicates it likely persists due to favorable land management.

Live Oak Creek, a tributary to the Pedernales River in Gillespie County, also contains a sparse Texas fatmucket population. In 2002, 11 shells were discovered, and in 2003, one live individual was recorded, confirming the species persisted in low numbers (Howells 2003, p. 10; Howells 2004, pp. 8–9). Since that time, surveys have been conducted in Live Oak Creek on a fairly regular basis. The stream was visited in two different occasions in 2004, with only shell material found (Howells 2005, pp. 7–8), and again in 2005, when two live individuals were recorded (Burlakova and Karatayev 2010a, p. 12). The stream was surveyed in 2007 and 2008, but no evidence of the species was found (Howells 2009, p. 5). This population is presumed to be small but persisting.

Original records of speckled pocketbook (*Lampsilis streckeri*) from Onion Creek in Travis County in 1931 are now believed to have been misidentified; instead they represent records of Texas fatmucket (Howells 2010c, p. 6; Randklev *et al.* 2010c, p. 4). The stream was surveyed in 1993, and no live freshwater mussels were found (Howells 1995, p. 28). However, in 2010, several live Texas fatmucket were found during a survey near Highway 71 (Groce 2011, pers. comm.), indicating the species persists there.

Elm Creek, a tributary to the Colorado River, has been known to harbor a Texas fatmucket population since 1993, when 10 live individuals were recorded (Howells 1995, p. 21). Since that time, the population has declined, with two individuals found in 1995 (Howells 1996, pp. 19–20), and no live individuals found in 2001 or 2005 (Howells 2002a, p. 5; 2006, p. 63). In 2008, additional sites downstream of the known population were surveyed and one live individual was recorded after 15 person-hours of searching (Burlakova and Karatayev 2010a, p. 12), indicating that the species continues to persist in Elm Creek, although in very low numbers.

Texas fatmucket also persist in the San Saba River, where the species has been known to occur historically (Randklev *et al.* 2010c, p. 2; OSUM 2011a, p. 1). The river was surveyed in 1997, and three live individuals were found (Howells 1998, p. 16). In 2000 and 2004, no Texas fatmucket were found in this stretch of river (Howells 2001, p. 29; Howells 2005, pp. 8–9). One live individual was found in 2005 (Howells 2006, p. 64), and, in 2008, only one shell of a recently dead individual was found (Burlakova and Karatayev 2010a, p. 12). In 2005, the number of mussels of all species collected was about 40 percent of the 1997 numbers (Howells 2006, p. 64), indicating an overall decline in the freshwater mussel fauna. Aquatic macrophyte (aquatic plants larger than algae) abundance has increased in this river, confounding survey efforts and degrading mussel habitat (Howells 2006, p, 64).

Texas fatmucket have not been found alive in the Pedernales River since 1978 (Howells 1999, p. 16). In 1992, a thorough search of the habitat yielded no live Texas fatmuckets, with only very old dead shell material collected in the banks above the normal high water line (Howells 1994, p. 4). Because the species was documented from Blanco County by museum records (OSUM 2011a, p. 1), additional sections of the river were also surveyed in 1992, with no evidence of Texas fatmucket found, although in 1993, very old Texas fatmucket shell fragments were discovered in Pedernales Falls State Park (Howells 1995, p. 28). Mussel habitat in this area is poor, and it is unlikely the species persists there. Subsequent searches of the river in 1998 yielded only dead shell material (Howells 1999, p. 16).

The Texas fatmucket is considered extirpated from the South Concho River and Jim Ned Creek. In the South Concho River, old Texas fatmucket shell fragments were found in gravel bars in Tom Green County in 1997, but there has been no additional evidence of the species (Howells 1998, p. 12). Additionally, three live individuals were recorded from Jim Ned Creek in Brown County in 1979 (Randklev *et al.* 2010c, p. 3), but the species has not been found in this stream since then (Howells 1997a, pp. 29–30).

Guadalupe River System

While the Texas fatmucket was never widely distributed in the Guadalupe River system, the only remaining populations are in the mainstem Guadalupe River and possibly the North Fork Guadalupe River. It is presumed extirpated from the entire San Antonio River system, as well as the Blanco River and Johnson Creek.

In the mainstem Guadalupe River, Texas fatmucket historically occurred in Kerr County (OSUM 2011a, p. 1). In 1992 and 1995, surveys yielded no evidence of the species (Howells 1994, pp. 7–8; Howells 1996, p. 25), although shell fragments collected in 1993 in Guadalupe County may have been Texas fatmucket but were too weathered for an accurate determination (Howells 1995, p. 31). In 1996, two live individuals were recorded in Kerr County directly below a dam (Howells 1997a, p. 36), and in 1997, three shells were found at the same site following a flood (Howells 1998, p. 18). No Texas fatmucket or other freshwater mussels have been found at that site since, and it is unlikely that Texas fatmucket persist there (Howells 2006, p. 71). However, 20 recently dead individuals were discovered approximately 1 km (0.6 mi) downstream in Louise Hayes Park during a drawdown (Howells 1999, pp. 18–19), and 6 live individuals were found at the same location in 2005 (Howells 2006, pp. 71–72). Surveys in 2007 and 2008 yielded no live or recently dead individuals (Burlakova and Karatayev 2010a, p. 12). It is likely that the species persists in the vicinity. There has been no other evidence of Texas fatmucket in the mainstem Guadalupe River in recent years.

In 1999, two recently dead Texas fatmucket were found in North Fork Guadalupe River (Howells 2000a, p. 27). This river was surveyed again in 2000 and 2003 at several sites, and no Texas fatmucket were found (Howells 2001, p. 31; Howells 2004, pp. 13–14).

Johnson Creek was a historical location for Texas fatmucket, but no live freshwater mussels of any species have been found in this stream for decades (Howells 1996, p. 25; Howells 1998, p. 18; Howells 2002a, p. 8). Additionally, the Blanco River has been surveyed extensively since 1992, and no evidence of Texas fatmucket has been collected, nor is suitable habitat present (Howells 1994, p. 9; Howells 1995, pp. 32–33; Howells 1996, p. 28; Johnson 2011, p. 1). The last collection of Texas fatmucket from the Blanco River occurred in the 1970s or 1980s (Howells 2005, p. 10).

Texas fatmucket have also been extirpated from the entire San Antonio River system. The mainstem San Antonio River was surveyed in 1993 and 1996, and no live or dead Texas fatmucket were found (Howells 1995, p. 35; 1997a, pp. 41–42). It was known from the Medina River, a tributary to the San Antonio River, historically (Randklev *et al.* 2010c, p. 3), but no mussels of any species have been found in this river in recent years (May 2011, pers. comm.). Additionally, although Texas fatmucket were collected from Cibolo Creek historically (OSUM 2011a, p. 1) and shell material, likely from Texas fatmucket, was found in 1993 (Howells 1995, p. 36), no live freshwater mussels have been found in Cibolo Creek since (Howells 1997a, pp. 40–41).

Summary

Based on historical and current data, the Texas fatmucket has declined significantly rangewide and has been extirpated from most of the Guadalupe River system and hundreds of miles of the Colorado River, as well as from numerous tributaries. Extant populations are represented by only a few individuals, and they are highly disjunct and restricted to short reaches. Two of the populations considered extant in recent years may now be extirpated, and the remaining seven populations are extremely small and likely not stable. No evidence of recent recruitment has been found in any of the populations, with the possible exception of the Llano River.

Species Information for Golden Orb

Species Description

The golden orb is small, usually less than 82 mm (3.2 in), with an oval to nearly round, smooth, and unsculptured shell, except for concentric growth rings (Howells 2002b, p. 6). External shell coloration varies from yellow-brown, gold, or orangish-brown to dark brown or black, and some individuals may show faint greenish rays. Internally, the nacre is white to bluish-white (Howells 2002b, p. 6).

Taxonomy

The golden orb was originally described as *Unio aureas* by Lea in 1859 and later moved to the genus *Quadrula* in 1900 (Simpson 1900, p. 783). Graf and Cummings (2007, p. 18) have proposed moving it to the genus *Amphinaias,* but other freshwater mussel taxonomists recommend waiting for additional work to be completed on members of *Quadrula* before splitting the genus (Bogan 2011, pers. comm.). Because the golden orb can exhibit an elongated shell structure in headwater riffles, old records of *Unio bolli* in the Colorado River (Dall 1882, p. 956) are very likely elongated forms of golden orb (Howells 2010a, p. 5). The golden orb is recognized by the Committee on Scientific and Vernacular Names of Mollusks of the Council of Systematic Malacologists, American Malacological Union (Turgeon *et al.* 1998, p 36), and we recognize it as a valid species.

Biology and Life History

There is no specific information on age, size of maturity, or host fish use for golden orb. Other species in the genus *Quadrula* successfully parasitize catfish, and it is likely golden orb do as well (Howells 2010a, p. 3). Gravid females have been found from May through August (Howells 2000b, p. 38). Mussels in the genus *Quadrula* are short-term brooders, which are species that hold fertilized eggs and glochidia for a short period, usually 3 to 6 weeks, before releasing glochidia (Gorden and Layzer 1989, p. 6; Garner *et al.* 1999, p. 277).

Habitat

The golden orb has been found almost exclusively in flowing waters in moderately sized rivers (Howells 2010a, p. 3). It has been found in only one reservoir in the lower Nueces River (Lake Corpus Christi), where wave action may simulate flowing water conditions (Howells 2010a, p. 3). This species is found in substrates of firm mud, sand, and gravel, and it does not appear to tolerate more unstable substrates such as loose sand or silt (Howells 2002b, p. 6).

Distribution and Abundance

Historical Distribution

The golden orb is endemic (native) to nearly the entire lengths of the Guadalupe, San Antonio, and Nueces-Frio River basins in central Texas (Howells 2010a, p. 5), including the Guadalupe, Medina, San Antonio, Frio, and Nueces Rivers and Cibolo Creek. It was originally reported from four sites in the Brazos River system (Strecker 1931, p. 63), but these are almost certainly misidentified smooth pimpleback (Howells 2002b, p. 5) based on numerous mussel surveys throughout the Brazos River system since the 1970s that failed to find any golden orb. The species has not been found in studies of archaeological specimens from the Brazos River (Howells 2010a, p. 5), further indicating golden orb did not historically occur in the Brazos River system.

The golden orb has also been reported from the upper Colorado River drainage (Howells *et al.* 1996, pp. 108–109; Randklev *et al.* 2010c, p. 4), but these appear to have been misidentified Texas pimpleback (Howells 2010a, p. 5). Since no other golden orb have been reported from the Colorado River system, we do not believe it occurred in that basin.

Current Distribution

Based on historical and current data, the golden orb has declined significantly rangewide and is now known from only four streams in disjunct locations. Despite mussel surveys across the historical range, since 1995 golden orb has only been found in Lake Corpus Christi and the Guadalupe, lower San Marcos, and lower San Antonio Rivers. The species has been extirpated from the entire Nueces-Frio River basin, except at the extreme downstream end of the Nueces River, where a population persists in Lake Corpus Christi. Aside from the upper Guadalupe River, all existing populations occur in the lower portion of occupied basins in a small geographical area; only about 130 km (80 mi) separate the farthest two populations. Only four populations appear to be relatively stable and recruiting, while the remaining five populations are represented by only a few individuals.

Guadalupe River System

In the Guadalupe River system, the golden orb historically ranged throughout the length of the Guadalupe, San Antonio, and San Marcos Rivers. Currently in this basin, the species only persists in the uppermost Guadalupe River and lower San Marcos, San Antonio, and Guadalupe Rivers. The lower portion of this basin (within approximately 120 km (75 mi) of the Gulf of Mexico) harbors all four of the large, presumably reproducing populations of golden orb.

Historically known from the mainstem Guadalupe River (Howells 2002a, p. 8), the golden orb was not seen in the upper Guadalupe River in Kerr County again, despite repeated surveys (Howells 1994, pp. 7–8; 1996, p. 30; 1997a, p. 36), until 1997, when three shells were discovered (Howells 1998, p. 18). No live freshwater mussels of any species have been found in this area, just downstream of a dam, since 1997 (Howells 1999, p. 18; Howells 2006, p. 71), and it is unlikely golden orb persists there. However, upstream of this area, above the dam and impounded reach, a single recently dead individual was found in 1998 during an extended drawdown of the river to construct a footbridge in a local park (Howells 1999, pp. 18–19). In 2005, two live individuals were also found at this site (Howells 2006, pp. 71–72), showing that the species had survived the drawdown and persists at the site.

Golden orb also occurs farther downstream in the mainstem Guadalupe River, near Lake Gonzales in Gonzales County. Upstream of the reservoir, subfossil shells (very old shells that are brittle, crumbling, and with extensive erosion) were found in 1993 (Howells 1995, p. 31), but the species has not been found there since. However, below the reservoir, one recently dead individual was collected in 1995 (Howells 1996, pp. 26–27), and in 1996, 25 live golden orb were recorded at two sites in this area (Howells 1997a, pp. 37–38). Later, in 2006, three live golden orb were also found in this area (Howells 2006, pp. 85–86). A small population apparently continues to persist below Lake Gonzales.

A large golden orb population occurs farther downstream in the mainstem Guadalupe River, below Lake Wood, also in Gonzales County. Although none were found during a survey in 1995 (Howells 1996, p. 27), 36 live golden orb were found at two sites below Lake Wood in 1996 (Howells 1997a, pp. 38–40). Density estimates were calculated based on the quantitative information collected from these surveys, but they were not considered statistically valid (Howells 1997a, p. 40) and so are not reported here. Only one live golden orb was found at this site in 2002 (Howells 2003, p. 11), but a relatively large population continues to persist; a total of around 100 live golden orb were found at three sites within 2 km (1.2 mi) of the Lake Wood Dam in 2006 (Howells 1996, pp. 87–91). Also, in 2008, 33 golden orb were recorded alive downstream of Lake Wood (Burlakova and Karatayev 2010a, p. 14). This portion of the Guadalupe River supports a relatively large population of golden orb, and it also contains one of the most abundant freshwater mussel communities in Texas (Burlakova and Karatayev 2010a, p. 14).

In 2009, a large population of golden orb was discovered farther downstream in the mainstem Guadalupe River in Victoria County, when over 100 individuals were found (Johnson 2009, p. 1). Multiple size classes were observed, including juveniles, indicating this population is reproducing and recruiting new individuals into the population. A large number of shells was collected upstream of this site in 1994 (Burlakova and Karatayev 2010c, p.1), but no golden orb were seen alive until 2009.

The San Marcos River, a tributary to the Guadalupe River, also supports a large golden orb population near its confluence with the tailwaters (outflow) of Lake Wood Dam. Although much of the San Marcos River has been extensively surveyed, with very few freshwater mussels present of any species (Howells 1995, pp. 33–34; 1997a, p. 40; 2004, pp. 15–16, 18; 2005, p. 10), one old golden orb shell was found near the town of Staples (Howells 1998, p. 19), and a single live individual was found near the town of Luling (Howells 1999, p. 28). Downstream from these locations, a large population persists in the vicinity of Palmetto State Park in Gonzales County. In 1995, a recently dead individual was discovered downstream of the park, indicating the recent presence of the species (Howells 1996, p. 28), and, based on surveys from 2000–2006, a relatively large population was confirmed to be in the area (Howells 2001, pp. 32–33; 2006, pp. 72–73; 2006, p. 91; Burlakova and Karatayev 2010a, pp. 14–15).

Historically, golden orb were numerous in the San Antonio River in Karnes County (OSUM 2011b, p. 1), but only a single subfossil shell was found at each of two sites in Karnes County in 1996 (Howells 1997a, pp. 41–42). No live animals have been found there since, although abundant shell material remains present (Karatayev and Burlakova 2008, p. 40).

The lower portion of the San Antonio River supports the largest known golden orb population. In 2007, 37 live golden orb were recorded near Goliad in Goliad County, both within and downstream of Goliad State Park (Howells 2009, p. 11). The following year, 285 live golden orb were found within the park and downstream surrounded by private lands (Burlakova and Karatayev 2010a, p. 15). This site represents the largest known population of golden orb.

In 2009, a single live golden orb was discovered in the lower San Antonio River south-southwest of Victoria in Victoria County (Johnson 2009, p. 1); this site has not been surveyed since. We presume golden orb may persist in this stretch of river.

The golden orb appears to have been extirpated from the Medina River. The species historically occurred in Medina and Bexar Counties (Randklev *et al.* 2010b, p. 4; OSUM 2011b, p. 1), but no live or dead mussels of any species have been found in this river in recent years (May 2011, pers. comm.).

Cibolo Creek, a tributary to the San Antonio River, was extensively surveyed in the 1990s, with only old golden orb shells collected in Wilson County (Howells 1995, pp. 35–37; 1997a, pp. 40–41). In 2006 and 2007, Burlakova and Karatayev (2010b, p. 1) surveyed this same general area and found only shell material. It is unlikely golden orb remain in Cibolo Creek.

Nueces-Frio River System

Information is limited on the occurrence of golden orb in the Nueces River. Other than a population that occurs in a reservoir on the lower Nueces River (Lake Corpus Christi), the species appears to be extirpated from the remainder of the basin.

Historically, the golden orb occurred in the Nueces River in Live Oak County (OSUM 2011b, p. 1). It was last seen alive in the Nueces River in 1993, when unreported numbers were found in the same area (Burlakova and Karatayev 2010c, p. 1). A shell was collected in the same general area in 1995 (Burlakova and Karatayev 2010c, p. 1), but additional surveys in 1996 and 1997 found no evidence of the species (Howells 1997a, pp. 43–44; 1998, p. 20). We presume the species no longer occurs in the upper portions of the Nueces River.

An anomalous (odd) population of golden orb has persisted in Lake Corpus Christi Reservoir in the lower Nueces River. While the species does not typically inhabit lentic (ponded) water, wave action is presumed to simulate flowing water conditions and has supported a golden orb population since at least the 1970s (OSUM 2011b, p. 1). A few live individuals of golden orb have been found within the reservoir consistently since 1994 (Howells 1995, p. 39; 1996, pp. 30–31; Burlakova and Karatayev 2010c, p. 1). Numbers of golden orb collected increased in 1996, when 86 live golden orb were found at three different locations within the reservoir (Howells 1996, pp. 30–31). However, a drawdown of the lake in 1996 resulted in large numbers of golden orb stranded and killed (Howells 2010a, p. 9), and in 1998 no live individuals were found (Howells 1999, p. 19). Again in 2005, no live individuals were found during surveys, but in 2006, a total of nine were collected at three different sites within the reservoir (Howells 2006, pp. 73–76, 91–93). A small golden orb population likely persists in the reservoir.

Very little information is available on the distribution of golden orb in the Frio River. Shells were last seen in McMullen County in 1994 (Burlakova and Karatayev 2010c, p. 1), but no evidence of the species has been found in this river since (Howells 1995, pp. 37–38; 1996, p. 29; 2002a, pp. 9–10; 2004, pp. 19–20).

Summary

Based on historical and current data, the golden orb has declined rangewide and is now known from only nine populations in four rivers and has been eliminated from nearly the entire Nueces-Frio River system. Four of these populations appear to be stable and reproducing; the remaining five populations are small and isolated and show no evidence of recruitment. Only the populations in the middle Guadalupe River and lower San Marcos River are likely connected; the remaining extant populations are highly fragmented and restricted to short reaches.

Species Information for Smooth Pimpleback

Species Description

The smooth pimpleback is a nearly round, thick-shelled freshwater mussel that generally reaches at least 60 mm (2.6 in) in length (Howells 2010b, p. 4). It is moderately thick, solid, and inflated. Externally, the smooth pimpleback, like its name suggests, is relatively smooth with minute sculpturing; it may or may not have a few small pustules (raised bumps) (Howells 2010b, p. 2). The external coloration of the shell ranges from tan to light brown, dark brown, and black with no rays (Howells 2010b, p. 4).

Taxonomy

The smooth pimpleback was originally described by Lea in 1859 as *Unio houstonensis.* It was later placed in the genus *Margaron* and ultimately moved to *Quadrula* by Simpson (1900, p. 782). Graf and Cummings (2007, p. 18) have proposed moving it to the genus *Amphinaias,* but other freshwater mussel taxonomists recommend waiting for additional work to be completed on members of *Quadrula* before splitting the genus (Bogan 2011, pers. comm.). The smooth pimpleback is recognized by the Committee on Scientific and Vernacular Names of Mollusks of the Council of Systematic Malacologists, American Malacological Union (Turgeon *et al.* 1998, p 37), and we recognize it as a valid species.

Biology and Life History

There is no specific information on age, size of maturity, or host fish use for smooth pimpleback. Numerous individuals were examined for gravidity between June and November, with no evidence of eggs or glochidia (Howells 2000b, p. 38). Other species in the genus *Quadrula* successfully parasitize catfish, and it is likely smooth pimpleback does as well (Howells 2010b, p. 2); additionally, mussels in the genus *Quadrula* are typically short-term brooders (Gorden and Layzer 1989, p. 6; Garner *et al.* 1999, p. 277), and we expect the same of the smooth pimpleback.

Habitat

The smooth pimpleback has been found in mud, sand, and fine gravel in medium-to-large rivers and some reservoirs (Howells 2010b, p. 3). Unlike most other *Quadrula* species in central Texas, smooth pimpleback do occur in some reservoirs (Howells 2002b, p. 8; 2010b, p. 3).

Distribution and Abundance

Historical Distribution

The smooth pimpleback is native to the central and lower Brazos and Colorado Rivers and their tributaries in central Texas (Howells 2010b, p. 4). The smooth pimpleback has also been reported from the Trinity River and other drainages in Texas, as well as from areas outside of Texas, including southern Arkansas and the Verdigris River in Kansas. These reports are likely misidentifications of other pimpleback species that can sometimes closely resemble smooth pimpleback (Howells 2010b, pp. 4–5). The smooth pimpleback was historically uncommon where it occurred; from the 1960s through the 1990s, experts failed to find large populations persisting throughout its range (Howells 2009, p. 12).

In the Colorado River, historical reports indicate that the smooth pimpleback occurred from San Saba County downstream to Wharton County, as well as in the Llano River and Onion and Skull Creeks. Within the Brazos River basin, the species historically occurred throughout the length of the mainstem of the Brazos River (Howells 2009, p. 12), as well as in the Clear Fork Brazos, Leon, Navasota, Little Brazos, San Gabriel, Lampasas, and Little Rivers and Yegua Creek (Howells 2010b, pp. 4–6; Randklev *et al.* 2010b, p. 20).

Current Distribution

The smooth pimpleback has been nearly extirpated from the Colorado River basin, and a few small populations persist in the Brazos River basin. Recent surveys suggest a greater abundance and distribution of the smooth pimpleback in the central Brazos River drainage than was indicated by collections from the past 40 years, with five populations represented by more than a few individuals.

Colorado River System

The smooth pimpleback historically occurred throughout the mainstem Colorado River as well as several tributaries, but it is currently restricted to one mainstem reservoir, two sites on the mainstem Colorado River, and the San Saba River. Populations in all of the other historically occupied tributaries and two reservoirs appear to have been extirpated.

In the mainstem Colorado River, smooth pimpleback were historically known from much of the length of the river (Howells 1996, p. 21; 1997a, pp. 34–35; Randklev *et al.* 2010c, p. 4; OSUM 2011c, p. 1). Numerous surveys in many locations on the Colorado River occurred between 1993 and 2009, and no evidence of smooth pimpleback was found (Howells 1995, p. 29; 1996, p. 23; 1997a, pp. 27, 31; 2002a, p. 6; 2004, p. 7, 11; 2005, p. 6; Burlakova and Karatayev 2010a, pp. 15–16), except for in Colorado County in 1999, when three live smooth pimpleback were found (Howells 2000a, p. 27). During two surveys in 2009, live smooth pimpleback were found in the same general area as in 1999 (Burlakova and Karatayev 2010a, p. 16; Johnson 2009, p. 1). Farther downstream, in Wharton County, live smooth pimpleback were found at two sites in 2009 (Burlakova and Karatayev 2010a, p. 16), despite having been surveyed in 1995 and none found (Howells 1996, p. 23).

Inks Lake is a small mainstem reservoir on the Colorado River in Burnet County. Several live smooth pimpleback were found in 1992 (Howells 1994, p. 4); however, since that time only shell material has been found during four separate surveys between 1996 and 2005 (Howells 1997a, pp. 32–33; 1999, p. 16; 2005, p. 8; 2006, p. 67). Frequent drawdowns in this lake appear to have affected all species of freshwater mussels, as there has been a sharp decline in the overall mussel community (Howells 1999, p. 16).

One live smooth pimpleback was found in Lake Lyndon B. Johnson, a large mainstem reservoir on the Colorado River, in 2001, but no live individuals have been found since (Howells 2002a, pp. 6–7; 2006, pp. 68–69). Farther downstream, in Lake Marble Falls, 13 live smooth pimpleback were found in 1995 during a drawdown of lake levels (Howells 1996, p. 22), but subsequent surveys in 1996 failed to find any additional living animals (Howells 1997a, p. 33). The small recent survey effort is not sufficient to conclude that the smooth pimpleback no longer occur in these lakes, and small populations may still persist there.

Smooth pimpleback were recently found in the San Saba River in San Saba County, when 29 individuals were found at two locations (Burlakova and Karatayev 2011, p. 5). Various size and age classes were represented, indicating a reproducing, recruiting population (Burlakova and Karatayev 2011, p. 5). Even more recently, 206 smooth pimpleback, including adults and juveniles, were recorded in this same area in riffle and pool habitat (Randklev 2011b, p. 1).

No smooth pimpleback populations remain in any of the Colorado River tributaries in which the species was historically known to occur, including the full length of the Llano River (Howells 1996, pp. 21–22; 1998, p. 17; 2000a, p. 25; 2005, p. 8; Randklev *et al.* 2010c, p. 4; OSUM 2011c, p. 1). A single subfossil shell, likely a smooth pimpleback, was found in the Llano River in Kimble County in 1995 (Howells 1996, pp. 21–22), but no other evidence of the species has been found in the Llano River in recent years. Additionally, although Onion and Skull Creeks were historically occupied by smooth pimpleback (Randklev *et al.* 2010c, p. 4), the species has not been found recently in either stream (Howells 1995, pp. 28–29).

Brazos River System

The smooth pimpleback historically occurred in the Brazos River system from Palo Pinto County downstream to Austin and Waller Counties, as well as in numerous tributaries. The species has been extirpated from the upstream half of the mainstem Brazos River and from at least three tributaries. Substantial populations persist in the Leon River, Navasota River, and Yegua Creek, and small populations remain in the lower Brazos and Little Brazos Rivers.

In the mainstem Brazos River, surveys in Palo Pinto, Somervell, and Bosque Counties between 1996 and 2000 indicate that the smooth pimpleback has been extirpated from the upstream portion of the river (Howells 1997a, pp. 16, 18–19; 1999, pp. 11–12; 2001, p. 19). Despite surveys in 1996 and 1998 in which no individuals were found (Howells 1997a, p. 21; 1999, p. 12), a single live smooth pimpleback was found in McLennan County in the middle Brazos River in 2005 (Howells 2010b, p. 5), and two live individuals were recorded in Falls County in 2006 (Karatayev and Burlakova 2008, pp. 6–10).

Although not extirpated from the middle Brazos River, the smooth pimpleback occurs only in low numbers. In Milam and Robertson Counties, no smooth pimpleback were found in 1998 (Howells 1999, p. 13), but eight live individuals were found in 2006 (Burlakova and Karatayev 2010b, p. 1). More recently, in 2008, 13 live smooth pimpleback were found at the same site (Randklev *et al.* 2009, p. 18). Additionally, downstream in Burleson and Brazos Counties, which were historically occupied by the smooth pimpleback (OSUM 2011c, p. 1), a small population persists. In 1995, one live and one recently dead individual were collected within Brazos County (Howells 1996, pp. 17–18). Although none were found here in 1999 (Howells 2000a, pp. 21–22), in 2006 a single live smooth pimpleback was collected at this site (Karatayev and Burlakova 2008, pp. 6–10). Additionally, further downstream in Grimes and Waller Counties, a single live individual was found in 2006 (Burlakova and Karatayev 2010b, p. 1) and again in 2008 (Randklev *et al.* 2009, p. 18). Smooth pimpleback are more numerous in the lower mainstem Brazos River, in Austin and Waller Counties, where 38 live individuals were found in 2006 (Karatayev and Burlakova 2008, pp. 6–10).

Tributaries to the Brazos River also contain smooth pimpleback populations. The Leon River, in the Little River drainage of the Brazos, historically contained smooth pimpleback throughout its length in Hamilton, Coryell, and Bell Counties (Howells 1994, p. 19, 1997a, p. 20; Randklev *et al.* 2010c, p. 4; OSUM 2011c, p. 1). Currently, a smooth pimpleback population persists in Hamilton County, where numerous live individuals were found in 2006 and 2011 (Howells 2006, pp. 82–83; Randklev 2011a, p. 1), as well as several locations in Coryell County, where numerous individuals were also recently found (Randklev 2011a, p. 1).

Only subfossil smooth pimpleback shells have been found in the Lampasas River in Bell County in 1996 (Howells 1997a, pp. 20, 23). Subsequent surveys of the river in both Bell and Lampasas Counties yielded no evidence of smooth pimpleback (Howells 1999, p.14; 2001, p. 20), and the species has likely been extirpated from the Lampasas River.

The Little River in Milam County is also a historical location for the smooth pimpleback (Randklev *et al.* 2010c, p. 4). Old shells were found at this site in 1996 (Howells 1997a, p. 22), and a single live individual was found here in 2006 (Karatayev and Burlakova 2008, p. 6). Farther downstream, at the confluence with the Brazos River, none have been found (Howells 1996, p. 17).

A single old smooth pimpleback shell has been found in the San Gabriel River in Milam County (Howells 1997a, p. 23), and it is likely the species has been extirpated from this Brazos River tributary as well.

In the Little Brazos River, the smooth pimpleback appears to persist in low numbers. Although none were found in Robertson County in 1993 and there had appeared to be a die off of numerous freshwater mussel species (Howells 1995, p. 18), one live smooth pimpleback was found during a 2006 survey (Karatayev and Burlakova 2008, p. 6). Farther downstream in Brazos County, recently dead individuals were discovered in 2001 (Howells 2002a, pp. 4–5). The species occurred in this area historically (Randklev *et al.* 2010c, p. 4), and reports of mussels in the Little Brazos River from the 1950s described the freshwater mussel community as numerous, including smooth pimpleback (Gentner and Hopkins 1966, pp. 458–459), but no live individuals have been collected in this area in recent years (Howells 1996, p. 18; 1999, p. 14).

The smooth pimpleback has been extirpated from the Clear Fork Brazos River. Although this species was originally documented from this river in Shackelford County in 1893 (Randklev *et al.* 2010c, p. 4), none have been found in this stream since (Howells 1999, p. 19).

In the Navasota River, smooth pimpleback historically occurred in Leon, Brazos, Grimes, and Washington Counties (Randklev *et al.* 2010c, p. 4; OSUM 2011c, p. 1). Currently, the species persists in each of those counties, with a large population occurring in the lower river. In Leon County three recently dead smooth pimpleback shells were found in 2000 (Howells 2001, p. 23), indicating that a few individuals may persist in the area. However, one of the largest known populations occurs farther downstream near the confluence of the Navasota and Brazos Rivers. Nine live individuals were found in this area in 2006 (Karatayev and Burlakova 2008, pp. 6–10), and in 2008 a total of 117 live smooth pimpleback were recorded at 3 different locations within Washington and Grimes Counties (Randklev *et al.* 2009, pp. 6, 18). A large population continues to persist in the Navasota River, with a total of 314 smooth pimpleback recorded at two sites in 2011 (Randklev 2011a, p. 1).

In Yegua Creek, no smooth pimpleback were found during several surveys between 1996 and 2003 (Howells 1997a, pp. 24–26; 2001, p. 22; 2004, p. 6), although subfossil shells were found in Washington County in 1996. However, in 2006, a live individual was discovered (Karatayev and Burlakova 2008, pp. 6–10), which prompted further surveys in 2008. Numerous smooth pimpleback were found during subsequent surveys at four different locations within Washington and Burleson Counties (Randklev *et al.* 2009, pp. 16–18; Randklev 2011a, p. 1), indicating the presence of a potentially large population in this stream.

Summary

Based on historical and current data, the smooth pimpleback has declined rangewide and is now known from only nine locations. The species has been eliminated from nearly the entire Colorado River and all but one of its tributaries, as well as from the upper Brazos River and several tributaries. The San Saba River, lower Brazos River, Navasota River, Leon River, and Yegua Creek populations appear to be stable and reproducing, but the remaining populations are small, isolated, and represented by only a few individuals.

Species Information for Texas Pimpleback

Species Description

The Texas pimpleback is a large pimpleback species with a moderately inflated shell that generally reaches 60–90 mm (2.4–3.5 in) (Howells 2002b, pp. 3–4). With the exception of growth lines, the shell of the Texas pimpleback is generally smooth and moderately thick (Howells 2002b, p. 4). Externally, coloration ranges from yellowish-tan to dark brown with some individuals mottled or with dark green rays. Internally, the nacre is white and iridescent posteriorly (Howells 2002b, p. 4).

Taxonomy

The Texas pimpleback was originally described as *Unio petrinus* by Gould in 1855. It was placed in the genus *Margaron* by Lea in 1870 and ultimately moved to *Quadrula* by Simpson in 1900 (Simpson 1900, p. 783). Graf and Cummings (2007, p. 18) have proposed moving it to the genus *Amphinaias,* but other freshwater mussel taxonomists recommend waiting for additional work to be completed on members of *Quadrula* before splitting the genus (Bogan 2011, pers. comm.). The Texas pimpleback is recognized by the Committee on Scientific and Vernacular Names of Mollusks of the Council of Systematic Malacologists, American Malacological Union (Turgeon *et al.* 1998, p. 37), and we recognize it as a valid species.

Biology and Life History

There is very little specific information on age, size of maturity, or host fish use for Texas pimpleback. Gravid females have been found from June through August, and the smallest documented gravid female was 45 mm (1.8 in) long (Howells 2000b, p. 38). Glochidia are hookless and elliptical in shape (Howells *et al.* 1996, p. 120). To date, no host fish have been confirmed for the Texas pimpleback; however, glochidia have been reported attached to and encysted on flathead catfish (*Pylodictis olivaris*), yellow bullhead (*Ameiurus natalis*), and bluegill in laboratory settings, although none transformed to the juvenile stage (Howells 2010e, p. 3). This is consistent with other species in the genus *Quadrula,* which also parasitize catfish species.

Habitat

The Texas pimpleback typically occurs in moderately sized rivers, usually in mud, sand, gravel, and cobble, and occasionally in gravel-filled cracks in bedrock slab bottoms (Horne and McIntosh 1979, p. 122; Howells 2002b, p. 4). The species has not been found in water depths over 2 m (6.6 ft). Texas pimpleback have not been found in reservoirs, which indicates that this species is intolerant of deep, low-velocity waters created by artificial impoundments (Howells 2002b, p. 4). In fact, Texas pimpleback appear to tolerate faster water more than many other mussel species (Horne and McIntosh 1979, p. 123).

Distribution and Abundance

Historical Distribution

The Texas pimpleback is endemic to the Colorado and Guadalupe-San Antonio River basins of central Texas (Howells 2002b, p. 3). In the Colorado River basin, Texas pimpleback occurred throughout nearly the entire mainstem, as well as numerous tributaries, including the Concho, North Concho, San Saba, Llano, and Pedernales Rivers, and Elm and Onion Creeks (Howells 2010e, p. 5; Randklev *et al.* 2010c, p. 4; OSUM 2011d, p. 1). Within the Guadalupe-San Antonio River basin, it occurred throughout most of the length of the Guadalupe River, as well as in the San Antonio, San Marcos, Blanco, and Medina Rivers (Horne and McIntosh 1979, p. 122; Howells 2010e, p. 5; OSUM 2011d, p. 1).

Current Distribution

The Texas pimpleback has declined significantly rangewide, and only four streams—the San Saba River, Concho River, Guadalupe River, and San Marcos River—are known to harbor persisting Texas pimpleback populations. These populations are disjunct, small, and isolated. The species has been extirpated from the remainder of its historical range.

Colorado River System

In the Colorado River system, Texas pimpleback once occurred throughout the mainstem and in many major tributaries. Currently, the species has been extirpated from the Pedernales, North Concho, and Llano Rivers, as well as Onion Creek. It has also likely been extirpated from the mainstem Colorado River and Elm Creek. The Concho River contains the most abundant population of Texas pimpleback and one of only two populations of the species likely to be remaining in the Colorado River system, but most individuals are old and there has been very little evidence of recruitment.

In the mainstem Colorado River, Texas pimpleback historically occurred from Runnels County downstream to Colorado County (Howells 2010e, p. 5; Randklev *et al.* 2010c, pp. 3–4; OSUM 2011d, p. 1). However, surveys in numerous locations along the river yielded no evidence of the species anywhere except in Runnels and San Saba Counties (Howells 1995, pp. 20, 29; 1997a, pp. 27, 31, 35; 2000a, p. 27; 2002a, p. 7). In Runnels County, Texas pimpleback shells were found in 1993 (Howells 1995, p. 20), but several subsequent surveys between 1996 and 2008 detected no further evidence of the species (Howells 1997a, p. 27; 1998, p. 10; 2002a, p. 7; 2004, p. 7; Burlakova and Karatayev 2010a, p. 10). In San Saba County, a single shell was collected in 1989 (Howells 2002b, p. 6), and three recently dead individuals were found in 1999 (Howells 2000a, pp. 25–26). An additional shell was collected in 2001 (Howells 2002a, p. 6). No live individuals have been collected from this reach of the Colorado River.

In Runnels County, Elm Creek once supported a Texas pimpleback population. Small numbers of Texas pimpleback were found in 1993 and 1995 (Howells 1995, p. 21; 1996, p. 20), but none were found in 1997, 2001, or 2003 (Howells 1998, p. 11; 2002a, p. 5; 2004, p. 7). In 2005 and 2008, only dead individuals were collected (Howells 2006, pp. 63–64; Burlakova and Karatayev 2010a, p. 10). No live individuals have been found in over a decade despite repeated sampling efforts, and it is likely the Texas pimpleback has been extirpated from this stream.

The Concho River in Concho County supports the largest Texas pimpleback population. Thirteen and 28 individuals were collected in 1993 and 1994, respectively (Howells 1995, pp. 24–25; 2006, p. 61). However, low water and high temperatures in 1997 killed large numbers of many freshwater mussel species in the area up and downstream of Paint Rock, and 63 recently dead Texas pimpleback were found (Howells 1998, pp. 14–15). A severe drought in 1999 resulted in this area of the Concho River being reduced to a series of small pools. Few live Texas pimpleback were collected during this drought, in addition to many recently dead individuals (Howells 2000a, p. 23). No evidence of the species was found in 2004 (Howells 2005, p. 9), but eight live individuals were found in 2005 (Howells 2006, p. 60), evidence that the species had survived the extreme dewatering of the river. In 2008, 61 live Texas pimpleback were collected in this same area, and the population was estimated to contain approximately 4,000 individuals (Burlakova and Karatayev 2010a, p. 10; 2010b, p. 1). However, the average length of individuals collected at this site was over 90 mm (3.5 in), indicating that reproduction is limited in this population. Further, although no mussel surveys occurred in 2009 and 2010, the river was reported to be extremely low during this time (Howells 2010e, p. 6); the result of this additional dewatering on the population is unknown.

The San Saba River historically contained Texas pimpleback (Randklev *et al.* 2010c, p. 2), but no live individuals had been collected in over a decade until recently when shells were collected in 1992 and 1995 (Howells 1994, p. 7; 1996, p. 21), and five live individuals were collected in 1997 (Howells 1998, p. 16). However, subsequent surveys were conducted in 2000, 2004, and 2005, with only shell material being found in 2000 (Howells 2001, pp. 28–29), and no evidence of Texas pimpleback was found in 2004 and 2005 (Howells 2005, pp. 8–9; 2006, pp. 64–65). A single shell was collected in 2008 (Burlakova and Karatayev 2010b, p. 1). However, in 2011, 39 live individuals were found at two sites in San Saba County (Burlakova and Karatayev 2011, p. 3). The individuals found were of various sizes and ages, indicating a reproducing population (Burlakova and Karatayev 2011, p. 4). Further surveys at this site confirm a large population in the area, with 140 individuals, including many juveniles, found here (Randklev 2011b, p. 1).

The Texas pimpleback also historically occurred in the North Concho, Pedernales, and Llano Rivers, as well as Onion Creek (Howells 2010e, p.5; Randklev *et al.* 2010c, p. 4; OSUM 2011d, p. 1); all are tributaries within the Colorado River system. In the North Concho River, all freshwater mussels are presumed extirpated from historically occupied areas (Howells 1995, pp. 22–23). The Pedernales River historically harbored a Texas pimpleback population (OSUM 2011d, p. 1), but only old shells have been collected in this river in recent years (Howells 1994, p. 5). Since 1993, no evidence of Texas pimpleback has been found (Howells 1995, pp. 27–28; 1999, p. 16), and the species is presumed to be extirpated. Additionally, repeated surveys in the Llano River in Kimble and Mason Counties consistently failed to collect live Texas pimpleback, with shells found only in Llano County in 1997 (Howells 1996, pp. 21–22; 1998, p. 17; 2005, p. 8). The Texas pimpleback is likely extirpated from all of these streams.

Guadalupe River System

In the Guadalupe River system, the Texas pimpleback has been extirpated from nearly the entire reach of the mainstem Guadalupe, San Antonio, and Blanco Rivers. Very small populations remain only in the lower Guadalupe and San Marcos Rivers, represented by one or two individuals in each.

In the mainstem Guadalupe River, the Texas pimpleback was historically known throughout the length of the river, from as long ago as 1905 (Randklev *et al.* 2010c, p. 1; OSUM 2011d, p. 1). Numerous surveys between 1992 and 2005 have not yielded any evidence of the species anywhere but in Victoria County (Howells 1994, pp. 7–9; 1995, pp. 30–32; 1996, pp. 25–27; 1997a, pp. 37–40; 1999, pp. 18–19; 2002a, p. 8; 2003, pp. 15, 17; 2006, pp. 71–72; Johnson 2009, p. 1), where two live individuals were collected in 2009. A small population may remain in the lower Guadalupe River.

In the San Marcos River near the confluence with the Blanco River in Hays County, repeated surveys between 1992 and 2000 yielded no evidence of Texas pimpleback (Howells 1994, pp. 9–10; 1995, pp. 33–34; 1996, p. 27; 1997a, p. 40; 2000a, p. 28; 2001, pp. 32–33). However, in 2003 two shells were collected (Howells 2004, p. 16), and in 2004, a single live individual was found (Howells 2005, p. 10). The Texas pimpleback likely persists in this river in very low numbers.

The Texas pimpleback appears to be extirpated from the San Antonio River, with only shell fragments found near the City of San Antonio in Bexar County in 1993 (Howells 1995, p. 35). No evidence of the species was found downstream in Karnes County in 1996 (Howells 1997a, pp. 41–42).

The Texas pimpleback was once described as abundant in the Blanco River just upstream of its confluence with the San Marcos River in Hays County (Horne and Mcintosh 1979, p. 126), but repeated surveys of this area between 1992 and 1995 yielded no recent evidence of the species (Howells 1994, p. 9; 1995, pp. 32–33; 1996, p. 27), with only a subfossil shell collected in 1993 (Howells 1995, p. 33). No shell material or live individuals were found in additional surveys in 2011 (Johnson 2011, p. 1).

Summary

The Texas pimpleback has been eliminated from long reaches of former habitat in hundreds of miles of the Colorado and Guadalupe River systems. Only two populations appear large enough to be stable, but evidence of recruitment in the Concho River population is limited. The San Saba River population may be the only remaining recruiting population of Texas pimpleback. Two additional populations are represented by one or two individuals; all populations are highly disjunct.

Species Information for Texas Fawnsfoot

Species Description

The Texas fawnsfoot is a small, relatively thin-shelled freshwater mussel that can reach 60 mm (2.4 in) in length but is usually much smaller (Howells 2010d, p. 2). The shell is long and oval, generally free of external sculpturing, with external coloration that varies from yellowish- or orangish-tan, brown, reddish-brown, to smoky-green with a pattern of broken rays or irregular blotches (Howells 2010d, p. 2). The nacre is bluish-white or white and iridescent posteriorly (Howells 2010d, p. 2).

Taxonomy

The Texas fawnsfoot was first described as *Unio macrodon* by Lea in 1859 and was subsequently placed in the genus *Margaron* by Lea in 1870 and then moved to *Plagiola* by Simpson (1900, p. 605). Ultimately the species was placed in the genus *Truncilla* by Strecker (1931, pp. 63, 65). The Texas fawnsfoot is recognized by the Committee on Scientific and Vernacular Names of Mollusks of the Council of Systematic Malacologists, American Malacological Union (Turgeon *et al.* 1998, p. 37), and we recognize it as a valid species.

Biology and Life History

There is no specific information on age, size of maturity, or host fish use for Texas fawnsfoot. However, other species in the genus *Truncilla* parasitize freshwater drum (*Aplodinotus grunniens*) (OSUM 2011f, p. 1), and it is likely the Texas fawnsfoot does as well. Freshwater drum are ubiquitous throughout the range of Texas fawnsfoot (Hubbs *et al.* 2008, p. 53).

Habitat

Since Texas fawnsfoot were not found alive for many years, very little information is available about its habitat preferences. In the past only Texas fawnsfoot shells and recently dead individuals were occasionally found along rivers following drought-related dewatering or bank deposition after high floods. These shells and recently dead individuals indicated that the Texas fawnsfoot occurs in flowing water, as it was never found in ponds, lakes, or reservoirs, suggesting that it is intolerant of deep, low-velocity waters created by artificial impoundments (Howells 2010d, p. 3). The recently discovered live population in the Brazos River indicates that the species occurs in rivers with soft, sandy sediment with moderate water flow (Randklev and

Lundeen 2010, p. 1; Randklev *et al.* 2010a, p. 298; Johnson 2011, p. 1).

Distribution and Abundance

Historical Distribution

The Texas fawnsfoot is endemic to the Brazos and Colorado Rivers of central Texas (Howells *et al.* 1996, p. 143; Randklev *et al.* 2010a, p. 297). From the 1960s to the 1990s, malacologists working in central Texas found few individuals and few new population locations (Howells 2010d, p. 6). Historical records suggest the Texas fawnsfoot inhabited much of the Colorado River, from Wharton County upstream as far as the North Fork Concho River in Sterling County, as well as throughout the Concho, San Saba, and Llano Rivers and Onion Creek within the Colorado River basin (Howells 2010d, p. 4; Randklev *et al.* 2010b, p. 24). In the Brazos River, the species occurred from Fort Bend County upstream to the lower reaches of the Clear Fork Brazos River in Shackelford County, as well as in the Leon River, Little River, San Gabriel River, Deer Creek, and Yegua Creek (Howells 2010d, pp. 4–5; Randklev *et al.* 2010b, p. 24). Species reports from the Trinity River and other east Texas locations are of misidentified fawnsfoot (*Truncilla donaciformis*) (Howells 2010d, p. 4).

Current Distribution

Relatively few Texas fawnsfoot have been documented since this species was first described in 1859, and very few live individuals have been found in recent decades (Randklev *et al.* 2010a, p. 297). All of these animals were flood deposited on gravel bars and near death just prior to collection (Randklev *et al.* 2010a, p. 297), preventing information from being gathered about population size, preferred habitat, and other parameters. A live population of Texas fawnsfoot was not discovered until 2008 in the Brazos River near its confluence with the Navasota River (Randklev *et al.* 2010a, p. 297). A second live population was found in 2009 in the Colorado River (Johnson 2009, p. 1). These two locations contain the only confirmed populations of the species to date. Evidence of other remnant populations has also been found in the Clear Fork Brazos River, San Saba River, and Deer Creek.

Colorado River System

The Texas fawnsfoot has been eliminated from almost all of the Colorado River system. Live individuals were found in the lower mainstem Colorado River in 2009, and the only other evidence of current occurrence of Texas fawnsfoot in the Colorado River basin is in the San Saba River, where a population persists.

In the mainstem Colorado River, the Texas fawnsfoot historically occurred from Wharton County upstream into the headwaters (Randklev *et al.* 2010c, p. 4; OSUM 2011e, p. 1). Surveys throughout the upper Colorado River between 1993 and 2009 yielded no evidence of Texas fawnsfoot (Howells 1994, pp. 20–21, 29; 1996, pp. 20–21, 23; 1997a, pp. 27, 31, 34–35; 1998, p. 10; 2000a, p. 27; 2002a, p. 6; 2004, p. 7; Burlakova and Karatayev 2010a, p. 16), except for one recently dead individual found in 1999 in San Saba County when the entire river was dewatered and all mussels were eliminated from the area (Howells 2000a, pp. 25–26; 2009, p. 17). The lack of evidence of the species since that time indicates that the population may have been lost. In the lower Colorado River in Colorado County, several old shells of Texas fawnsfoot were found at several sites in 1996 (Howells 1997a, p. 35), and, subsequently in 2009, two live individuals were discovered (Johnson 2011, p. 1). The population was later estimated to be approximately 2,800 individuals, with individuals ranging in size from 21 to 38 mm (0.8–1.5 in) (Burlakova and Karatayev 2010a, p. 17), indicating that reproduction and recruitment is occurring.

Texas fawnsfoot were not known to occur in the San Saba River until a single live individual was collected in 2011 (Burlakova and Karatayev 2011, p. 6). Additional surveys yielded 16 Texas fawnsfoot of various ages collected at the site (Randklev 2011b, p. 1), indicating a persistent, recruiting population.

Texas fawnsfoot is presumed extirpated from the remainder of the Colorado River basin. Although historical records exist in the North Concho, Concho, and Llano Rivers and in Onion Creek (Randklev *et al.* 2010c, p. 4), numerous surveys of these streams indicate the extirpation of the species (Howells 1994, pp. 5–6; 1995, pp. 22–25, 28–29; 1996, pp. 21–22; 1998, pp. 14–17; 1999, pp. 15–16; 2000a, pp. 23, 25; 2001, p. 27; 2005, p. 9; Burlakova and Karatayev 2011, p. 6).

Brazos River System

In the Brazos River system, the Texas fawnsfoot persists in the mainstem Brazos River, Clear Fork Brazos River, Navasota River, and possibly in Deer Creek. The species has been extirpated from the Leon River, Little River, San Gabriel River, and Yegua Creek.

In the mainstem Brazos River, the Texas fawnsfoot historically occurred throughout the length of the river, from Palo Pinto County downstream to Fort Bend County (Randklev *et al.* 2010c, pp. 2–4; Burlakova and Karatayev 2010b, p. 1; OSUM 2011e, p. 1). While the species appears to have retained its range through the length of the Brazos River, occurrences are represented by very few live or recently dead individuals. In the upper Brazos River in Palo Pinto and Parker Counties, two live individuals were found at each of two sites in 1996, as well as numerous shells (Howells 1997a, pp. 16, 17). A survey in 2000 yielded no evidence of Texas fawnsfoot in this area (Howells 2001, p. 19). Nearby, in Somervell County, four recently dead individuals were found in the mainstem Brazos River in 1996 (Howells 1997a, pp. 18–19. In 2007, only one old shell was found in the same area (Burlakova and Karatayev 2010b, p. 1).

Surveys in Milam and Falls Counties have not yielded any evidence of Texas fawnsfoot, indicating the species has been extirpated from this section of the Brazos River (Howells 1995, p. 17; 1999, pp. 12–13).

In the middle Brazos River, Texas fawnsfoot persists in low numbers in the vicinity of Brazos County. One live individual was found in 1994 (Howells 1996, pp. 17–18), representing the first live collection of the species anywhere since the 1970s. In 1999, numerous recently dead Texas fawnsfoot of mixed sizes and ages were found at several sites in Burleson and Brazos Counties (Howells 2000a, pp. 21–22), indicating a recruiting population existed in the area. The species has been documented here in repeated surveys in 2000, 2003, and 2006 (Howells 2001, p. 22; Karatayev and Burlakova 2008, p. 7; Howells 2009, p. 17), indicating that the species continues to persist in the area.

The first account of a living population of Texas fawnsfoot (animals living *in situ* rather than deposited on or near the banks by floods) occurred in 2008 in the lower Brazos River near its confluence with the Navasota River (Randklev *et al.* 2010a, p. 297). Ten live individuals were collected, and all were small, indicating successful reproduction and recent recruitment. An additional Texas fawnsfoot was found in this area in 2011 (Randklev 2011a, p. 1).

The farthest downstream collection of Texas fawnsfoot in the Brazos River in recent years was in Austin and Waller Counties, when one live individual was found in 2006 (Karatayev and Burlakova 2008, p. 39). It is likely the species occurs sporadically through the section of the Brazos River between Brazos and Austin Counties.

Texas fawnsfoot was first discovered in the Navasota River in 2011, when three individuals were found in Washington and Grimes Counties (Randklev 2011a, p. 1). Previous surveys had not yielded evidence of the species in this river (Howells 2001, p. 23).

In Deer Creek, a tributary to the Brazos River in Falls County, a recently dead Texas fawnsfoot was collected in 2006 (Burlakova and Karatayev 2010b, p.1), despite previous surveys that yielded no evidence of the species (Howells 1999, p. 12).

Additionally, a Texas fawnsfoot population persists in the Clear Fork Brazos River. Recently dead Texas fawnsfoot have been collected in several locations along the length of the river, in Shackelford, Stephens, and Young Counties (Randklev *et al.* 2010c, p. 4; Randklev 2011, pers. comm.). Several other tributaries to the Brazos River that historically contained Texas fawnsfoot appear to no longer support the species after numerous surveys reveal no living or dead individuals, including the Leon River (Howells 1994, pp. 18–20; 1997a, pp. 19–20), the Little River (Howells 1997a, pp. 22–23), the San Gabriel River (Howells 1997a, p. 23), and Yegua Creek (Howells 1997a, pp. 24, 25–26; 1999, p. 14; 2001, p. 22; 2004, p. 6).

Summary

The Texas fawnsfoot has declined rangewide and is now known from only five populations. The species has been extirpated from nearly all of the Colorado River basin and from much of the Brazos River basin. Of the populations that remain, only the Colorado, San Saba, and Brazos River populations are likely to be stable and recruiting; the remaining populations are disjunct and restricted to short stream reaches.

Five-Factor Evaluation and Findings

Texas fatmucket, golden orb, smooth pimpleback, Texas pimpleback, and Texas fawnsfoot all occur in central Texas across four major river basins (Brazos, Colorado, Guadalupe, and Nueces-Frio River basins). These species depend on similar physical and biological features and on the successful functioning of riverine ecosystems to survive. Many of the species face the same or very similar threats. For each species, we identified and evaluated all the factors that may be threatening the species. However, to avoid redundancy of information when the analysis of the threats is the same between species, we referenced the reader to the initial description of the common threats. For example, the degradation of habitat and habitat loss due to dams and impoundments is a common threat to all five species, so a full description of the threat was provided for the Texas fatmucket, and for the remaining species the initial description was referenced with species-specific information provided, as available.

Five-Factor Evaluation for Texas Fatmucket

Information pertaining to the Texas fatmucket in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.

The decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation (Neves 1991, pp. 252, 265; Howells *et al.* 1996, pp. 21–22). Chief among the causes of mussel decline in Texas are the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants (Neck 1982a, pp. 33–35; Howells *et al.* 1996, pp. 21–22; Winemiller *et al.* pp. 17–18). These threats are discussed below.

Impoundments

A major factor in the decline of freshwater mussels across the United States has been the large-scale impoundment of rivers (Vaughn and Taylor 1999, p. 913). Dams are the source of numerous threats to freshwater mussels: They block upstream and downstream movement of species by blocking host fish movement; they eliminate or reduce river flow within impounded areas, thereby trapping silts and causing sediment deposition; and dams change downstream water flow timing and temperature, decrease habitat heterogeneity, and affect normal flood patterns (Layzer *et al.* 1993, pp. 68–69; Neves *et al.* 1997, pp. 63–64; Watters 2000, pp. 261–264; Watters 1996, p. 80). Within reservoirs (the impounded waters behind dams), the decline of freshwater mussels has been attributed to sedimentation, decreased dissolved oxygen, and alteration of resident fish populations (Neves *et al.* 1997, pp. 63–64; Pringle *et al.* 2000, pp. 810–815; Watters 2000, pp. 261–264). Dams significantly alter downstream water quality and stream habitats (Allan and Flecker 1993, p. 36; Collier *et al.* 1996, pp. 1, 7) resulting in negative effects to tailwater (the area downstream of a dam) mussel populations (Layzer *et al.* 1993, p. 69; Neves *et al.* 1997, p. 63; Watters 2000, pp. 265–266). Below dams, mussel declines are associated with changes and fluctuation in flow regime, scouring and erosion of stream channels, reduced dissolved oxygen levels and water temperatures, and changes in resident fish assemblages (Williams *et al.* 1992, p. 7; Layzer *et al.* 1993, p. 69; Neves *et al.* 1997, pp. 63–64; Pringle *et al.* 2000, pp. 810–815; Watters 2000, pp. 265–266). Numerous dams have been constructed throughout the Colorado, Guadalupe, Brazos, and Nueces-Frio River systems within the range of all five mussels addressed in this finding (Stanley *et al.* 1990, p. 61).

Population losses due to the effects of dams and impoundments have likely contributed more to the loss of diversity and abundance of freshwater mussels across Texas, including the Texas fatmucket, than any other factor. Stream habitat throughout nearly all of the range of Texas fatmucket has been affected by numerous impoundments, leaving generally short, isolated patches of remnant habitat between dams. Impoundments have resulted in profound changes to the nature of the rivers, primarily replacing free-flowing river systems with a series of large reservoirs.

There are no natural lakes within the range of the Texas fatmucket, nor has it ever been found in reservoirs. Surveys of the reservoirs on the Guadalupe and Colorado Rivers have been ongoing since at least 1992, and no evidence of live or dead Texas fatmucket has been found in any reservoir (Howells 1994, pp. 1–20; 1995, pp. 1–50; 1996, pp. 1–45; 1997a, pp. 1–58; 1998, pp. 1–30; 1999, pp. 1–34; 2000a, pp. 1–56; 2001, pp. 1–50; 2002a, pp. 1–28; 2003, pp. 1–42; 2004, pp. 1–48; 2005, pp. 1–23; 2006, pp. 1–106; Karatayev and Burlakova 2008, pp. 1–47; Burlakova and Karatayev 2010a, pp. 1–30; 2011, pp. 1–8), further indicating this species is not tolerant of impoundments.

Impoundments occur throughout the range of the Texas fatmucket. The majority of the Nueces-Frio, Guadalupe, San Antonio, Colorado, and Brazos Rivers, as well as many tributaries, are now impounded. There are 31 major reservoirs within the Colorado River basin, with another reservoir (Goldthwaite Reservoir) being considered on the Colorado River in Mills and San Saba Counties; this reservoir was the number one recommendation in the water plan for the region (Texas Water Development Board (TWDB) 2011, p. 4–85). There are 29 reservoirs throughout the Guadalupe River basin and 34 reservoirs throughout the San Antonio River basin, each with a storage capacity of 3000 acre-feet or more, and many smaller reservoirs (Exelon 2010, p. 2.3–4). The majority of the large dams were constructed for power generation, flood control, and water supply, primarily by the Lower Colorado River and Guadalupe-Blanco River Authorities, beginning in the early twentieth century (Guadalupe-Blanco River Authority 2011, p. 1; Lower Colorado River Authority (LCRA) 2011a, p. 1). These, and numerous smaller dams, occur throughout the Colorado and Guadalupe River basins and have resulted in ongoing destruction and modification of Texas fatmucket habitat and the curtailment of its range.

Dams threaten freshwater mussels in several ways. First, they can prevent the movement of freshwater mussel host fish. The overall distribution of mussels is a function of the dispersal of their hosts (Watters 1996, p. 83). For example, Watters (1996, p. 80) found that the distributions of the fragile papershell (*Leptodea fragilis*) and pink heelsplitter (*Potamilus alatus*) in five midwestern rivers were determined by the presence of low-head dams. These dams were non-navigable (without locks), lacked fish ladders, and varied in height from 1 to 17.7 m (3 ft to 58 ft), and the host fish could not disperse through them. Although the distribution of mussels may depend on many ecological factors, the evidence presented in Watters (1996, pp. 79–85) illustrates that dams as small as 1 m (3 ft) high can limit the distribution of mussels. There are many dams that occur throughout the range of the Texas fatmucket that lack fish ladders and may be a barrier to the movement of fish hosts and, therefore, the distribution of mussels. Because the Texas fatmucket populations are all separated by dams of various sizes that are not passable by fish, the mussel is unable to disperse from its current occupied range through host fish migration.

Dams also alter aquatic habitat within the resulting impoundments. It is well documented that many mussel species that are adapted to flowing water stream environments do poorly in the altered aquatic conditions found within impoundments (Williams *et al.* 1992, p. 7; Vaughn and Taylor 1999, p. 913). Once a dam is constructed, the original river channel upstream remains intact but under much deeper water with much lower velocities. As water velocity decreases, water loses its ability to carry sediment; sediment falls to the substrate, eventually smothering mussels that cannot adapt to soft substrates (Watters 2000, p. 263). Over time, the original mussel species composition of the stream channel may be eliminated or changed in favor of silt-tolerant species (Watters 2000, p. 264). The mussel community may be altered from one with many different species to a community dominated by one to several very common species (Neck 1982b, p. 174). Texas fatmucket does not occur in reservoirs, indicating it is not tolerant of lentic conditions, and it is now extirpated from impounded areas where it occurred prior to inundation. The inundation of stream habitat by impoundments is a likely cause of the reduction in the distribution of the Texas fatmucket. The presence of the impoundments has caused the permanent loss of Texas fatmucket habitat throughout its range.

The loss of seven freshwater mussel species native to Texas, including Texas fatmucket and golden orb, due to impoundment construction was documented on the Medina River (Neck 1989, p. 323). The Medina River was impounded in 1913 by construction of Medina Dam, and now only three different species of mussels, all of which are tolerant of lentic habitats, occur in the impounded area. The bottom of Medina Lake now consists of moderate and steep limestone slopes and excessive silt deposits, whereas before it was most likely made up of a combination of silt, sand, and gravel substrates. Most mussels native to the Medina River were unable to adapt to the change in flowing water and substrate conditions (Neck 1989, p. 323), including the Texas fatmucket, which is no longer found in the river.

Mussels downstream of impoundments are often affected through changes in fish host availability, water quality (particularly lower water temperatures), habitat structure, and stream channel scouring (Vaughn and Taylor 1999, p. 916). The release of cold water from the hypolimnion (deeper and colder layer of water in reservoirs) can decrease the occurrence of fish species adapted to warm water and increase the occurrence of fish species adapted to colder water (Edwards 1978, pp. 73–75). This changes the species composition of suitable host fish and may prevent mussels from completing an essential part of their reproductive cycle. This has been demonstrated by the extirpation of mussel species from several rivers on the eastern seaboard of the United States, which has been linked to the disappearance of appropriate host fish; the reintroduction of the host fish to rivers has enabled mussel species to recolonize areas (Kat and Davis 1984, p. 174). In addition, because mussel reproduction is temperature dependent (Watters and O'Dee 1999, pp. 455–456), it is likely that individual mussels living in cold waters downstream of dam releases may reproduce less frequently, if at all (Layzer *et al.* 1993, p. 69). Low water temperatures can also significantly delay or prevent metamorphosis (Watters and O'Dee 1999, pp. 454–455) and glochidial release, which is often triggered by water temperature (Watters and O'Dee 2000, p. 136).

Similar changes in water temperatures downstream of dams may be responsible for the loss of some Texas fatmucket populations. For example, Canyon Reservoir on the Guadalupe River in Comal County is a deep impoundment built in 1964 that has hypolimnetic water releases. Temperature monitoring stations throughout the Guadalupe River basin show that maximum temperatures above Canyon Reservoir averaged 29.6 degrees Celsius (°C) (85.3 degrees Fahrenheit (°F)); the maximum stream temperatures below the reservoir averaged only 19.7 °C (67.5 °F) (Edwards 1978, p. 72). After impoundment, dissolved oxygen and water temperature dropped, with an accompanying drop in mussel numbers and species diversity (Young *et al.* 1976, p. 216). According to historical museum records analyzed by Randklev *et al.* (2010b, pp. 1–32), the Texas fatmucket once occurred in this area of the Guadalupe River prior to the construction of Canyon Reservoir. The Guadalupe River and Canyon Lake in Comal and Kendall Counties were surveyed in 2009, and no live or recently dead Texas fatmucket were found (Burlakova and Karatayev 2010a, pp. 12–13). We reasonably conclude that the loss of the Texas fatmucket from this area was caused by the changes to the aquatic habitat of the Guadalupe River from the effects of Canyon Reservoir. Many of the dams throughout the range of Texas fatmucket have hypolimnetic water releases, including Canyon Reservoir on the Guadalupe River (Magnelia 2001, p. 1), and Inks Lake, Lake LBJ (Schnoor and Fruh 1979, p. 506), and Lake Travis (Texas Natural Resource Conservation Commission 2001, p. 4) on the Colorado River, among others. We anticipate that changes in water temperatures from water released by these and other reservoirs also alter mussel habitats in streams, causing the elimination of mussel populations downstream.

In addition to the temperature of water released from dams, highly fluctuating, turbulent tailwaters devoid of sediment will scour the riverbed downstream of dams, rendering the area without mussel habitat (Layzer *et al.* 1993, p. 69). Depending on the use of the dam, water levels may fluctuate on a regular interval (for hydroelectric purposes) or at random (for flood control) (Watters 2000, p. 265). On the Colorado River, Inks Lake, Lake Marble Falls, Lake Buchanan, Lake Austin, Lake Travis, and Lady Bird Lake are each used for one or both of these purposes. Mortality of another rare mussel species in Texas, the Texas heelsplitter (*Potamilus amphichaenus*) was attributed to scheduled dewatering of the Neches River below B.A. Steinhagen Reservoir in east Texas (Neck and Howells 1994, p. 15).

Fluctuating water levels below dams also result in dramatic changes in water velocity. Downstream of Lake Livingston on the Trinity River in east Texas, for example, high-volume water discharges and abrupt stoppages of flow resulted in a river bed composed of large rocks and shifting sand (Neck and Howells 1994, p. 14); these kinds of habitat changes would be inhospitable to Texas fatmucket below the dams within its range. In some rivers this unstable zone may be extensive. For example, on the Brazos River downstream of Possum Kingdom Reservoir in Texas exhibited unstable substrate for 150 km (240 mi) below the dam (Yeager 1993, p. 68).

In one study of the downstream effects of dams, Vaughn and Taylor (1999, p. 915) found a strong, gradual, linear increase in mussel species richness and abundance at sites on the Little River in Oklahoma downstream from Pine Creek Reservoir. Their research revealed that mussel species richness and total abundance did not begin to rebound until 20 km (12 mi) downstream of the impoundment and did not peak until 53 km (33 mi) downstream. They noted the most obvious difference since reservoir construction has been the alteration of the flow and temperature regimes, which gradually return to pre-impoundment levels with downstream distance from the dam. These alterations appear to have produced an extinction gradient of mussels that is most severe near the dam (Vaughn and Taylor 1999, p. 915). We expect similar effects on the Texas fatmucket and other Texas mussels downstream of dams.

In one area on the Guadalupe River in Kerr County, a Texas fatmucket population once existed directly below a small dam (Howells 1997a, p. 36), indicating the effects of the dam construction and closure were not immediately lethal. However, the population has been presumed extirpated since 1998 (Howells 2006, p. 71), and it is likely that fluctuating downstream flows from the dam contributed to the loss of this population.

Dam construction also fragments the range of Texas fatmucket, leaving remaining habitats and populations isolated by the structures as well as by extensive areas of deep uninhabitable, impounded waters. These isolated populations are unable to naturally recolonize suitable habitat that may be impacted by temporary but devastating events, such as severe drought, floods, or pollution. Dams impound river habitats throughout almost the entire range of the species, and these impoundments have left short and isolated patches of remnant habitat, typically between impounded reaches.

In summary, the widespread construction of dams has affected the Texas fatmucket throughout its range by significantly altering stream habitat both upstream and downstream of the dams by changing fish assemblages, water depths and velocities, water temperature, dissolved oxygen, substrate, and stream channels. The effects of dams are ongoing and continue to negatively impact the Texas fatmucket rangewide. Because of this loss of habitat and its effects on the populations, we find that the effects of impoundments are a threat to the Texas fatmucket.

Sedimentation

Siltation and general sediment runoff is a pervasive problem in streams and has been implicated in the decline of stream mussel populations (Ellis 1936, pp. 39–40; Vannote and Minshall 1982, p. 4105; Dennis 1984, p. ii; Brim Box and Mossa 1999, p. 99; Fraley and Ahlstedt 2000, pp. 193–194). Specific biological effects on mussels from excessive sediment include reduced feeding and respiratory efficiency from clogged gills (Ellis 1936, p. 40), disrupted metabolic processes, reduced growth rates, increased substrate instability, limited burrowing activity (Marking and Bills 1979, pp. 208–209; Vannote and Minshall 1982, p. 4106), physical smothering, and disrupted host fish attractant mechanisms (Hartfield and Hartfield 1996, p. 373). The primary effects of excess sediment on mussels are sublethal, with detrimental effects not immediately apparent (Brim Box and Mossa 1999, p. 101).

The physical effects of sediment on mussel habitats are multifold and include changes in suspended material load; changes in streambed sediment composition from increased sediment production and runoff in the watershed; changes in the form, position, and stability of stream channels; changes in water depth or the width-to-depth ratio, which affects light penetration and flow regime; actively aggrading (filling) or degrading (scouring) channels; and changes in channel position that may leave mussels stranded (Brim Box and Mossa 1999, pp. 109–112).

Increased sedimentation and siltation may explain, in part, why Texas fatmucket appear to be experiencing recruitment failure in some streams. Interstitial spaces (small openings between rocks and gravels) in the substrate provide essential habitat for juvenile mussels. When clogged with sand or silt, interstitial flow rates and spaces may become reduced (Brim Box and Mossa 1999, p. 100), thus reducing juvenile habitat availability. Juvenile freshwater mussels, including Texas fatmucket juveniles, burrow into interstitial substrates, making it particularly susceptible to degradation of this habitat.

Even in 1959, both the Colorado and Guadalupe Rivers were noted as having high sedimentation rates from agricultural activities (Soil Conservation Service 1959, pp. 56, 59). Approximately 40 percent of U.S. river miles do not meet Clean Water Act standards due to excessive sediment loads (Environmental Protection Agency (EPA) 2000, p. 1), with agricultural activities being the primary source of sediment in streams (Waters 1995, p. 170). In general, sedimentation, resulting from unrestricted access by livestock, has been shown to be a significant threat to many streams and their mussel populations (Fraley and Ahlstedt 2000, p. 193). A primary land use throughout the range of the Texas fatmucket is grazing by cattle, sheep, and goats (Hersh 2007, p. 11). Soil compaction, which reduces vegetative growth, from intensive grazing may reduce infiltration rates and increase runoff and erosion, and trampling of riparian vegetation increases the probability of erosion (Armour *et al.* 1994, p.10; Brim Box and Mossa 1999, p. 103).

Another cause of increased sediments in streams is widespread brush removal, such as that of the native plant, *Juniperus ashei* (Ashe juniper), throughout central Texas. *Juniperus ashei* removal can cause a marked increase in sediment runoff into streams (Greer 2005, p. 76). The Texas State Soil and Water Conservation Board has a funding program specifically for *Juniperus ashei* removal in Blanco, Gillespie, Kerr, Kendall, and Travis Counties (Gillespie County Soil and Water Conservation District 2011, p. 1), which includes the watersheds of three known Texas fatmucket populations in Live Oak Creek, Threadgill Creek, and the upper Guadalupe River. In one example, Howells (2010f, p. 6) noted increased sediment deposition after widespread *Juniperus ashei* removal upstream of the Texas fatmucket population in Live Oak Creek.

Sedimentation may become an increasing threat to the Texas fatmucket in the Colorado and Guadalupe River basins as the Austin and San Antonio metro areas continue to expand. Activities associated with urbanization, such as road construction and increased impervious surfaces (surfaces that do not allow infiltration of rain water), can be detrimental to stream habitats (Couch and Hamilton 2002, p. 1). Runoff from increased impervious surfaces increases sediment loads in streams and destabilizes stream channels (Pappas *et al.* 2008, p. 151). Impervious surfaces also result in channel instability by accelerating stormwater runoff, which increases bank erosion and bed scouring, thereby further increasing downstream sedimentation (Brim Box and Mossa 1999, p. 103). While erosion and sedimentation associated with road construction may be temporary, the existence of road crossings is shown to have ongoing impacts to mussel habitat. For example, in the Guadalupe River, road crossings were found to cause a long-term increase in sedimentation both upstream and downstream, as channel constriction reduced flow upstream, causing sediment deposition, and runoff from the road increased sedimentation downstream (Keen-Zebert and Curran 2009, p. 301). Urban development activities may also affect streams and their mussel fauna where adequate streamside buffers are not maintained and erosion from adjacent land is allowed to enter streams (Brainwood *et al.* 2006, p. 511).

Large projects that reduce vegetative cover within the watersheds supporting Texas fatmucket populations can also increase sedimentation flowing into streams. For example, the Lower Colorado River Authority Transmission Services Corporation (LCRA TSC) is proposing to construct two new 345-kilovolt (kV) electric transmission line facilities between Tom Green (in the Colorado River basin near San Angelo) and Kendall Counties (in the Guadalupe River basin north of San Antonio) to provide electrical power to accommodate increased human populations (Clary 2010, p. 1). All of the proposed project routes occur within the range of the Texas fatmucket. Two proposed segments would cross through Live Oak Creek, one through the San Saba River, and one through the upper Guadalupe River; all of these streams contain populations of the Texas fatmucket. The proposed project could negatively affect Texas fatmucket habitat if construction or maintenance of the transmission line requires removal of vegetation within the riparian zone and that removal results in an increase in sediment runoff into Live Oak Creek and the Guadalupe and San Saba Rivers (Clary 2010, pp. 7, 9, 15). Similar infrastructure development activities to accommodate Texas population growth are expected to be undertaken across the species' range and will likely lead to additional sources of sediment in the streams inhabited by the Texas fatmucket.

Streams occupied by Texas fatmucket are subject to increasing levels of sedimentation from agricultural activities, instream sand and gravel mining, vegetation removal, and urbanization. All of these activities are ongoing throughout the range of the Texas fatmucket and are unlikely to decrease, resulting in significant threats to the Texas fatmucket.

Dewatering

River dewatering can occur in several ways: Anthropogenic activities such as surface water diversions and groundwater pumping, and natural events, such as drought. Surface water diversions and groundwater pumping can lower water tables, reducing river flows and reservoir levels. When water levels in streams and reservoirs are lowered dramatically, it can result in mussels being stranded and dying in previously wetted areas. This is a particular concern within and below reservoirs where water levels are managed for purposes that result in water levels in the reservoir or downstream to rise or fall in very short periods of time, such as when hydropower facilities release water during peak energy demand periods. Rivers can also be dewatered to expedite construction activities, which happened in the upper Guadalupe River in Kerr County in 1998 for bridge construction; numerous Texas fatmuckets were exposed and desiccated (dried out and died) (Howells 1999, pp. 18–19).

Drought can also severely affect Texas fatmucket populations. For example, near-record dry conditions in 2008, followed by a pattern of below-normal rainfall during the winter and spring of 2009, led to one of the worst droughts in recorded history for most of central Texas, including the range of the Texas fatmucket (Nielsen-Gammon and McRoberts 2009, p. 2). This drought's severity was exacerbated by abnormally high air temperatures, a likely effect of climate change, which has increased average air temperatures in Texas by at least 1 °C (1.8 °F) (Nielsen-Gammon and McRoberts 2009, p. 22). The reservoirs within the Colorado River basin were extremely low during this time due to the drought (Clean Water Action 2011, p. 1), as were river levels. Minimal to no flow was recorded at numerous sites within the basin (U.S. Geological Survey (USGS) 2011a, p. 1). Four of the five current sites of the Texas fatmucket may have had very low flows during the 2009 drought, including populations in the San Saba, Llano, Pedernales, and Guadalupe Rivers (Howells 2010c, pp. 9–10). As low flows persist, mussels face oxygen deprivation, increased water temperature, and, ultimately, stranding (Golladay *et al.* 2004, p. 501). Only the Llano River has been surveyed since 2009, and the species persists in that river (Burlakova and Karatayev 2011, p. 1). Central Texas is currently experiencing another extreme drought, with rainfall between October 2010 and July 2011 being the lowest on record during those months (LCRA 2011c, p. 1), and the effects of this drought are being observed but are not yet fully known. As of the date of publication of this finding, the Llano River has nearly stopped flowing (Mashhood 2011, p. 1); this has undoubtedly affected Texas fatmucket populations in this river.

We do not know the extent of the impacts of stream dewatering on the Texas fatmucket; however, because this species' populations are so small and isolated, the loss of numerous individuals at a site can have dramatic consequences to the population. Hydropower facilities, construction, surface water diversions, groundwater pumping, and drought are occurring throughout the range of the Texas fatmucket; therefore, the effects of dewatering are ongoing and unlikely to decrease in the future, resulting in significant threats to the Texas fatmucket.

Sand and Gravel Mining

Sand and gravel mining (removing bed materials from streams) has been implicated in the destruction of mussel populations across the United States (Hartfield 1993, pp. 136–138). Sand and gravel mining causes stream instability by increasing erosion and turbidity (a measure of water clarity) and causing subsequent sediment deposition downstream (Meador and Layher 1998, pp. 8–9). These changes to the stream can result in large-scale changes to aquatic fauna, by altering habitat and affecting spawning of fish, mussels, and other aquatic species (Kanehl and Lyons 1992, pp. 4–11).

Sedimentation and increased turbidity can accrue from instream mining activities. In the Brazos River, a gravel dredging operation was documented as depositing sediment as far as 1.6 km (1 mi) downstream (Forshage and Carter 1973, p. 697). Accelerated streambank erosion and downcutting of streambeds are common effects of instream sand and gravel mining, as is the mobilization of fine sediments during sand and gravel extraction (Roell 1999, p. 7).

Mining activities may threaten some local Texas fatmucket populations. Currently, one mining operation is permitted near the population in Onion Creek (TPWD 2008c, p. 1), and another in the Llano River watershed in Kimble County (TPWD 2008a, p. 1). The permits allow for repeated removal of sand and gravel at various instream locations. Two additional mining operations occur in historical habitat for the species—the mainstem Colorado River (U.S. Army Corps of Engineers (USACE) 2010, p. 2) and Johnson Creek (TPWD 2007a, p. 1).

In areas where repeated mining occurs, an upstream progression of channel degradation and erosion (called headcutting) can occur (Meador and Layher 1998, p. 8). Headcutting may move miles upstream in a zipper-like fashion as the upper boundary of the modified area collapses. Headcutting can be found within the majority of rivers and streams in Texas, including within the Texas fatmucket's current and historical range (Kennon *et al.* 1967, p. 22). Headcuts induced by sand and gravel mining can cause dramatic changes in streambank and channel shape that may affect instream flow, water chemistry and temperature, bank stability, and siltation (Meador and Layher 1998, p. 8), all of which are harmful to freshwater mussels. Mussels are particularly vulnerable to channel degradation and sedimentation processes associated with headcutting due to their immobility (Pringle 1997, p. 429).

In addition to headcutting, mines that are located near stream channels are subject to the gravel pit being captured by the stream during flood events or due to gradual channel migration (Simmang and Curran 2006, p. 1). For example, two gravel mines along the Colorado River downstream of Austin were inundated; one by stream channel migration in 1984, one by stream capture in 1991 (Simmang and Curran 2006, p. 1). Once captured by the mainstem river, gravel mines contribute large amounts of suspended sediment to the river, causing additional turbidity and sedimentation and further degrading mussel habitat.

Two Texas fatmucket populations in the mainstem Colorado River and Johnson Creek may be currently affected by sand and gravel mining. These activities occur over a long period of time, destabilizing habitat and altering substrates and banks both upstream and downstream. Altered habitat will cause a decrease in the likelihood of recolonization by mussels after the activity has been completed. Therefore, the effects of sand and gravel mining are an ongoing threat to the Texas fatmucket.

Chemical Contaminants

Chemical contaminants are ubiquitous throughout the environment and are a major reason for the decline of freshwater mussel species nationwide (Richter *et. al.* 1997, p. 1081; Strayer *et al.* 2004, p. 436; Wang *et al.* 2007a, p. 2029). Chemicals enter the environment through both point and nonpoint discharges, including spills, industrial sources, municipal effluents, and agriculture runoff. These sources contribute organic compounds, heavy metals, pesticides, herbicides, and a wide variety of newly emerging contaminants to the aquatic environment. As a result, water quality can be degraded to the extent that mussel populations are adversely affected.

Chemical and oil spills can be especially devastating to mussels because they may result in exposure of a relatively immobile species to elevated concentrations that far exceed toxic levels. Acute and chronic exposure to oil spills in freshwater systems is largely understudied; therefore, little information is available on effects of oil spills on freshwater ecosystems (Harrel 1985, p. 223; Bhattacharyya *et al.* 2002, p. 205). Oil is retained much longer in marshes and other low-energy environments, such as slow-moving streams and rivers, than on wave-swept coasts (Bhattacharyya *et al.* 2002, p. 205). Oils have been found in sediments at low energy sites as much as 5 years after the occurrence of spills, and they may be released into the water column long after the initial spill. Oil may have various chronic effects on water-column and benthic (bottom-dwelling) species. These effects include sensory disruption, behavioral and developmental abnormalities, and reduced fertility (Bhattacharyya *et al.* 2002, p. 205). Oil spilled on the water surface may also limit oxygen exchange, coat the gills of aquatic organisms, and cause pathological lesions on respiratory surfaces, thereby affecting respiration in aquatic organisms. Effects of oil on freshwater mussels may result from oil settling on the sediment surfaces and accumulating in the sediment. This can prevent invertebrate colonization (Bhattacharyya *et al.* 2002, p. 205). Complete recovery of benthic communities may be a matter of years, with communities in the meantime consisting solely of pollutant-tolerant organisms (Bhattacharyya *et al.* 2002, p. 205). Oil spills can occur from on-site accidents (tank, pipeline spills) or from tanker truck accidents within watersheds occupied by Texas fatmucket. For example, 450 gallons of oil were spilled into Lake Bastrop, a reservoir on a tributary to the Colorado River, in February 2011 (Cihock 2011, p. 1).

Exposure of mussels to persistent low concentrations of contaminants likely to be found in aquatic environments can also adversely affect mussels and their populations. Such concentrations may not be immediately lethal, but over time can result in mortality, reduced filtration efficiency, reduced growth, decreased reproduction, changes in enzyme activity, and behavioral changes to all mussel life stages (Naimo 1995, pp. 351–352; Baun *et al.* 2008, p. 392). Frequently, procedures that evaluate the ''safe'' concentration of an environmental contaminant (for example, national water quality criteria) do not have data for freshwater mussel species or do not consider data that are available for freshwater mussels (March *et al.* 2007, pp. 2066–2067, 2073).

One chemical that is particularly toxic to early life stages of mussels is ammonia. Sources of ammonia include agricultural activities (animal feedlots and nitrogenous fertilizers), municipal wastewater treatment plants, and industrial waste (Augspurger *et al.* 2007, p. 2026), as well as precipitation and natural processes (decomposition of organic nitrogen) (Goudreau *et al.* 1993, p. 212; Hickey and Martin 1999, p. 44; Augspurger *et al.* 2003, p. 2569; Newton 2003, p. 2543). Therefore, ammonia is considered a limiting factor for survival and recovery of some mussel species due to its ubiquity in aquatic environments, high level of toxicity, and because the highest concentrations typically occur in mussel microhabitats (Augspurger *et al.* 2003, p. 2574). In addition, studies have shown that ammonia concentrations increase with increasing temperature and low-flow conditions (Cherry *et al.* 2005, p. 378; Cooper *et al.* 2005, p. 381), which may be exacerbated during low-flow events in streams. Within the range of Texas fatmucket, high ammonia levels are common, either chronically, such as in Elm Creek, which is listed as impaired due to high ammonia concentrations (Texas Commission on Environmental Quality (TCEQ) 2010a, p. 294), or due to spills. A wastewater leak in August 2010 spilled approximately 380,000 liters (L) (100,000 gallons (gal)) of sewage into Elm Creek (Bramlette and Cosel 2010, p. 1); ammonia is present in high concentrations in sewage, among other pollutants. Additionally, a sewage spill in 2008 in Onion Creek discharged nearly 380,000 L (100,000 gal), and another sewage spill occurred in April 2011 in Quinlan Creek, a tributary to the Guadalupe River near the Kerr County population (MacCormack 2011, p. 1). High ammonia levels from chronic sources as well as from spills may be affecting Texas fatmucket populations.

In addition to ammonia, agricultural sources of chemical contaminants include two broad categories that have the potential to adversely affect mussel species: Nutrients and pesticides. High amounts of nutrients, such as nitrogen and phosphorus, in streams can stimulate excessive plant growth (algae and periphyton, among others), which in turn can reduce dissolved oxygen levels when dead plant material decomposes. Nutrient over-enrichment in streams is primarily a result of runoff of fertlizer and animal manure from livestock farms, feedlots, and heavily fertilized row crops (Peterjohn and Correll 1984, p. 1471). Over-enriched conditions are exacerbated by low-flow stream conditions, such as those experienced during typical summer season flows. Bauer (1988, p. 244) found that excessive nitrogen concentrations can be detrimental to the adult freshwater pearl mussel (*Margaritifera margaritifera*), as was evident by the positive linear relationship between mortality and nitrate concentrations. Also, a study of mussel life span and size (Bauer 1992, p. 425) showed a negative correlation between growth rate and high nutrient concentrations, and longevity was reduced as the concentration of nitrates increased. Juvenile mussels in interstitial habitats are particularly affected by depleted dissolved oxygen levels resulting from nutrient over-enrichment (Sparks and Strayer 1998, p. 133). The Texas fatmucket occurs within the Concho River watershed, which has been documented as having particularly high nitrates for nearly 20 years, likely due to intensive agriculture in the area (Texas Clean Rivers Program 2008, p. 2), which may be affecting the Texas fatmucket population.

Mussels are also affected by metals (Keller and Zam 1991, p. 543) such as cadmium, chromium, copper, mercury, and zinc, which can negatively affect biological processes such as growth, filtration efficiency, enzyme activity, valve closure, and behavior (Keller and Zam 1991, p. 543; Naimo 1995, pp. 351–355; Jacobson *et al.* 1997, p. 2390; Valenti *et al.* 2005, p. 1244). Metals occur in industrial and wastewater effluents and are often a result of atmospheric deposition from industrial processes and incinerators. Studies have shown that copper can have toxic effects on glochidia and juvenile freshwater mussels (Wang *et al.* 2007a, pp. 2036–2047; Wang *et al.* 2007b, pp. 2048–2056). In the range of Texas fatmucket, high copper concentrations have been recorded in fish in the lower Guadalupe River and San Antonio River (Lee and Schultz 1994, p. 8). While these high levels of copper in fish are not directly informative of the level of copper within the habitat of the Texas fatmucket, these observations demonstrate that copper levels are likely high in the lower Guadalupe and San Antonio Rivers. Because we know that copper contamination in water can lead to death of mussels, we conclude that the copper may be adversely affecting Texas fatmucket.

Mercury is another heavy metal that has the potential to negatively affect mussel populations, and it is widely distributed in the environment. Mercury has been detected throughout aquatic environments as a product of municipal and industrial waste and atmospheric deposition from coal burning plants. Rainbow mussel (*Villosa iris*) glochidia have been demonstrated to be more sensitive to mercury than juvenile mussels, with the median lethal concentration value of 14 parts per billion (ppb) for glochidia, compared to 114 ppb for the juvenile life stages (Valenti 2005, p. 1242). The chronic toxicity tests conducted determined that juveniles exposed to mercury greater than or equal to 8 ppb exhibited reduced growth. Acute mercury toxicity was determined to be the cause of extirpation of a diverse mussel community for a 112 km (70 mi) portion of the North Fork Holston River in Virginia (Brown *et al.* 2005, pp. 1455–1457). Mercury has been documented throughout the Guadalupe and San Antonio Rivers, with particularly high concentrations in fish in the upper reaches of both rivers (Lee and Schultz 1994, p. 8). As with copper, we do not have information on the concentration of mercury that Texas fatmucket is being exposed to in these streams, but the higher than expected levels in fish indicate high mercury levels in the area, which may be adversely affecting Texas fatmucket.

Pesticides are another source of contaminants in streams. Elevated concentrations of pesticides frequently occur in streams due to pesticide runoff, overspray application to row crops, and lack of adequate riparian buffers. The timing of agricultural pesticide applications in the spring often coincides with the reproductive and early life stages of mussels, which may increase the vulnerability of mussels to pesticides (Bringolf *et al.* 2007a, p. 2094). Little is known regarding the effect of currently used pesticides to freshwater mussels even though some pesticides, such as glyphosate (active ingredient in Roundup®), are used globally. Recent studies tested the toxicity of glyphosate, its formulations, and a surfactant (MON 0810) used in several glyphosate formulations, to early life stages of the fatmucket (*Lampsilis siliquoidea*) (Bringolf *et al.* 2007a, p. 2094), a freshwater mussel closely related to the Texas fatmucket. Studies conducted with fatmucket juveniles and glochidia determined that the surfactant was the most toxic of the compounds tested and that fatmucket glochidia were the most sensitive organisms tested to date (Bringolf *et al.* 2007a, p. 2094). Roundup®, technical grade glyphosate isopropylamine salt, and isopropylamine were also acutely toxic to juveniles and glochidia (Bringolf *et al.* 2007a, p. 2097). These commonly applied pesticides may be adversely affecting Texas fatmucket populations.

The effects of other widely used pesticides, including atrazine, chlorpyrifos, and permethrin, on glochidia and juvenile life stages have also recently been studied (Bringolf *et al.* 2007b, p. 2101). Environmentally relevant concentrations (concentrations that may be found in streams) of permethrin and chlorpyrifos were found to be toxic to glochidia and juvenile fatmucket (Bringolf *et al.* 2007b, pp. 2104–2106). Commonly applied pesticides are a threat to mussels as a result of their widespread use. All of these pesticides are commonly used on agricultural lands throughout the range of the Texas fatmucket, which may be adversely affecting the species.

A potential, but undocumented, threat to freshwater mussels, including Texas fatmucket, are compounds referred to as ''emerging contaminants'' that are being detected in aquatic ecosystems at an increasing rate. These include pharmaceuticals, hormones, and other organic contaminants that have been detected downstream from urban areas and livestock production (Kolpin *et al.* 2002, p. 1202) and have been shown to affect fish behavior (TCEQ 2010b, p. 3). In samples of the Trinity River, for example, compounds such as antidepressants, antihistamines, blood pressure lowering medication, anti-seizure medication, and antimicrobial compounds were all detected during a 2006 study (TCEQ 2010b, pp. 27–28). A large potential source of these emerging contaminants is wastewater being discharged through both permitted (National Pollutant Discharge Elimination System (NPDES)) and non-permitted sites within the Colorado and Guadalupe River systems. Although streams within the range of Texas fatmucket have not been tested for these emerging contaminants, permitted discharge sites are ubiquitous in watersheds with Texas fatmucket populations, providing many opportunities for contaminants to impact the species.

A study in the Blanco River found that mussels may be adversely affected by sewage effluent (Horne and McIntosh 1979, p. 132). Ammonia levels below the outfall were three times higher than the levels above the outfall and were higher than recently determined toxicity values of ammonia for mussels (Augsperger *et al.* 2003, p. 2572). The river was nutrient-enriched for miles downstream, and mussels were less abundant below the outfall than above (Horne and McIntosh 1979, pp. 124–125, 132). Texas fatmucket have not been found alive in the Blanco River since 1978.

Texas Commission on Environmental Quality (TCEQ) data for 2010 indicated that 26 of the 98 assessed water bodies within the Texas fatmucket's historical and current range did not meet surface water quality standards and were classified as impaired water bodies under the Clean Water Act (Texas Clean Rivers Program 2010a, p. 5; 2010b, p. 13), including Elm Creek, due to high ammonia. These water bodies were impaired with dissolved solids, nitrates, bacteria, low dissolved oxygen, aluminum, sulfates, selenium, chloride, and low pH associated with agricultural, urban, municipal, and industrial runoff. Of these, nitrates and low dissolved oxygen pose the greatest threat to Texas fatmucket, as discussed above. Chemical contaminants, such as oil, ammonia, copper, mercury, nutrients, pesticides, and other compounds, are currently a threat to the Texas fatmucket. The species is vulnerable to acute contamination from spills, which have been documented in four of the seven remaining populations, as well as chronic contaminant exposure, which is occurring rangewide.

Summary of Factor A

The reduction in numbers and range of the Texas fatmucket is primarily the result of the long-lasting effects of habitat alterations such as the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Impoundments occur throughout the range of the species and have far-reaching effects both up- and downstream. Both the Colorado and Guadalupe River systems have experienced a large amount of sedimentation from agriculture, mining, urban development, and widespread *Juniperus ashei* removal. Sand and gravel mining affects Texas fatmucket habitat by increasing sedimentation and channel instability downstream and causing headcutting upstream. Finally, chemical contaminants have been documented throughout the range of the species and are significant concern to Texas fatmucket. Based upon our review of the best commercial and scientific data available, we conclude that the present or threatened destruction, modification, or curtailment of its habitat or range is an immediate threat of high magnitude to the Texas fatmucket.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

The Texas fatmucket is not a commercially valuable species and has never been harvested in Texas as a commercial mussel species (Howells 2010c, p. 11), although in the Llano River shells were found that were apparently collected by anglers for use as bait (Howells 1996, p. 22; 2010c, p. 11). Additionally, the Elm Creek population is suspected to have declined in part due to the publication of detailed location information, which may have inspired collectors to visit the site (Howells 2009, pp. 5–6). Scientific collecting is not likely to be a significant threat to the status of the species, although disturbing gravid females can result in glochidial loss and subsequent reproductive failure. Additionally, handling has been shown to reduce shell growth in other mussel species, including several other species of *Lampsilis* (Haag and Commens-Carson 2008, pp. 505–506). Repeated handling by researchers may adversely affect Texas fatmucket individuals, but these activities are occurring rarely and are not likely to be a threat to populations. Handling for scientific purposes contributes to the long-term conservation of the species.

We do not have any evidence of risks to the Texas fatmucket from overutilization for commercial, recreational, scientific, or educational purposes, and we have no reason to believe this factor will become a threat to the species in the future. Based upon the best scientific and commercial information available, we conclude that overutilization for commercial, recreational, scientific, or educational purposes does not pose a significant threat to the Texas fatmucket.

Factor C. Disease and Predation.

Disease

Little is known about disease in freshwater mussels. However, disease is believed to be a contributing factor in documented mussel die-offs in other parts of the United States (Neves 1987, pp. 11–12). Diseases have not been documented or observed during any studies of Texas fatmucket.

Predation

Raccoons have preyed on individual Texas fatmuckets stranded by low waters or deposited in shallow water or on bars following flooding or low water periods (Howells 2010c, p. 12). Predation of Texas fatmucket by raccoons may be occurring occasionally but there is no indication it is a significant threat to the status of the species.

Some species of fish feed on mussels, such as common carp (*Cyprinus carpio),* freshwater drum, and redear sunfish (*Lepomis microlophus*), all of which are common throughout the range of Texas fatmucket (Hubbs *et al.* 2008, pp. 19, 45, 53). Common species of flatworms are voracious predators of newly metamorphosed juvenile mussels of many species (Zimmerman *et al.* 2003, p. 30), including other species in the genus *Lampsilis* (Delp 2002, pp. 12–13). Predation is a normal aspect of the population dynamics of a healthy mussel population; however, predation may amplify declines in small populations.

Summary of Factor C

Disease in freshwater mussels is poorly known, and we do not have any information indicating it is a threat to the Texas fatmucket. Additionally, while predation is likely occurring within Texas fatmucket populations, it is a natural ecological interaction and we have no information indicating the extent of such predation is large enough to be a threat to populations of Texas fatmucket. Based upon the best scientific and commercial information available, we conclude that disease or predation is not a threat to the Texas fatmucket.

Factor D. The Inadequacy of Existing Regulatory Mechanisms.

The Act requires us to examine the adequacy of existing regulatory mechanisms with respect to threats that may place the Texas fatmucket in danger of extinction or increase its likelihood of becoming so in the future. Existing regulatory mechanisms that could affect threats to the Texas fatmucket include State and Federal laws such as the Texas Threatened and Endangered Species regulations, Texas freshwater mussel sanctuaries, State and Federal sand and gravel mining regulations, and regulation of point and non-point source pollution.

Texas Threatened and Endangered Species Regulations

On January 8, 2010, the Texas Parks and Wildlife Commission placed 15 species of freshwater mussels, including the Texas fatmucket, on the State threatened list (Texas Register 2010, pp. 6–10). Section 68.002 of the Texas Parks and Wildlife (TPW) Code and Section 65.171 of the Texas Administrative Code (TAC) prohibit the direct take of a threatened species, except under issuance of a scientific collecting permit. ''Take'' is defined in Section 1.101(5) of the TPW Code as collect, hook, hunt, net, shoot, or snare, by any means or device, and includes an attempt to take or to pursue in order to take. While this law protects individuals from take, it is difficult to enforce and does not provide any protection for Texas fatmucket habitat. Moreover, our assessment finds that the species is not threatened by take (see Factor B above). There are no State provisions under the Texas Threatened and Endangered Species Regulations for reducing or eliminating the threats (see Factor A above) that may adversely affect Texas fatmucket or its habitat. In addition, these State regulations do not call for development of a recovery plan that will restore and protect existing habitat for the species. For these reasons, we find that existing Texas regulatory mechanisms for State-listed threatened species are currently inadequate to protect Texas fatmucket and its habitat or to prevent further decline of the species.

Freshwater Mussel Sanctuaries

The TPWD has designated specific areas of streams and reservoirs as no-harvest mussel sanctuaries (31 TAC, part 2, chapter 57, subpart B, Rule 57.157). The locations of the designated mussel sanctuaries were selected because they support populations of rare and endemic mussel species or are important for maintaining, repopulating, or allowing recovery of mussels in watersheds where they have been depleted. As a result of the designation of mussel sanctuaries, four of the Texas fatmucket populations are protected from harvesting disturbance of other species (Howells 2010f, p. 12). Unfortunately, mussel sanctuaries only restrict the harvest of mussels and do not address other activities that may affect mussels or their habitats. Therefore, these designations provide no regulatory mechanisms to protect Texas fatmucket from habitat alteration.

State Sand and Gravel Mining Regulations

TPWD has been responsible for regulating the ''disturbance of taking'' streambed materials since 1911 (Meador and Layher 1998, p. 11) and has issued several permits for ongoing activities within the Texas fatmucket range (for more information on the effects of sand and gravel mining on Texas fatmucket, please refer to ''Sand and Gravel Mining'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket*). In addition to authorized activities, there are ongoing unauthorized sand and gravel mining activities within the range of Texas fatmucket. For example, the LCRA, which monitors water quality permit applications submitted through other agencies (LCRA 2011b, p. 1), found unpermitted sand removal from the Llano River in Llano County during a site visit in 2010 (Lehman 2010, p. 1). This site is located upstream from a known population of the Texas fatmucket and other rare mussels (Howells 1994, p. 6), and the sand removal may have increased turbidity and sedimentation downstream within Texas fatmucket habitat. Sand and gravel mining may be one of the least regulated of all mining activities (Meador and Layher 1998, p. 10).

Clean Water Act

The U.S. Army Corps of Engineers (USACE) retains oversight authority and requires a permit for gravel and sand mining activities that deposit fill into streams under section 404 of the Clean Water Act (33 U.S.C. 1251 *et seq.*). Additionally, a permit is required under section 10 of the Rivers and Harbors Act (33 U.S.C. 401 *et seq.*) for navigable waterways. However, many mining operations do not fall under these two categories. For example, nationwide permits are issued by the USACE for types of projects that are presumed to have minimal environmental impacts. However, projects permitted by nationwide permits, such as small mining operations, may have cumulative effects on aquatic species like the Texas fatmucket through increased sedimentation and channel instability.

Point source discharges of potential contaminants within the range of the Texas fatmucket have been reduced since the inception of the Clean Water Act, but this reduction may not provide adequate protection for filter-feeding organisms that can be affected by extremely low levels of contaminants (see ''Chemical Contaminants'' under Factor A in the *Five-Factor Evaluation for Texas Fatmucket* section). The EPA's established water quality criteria may not be protective of mussels. Current water quality standards applied by EPA were established to be protective of aquatic life; however, freshwater mussels were not used to develop these standards (EPA 2005, p. 5), and current research reveals mussels to be more sensitive to many aquatic pollutants than the tested organisms (Augspserger *et al.* 2007, p. 2025). For example, Augspurger *et al.* (2003, p. 2572) and Sharpe (2005, p. 28) suggested that the criteria for ammonia may not be sufficient to prevent impacts to mussels under current and future climate conditions. In addition, chronic copper concentrations lethal to juvenile freshwater mussels have been shown to be less than the EPA's 1996 chronic water quality criterion for copper (Wang *et al.* 2007b, pp. 2052–2055), and, as stated above (see ''Chemical Contaminants'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket*), high copper concentrations have been documented in the lower Guadalupe and San Antonio Rivers (Lee and Schultz 1994, p. 8). Based on this information, the existing EPA water quality criteria may not be sufficient to prevent negative effects to the Texas fatmucket.

Nonpoint source pollution such as sedimentation and chemical contaminantation is considered a significant threat to Texas fatmucket habitat; however, the Clean Water Act does not adequately protect Texas fatmucket habitat from nonpoint source pollution, because most activities that cause nonpoint source pollution are not regulated under the Clean Water Act.

Summary of Factor D

Despite some State and Federal laws protecting the species and water quality, the Texas fatmucket continues to decline due to the effects of habitat destruction, poor water quality, contaminants, and other factors. The regulatory measures described above are not sufficient to significantly reduce or remove the threats to the Texas fatmucket. Based upon our review of the best commercial and scientific data available, we conclude that the lack of existing regulatory mechanisms is an immediate threat of moderate magnitude to the Texas fatmucket.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence.

Other natural and manmade factors that threaten the Texas fatmucket include climate change, population fragmentation and isolation, and nonnative species.

Climate Change

It is widely accepted that changes in climate are occurring worldwide (International Panel on Climate Change (IPCC) 2007, p. 30). Understanding the effects of climate change on the Texas fatmucket is important because the disjunct nature of the remaining Texas fatmucket populations, coupled with the limited ability of mussels to migrate, makes it unlikely that the Texas fatmucket can adjust its range in response to changes in climate (Strayer 2008, p. 30). For example, changes in temperature and precipitation can increase the likelihood of flooding or increase drought duration and intensity, resulting in direct effects to freshwater mussels like the Texas fatmucket (Hastie *et al.* 2003, pp. 40–43; Golloday *et al.* 2004, p. 503). Because the range of the Texas fatmucket has been reduced to isolated locations with low population numbers in small rivers and streams, the Texas fatmucket is vulnerable to climatic changes that could decrease the availability of water or produce more frequent scouring flood events. Indirect effects of climate change may include declines in host fish populations, habitat reduction, and changes in human activity in response to climate change (Hastie *et al.* 2003, pp. 43–44).

For the next two decades, a warming of about 0.2 °C (0.4 °F) per decade is projected across the United States (IPCC 2007, p. 12), and hot extremes, heat waves, and heavy precipitation and flooding are expected to increase in frequency (IPCC 2007, p. 18). As with many areas of North America, central Texas is projected to experience an overall warming trend in the range of 2.5 to 3.3 °C (4.5 to 6 °F) over the next 50 to 200 years (Mace and Wade 2008, p. 656). Even under lower greenhouse gas emission scenarios, recent projections forecast a 2.8 °C (5 °F) increase in temperature and a 10 percent decline in precipitation in central Texas by 2080–2099 (Karl *et al.* 2009, pp. 123–124). Based on our current understanding of climate change, air temperatures are expected to rise and precipitation patterns are expected to change in areas occupied by the Texas fatmucket. Karl *et al.* (2009, p. 12) also suggests that climate change impacts on water resources in the southern Great Plains (including central Texas) are expected as rising temperatures and decreasing precipitation exacerbate an area already plagued by low rainfall, high temperatures, and unsustainable water use practices.

One preliminary study forecasting the possible hydrological impacts of climate change on the annual runoff and its seasonality in the upper Colorado River watershed was conducted by CH2M HILL (2008). In this initial evaluation, four modeling scenarios (chosen to represent a range of possible future climatic conditions) were each run under a 2050 and 2080 time scenario, producing annual surface water runoff estimates at multiple sites with stream gages in the Colorado River basin. For the 2050 scenarios, the results from all four climate change scenarios predicted significant decreases in annual runoff totals compared to historic averages (CH2M HILL 2008, pp. 7–30—7–32). For the 2080 scenarios, one model predicted increases in annual runoff; the other three 2080 scenarios predicted decreases in annual runoff (CH2M HILL 2008, pp. 7–30—7–33). The modeling efforts from this study focus on annual averages and cannot necessarily account for the seasonal variations in flooding events or long periods of drought. However, the study demonstrates the potential effects of climate change on surface water availability, which is forecasted to result in an overall decline in stream flows in the region where the Texas fatmucket occurs.

In summary, climate change could affect the Texas fatmucket through the combined effects of global and regional climate change, along with the increased probability of long-term drought. Climate change exacerbates threats such as habitat degradation from prolonged periods of drought, increased water temperature, and the increased allocation of water for municipal, agricultural, and industrial use. As such, climate change, in and of itself, may affect the Texas fatmucket, but the magnitude and imminence (when the effects occur) of the effects remain uncertain. Based upon our review of the best commercial and scientific data available, we conclude that the effects of climate change in the future will likely exacerbate the current and ongoing threats of habitat loss and degradation caused by other factors, as discussed above.

Population Fragmentation and Isolation

All of the remaining populations of the Texas fatmucket are small and geographically isolated and thus are susceptible to genetic drift (change of gene frequencies in a population over time), inbreeding depression, and random or chance changes to the environment, such as toxic chemical spills (Watters and Dunn 1995, pp. 257–258) or dewatering. Inbreeding depression can result in death, decreased fertility, smaller body size, loss of vigor, reduced fitness, and various chromosomal abnormalities (Smith 1974, pp. 350). Despite any evolutionary adaptations for rarity, habitat loss and degradation increase a species' vulnerability to extinction (Noss and Cooperrider 1994, pp. 58–62). Numerous authors (including Noss and Cooperrider 1994, pp. 58–62; Thomas 1994, p. 373) have indicated that the probability of extinction increases with decreasing habitat availability. Although changes in the environment may cause populations to fluctuate naturally, small and low-density populations are more likely to fluctuate below a minimum viable population (the minimum or threshold number of individuals needed in a population to persist in a viable state for a given interval) (Gilpin and Soule 1986, pp. 25–33; Shaffer 1981, p. 131; Shaffer and Samson 1985, pp. 148–150).

The Texas fatmucket was widespread throughout much of the Colorado and Guadalupe River systems when few natural barriers existed to prevent migration (via host species) among suitable habitats. Construction of dams, however, likely destroyed many Texas fatmucket populations through drastic habitat changes and isolated the remnant populations from each other. For fertilization, Texas fatmucket females need an upstream male to release sperm; populations with few individuals reduce the likelihood that females will be exposed to sperm while siphoning. Therefore, recruitment failure is a potential problem for many small populations rangewide, a potential condition exacerbated by its reduced range and increasingly isolated populations. If downward population trends continue, further significant declines in total Texas fatmucket population size and consequent reduction in long-term survivability may soon become apparent.

The small, isolated nature of the Texas fatmucket's remaining populations also increases the species' vulnerability to stochastic (random) natural events. When species are limited to small, isolated habitats, as the Texas fatmucket is, they are more likely to become extinct due to a local event that negatively effects the population (McKinney 1997, p. 497; Minckley and Unmack 2000, pp. 52–53; Shepard 1993, pp. 354–357). While the populations' small, isolated nature does not represent an independent threat to the species, it does substantially increase the risk of extirpation from the effects of all other threats, including those addressed in this analysis, and those that could occur in the future from unknown sources.

Based upon our review of the best commercial and scientific data available, we conclude that fragmentation and isolation of small remaining populations of the Texas fatmucket exacerbate ongoing threats to the species throughout all of its range and are expected to continue.

Nonnative Species

Various nonnative species of aquatic organisms are firmly established within the range of the Texas fatmucket and pose a threat to the species. Golden algae (*Prymnesium parvum*) is a microscopic algae considered to be one of the most harmful algal species to fish and other gill-breathing organisms (Lutz-Carrillo *et al.* 2010, p. 24). Golden algae was first discovered in Texas in 1985 and is presumed to have been introduced from western Europe (Lutz-Carrillo *et al.* 2010, p. 30). Since its introduction, golden algae has been found in Texas rivers and lakes, including two lakes in central Texas (Baylor University 2009, p. 1). Under certain environmental conditions, this algae can produce toxins that can cause massive fish and mussel kills (Barkoh and Fries 2010, p. 1; Lutz-Carrillo *et al.* 2010, p. 24). Evidence shows that golden algae probably caused fish kills in Texas as early as the 1960s, but the first documented fish kill due to golden algae in inland waters of Texas occurred in 1985 on the Pecos River in the Rio Grande basin (TPWD 2002, p. 1). The range of golden algae has increased to include portions of the Brazos and Colorado River basins, among others, and it has been responsible for killing more than 8 million fish in the Brazos River since 1981 and more than 2 million fish in the Colorado River since 1989 (TPWD 2010a, p. 1). Although actual mussel kills in Texas due to golden algae have not been recorded in the past, the toxin can kill mussels. Therefore, the elimination of host fish and the poisonous nature of the toxin to mussels make future golden algae blooms a threat to the Texas fatmucket.

An additional nonnative species, the zebra mussel (*Dreissena polymorpha*), poses a potential threat to the Texas fatmucket. This invasive species has been responsible for the extirpation of freshwater mussels in other regions of the United States, including the Higgin's eye (*Lampsilis higginsii*) in Wisconsin and Iowa (Service 2006, pp. 9–10). Zebra mussels attach in large numbers to the shells of live native mussels and are implicated in the loss of entire native mussel beds (Ricciardi *et al.* 1998, p. 615). This fouling impedes locomotion (both laterally and vertically), interferes with normal valve movements, deforms valve margins, and essentially suffocates and starves the native mussels by depleting the surrounding water of oxygen and food (Strayer 1999, pp. 77–80). Heavy infestations of zebra mussels on native mussels may overly stress the animals by reducing their energy reserves. Zebra mussels may also filter the sperm and possibly glochidia of native mussels from the water column, thus reducing reproductive potential. Habitat for native mussels may also be degraded by large deposits of zebra mussel pseudofeces (undigested waste material passed out of the incurrent siphon) (Vaughan 1997, p. 11).

Zebra mussels are not currently found within the range of the Texas fatmucket. However, a live adult zebra mussel was first documented in Lake Texoma on the Red River (on the north Texas border with Oklahoma) in 2009 (TPWD 2009a, p. 1). Since that time, additional zebra mussels have been reported from Lake Texoma, where they are now believed to be well established (TPWD 2009c, p. 1). Zebra mussels are likely to spread to many other Texas reservoirs through accidental human transport (Schneider *et al.* 1998, p. 789). Although zebra mussels tend to proliferate in reservoirs or large pools, released zebra mussel larvae, called veligers, float downstream and attach to any hard surface available, rendering downstream Texas fatmucket populations extremely vulnerable to attachment and fouling. Because zebra mussels are so easily introduced to new locations, the potential for zebra mussels to continue to expand in Texas and invade the range of the Texas fatmucket is high. If this occurs, the Texas fatmucket is vulnerable to zebra mussel attachment and subsequent deprivation of oxygen, food, and mobility.

A molluscivore (mollusk eater), the black carp (*Mylopharyngodon piceus*) is a potential threat to the Texas fatmucket. The species has been commonly used by aquaculturists to control snails or for research in fish production in several States, including Texas (72 FR 59019, October 18, 2007). Black carp can reach more than 1.3 m (4 ft) in length and 150 pounds (68 kilograms (kg)) (Nico and Williams 1996, p. 6). Foraging rates for a 4-year-old fish average 3 to 4 pounds (1.4 to1.8 kg) a day, indicating that a single individual could consume 10 tons (9,072 kg) of native mollusks over its lifetime (Mississippi Interstate Cooperative Resource Association (MICRA) 2005, p. 1). Black carp can escape from aquaculture facilities. For example, in 1994 30 black carp escaped from an aquaculture facility in Missouri during a flood. Other escapes into the wild by non-sterile carp are likely to occur. Because of the high risk to freshwater mussels and other native mollusks, the Service recently listed black carp as an injurious species under the Lacey Act (72 FR 59019, October 18, 2007), which prevents importations and interstate transfer of this harmful species, but does not prevent its release into the wild once it is in the State. If the black carp were to escape within the range of the Texas fatmucket, it would likely negatively affect native mussels, including the Texas fatmucket.

Based upon our review of the best commercial and scientific data available, we conclude that golden algae is an ongoing threat to the Texas fatmucket, and other nonnative species, such as zebra mussels and black carp, are a potential future threat to the Texas fatmucket that is likely to increase as these exotic species expand their occupancy within the range of the Texas fatmucket.

Summary of Factor E

The effects of climate change, while difficult to quantify at this time, are likely to exacerbate the current and ongoing threat of habitat loss caused by other factors, and the small sizes and fragmented nature of the remaining populations render them more vulnerable to extirpation. In addition, nonnative species, such as golden algae, currently threaten the Texas fatmucket, and the potential introduction of zebra mussels and black carp are potential future threats. Based upon our review of the best commercial and scientific data available, we conclude that other natural or manmade factors are immediate threats of moderate magnitude to the Texas fatmucket.

Finding for Texas Fatmucket

As required by the Act, we considered the five factors in assessing whether Texas fatmucket is threatened or endangered throughout all of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the Texas fatmucket. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with recognized Texas fatmucket experts and other Federal and State agencies.

This status review identified threats to the Texas fatmucket attributable to Factors A, D, and E. The primary threat to the species is from habitat destruction and modification (Factor A) from impoundments, which scour riverbeds, thereby removing mussel habitat, decrease water quality, modify stream flows, and prevent fish host migration and distribution of freshwater mussels, as well as sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Additionally, most of these threats may be exacerbated by the current and projected effects of climate change (discussed in Factor E). Threats to the Texas fatmucket and its habitat are not being adequately addressed through existing regulatory mechanisms (Factor D). Because of the limited distribution of this endemic species and its lack of mobility, these threats are likely to result in the extinction of the Texas fatmucket in the foreseeable future.

On the basis of the best scientific and commercial information available, we find that the petitioned action to list the Texas fatmucket under the Act is warranted. We will make a determination on the status of the species as threatened or endangered when we complete a proposed listing determination. When we complete a proposed listing determination, we will examine whether the species may be endangered or threatened throughout all of its range or whether the species may be endangered or threatened in a significant portion of its range. However, as explained in more detail below, an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove other qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

We reviewed the available information to determine if the existing and foreseeable threats render the Texas fatmucket at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act is warranted. We determined that issuing an emergency regulation temporarily listing the species is not warranted for the Texas fatmucket at this time, because we have not identified a threat or activity that poses a significant risk, such that losses to the species during the normal listing process would endanger the continued existence of the entire species. However, if at any time we determine that issuing an emergency regulation temporarily listing Texas fatmucket is warranted, we will initiate this action at that time.

Listing Priority Number for Texas Fatmucket

The Service adopted guidelines on September 21, 1983 (48 FR 43098), to establish a rational system for utilizing available resources for the highest priority species when adding species to the Lists of Endangered and Threatened Wildlife and Plants or reclassifying species listed as threatened to endangered status. These guidelines, titled ''Endangered and Threatened Species Listing and Recovery Priority Guidelines,'' address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates).

As a result of our analysis of the best available scientific and commercial information, we have assigned the Texas fatmucket a Listing Priority Number (LPN) of 2, based on our finding that the species faces threats that are of high magnitude and are imminent. These threats include habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants; other natural or manmade factors such as climate change, small, isolated populations, and nonnative species; and the fact that the threats to the species are not being adequately addressed by existing regulatory mechanisms. Our rationale for assigning the Texas fatmucket an LPN of 2 is outlined below.

Under the Service's guidelines, the magnitude of threat is the first criterion we look at when establishing a listing priority. The guidance indicates that species with the highest magnitude of threat are those species facing the greatest threats to their continued existence. These species receive the highest listing priority. We consider the threats that the Texas fatmucket faces to be high in magnitude. Habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants are widespread throughout the range of the Texas fatmucket and profoundly affect its survival and recruitment. Remaining populations are small, isolated, and highly vulnerable to stochastic events.

Under our LPN guidelines, the second criterion we consider in assigning a listing priority is the immediacy of threats. This criterion is intended to ensure that the species facing actual, identifiable threats are given priority over those for which threats are only potential or that are intrinsically vulnerable but are not known to be presently facing such threats. We consider the threats to the Texas fatmucket as described under Factors A, D, and E in the *Five-Factor Evaluation for Texas Fatmucket* section to be imminent because these threats have affected the species in the past, are ongoing, and will continue in the foreseeable future. Habitat loss and destruction have already occurred and will continue as the human population continues to grow in central Texas. Texas fatmucket populations may already be below the minimum viable population requirement, which would cause a reduction in the number of populations and an increase in the species' vulnerability to extinction. These threats are exacerbated by climate change, which will increase the frequency and magnitude of droughts. Therefore, we consider these threats to be imminent.

The third criterion in our Listing Priority Number guidance is intended to devote resources to those species representing highly distinctive or isolated gene pools as reflected by taxonomy. The Texas fatmucket is a valid taxon at the species level and, therefore, receives a higher priority than subspecies, but a lower priority than species in a monotypic genus. Therefore, we assigned Texas fatmucket an LPN of 2.

We will continue to monitor the threats to the Texas fatmucket and the species' status on an annual basis, and should the magnitude or imminence of the threats change, we will revisit our assessment of the LPN.

While we conclude that listing the Texas fatmucket is warranted, an immediate proposal to list this species is precluded by other higher priority listings, which we address in the Preclusion and Expeditious Progress section below. Because we have assigned the Texas fatmucket an LPN of 2, work on a proposed listing determination for the species is precluded by work on higher priority listing actions with absolute statutory, court-ordered, or court-approved deadlines and final listing determinations for those species that were proposed for listing with funds from Fiscal Year (FY) 2011. This work includes all the actions listed in the tables below under Preclusion and Expeditious Progress.

Five-Factor Evaluation for Golden Orb

Information pertaining to the golden orb in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.

As discussed above, the decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation. Chief among the causes of decline of the golden orb in Texas are the effects of impoundments, dewatering, sedimentation, sand and gravel mining, chemical contaminants, and off-road vehicle use. These threats are discussed below.

Impoundments

For general information on the effects of impoundments on freshwater mussels, please refer to ''Impoundments'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.* Golden orb occur in one impoundment, Lake Corpus Christi, indicating that inundation may not be as detrimental to this species as it is to other, more flow-dependent mussel species. However, dams continue to fragment golden orb populations. There are 29 reservoirs, each with a storage capacity of 3,000 acre-feet or more, within the Guadalupe River basin and 34 within the San Antonio River basin, in addition to many other smaller reservoirs in these basins (Exelon 2010, p. 2.3–4). Three large reservoirs exist within the Nueces River basin.

Historical records showed that the golden orb once occurred in the Guadalupe River in Comal County before the Canyon Reservoir was constructed in 1964 (Randklev *et al.* 2010c, p. 4). No live or recently dead golden orb have been found in this reach since the reservoir was completed (Burlakova and Karatayev 2010a, pp. 14–15), and we presume the species is extirpated from this reach because of the effects of the reservoir. Surveys of the reservoirs in the Guadalupe River system have been ongoing since at least 1992, and no evidence of live or dead golden orb has been found in any of the reservoirs (Howells 1994, pp. 1–20; 1995, pp. 1–50; 1996, pp. 1–45; 1997a, pp. 1–58; 1998, pp. 1–30; 1999, pp. 1–34; 2000a, pp. 1–56; 2001, pp. 1–50; 2002a, pp. 1–28; 2003, pp. 1–42; 2004, pp. 1–48; 2005, pp. 1–23; 2006, pp. 1–106; Karatayev and Burlakova 2008, pp. 1–47; Burlakova and Karatayev 2010a, pp. 1–30; 2011, pp. 1–8).

For species such as golden orb that may be able to survive the initial inundation of reservoirs, conditions within the reservoir are likely to become uninhabitable. The deep water in reservoirs is very cold and often devoid of oxygen and necessary nutrients (Watters 2000, p. 264). Cold water (less than 11 °C (52 °F)) has been shown to stunt mussel growth (Hanson *et al.* 1988, p. 352). Because mussel reproduction is temperature dependent (Watters and O'Dee 1999, p. 455), it is likely that individuals living in the constantly cold hypolimnion in these channels may never reproduce, or reproduce less frequently (Watters 2000, p. 264). Any golden orb that survived the initial inundation may have been unable to reproduce, eventually eliminating the species from large areas of the reservoir. The same would be true for mussels living in cold-water discharges downstream of large impoundments (Watters 2000, p. 264).

Dam construction also fragments the range of golden orb, leaving remaining habitats and populations isolated by the structures, as well as by extensive areas of deep, uninhabitable, impounded waters. These isolated populations are unable to naturally recolonize suitable habitat that may be impacted by temporary but devastating events, such as severe drought, chemical spills, or unauthorized discharges. Dams impound river habitats throughout almost the entire range of the species. These impoundments have left short and isolated patches of remnant habitat, typically in between impounded reaches, such as the golden orb population on the Guadalupe River within about one mile (1.6 km) downstream of Lake Wood. This population is subject to dramatic flow fluctuations from the hydroelectric facility associated with the dam (Howells 2010a, p. 4), which can leave individuals stranded when water levels are quickly lowered or wash individuals downstream when flow is increased.

The widespread construction of dams throughout the range of golden orb has significantly altered stream habitat both upstream and downstream of the dams by changing fish assemblages, temperature, dissolved oxygen, and substrate. The effects of dams on the golden orb are expected to be ongoing decades after construction and are presumed to be continuing today. Because of this loss of habitat and its widespread effects on the populations, we conclude that the effects of dams are a threat to the golden orb.

Sedimentation

For general information on the effects of sedimentation on freshwater mussels like the golden orb, please refer to ''Sedimentation'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussel species, the golden orb is affected by excessive sedimentation in streams. Even in 1959, the Guadalupe River was noted as having high sedimentation rates from agricultural activities (Soil Conservation Service 1959, p. 59). Turbidity has also been recorded as high in the Guadalupe River near Victoria (Exelon 2010, p. 2.3–186), indicating a large amount of suspended sediment where a small golden orb population was recently found. Sedimentation can occur from agricultural activities, sand and gravel mining, urban runoff, and construction activities, among other sources.

One example of a proposed project that could lead to localized increases in sedimentation within the range of the golden orb is the LCRA TSC. This project proposes to construct two new, 345-kV electric transmission line facilities between Tom Green (in the Colorado River basin near San Angelo) and Kendall Counties (in the Guadalupe River basin north of San Antonio) to provide electrical power to accommodate increased human populations (Clary 2010, p. 1). One of the proposed transmission lines would cross the upper Guadalupe River in Kerr County, which contains a small population of golden orb. The proposed project could negatively affect golden orb habitat by clearing land within the riparian zone and may increase sediment runoff into the Guadalupe River (Clary 2010, p. 7). Similar activities to accommodate Texas population growth are expected to be undertaken across the species' range and will likely lead to additional sources of sediment in the streams inhabited by the golden orb.

Streams occupied by golden orb are subject to increasing levels of sedimentation from agriculture, urbanization, and sand and gravel mining. Agriculture is a common land use in the Guadalupe and San Antonio River basins. Sedimentation may become an increasing threat to the golden orb in the Guadalupe River basin as the San Antonio metro area continues to expand. Activities associated with urbanization, such as road construction, increased impervious surfaces, and road construction can be detrimental to stream habitats (Couch and Hamilton 2002, p. 1), and the City of San Antonio, the second largest city in Texas, continues to grow (City of San Antonio 2010, p. 5). Sedimentation from agriculture, urbanization, and sand and gravel mining is widespread in the range of the golden orb will continue to threaten the species.

Dewatering

River dewatering can occur in several ways: anthropogenic activities such as surface water diversions and groundwater pumping, and natural events, such as drought, which can result in mussels stranded in previously wetted areas. This is a particular concern within and below reservoirs, whose water levels are managed for various purposes that can cause water levels in the reservoir or downstream to rise or fall in very short periods of time, such as when hydropower facilities release water during peak energy demand periods. For example, Lake Corpus Christi reservoir has experienced several drawdowns of lake levels to reduce salinity levels in the reservoir, such as in 1996 and 2006. Golden orb have been stranded above the water line during both drawdowns, killing the exposed mussels (Howells 2006, pp. 75–76). Rivers can also be dewatered to facilitate construction activities, such as in the upper Guadalupe River in Kerr County, which was dewatered in 1998 for bridge construction, which exposed and killed golden orb (Howells 1999, pp. 18–19).

Drought can also severely impact golden orb populations. Central Texas, including the Guadalupe River basin, experienced a major drought in the late 1970s (Lewis and Oliveria 1979, p. 243). Near record dry conditions in 2008 followed by a pattern of below-normal rainfall during the winter and spring of 2009 led to one of the worst droughts in recorded history for most of central Texas, including the range of the golden orb (Nielsen-Gammon and McRoberts 2009, p. 2). This drought's severity was exacerbated by abnormally high air temperatures, a likely effect of climate change, which has already increased average air temperatures in Texas by at least 1 °C (1.8 °F) (Nielsen-Gammon and McRoberts 2009, p. 22). The Guadalupe River in Kerr County experienced minimal to no flow during periods of the 2009 drought (USGS 2011b, p. 2), which may have negatively affected this golden orb population. Central Texas is currently experiencing another extreme drought, with rainfall between October 2010 and July 2011 being the lowest on record during those months (LCRA 2011c, p. 1); the effects of this drought are being observed but are not yet fully known.

We do not know the extent of the impacts of stream dewatering on the golden orb; however, because several populations are small and isolated, the loss of numerous individuals at a site can have dramatic consequences to the population. Hydropower facilities, construction, and drought are occurring throughout the range of the golden orb; therefore, the effects of dewatering are ongoing and unlikely to decrease, resulting in significant threats to the golden orb.

Sand and Gravel Mining

For general information on the effects of sand and gravel mining on freshwater mussels, please refer to ''Sand and Gravel Mining'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.*

In 1995, the reach of the Guadalupe River near Victoria, which contains a golden orb population, was described as having numerous current and abandoned sand and gravel mining areas (USACE 1995, p. 7). Currently, TPWD has permitted one sand mining activity within the existing range of golden orb, in the Guadalupe River basin in Comal County (TPWD 2009b, p. 1); golden orb populations occur upstream and downstream of this area in the Guadalupe River. The permit allows for the repeated removal of sand and gravel at various locations within the stream.

Headcuts from sand and gravel mining operations have been documented in the San Antonio River basin in Karnes County from as early as 1967, with downstream channels having steep, eroded banks (Kennon *et al.* 1967, p. 22). The golden orb has not been documented from this area since 1996, and only an old, eroded shell was collected at that time (Howells 1997a, pp. 41–42).

The golden orb populations in the Guadalupe River may be currently threatened by sand and gravel mining. These activities occur over a long period of time, destabilizing habitat both upstream and downstream, which decreases the likelihood of recolonization after the activity has been completed. Therefore, the effects of sand and gravel mining are an ongoing threat to the golden orb.

Chemical Contaminants

For general information on the effects of chemical contaminants on freshwater mussels, please refer to ''Chemical Contaminants'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussel species, the golden orb is also threatened by chemical contaminants. TCEQ water quality standards for 2010 indicated the majority of the assessed water bodies within the golden orb's historical and current range did not meet surface water quality standards and were classified as impaired water bodies (Nueces River Authority 2010, pp. 1–37; Texas Clean Rivers Program 2010b, p. 13). These water bodies were impaired with dissolved solids, nitrates, bacteria, low dissolved oxygen, sulfates, phosphates, chloride, chlorophyll-a, and low pH associated with agricultural, urban, municipal, and industrial runoff. Of these, nitrates and low dissolved oxygen pose the greatest threat to the golden orb. Additionally, several streams within the range of the golden orb have been listed as impaired due to high ammonia concentrations, including Elm Creek in the Guadalupe River basin (TCEQ 2010a, p. 294). High copper concentrations have been recorded in the lower Guadalupe and San Antonio Rivers (Lee and Schultz 1994, p. 8), and mercury has been documented throughout the Guadalupe and San Antonio Rivers, with particularly high concentrations found in fish tissues from the upper reaches of both rivers (Lee and Schultz 1994, p. 8). Row crop agriculture and wastewater discharges are prominant within the range of the golden orb. These activities result in chronic contamination from agricultural pesticides and emerging contaminants of rivers inhabited by the species and are a threat to golden orb.

Numerous spills of potential contaminant materials have occurred within the range of the golden orb. These can occur from on site accidents (tank, pipeline spills) or from tanker truck accidents within watersheds occupied by golden orb. For example, 100,000 gallons of sewage spilled into the San Antonio River near the City of San Antonio when a pipeline collapsed in October 2010 (San Antonio Water System 2010, p. 1). The largest known golden orb population occurs downstream of this location. Raw sewage contains very high ammonia levels, which is toxic to freshwater mussels, as well as other pollutants. Additionally, 300 gallons of diesel fuel spilled into the San Antonio River near the same location in May 2011 (Serna 2011, p. 1). Another sewage spill occurred in April 2011 in Quinlan Creek, a tributary to the Guadalupe River near the Kerr County population of golden orb (MacCormack 2011, p. 1). The actual effects on the golden orb of spills such as these recent examples are unknown, but there are likely to be negative consequences.

Because of the risk of spills as well as chronic contamination, chemical contaminants, such as oil, ammonia, copper, mercury, nutrients, pesticides, and other compounds are currently a threat to the golden orb. The species is vulnerable to acute contamination from spills as well as chronic contaminant exposure, which is occurring rangewide.

Summary of Factor A

The reduction in numbers and range of the golden orb is primarily the result of the long-lasting effects of habitat alterations such as the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Impoundments occur throughout the range of the species and have far-reaching effects both up- and downstream. Both the Colorado and Guadalupe River systems experience a large amount of sedimentation from agriculture, instream mining, and urban development. Sand and gravel mining affects golden orb habitat by causing headcutting upstream, increasing sedimentation concentrations in the water downstream, and causing channel instability downstream. Chemical contaminants have been documented throughout the range of the species and may represent a significant threat to the golden orb. However, the large populations in the middle and lower Guadalupe River, lower San Antonio River, and San Marcos River indicate that some golden orb populations are not currently as vulnerable to habitat loss as others. Based upon our review of the best commercial and scientific data available, we conclude that the present or threatened destruction, modification, or curtailment of its habitat or range is an immediate threat of moderate magnitude to golden orb populations rangewide.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

The golden orb is not a commercially valuable species and has never been harvested in Texas as a commercial mussel species (Howells 2010a, p. 12). Some scientific collecting occurs but is not likely to be a significant threat to the species because it occurs only rarely. However, handing mussels can disturb gravid females and result in glochidial loss and subsequent reproductive failure (Waller *et. al* 1995, p. 205). Additionally, handling has also been shown to reduce shell growth across mussel species, including several species of *Lampsilis* (Haag and Commens-Carson 2008, pp. 505–506). Repeated handling by researchers may adversely affect golden orb individuals, but these activities are occurring rarely and are not likely to threaten populations. Handling for scientific purposes contributes to the long-term conservation of the species.

We do not have any evidence of risks to the golden orb from overutilization for commercial, recreational, scientific, or educational purposes, and we have no reason to believe this factor will become a threat to the species in the future. Based upon the best scientific and commercial information available, we conclude that overutilization of the golden orb for commercial, recreational, scientific, or educational purposes does not pose a significant threat to the species rangewide.

Factor C. Disease and Predation.

Disease

Little is known about disease in freshwater mussels. However, disease is believed to be a contributing factor in documented mussel die-offs in other parts of the United States (Neves 1987, pp. 11–12). Diseases have not been documented or observed during any studies of golden orb.

Predation

Raccoons will prey on freshwater mussels stranded by low waters or deposited in shallow water or on bars following flooding or low water periods (Howells 2010c, p. 12). Predation of golden orb by raccoons may be occurring occasionally but there is no indication it is a significant threat to the status of the species.

Some species of fish feed on mussels, such as common carp, freshwater drum, and redear sunfish, all of which are common throughout the range of golden orb (Hubbs *et al.* 2008, pp. 19, 45, 53). Common species of flatworms are voracious predators of newly metamorphosed juvenile mussels of many species (Zimmerman *et al.* 2003, p. 30). Predation is a normal factor influencing population dynamics of a healthy mussel population; however, predation may amplify declines in small populations primarily caused by other factors.

Summary of Factor C

Disease in freshwater mussels is poorly known, and we do not have any information indicating it is a threat to the golden orb. Additionally, predation is a natural ecological interaction and we have no information indicating the extent of any predation is a threat to populations of golden orb. Based upon the best scientific and commercial information available, we conclude that disease or predation is not a threat to the golden orb.

Factor D. The Inadequacy of Existing Regulatory Mechanisms.

Existing regulatory mechanisms that could have an effect on threats to the golden orb include State and Federal laws such as Texas Threatened and Endangered Species regulations and freshwater mussel sanctuaries, State and Federal sand and gravel mining regulations, and regulation of point and non-point source pollution. For more information on the effects of these regulations on the threats to freshwater mussels in central Texas, please refer to Factor D under *Five-Factor Evaluation for Texas Fatmucket.*

Summary of Factor D

Despite State and Federal laws protecting the species and water quality, the golden orb continues to decline due to the effects of habitat destruction, poor water quality, contaminants, and other factors. The regulatory measures described above have been insufficient to significantly reduce or remove the threats to the golden orb. Based upon our review of the best commercial and scientific data available, we conclude that the lack of existing regulatory mechanisms is an immediate threat of moderate magnitude to the golden orb.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence.

Natural and manmade factors that threaten the golden orb include climate change, population fragmentation and isolation, and nonnative species.

Climate Change

For more general information on the effects of climate change on freshwater mussels in central Texas, please refer to ''Climate Change'' under Factor E in *Five-Factor Evaluation for Texas Fatmucket.* Because the range of the golden orb has been reduced to isolated locations, many with low population numbers in small rivers and streams, the golden orb is vulnerable to climatic changes that could decrease the availability of water.

The disjunct nature of the remaining golden orb populations, coupled with the limited ability of mussels to migrate, makes it unlikely that golden orb can adjust their range in response to changes in climate (Strayer 2008, p. 30). Climate change could affect the golden orb through the combined effects of global and regional climate change, along with the increased probability of long-term drought. Climate change exacerbates threats such as habitat degradation from prolonged periods of drought, increased water temperature, and the increased allocation of water for municipal, agricultural, and industrial uses. Climate change may be a significant stressor that exacerbates existing threats by increasing the likelihood of prolonged drought. As such, climate change, in and of itself, may affect the golden orb, but the magnitude and imminence of the effects remain uncertain. Based upon our review of the best commercial and scientific data available, we conclude that the effects of climate change in the future will likely exacerbate the current and ongoing threats of habitat loss and degradation caused by other factors, as discussed above.

Population Fragmentation and Isolation

For general information on the effects of population fragmentation and isolation on freshwater mussels in central Texas, please refer to ''Population Fragmentation and Isolation'' under Factor E in *Five-Factor Evaluation for Texas Fatmucket.* As with many freshwater mussels, several of the remaining populations of the golden orb are small and geographically isolated and thus are more susceptible to genetic drift, inbreeding depression, and random or chance changes to the environment, such as toxic chemical spills (Watters and Dunn 1995, pp. 257–258) or dewatering. Historically, the golden orb was widespread throughout much of the Guadalupe River system and in portions of the Nueces-Frio River system when few natural barriers existed to prevent migration (via host species) among suitable habitats. The extensive impoundment of the Nueces, Guadalupe, and San Antonio River basins by the construction of dams has fragmented the few remaining golden orb populations throughout these river systems.

Small golden orb populations, including those in Lake Corpus Christi Reservoir, the upper Guadalupe River in Kerr County, and the San Antonio River in Victoria County, may now be below the minimum population size required to maintain population viability into the future, since they are less likely to be able to recover through recruitment from events that reduce but do not extirpate populations. Additionally, these small populations are more vulnerable to extirpation from stochastic events, as the lack of connectivity among populations does not permit nearby populations to recolonize areas affected by intense droughts, toxic spills, or other isolated events that result in significant mussel dieoffs. While the small, isolated populations do not represent an independent threat to the species, the situation does substantially increase the risk of extirpation from the effects of all other threats, including those addressed in this analysis, and those that could occur in the future from unknown sources.

Based upon our review of the best commercial and scientific data available, we conclude that fragmentation and isolation of small remaining populations of the golden orb are occurring and are ongoing threats to the species throughout all of its range.

Nonnative Species

For general information on the effects of nonnative species on freshwater mussels of central Texas, please refer to ''Nonnative Species'' under Factor E in *Five-Factor Evaluation for Texas Fatmucket.* Various nonnative aquatic species pose a threat to the golden orb, including golden algae, zebra mussels, and black carp. Zebra mussels and black carp are not currently found within the range of golden orb, but they are likely to be introduced within its range in the future.

Based upon our review of the best commercial and scientific data available, we conclude that golden algae is an ongoing threat to the golden orb, and other nonnative species, such as zebra mussels and black carp, are a potential threat to the golden orb that is likely to increase as these exotic species expand their occupancy to include the range of the golden orb.

Summary of Factor E

The effects of climate change, while difficult to quantify at this time, are likely to exacerbate the current and ongoing threat of habitat loss caused by other factors, and the small sizes and fragmented nature of the remaining populations render them more vulnerable to extirpation. In addition, nonnative species, such as golden algae, currently threaten the golden orb, and the potential introduction of zebra mussels and black carp are potential future threats. Based upon our review of the best commercial and scientific data available, we conclude that other natural or manmade factors are immediate threats of moderate magnitude to the golden orb.

Finding for Golden Orb

As required by the Act, we considered the five factors in assessing whether the golden orb is threatened or endangered throughout all of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the golden orb. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with recognized golden orb experts and other Federal and State agencies.

This status review identifies threats to the golden orb attributable to Factors A, D, and E. The primary threat to the species is from habitat destruction and modification (Factor A) from impoundments, which scour riverbeds, thereby removing mussel habitat, decrease water quality, modify stream flows, and restrict fish host migration and distribution of freshwater mussels. Additional threats under Factor A include sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Also, most of these threats may be exacerbated by the current and projected effects of climate change, population fragmentation and isolation, and the anticipated threat of nonnative species (discussed under Factor E). Threats to the golden orb are not being adequately addressed through existing regulatory mechanisms (Factor D). Because of the limited distribution of this endemic species and its lack of mobility, these threats are likely to lead to the extinction of the golden orb in the foreseeable future.

On the basis of the best scientific and commercial information available, we find that the petitioned action to list the golden orb under the Act is warranted. We will make a determination on the status of the species as threatened or endangered when we complete a proposed listing determination. When we complete a proposed listing determination, we will examine whether the species may be endangered or threatened throughout all of its range or whether the species may be endangered or threatened in a significant portion of its range. However, as explained in more detail below, an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

We reviewed the available information to determine if the existing and foreseeable threats render the golden orb at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act is warranted. We determined that issuing an emergency regulation temporarily listing the species is not warranted for the golden orb at this time, because we have not identified a threat or activity that poses a significant risk, such that losses to the species during the normal listing process would endanger the continued existence of the entire species. However, if at any time we determine that issuing an emergency regulation temporarily listing the golden orb is warranted, we will initiate this action at that time.

Listing Priority Number for Golden Orb

The Service adopted guidelines on September 21, 1983 (48 FR 43098), to establish a rational system for utilizing available resources for the highest priority species when adding species to the Lists of Endangered and Threatened Wildlife and Plants or reclassifying species listed as threatened to endangered status. These guidelines, titled ''Endangered and Threatened Species Listing and Recovery Priority Guidelines'' address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates).

As a result of our analysis of the best available scientific and commercial information, we have assigned the golden orb a Listing Priority Number (LPN) of 8, based on our finding that the species faces threats that are of moderate magnitude and are imminent. These threats include habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants; other natural or manmade factors such as climate change, small, isolated populations, and nonnative species; and the fact that the threats to the species are not being adequately addressed by existing regulatory mechanisms. Our rationale for assigning the golden orb an LPN of 8 is outlined below.

Under the Service's guidelines, the magnitude of threat is the first criterion we look at when establishing a listing priority. The guidance indicates that species with the highest magnitude of threat are those species facing the greatest threats to their continued existence. These species receive the highest listing priority. We consider the threats that the golden orb faces to be moderate in magnitude. Habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants are widespread throughout the range of the golden orb, but several large populations remain, including one that was recently discovered, suggesting that the threats are not high in magnitude.

Under our LPN guidelines, the second criterion we consider in assigning a listing priority is the immediacy of threats. This criterion is intended to ensure that the species facing actual, identifiable threats are given priority over those for which threats are only potential or that are intrinsically vulnerable but are not known to be presently facing such threats. We consider the threats to the golden orb as described in Factors A, D, and E under the *Five-Factor Evaluation for Golden Orb* to be imminent because these threats are ongoing and will continue in the foreseeable future. Habitat loss and destruction has already occurred and will continue as the human population continues to grow in central Texas. Several golden orb populations may already be below the minimum viable population requirement, which would cause a reduction in the number of populations and an increase in the species' vulnerability to extinction. These threats are exacerbated by climate change, which will increase the frequency and magnitude of droughts. Therefore, we consider these threats to be imminent.

The third criterion in our Listing Priority Number guidance is intended to devote resources to those species representing highly distinctive or isolated gene pools as reflected by taxonomy. The golden orb is a valid taxon at the species level and, therefore, receives a higher priority than subspecies, but a lower priority than species in a monotypic genus. Therefore, we assigned golden orb an LPN of 8.

We will continue to monitor the threats to the golden orb and the species' status on an annual basis, and should the magnitude or imminence of the threats change, we will revisit our assessment of the LPN.

While we conclude that listing the golden orb is warranted, an immediate proposal to list this species is precluded by other higher priority listings, which we address in the Preclusion and Expeditious Progress section below. Because we have assigned the golden orb an LPN of 8, work on a proposed listing determination for the species is precluded by work on higher priority listing actions with absolute statutory, court-ordered, or court-approved deadlines and final listing determinations for those species that were proposed for listing with funds from Fiscal Year (FY) 2011. This work includes all the actions listed in the tables below under Preclusion and Expeditious Progress.

Five-Factor Evaluation for Smooth Pimpleback

Information pertaining to the smooth pimpleback in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.

As discussed above, the decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation. Chief among the causes of decline of the smooth pimpleback in Texas are the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants.

Impoundments

For general information on the effects of impoundments on freshwater mussels, please refer to ''Impoundments'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.* As with golden orb, smooth pimpleback are able to tolerate some impoundment conditions. Smooth pimpleback have been known to occur in three mainstem reservoirs on the Colorado River, although all but one population is likely extirpated (Howells 1997a, pp. 32–33; 1999, p. 16; 2005, p. 8; 2006, p. 67). Dams continue to fragment smooth pimpleback populations, and the downstream effects of dams are detrimental to smooth pimpleback habitat. There are 74 major reservoirs and numerous smaller impoundments within the historical and current range of the smooth pimpleback. Thirty-one of the 74 major reservoirs are located within the Colorado River basin and the remaining 43 reservoirs are located within the Brazos River basin. There are also eleven new reservoirs that have been recommended for development as feasible alternatives to meet future water needs within the Brazos River basin (Brazos G Regional Water Planning Group 2010, p. 4B.12–1). In addition, six new off-channel reservoirs are also being considered for future development (Brazos G Regional Water Planning Group 2010, p. 4B.13–2). At least one of the proposed reservoir sites on the Little River in Milam County is in the vicinity of where a single live smooth pimpleback was found in 2006 (Karatayev and Burlakova 2008, p. 6).

Dam construction fragments the range of smooth pimpleback, leaving remaining habitats and populations isolated by the structures as well as by extensive areas of deep, uninhabitable, impounded waters. These isolated populations are unable to naturally recolonize suitable habitat that may be impacted by temporary but devastating events, such as severe drought, chemical spills, or unauthorized discharges. Dams impound river habitats throughout almost the entire range of the species. These impoundments have left short and isolated patches of remnant habitat, typically in between impounded reaches. Habitat downstream of dams may be impaired for many miles; in the Brazos River downstream of Possum Kingdom Reservoir, substrate was unstable for 150 km (240 mi) below the dam (Yeager 1993, p. 68).

For species such as smooth pimpleback that may be able to survive the initial inundation of reservoirs, conditions within the reservoir are likely to become uninhabitable. The deep water in reservoirs is very cold and often devoid of oxygen and necessary nutrients (Watters 2000, p. 264). Cold water (less than 11 °C (52 °F)) has been shown to stunt mussel growth (Hanson *et al.* 1988, p. 352). Because mussel reproduction is temperature dependent (Watters and O'Dee 1999, p. 455), it is likely that individuals living in the constantly cold hypolimnion in these channels may never reproduce, or reproduce less frequently (Watters 2000, p. 264). Any smooth pimpleback that survived the initial inundation may have been unable to reproduce, eventually eliminating the species from large areas of the reservoir. The same would be true for mussels living in cold-water discharges downstream of large impoundments (Watters 2000, p. 264).

The widespread construction of dams throughout the range of smooth pimpleback has significantly altered stream habitat both upstream and downstream of the dams by changing fish assemblages, temperature, dissolved oxygen, and substrate. The effects of dams are ongoing, decades after construction. In addition, the construction of new reservoirs is also being considered within the species' range that could result in additional habitat loss. Because of this loss of habitat and its effects on the populations, we conclude that the effects of impoundments are a threat to the smooth pimpleback.

Sedimentation

For general information on the effects of sedimentation on freshwater mussels, please refer to ''Sedimentation'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussel species, the smooth pimpleback is also threatened by sedimentation. The dominant land use in the Colorado River basin is grazing (Hersh 2007, p. 11). Soil compaction from intensive grazing may reduce infiltration rates and increase runoff, and trampling of riparian vegetation increases the probability of erosion (Armour *et al.* 1994, p. 10; Brim Box and Mossa 1999, p. 103). Additionally, much of the Brazos River basin is grazed or farmed for row crops, which often contributes large amounts of sediment to the basin (Brazos River Authority 2007, p. 4). Reservoir construction in the upper portion of the basin has been attributed with the erosion and subsequent sedimentation of the lower river (USGS 2001, p. 30), as sediment-poor tailwaters scour the riverbanks below the dam and deposit sediment farther downstream. In 2004, sedimentation was high enough in the Brazos River below Possum Kingdom Reservoir to cause residents to raise concerns to the Brazos River Authority (Brazos River Authority 2006, p. 2), and elevated suspended sediment levels have been reported throughout the basin (Brazos River Authority 2006, p. 8).

Sedimentation may become an increasing threat to the smooth pimpleback in the Colorado and Brazos River basins as the Austin metropolitan area continues to expand. Activities associated with urbanization, such as road construction, increased impervious surfaces, and road construction can be detrimental to stream habitats (Couch and Hamilton 2002, p. 1). The City of Austin, population approximately 800,000 people (Austin City Connection 2011, p. 1) lies within the Colorado River basin, and 3.9 million people live within the Brazos River basin (Brazos River Authority 2007, p. 1). Both of these basins have undergone substantial urbanization providing sources of increased sediment runoff into habitats of the smooth pimpleback.

The range of the smooth pimpleback receives sediment from increasing levels of sedimentation from agriculture, urbanization, and sand and gravel mining; sedimentation is likely to continue to threaten the smooth pimpleback.

Dewatering

River dewatering can occur in several ways: Anthropogenic activities such as surface water diversions and groundwater pumping, and natural events, such as drought, which can result in mussels stranded in previously wetted areas. This is a particular concern for smooth pimpleback within and below reservoirs, where water levels are managed for various purposes that can cause water levels in the reservoir or downstream to rise or fall in very short periods of time, such as when hydropower facilities release water during peak energy demand periods. The three impoundments on the Colorado River with records of smooth pimpleback all experience periodic water level drawdowns, which may have contributed to the species' apparent extirpation from Inks Lake and Lake Marble Falls. In fact, smooth pimpleback have been found stranded (which leads to death) after drawdowns in both of these reservoirs (Howells 1996, p. 22; 1999, p. 16).

Drought can also severely impact smooth pimpleback populations. For example, the Little Brazos River, which once contained a diverse and numerous freshwater mussel community that included smooth pimpleback (Gentner and Hopkins 1966, p. 458), experienced a severe drought from about 1950 to 1956 that reduced the river to a series of small, stagnant pools. The results of this habitat degradation from the low water nearly eliminated the mussel community and killed many smooth pimpleback (Gentner and Hopkins 1966, p. 458). Later, central Texas, including the Colorado and Brazos River basins, experienced a major drought in the late 1970s (Lewis and Oliveria 1979, p. 243). Near record dry conditions in 2008 followed by a pattern of below-normal rainfall during the winter and spring of 2009 led to one of the worst droughts in recorded history for most of central Texas, including the range of the smooth pimpleback (Nielsen-Gammon and McRoberts 2009, p. 2). This drought's severity was exacerbated by abnormally high air temperatures, a likely effect of climate change, which has already increased average air temperatures in Texas by at least 1 °C (1.8 °F) (Nielsen-Gammon and McRoberts 2009, p. 22). Instream flows throughout the Brazos River basin during this drought were significantly reduced (USGS 2011c, p. 1) and smooth pimpleback populations in areas with reduced water levels, such as in the middle Brazos River, may have been negatively affected. Central Texas is currently experiencing another extreme drought, with rainfall between October 2010 and July 2011 being the lowest on record during those months (LCRA 2011c, p. 1); the effects of this drought are being observed but are not yet fully known. Droughts result in a decrease in water depth and flow velocity in streams inhabited by smooth pimpleback, which reduces the availability of food and dissolved oxygen and reduces survivability. As droughts persist, mussels face hypoxia, elevated water temperature and, ultimately, death due to stranding (Golladay *et al.* 2004, p. 501).

Sand and Gravel Mining

For general information on the effects of sand and gravel mining on freshwater mussels, please refer to ''Sand and Gravel Mining'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.*

The Brazos River has a long history of sand mining, particularly in the lower river, and channel morphology changes have been attributed to destabilization due to instream sand mining in the area (USGS 2001, p. 27). The removal of sand from within the river creates sediment traps during periods of high flow, which causes scouring and erosion downstream (USGS 2001, p. 27). One gravel dredging operation in the Brazos River was documented depositing sediment as far as 1.6 km (1 mile) downstream (Forshage and Carter 1973, p. 697). Accelerated stream bank erosion and downcutting of streambeds are common effects of instream sand and gravel mining, as is the mobilization of fine sediments during sand and gravel extraction (Roell 1999, p. 7).

Within the range of the smooth pimpleback, TPWD has issued permits for four current sand mining activities within the Brazos River (Austin, Bosque, and Fort Bend Counties) (TPWD 2004, p. 1; 2007b, p. 1, 2008b, p. 1; 2010b, p. 1). The permits allow for the repeated removal of sand and gravel at various locations within the Brazos River. The lower Brazos River, where these mining activities occur, contains one of the more numerous populations of smooth pimpleback.

The smooth pimpleback population in the lower Brazos River may be currently affected by sand and gravel mining. These activities occur over a long period of time, destabilizing mussel habitat both upstream and downstream, which decreases the likelihood of recolonization after the activity has been completed. Therefore, the effects of sand and gravel mining are an ongoing threat to the smooth pimpleback and are expected to continue to occur throughout the range of the species.

Chemical Contaminants

For general information on the effects of chemical contaminants on freshwater mussels, please refer to ''Chemical Contaminants'' under Factor A in *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussels, the smooth pimpleback is also threatened by chemical contaminants. TCEQ data for 2010 indicated that 26 of the 98 assessed water bodies within Colorado River basin and 81 of approximately 124 assessed water bodies within Brazos River basin did not meet surface water quality standards and were classified as impaired water bodies (Texas Clean Rivers Program 2010a, p. 5; TCEQ 2010c, pp. 1–106). These water bodies were impaired with dissolved solids, nitrites, nitrates, bacteria, low dissolved oxygen, aluminum, sulfates, selenium, chloride, orthophosphorus, phosphorus, Chlorophyll a, and low pH associated with agricultural, urban, municipal, and industrial runoff. Of these, nitrites and low dissolved oxygen are known to be harmful to freshwater mussels. Agricultural pesticides and emerging contaminants are likely also present in streams inhabited by smooth pimpleback. There are 53 wastewater treatment plants permitted to discharge more than one million gallons per day into the Brazos River basin (Valenti and Brooks 2008, p. 12); the outfalls of these treatment plants have not been tested to determine if they contain contaminants of note.

Examples of the exposure of smooth pimpleback to chemical contaminants include an event in 1993 when an unknown substance was dumped into a segment of the Little Brazos River upstream from a smooth pimpleback population. This site once supported an abundant and diverse number of mussel species, including the smooth pimpleback, but when it was revisited in 1993, a massive die-off of freshwater mussels had occurred (Howells 2010b, p. 11). In another instance in 2010, crude oil overflowed from a failed storage tank into Keechi Creek in Leon County, a tributary to the Navasota River (National Response Center 2010, p. 2). This location is near a small population of smooth pimpleback and upstream of one of the largest known populations of the species.

Numerous other spills have occurred within the range of the smooth pimpleback. These occurred from on-site accidents (storage tank or pipeline spills) or from tanker truck accidents within watersheds occupied by smooth pimpleback. For example, oil has spilled into the Brazos River a number of times. As much as 320,000 L (84,000 gal) of crude oil was spilled in the Brazos River in Knox County in 1991 (Associated Press 1991, p. 1). In June 2010, flooding of holding ponds adjacent to oil drilling operations leaked oil into Thompson Creek and subsequently into the Brazos River (Lewis 2010, p. 1). Also, in July 2010, oil pipelines burst and released approximately 165 barrels of crude oil into the upper Double Mountain Fork of the Brazos River in Garza County (Joiner 2010, p. 1). Although no analyses were conducted of the specific effects of these spills on smooth pimpleback, we expect that if the mussels are exposed to even moderate levels of toxic chemical contaminants, such as crude oil, adverse effects (both direct mortality and indirect effects to food source availabity) are likely to occur.

Releases of chemical contaminants, such as oil, ammonia, copper, mercury, nutrients, pesticides, and other compounds into the habitat of the smooth pimpleback are an ongoing threat to the smooth pimpleback. The species is vulnerable to acute contamination from spills, as well as chronic contaminant exposure, which has occurred and is expected to continue to occur throughout the range of the smooth pimpleback.

Summary of Factor A

The reduction in numbers and range of the smooth pimpleback is primarily the result of the long-lasting effects of habitat alterations such as the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Impoundments occur throughout the range of the species and have far-reaching effects to riverine habitat both upstream and downstream of the dams. Both the Colorado and Brazos River systems have experienced a large amount of sedimentation from agriculture, instream mining, and urban development. Sand and gravel mining affects smooth pimpleback habitat by increasing sedimentation and channel instability downstream and by causing headcutting upstream. Chemical contaminants exceeding the standards developed to support aquatic life have been documented throughout the range of the species and may represent a significant threat to the smooth pimpleback. However, the large populations in the San Saba River, lower Brazos River, Navasota River, Leon River, and Yegua Creek indicate that some smooth pimpleback populations are not currently as vulnerable to habitat loss as others. Therefore, based upon our review of the best commercial and scientific data available, we conclude that the present or threatened destruction, modification, or curtailment of its habitat or range is an immediate threat of moderate magnitude to the smooth pimpleback.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

The smooth pimpleback is not a commercially valuable species and has never been harvested in Texas as a commercial mussel species (Howells 2010b, p.12). Some scientific collecting occurs but is not likely to be a significant threat to the species because it occurs only rarely. However, handling mussels can disturb gravid females and result in glochidial loss and subsequent reproductive failure. Additionally, handling has also been shown to reduce shell growth across mussel species, including several species of *Lampsilis* (Haag and Commens-Carson 2008, pp. 505–506). Repeated handling by researchers may adversely affect smooth pimpleback individuals, but these activities are occurring rarely and are not likely to be a threat to populations. Handling for scientific purposes contributes to the long-term conservation of the species.

We do not have any evidence of risks to the smooth pimpleback from overutilization for commercial, recreational, scientific, or educational purposes, and we have no reason to believe this factor will become a threat to the species in the future. Based upon the best scientific and commercial information available, we conclude that overutilization for commercial, recreational, scientific, or educational purposes does not pose a threat to the smooth pimpleback rangewide.

Factor C. Disease and Predation.

Disease

Little is known about disease in freshwater mussels. However, disease is believed to be a contributing factor in documented mussel die-offs in other parts of the United States (Neves 1987, pp. 11–12). Diseases have not been documented or observed during any studies of smooth pimpleback.

Predation

Raccoons will prey on freshwater mussels stranded by low waters or deposited in shallow water or on bars following flooding or low water periods (Howells 2010c, p. 12). Predation of smooth pimpleback by raccoons may be occurring occasionally, but there is no indication it is a significant threat to the status of the species.

Some species of fish feed on mussels, such as common carp, freshwater drum, and redear sunfish, all of which are common throughout the range of smooth pimpleback (Hubbs *et al.* 2008, pp. 19, 45, 53). Common species of flatworms are voracious predators of newly metamorphosed juvenile mussels of many species (Zimmerman *et al.* 2003, p. 30). Predation is a normal factor influencing the population dynamics of a healthy mussel population; however, predation may amplify declines in small populations primarily caused by other factors.

Summary of Factor C

Disease in freshwater mussels is poorly known, and we do not have any information indicating it is a threat to the smooth pimpleback. Additionally, predation is a natural ecological interaction and we have no information indicating the extent of any predation is a threat to populations of smooth pimpleback. Based upon the best scientific and commercial information available, we conclude that disease or predation is not a threat to the smooth pimpleback.

Factor D. The Inadequacy of Existing Regulatory Mechanisms.

Existing regulatory mechanisms that could have an effect on threats to the smooth pimpleback include State and Federal laws such as Texas Threatened and Endangered Species regulations and freshwater mussel sanctuaries, State and Federal sand and gravel mining regulations, and regulation of point and non-point source pollution. For more information on the effects of State and Federal laws on the threats to freshwater mussels in central Texas, please refer to Factor D under *Five-Factor Evaluation for Texas Fatmucket.*

Summary of Factor D

Despite State and Federal laws protecting the species and water quality, the smooth pimpleback continues to decline due to the effects of habitat destruction, poor water quality, contaminants, and other factors. The regulatory measures described under Factor D in the *Five-Factor Evaluation for Texas Fatmucket* have been insufficient to significantly reduce or remove the threats to the smooth pimpleback. Based upon our review of the best commercial and scientific data available, we conclude that the lack of existing regulatory mechanisms is an immediate and ongoing threat of moderate magnitude to the smooth pimpleback.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence.

Natural and manmade factors that threaten the smooth pimpleback include climate change, population fragmentation and isolation, and nonnative species.

Climate Change

For general information on the effects of climate change on freshwater mussels of central Texas, please refer to ‘‘Climate Change’’ under Factor E in *Five-Factor Evaluation for Texas Fatmucket.* Because the range of the smooth pimpleback has been reduced to isolated locations, many with low population numbers, in small rivers and streams, the smooth pimpleback is vulnerable to climatic changes that could decrease the availability of water.

The disjunct nature of the remaining smooth pimpleback populations, coupled with the limited ability of mussels to migrate, makes it unlikely that smooth pimpleback can adjust their range in response to changes in climate (Strayer 2008, p. 30). Climate change exacerbates threats to the smooth pimpleback, such as habitat degradation from prolonged periods of drought; increased water temperature; and the increased allocation of water for municipal, agricultural, and industrial uses The magnitude and imminence of these effects, however, remain uncertain. Based upon our review of the best commercial and scientific data available, we conclude that the effects of climate change in the future will likely exacerbate the current and ongoing threats of habitat loss and degradation caused by other factors, as discussed in Factor A.

Population Fragmentation and Isolation

For general information on the effects of population fragmentation and isolation on freshwater mussels of central Texas, please refer to ‘‘Population Fragmentation and Isolation’’ under Factor E in *Five-Factor Evaluation for Texas Fatmucket.* As with many freshwater mussels, several of the remaining populations of the smooth pimpleback are small and geographically isolated and thus are susceptible to genetic drift, inbreeding depression, and random or chance changes to the environment, such as toxic chemical spills (Watters and Dunn 1995, pp. 257–258), or dewatering. Historically, the smooth pimpleback was widespread throughout much of the Colorado and Brazos River systems when few natural barriers existed to prevent migration (via host species) among suitable habitats. The extensive impoundment of the Brazos and Colorado River basins has fragmented smooth pimpleback populations throughout these river systems.

Small smooth pimpleback populations, including those in Lake LBJ Reservoir and the middle Brazos, Little, and Little Brazos Rivers, may be below the minimum population size required to maintain population viability into the future, therefore making these populations more vulnerable to extirpation since they are less likely to be able to recover through recruitment from events that reduce but do not extirpate populations. Additionally, these small populations are more vulnerable to extirpation from stochastic events, as the lack of connectivity among populations does not permit nearby populations to recolonize areas affected by intense droughts, toxic spills, or other isolated events that result in significant mussel die-offs. While the small, isolated populations do not represent an independent threat to the species, the situation does substantially increase the risk of extirpation from the effects of all other threats, including those addressed in this analysis, and those that could occur in the future from unknown sources.

Based upon our review of the best commercial and scientific data available, we conclude that fragmentation and isolation of small remaining populations of the smooth pimpleback are occurring and are ongoing threats to the species throughout all of its range. Further, stochastic events may play a magnified role in extirpation of small, isolated populations.

Nonnative Species

For general information on the effects of nonnative species on freshwater mussels of central Texas, please refer to ''Nonnative Species'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* As with other freshwater mussels, the smooth pimpleback is threatened by nonnative species. Various nonnative aquatic species pose a threat to the smooth pimpleback, including golden algae, zebra mussels, and black carp. Of these, golden algae has been responsible for killing more than eight million fish in the Brazos River since 1981 and more than two million fish in the Colorado River since 1989 (TPWD 2010a, p. 1). Although mussel kills due to golden algae have not been recorded, we expect golden algae to negatively affect mussel populations through loss of host fish and direct toxicity. Zebra mussels and black carp do not currently occur within the range of the smooth pimpleback, although both are found in Texas and could be introduced to the Brazos and Colorado Rivers in the forseeable future. Based on population responses of other mussel species that overlap with zebra mussels and black carp in similar river conditions, we conclude that the introduction of zebra mussels or black carp into the range of smooth pimpleback would be devastating to the species.

Based upon our review of the best commercial and scientific data available, we conclude that golden algae is an ongoing threat to the smooth pimpleback, and other nonnative species, such as zebra mussels and black carp, are a potential threat to the smooth pimpleback that is likely to increase as these exotic species expand their occupancy to include the range of the smooth pimpleback.

Summary of Factor E

The effects of climate change, while difficult to quantify at this time, are likely to exacerbate the current and ongoing threat of habitat loss caused by other factors, and the small sizes and fragmented nature of the remaining populations render them more vulnerable to extirpation. In addition, nonnative species, such as golden algae, currently threaten the Texas fatmucket, and the potential introduction of zebra mussels and black carp are potential future threats. Based upon our review of the best commercial and scientific data available, we conclude that other natural or manmade factors are immediate and ongoing threats of moderate magnitude to the smooth pimpleback.

Finding for Smooth Pimpleback

As required by the Act, we considered the five factors in assessing whether the smooth pimpleback is threatened or endangered throughout all of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the smooth pimpleback. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with recognized smooth pimpleback experts and other Federal and State agencies.

This status review identifies threats to the smooth pimpleback attributable to Factors A, D, and E. The primary threat to the species is from habitat destruction and modification (Factor A) from impoundments, which scour riverbeds, thereby removing mussel habitat, decreases water quality, modifies stream flows, and restricts fish host migration and distribution of freshwater mussels. Additional threats under Factor A include sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Also, most of these threats may be exacerbated by the current and projected effects of climate change (discussed under Factor E). Threats to the smooth pimpleback are not being adequately addressed through existing regulatory mechanisms (Factor D). Because of the limited distribution of this endemic species and its lack of mobility, these threats are likely to lead to the extinction of the smooth pimpleback in the foreseeable future.

On the basis of the best scientific and commercial information available, we find that the petitioned action to list the smooth pimpleback under the Act is warranted. We will make a determination on the status of the species as threatened or endangered when we complete a proposed listing determination. When we complete a proposed listing determination, we will examine whether the species may be endangered or threatened throughout all of its range; or whether the species may be endangered or threatened in a significant portion of its range. However, as explained in more detail below, an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

We reviewed the available information to determine if the existing and foreseeable threats render the smooth pimpleback at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act is warranted. We determined that issuing an emergency regulation temporarily listing the species is not warranted for the smooth pimpleback at this time, because we have not identified a threat or activity that poses a significant risk, such that losses to the species during the normal listing process would endanger the continued existence of the entire species. However, if at any time we determine that issuing an emergency regulation temporarily listing the smooth pimpleback is warranted, we will initiate this action at that time.

Listing Priority Number for Smooth Pimpleback

The Service adopted guidelines on September 21, 1983 (48 FR 43098), to establish a rational system for utilizing available resources for the highest priority species when adding species to the Lists of Endangered and Threatened Wildlife and Plants or reclassifying species listed as threatened to endangered status. These guidelines, titled ''Endangered and Threatened Species Listing and Recovery Priority Guidelines'' address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates).

As a result of our analysis of the best available scientific and commercial information, we have assigned the smooth pimpleback an LPN of 8, based on our finding that the species faces threats that are of moderate magnitude and are imminent. These threats include habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants; other natural or manmade factors such as climate change, small, isolated populations, and nonnative species; and the fact that the threats to the species are not being adequately addressed by existing regulatory mechanisms. Our rationale for assigning the smooth pimpleback an LPN of 8 is outlined below.

We consider the threats that the smooth pimpleback faces to be moderate in magnitude. Habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants are widespread throughout the range of the smooth pimpleback, but several large populations remain, including one that was recently discovered, indicating the threats are not high in magnitude.

Under our LPN guidelines, the second criterion we consider in assigning a listing priority is the immediacy of threats. We consider the threats to the smooth pimpleback as described under ''Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range,'' ''Factor D. The Inadequacy of Existing Regulatory Mechanisms,'' and ''Factor E. Other Natural Or Manmade Factors Affecting Its Continued Existence'' under the *Five-Factor Evaluation for Smooth Pimpleback* to be imminent because these threats are ongoing and will continue in the foreseeable future. Habitat loss and destruction has already occurred and will continue as the human population continues to grow in central Texas. Several smooth pimpleback populations may already be below the minimum viable population requirement, which would cause a reduction in the number of populations and an increase in the species' vulnerability to extinction. These threats are exacerbated by climate change, which will increase the frequency and magnitude of droughts. Therefore, we consider these threats to be imminent.

Thirdly, the smooth pimpleback is a valid taxon at the species level and, therefore, receives a higher priority than subspecies, but a lower priority than species in a monotypic genus. Therefore, we assigned smooth pimpleback an LPN of 8. We will continue to monitor the threats to the smooth pimpleback and the species' status on an annual basis, and should the magnitude or imminence of the threats change, we will revisit our assessment of the LPN.

While we conclude that listing the smooth pimpleback is warranted, an immediate proposal to list this species is precluded by other higher priority listings, which we address in the Preclusion and Expeditious Progress section below. Because we have assigned the smooth pimpleback an LPN of 8, work on a proposed listing determination for the species is precluded by work on higher priority listing actions with absolute statutory, court-ordered, or court-approved deadlines and final listing determinations for those species that were proposed for listing with funds from Fiscal Year (FY) 2011. This work includes all the actions listed in the tables below under Preclusion and Expeditious Progress.

Five-Factor Evaluation for Texas Pimpleback

Information pertaining to the Texas pimpleback in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.

As discussed above, the decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation. Chief among the causes of decline of the Texas pimpleback are the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. These threats are discussed below.

Impoundments

For general information on the effects of impoundments on freshwater mussels, please refer to ''Impoundments'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussel species, the Texas pimpleback is also threatened by impoundments. There are 37 major reservoirs and numerous smaller impoundments within the historical and current range of the Texas pimpleback. There are 31 major reservoirs within the Colorado River basin, with another reservoir (Goldthwaite Reservoir) proposed for the Colorado River in San Saba County near a Texas pimpleback population; this reservoir was the number one recommendation in the water plan for the region (TWDB 2011, pp. 4–85). There are 29 reservoirs within the Guadalupe River basin and 34 within the San Antonio River basin, each with a storage capacity of 3,000 acre-feet or more, and many other smaller reservoirs (Exelon 2010, p. 2.3–4). The majority of the large dams were constructed for power generation, flood control, and water supply by the Lower Colorado River and Guadalupe-Blanco River Authorities beginning as early as 1935 (Guadalupe-Blanco River Authority 2011, p. 1; LCRA 2011a, p. 1). These and numerous smaller dams occur throughout the Colorado and Guadalupe River basins, fragmenting habitat and populations of Texas pimpleback.

There are no natural lakes within the range of the Texas pimpleback, nor has it ever been found in reservoirs. Historically, the Texas pimpleback could be found in areas of the Guadalupe River in Comal County (Randklev *et al.* 2010c, p. 4), but it has not been found in the area since the construction of Canyon Reservoir (Burlakova and Karatayev 2009, p. 6). We presume the species is extirpated from this reach because of the effects of the reservoir. Surveys of other reservoirs on the Guadalupe and Colorado Rivers have been ongoing since at least 1992, and no evidence of live or dead Texas pimpleback has been found in any reservoir (Howells 1994, pp. 1–20; 1995, pp. 1–50; 1996, pp. 1–45; 1997a, pp. 1–58; 1998, pp. 1–30; 1999, pp. 1–34; 2000a, pp. 1–56; 2001, pp. 1–50; 2002a, pp. 1–28; 2003, pp. 1–42; 2004, pp. 1–48; 2005, pp. 1–23; 2006, pp. 1–106; Karatayev and Burlakova 2008, pp. 1–47; Burlakova and Karatayev 2010a, pp. 1–30; 2011, pp. 1–8), further indicating that this species is not tolerant of impoundments.

Texas pimpleback populations downstream of dams are affected as well. Cold water (less than 11 °C (52 °F)) has been shown to stunt mussel growth (Hanson *et al.* 1988, p. 352) and reduce or inhibit reproduction, because mussel reproduction is temperature dependent (Watters and O'Dee 1999, pp. 455). Texas pimpleback living in cold-water discharges downstream of large impoundments are unlikely to reproduce (Watters 2000, p. 264).

Dam construction also fragments the range of Texas pimpleback, leaving remaining habitats and populations isolated by the structures as well as by extensive areas of deep, uninhabitable, impounded waters. These isolated populations are unable to naturally recolonize suitable habitat that may be impacted by temporary but devastating events, such as severe drought, chemical spills, or unauthorized discharges. Dams impound river habitats throughout almost the entire range of the species. These impoundments have left short and isolated patches of suitable habitat, typically in between impounded reaches.

The widespread construction of dams throughout the range of Texas pimpleback has significantly altered stream habitat both upstream and downstream of the dams by changing fish assemblages, temperature, dissolved oxygen, and substrate. The effects of dams are ongoing decades after construction. Because of this loss of habitat and its effects on the populations, we conclude that the effects of dams are a threat to the Texas pimpleback.

Sedimentation

For general information on the effects of sedimentation on freshwater mussels, please refer to ''Sedimentation'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussel species, the Texas pimpleback is affected by sedimentation. The dominant land use in the Colorado River basin is grazing (Hersh 2007, p. 11); soil compaction from intensive grazing may reduce infiltration rates and increase runoff, and trampling of riparian vegetation increases the probability of erosion (Armour *et al.* 1994, p. 10; Brim Box and Mossa 1999, p. 103). Even in 1959, the Guadalupe River was noted as having high sedimentation rates from agricultural activities (Soil Conservation Service 1959, p. 59). Turbidity has also been recorded as high in the Guadalupe River near Victoria (Exelon 2010, p. 2.3–186), indicating a large amount of suspended sediment where a small Texas pimpleback population was recently found.

Streams occupied by Texas pimpleback are subject to increasing levels of sedimentation from agriculture, urbanization, and sand and gravel mining. Agriculture is a common land use in the Guadalupe and San Antonio River basins, and the city of San Antonio, the second largest city in Texas, continues to grow (City of San Antonio 2010, p. 5). Sedimentation from agriculture, urbanization, and sand and gravel mining will continue to threaten the Texas pimpleback in the foreseeable future.

Dewatering

River dewatering can occur in several ways: Anthropogenic activities such as surface water diversions and groundwater pumping, and natural events, such as drought, which can result in mussels stranded in previously wetted areas. This is a particular concern below reservoirs, whose water levels are managed for various purposes that can cause water levels in the reservoir or downstream to rise or fall in very short periods of time, such as when hydropower facilities release water during peak energy demand periods.

Drought can also severely impact Texas pimpleback populations. Central Texas, including the Colorado and Guadalupe River basins, experienced a major drought in the late 1970s (Lewis and Oliveria 1979, p. 243). Near record dry conditions in 2008 followed by a pattern of below-normal rainfall during the winter and spring of 2009 led to one of the worst droughts in recorded history for most of central Texas, including the range of the Texas pimpleback (Nielsen-Gammon and McRoberts 2009, p. 2). This drought's severity was exacerbated by abnormally high air temperatures, a likely effect of climate change, which has already increased average air temperatures in Texas by at least 1 °C (1.8 °F) (Nielsen-Gammon and McRoberts 2009, p. 22). Instream flows throughout the Colorado River basin during this drought were significantly reduced (USGS 2011c, p. 1) and Texas pimpleback populations in areas with reduced water levels may have been negatively affected. Central Texas is currently experiencing another extreme drought, with rainfall between October 2010 and July 2011 being the lowest on record during those months (LCRA 2011c, p. 1); the effects of this drought are being observed but are not yet fully known. Droughts result in a decrease in water depth and flow velocity, which reduces food and oxygen delivery. As droughts persist, mussels face hypoxia, elevated water temperature and, ultimately, stranding (Golladay *et al.* 2004, p. 501).

We do not know the extent of the impacts of stream dewatering on the Texas pimpleback; however, because several populations are small and isolated, the loss of numerous individuals at a site can have dramatic consequences to the population. Hydropower facilities, diversions associated with construction, and drought are occurring throughout the range of the Texas pimpleback; therefore, the effects of dewatering are ongoing and unlikely to decrease, resulting in significant threats to the Texas pimpleback.

Sand and Gravel Mining

For general information on the effects of sand and gravel mining on freshwater mussels, please refer to ''Sand and Gravel Mining'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.*

In 1995, the reach of the Guadalupe River near Victoria, which contains a Texas pimpleback population, was described as having numerous current and abandoned sand and gravel mining areas (USACE 1995, p. 7). Currently, TPWD has permitted one sand mining activity within the current range of Texas pimpleback, in the Guadalupe River basin in Comal County (TPWD 2009b, p. 1); a small Texas pimpleback population occurs downstream of this area in the Guadalupe River. The permit allows for the repeated removal of sand and gravel at various locations within the stream.

Headcuts from sand and gravel mining operations have been documented in the San Antonio River basin in Karnes County from as early as 1967, with downstream channels having steep, eroded banks (Kennon *et al.* 1967, p. 22). There has been no evidence of Texas pimpleback in Karnes County in recent years (Howells 1997a, pp. 41–42), and the effects of sand mining may have been a factor in the species' extirpation.

The Texas pimpleback population in the Guadalupe River may be currently threatened by sand and gravel mining. These activities occur over a long period of time, destabilizing habitat both upstream and downstream, which decreases the likelihood of recolonization after the activity has been completed. Therefore, the effects of sand and gravel mining are an ongoing threat to the Texas pimpleback.

Chemical Contaminants

For general information on the effects of chemical contaminants on freshwater mussels, please refer to ''Chemical Contaminants'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussels, the Texas pimpleback is affected by chemical contaminants. TCEQ data for 2010 indicated that 26 of the 98 assessed water bodies within the historical and current range of the Texas pimpleback did not meet surface water quality standards and were classified as impaired water bodies under the Clean Water Act (Texas Clean Rivers Program 2010a, p. 5). These water bodies were impaired with dissolved solids, nitrates, bacteria, low dissolved oxygen, aluminum, sulfates, selenium, chloride, and low pH associated with agricultural, urban, municipal, and industrial runoff. Additionally, the Concho River near Paint Rock has been repeatedly documented as having high nitrates (Texas Clean Rivers Program 2008, p. 2); a significant Texas pimpleback population occurs just upstream of this site. Nitrates and low dissolved oxygen pose the greatest threat to Texas pimpleback.

Within the range of Texas pimpleback, several streams have been listed as impaired due to high ammonia concentrations, including Elm Creek in the Guadalupe River basin (TCEQ 2010a, p. 294). Additionally, high copper concentrations have been recorded in the lower Guadalupe and San Antonio Rivers (Lee and Schultz 1994, p. 8), and mercury has been documented throughout the Guadalupe and San Antonio Rivers, with particularly high concentrations in fish in the upper reaches of both rivers (Lee and Schultz 1994, p. 8). Agricultural pesticides and emerging contaminants are likely also present in streams inhabited by Texas pimpleback.

Chemical contaminants, such as ammonia, copper, mercury, nutrients, pesticides, and other compounds are currently a threat to the Texas pimpleback. The species is vulnerable to acute contamination from spills as well as chronic contaminant exposure, which is occurring rangewide.

Summary of Factor A

The reduction in numbers and range of the Texas pimpleback is primarily the result of the long-lasting effects of habitat alterations such as the effects of impoundments, sedimentation, sand and gravel mining, and chemical contaminants. Impoundments occur throughout the range of the species and have far-reaching effects both up and downstream. Both the Colorado and Guadalupe River systems have experienced a large amount of sedimentation from agriculture, instream mining, and urban development. Sand and gravel mining affects Texas pimpleback habitat by increasing sedimentation and channel instability downstream and causing headcutting upstream. Chemical contaminants have been documented throughout the range of the species and may represent a significant threat to the Texas pimpleback. Based upon our review of the best commercial and scientific data available, we conclude that the present or threatened destruction, modification, or curtailment of its habitat or range is an immediate threat of high magnitude to the Texas pimpleback.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

The Texas pimpleback was historically harvested occasionally but never experienced high levels of collecting pressure (Howells 2010e, p.10). Although levels were light enough that commercial harvest was likely not a threat to populations, all commercial collecting became illegal when Texas pimpleback was listed as threatened by TPWD; therefore, commercial harvest is not a current threat to Texas pimpleback. Some scientific collecting occurs but is not likely to be a significant threat to the species because it occurs only rarely. However, handling mussels can disturb gravid females and result in glochidial loss and subsequent reproductive failure. Additionally, handling has been shown to reduce shell growth across mussel species, including several species of *Lampsilis* (Haag and Commens-Carson 2008, pp. 505–506). Repeated handling by researchers may adversely affect Texas pimpleback individuals, but these activities are occurring rarely and are not likely to be a threat to populations. Handling for scientific purposes contributes to the long-term conservation of the species.

We do not have any evidence of risks to the Texas pimpleback from overutilization for commercial, recreational, scientific, or educational purposes, and we have no reason to believe this factor will become a threat to the species in the future. Based upon the best scientific and commercial information available, we conclude that overutilization for commercial, recreational, scientific, or educational purposes does not pose a significant threat to the Texas pimpleback rangewide.

Factor C. Disease and Predation.

Disease

Little is known about disease in freshwater mussels. However, disease is believed to be a contributing factor in documented mussel die-offs in other parts of the United States (Neves 1987, pp. 11–12). Diseases have not been documented or observed during any studies of Texas pimpleback.

Predation

Raccoons will prey on freshwater mussels stranded by low waters or deposited in shallow water or on bars following flooding or low water periods (Howells 2010c, p. 12). Predation of Texas pimpleback by raccoons may be occurring occasionally but there is no indication it is a significant threat to the status of the species.

Some species of fish feed on mussels, such as common carp, freshwater drum, and redear sunfish, all of which are common throughout the range of Texas pimpleback (Hubbs *et al.* 2008, pp. 19, 45, 53). Common species of flatworms are voracious predators of newly metamorphosed juvenile mussels of many species (Zimmerman *et al.* 2003, p. 30). Predation is a normal factor influencing the population dynamics of a healthy mussel population; however, predation may amplify declines in small populations primarily caused by other factors.

Summary of Factor C

Disease in freshwater mussels is poorly known, and we do not have any information indicating it is a threat to the Texas pimpleback. Additionally, predation is a natural ecological interaction and we have no information indicating the extent of any predation is a threat to populations of Texas pimpleback. Based upon the best scientific and commercial information available, we conclude that disease or predation is not a threat to the Texas pimpleback.

Factor D. The Inadequacy of Existing Regulatory Mechanisms.

Existing regulatory mechanisms that could have an effect on threats to the Texas pimpleback include State and Federal laws such as Texas Threatened and Endangered Species regulations and freshwater mussel sanctuaries, State and Federal sand and gravel mining regulations, and regulation of point and non-point source pollution. For more information on the effects of State and Federal laws on the threats to freshwater mussels in central Texas, please refer to Factor D under *Five-Factor Evaluation for Texas*

Fatmucket

Summary of Factor D

Despite State and Federal laws protecting the species and water quality, the Texas pimpleback continues to decline due to the effects of habitat destruction, poor water quality, contaminants, and other factors. The regulatory measures described above have been insufficient to significantly reduce or remove the threats to the Texas pimpleback. Based upon our review of the best commercial and scientific data available, we conclude that the lack of existing regulatory mechanisms is an immediate threat of moderate magnitude to the Texas pimpleback.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence.

Natural and manmade factors that threaten the Texas pimpleback include climate change, population fragmentation and isolation, and nonnative species.

Climate Change

For general information on the effects of climate change on freshwater mussels of central Texas, please refer to''Climate Change'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* Because the range of the Texas pimpleback has been reduced to isolated locations with low population numbers in small rivers and streams, the Texas pimpleback is vulnerable to climatic changes that could decrease the availability of water.

The disjunct nature of the remaining Texas pimpleback populations, coupled with the limited ability of mussels to migrate, makes it unlikely that Texas pimpleback can adjust their range in response to changes in climate (Strayer 2008, p. 30). Climate change could affect the Texas pimpleback through the combined effects of global and regional climate change, along with the increased probability of long-term drought. Climate change exacerbates threats such as habitat degradation from prolonged periods of drought, increased water temperature, and the increased allocation of water for municipal, agricultural, and industrial use. Climate change may be a significant stressor that exacerbates existing threats by increasing the likelihood of prolonged drought. As such, climate change, in and of itself, may affect the Texas pimpleback, but the magnitude and imminence of the effects remain uncertain. Based upon our review of the best commercial and scientific data available, we conclude that the effects of climate change in the future will likely exacerbate the current and ongoing threats of habitat loss and degradation caused by other factors, as discussed above.

Population Fragmentation and Isolation

For more information on the effects of population fragmentation and isolation on freshwater mussels of central Texas, please refer to ''Population Fragmentation and Isolation'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* As with many freshwater mussels, most of the remaining populations of the Texas pimpleback are small and geographically isolated and thus are susceptible to genetic drift, inbreeding depression, and random or chance changes to the environment, such as toxic chemical spills (Watters and Dunn 1995, pp. 257–258) or dewatering. Historically, the Texas pimpleback was once widespread throughout much of the Colorado and Guadalupe River systems when few natural barriers existed to prevent migration (via host species) among suitable habitats. The extensive impoundment of the Colorado and Guadalupe River basins has fragmented Texas pimpleback populations throughout these river systems.

Small Texas pimpleback populations, including those in the lower Guadalupe River, mainstem Colorado River, and San Marcos River, may be below the minimum population size required to maintain population viability into the future. These populations are more vulnerable to extirpation since they are less likely to be able to recover through recruitment from events that reduce but do not extirpate populations. Additionally, these small populations are more vulnerable to extirpation from stochastic events, as the lack of connectivity among populations does not permit nearby populations to recolonize areas affected by intense droughts, toxic spills, or other isolated events that result in significant mussel die-offs. While the small, isolated populations do not represent an independent threat to the species, the situation does substantially increase the risk of extirpation from the effects of all other threats, including those addressed in this analysis, and those that could occur in the future from unknown sources.

Based upon our review of the best commercial and scientific data available, we conclude that fragmentation and isolation of small remaining populations of the Texas pimpleback are occurring and are ongoing threats to the species throughout all of its range. Further, stochastic events may play a magnified role in extirpation of small, isolated populations.

Nonnative Species

For general information on the effects of nonnative species on freshwater mussels of central Texas, please refer to ''Nonnative Species'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* As with other freshwater mussels, the Texas pimpleback is threatened by nonnative species. Various nonnative aquatic species pose a threat to the Texas pimpleback, including golden algae, zebra mussels, and black carp. Of these, golden algae has been responsible for killing more than two million fish in the Colorado River since 1989 (TPWD 2010a, p. 1). Although mussel kills due to golden algae have not been recorded, we expect golden algae to negatively affect mussel populations through loss of host fish and direct toxicity. Zebra mussels and black carp do not currently occur within the range of the Texas pimpleback, although both are found in Texas and could be introduced to the Colorado and Guadalupe Rivers in the forseeable future. Their introduction into the range of Texas pimpleback would be devastating.

Based upon our review of the best commercial and scientific data available, we conclude that golden algae is an ongoing threat to the Texas pimpleback and other nonnative species, such as zebra mussels and black carp, are a potential threat to the Texas pimpleback that is likely to increase as these exotic species expand their occupancy within the range of the Texas pimpleback.

Summary of Factor E

The effects of climate change, while difficult to quantify at this time, are likely to exacerbate the current and ongoing threat of habitat loss caused by other factors, and the small sizes and fragmented nature of the remaining populations render them more vulnerable to extirpation. In addition, nonnative species, such as golden algae, currently threaten the Texas fatmucket, and the potential introduction of zebra mussels and black carp are potential future threats. Based upon our review of the best commercial and scientific data available, we conclude that other natural or manmade factors are immediate threats of moderate magnitude to the Texas pimpleback.

Finding for Texas Pimpleback

As required by the Act, we considered the five factors in assessing whether the Texas pimpleback is threatened or endangered throughout all of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the Texas pimpleback. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with recognized Texas pimpleback experts and other Federal and State agencies.

This status review identifies threats to the Texas pimpleback attributable to Factors A, D, and E. The primary threat to the species is from habitat destruction and modification (Factor A) from impoundments, which scour riverbeds, thereby removing mussel habitat, decrease water quality, modify stream flows, and restrict fish host migration and distribution of freshwater mussels. Additional threats under Factor A include sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Also, most of these threats may be exacerbated by the current and projected effects of climate change (discussed under Factor E). Threats to the Texas pimpleback are not being adequately addressed through existing regulatory mechanisms (Factor D). Because of the limited distribution of this endemic species and its lack of mobility, these threats are likely to lead to the extinction of the Texas pimpleback in the foreseeable future.

On the basis of the best scientific and commercial information available, we find that the petitioned action to list the Texas pimpleback under the Act is warranted. We will make a determination on the status of the species as threatened or endangered when we complete a proposed listing determination. When we complete a proposed listing determination, we will examine whether the species may be endangered or threatened throughout all of its range or whether the species may be endangered or threatened in a significant portion of its range. However, as explained in more detail below, an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

We reviewed the available information to determine if the existing and foreseeable threats render the Texas pimpleback at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act is warranted. We determined that issuing an emergency regulation temporarily listing the species is not warranted for the Texas pimpleback at this time, because we have not identified a threat or activity that poses a significant risk, such that losses to the species during the normal listing process would endanger the continued existence of the entire species. However, if at any time we determine that issuing an emergency regulation temporarily listing the Texas pimpleback is warranted, we will initiate this action at that time.

Listing Priority Number for Texas Pimpleback

The Service adopted guidelines on September 21, 1983 (48 FR 43098), to establish a rational system for utilizing available resources for the highest priority species when adding species to the Lists of Endangered and Threatened Wildlife and Plants or reclassifying species listed as threatened to endangered status. These guidelines, titled ''Endangered and Threatened Species Listing and Recovery Priority Guidelines'' address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates).

As a result of our analysis of the best available scientific and commercial information, we have assigned the Texas pimpleback an LPN of 2, based on our finding that the species faces threats that are of high magnitude and are imminent. These threats include habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants; other natural or manmade factors such as climate change, small, isolated populations, and nonnative species; and the fact that the threats to the species are not being adequately addressed by existing regulatory mechanisms. Our rationale for assigning the Texas pimpleback an LPN of 2 is outlined below.

We consider the threats that the Texas pimpleback faces to be high in magnitude. Habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants are widespread throughout the range of the Texas pimpleback and profoundly affect its habitat, and remaining populations are small, isolated, and highly vulnerable to stochastic events.

Under our LPN guidelines, the second criterion we consider in assigning a listing priority is the immediacy of threats. We consider the threats to the Texas pimpleback as described under Factors A, D, and E in the *Five-Factor Evaluation for Texas Pimpleback* section to be imminent because these threats are ongoing and will continue in the foreseeable future. Habitat loss and destruction has already occurred and will continue as the human population continues to grow in central Texas. The Texas pimpleback populations may already be below the minimum viable population requirement, which would cause a reduction in the number of populations and an increase in the species' vulnerability to extinction. These threats are exacerbated by climate change, which will increase the frequency and magnitude of droughts. Therefore, we consider these threats to be imminent.

Thirdly, the Texas pimpleback is a valid taxon at the species level and, therefore, receives a higher priority than subspecies, but a lower priority than species in a monotypic genus. Therefore, we assigned Texas pimpleback an LPN of 2. We will continue to monitor the threats to the Texas pimpleback and the species' status on an annual basis, and should the magnitude or imminence of the threats change, we will revisit our assessment of the LPN.

While we conclude that listing the Texas pimpleback is warranted, an immediate proposal to list this species is precluded by other higher priority listings, which we address in the Preclusion and Expeditious Progress section below. Because we have assigned the Texas pimpleback an LPN of 2, work on a proposed listing determination for the species is precluded by work on higher priority listing actions with absolute statutory, court-ordered, or court-approved deadlines and final listing determinations for those species that were proposed for listing with funds from Fiscal Year (FY) 2010. This work includes all the actions listed in the tables below under Preclusion and Expeditious Progress.

Five-Factor Evaluation for Texas Fawnsfoot

Information pertaining to the Texas fawnsfoot in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range.

As discussed above, the decline of mussels in Texas and across the United States is primarily the result of habitat loss and degradation. Chief among the causes of decline of the Texas fawnsfoot in Texas are the effects of impoundments, sedimentation, dewatering, sand and gravel mining, and chemical contaminants. These threats are discussed below.

Impoundments

For general information on the effects of impoundments on freshwater mussels, please refer to ''Impoundments'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.* Impoundments and numerous smaller dams occur throughout the Colorado and Guadalupe River basins, fragmenting habitat and populations of Texas fawnsfoot. There are 74 major reservoirs and numerous smaller impoundments within the historical and current range of the smooth pimpleback. Thirty-one of the 74 major reservoirs are located within the Colorado River basin and the remaining 43 reservoirs are located within the Brazos River basin. There are also eleven new reservoirs that have been recommended for development as feasible alternatives to meet future water needs within the Brazos River basin (Brazos G Regional Water Planning Group 2010, p. 4B.12–1). In addition, six new off-channel reservoirs are also being considered for future development (Brazos G Regional Water Planning Group 2010, p. 4B.13–2).

There are no natural lakes within the range of the Texas fawnsfoot, nor has it ever been found in reservoirs. Surveys of the reservoirs on the Brazos and Colorado Rivers have been ongoing since at least 1992, and no evidence of live or dead Texas pimpleback has been found in any reservoir (Howells 1994, pp. 1–20; 1995, pp. 1–50; 1996, pp. 1–45; 1997a, pp. 1–58; 1998, pp. 1–30; 1999, pp. 1–34; 2000a, pp. 1–56; 2001, pp. 1–50; 2002a, pp. 1–28; 2003, pp. 1–42; 2004, pp. 1–48; 2005, pp. 1–23; 2006, pp. 1–106; Karatayev and Burlakova 2008, pp. 1–47; Burlakova and Karatayev 2010a, pp. 1–30; 2011, pp. 1–8), further indicating that this species is not tolerant of impoundments.

Texas fawnsfoot populations downstream of dams are affected as well. Cold water (less than 11 °C (52 °F)) has been shown to stunt mussel growth (Hanson *et al.* 1988, p. 352) and reduce or inhibit reproduction, because mussel reproduction is temperature dependent (Watters and O'Dee 1999, pp. 455). Texas fawnsfoot living in cold-water discharges downstream of large impoundments are unlikely to reproduce (Watters 2000, p. 264).

Dam construction also fragments the range of Texas fawnsfoot, leaving remaining habitats and populations isolated by the structures as well as by extensive areas of deep, uninhabitable, impounded waters. These isolated populations are unable to naturally recolonize suitable habitat that may be impacted by temporary but devastating events, such as severe drought, chemical spills, or unauthorized discharges. Dams impound river habitats throughout almost the entire range of the species. These impoundments have left short and isolated patches of remnant habitat, typically in between impounded reaches. Habitat downstream of dams may be impaired for many miles; in the Brazos River downstream of Possum Kingdom Reservoir, substrate was unstable for 150 km (240 mi) below the dam (Yeager 1993, p. 68).

The widespread construction of dams throughout the range of Texas fawnsfoot has significantly altered stream habitat both upstream and downstream of the dams by changing fish assemblages, temperature, dissolved oxygen, and substrate. The effects of dams are ongoing decades after construction. Because of this loss of habitat and its effects on the populations, we conclude that the effects of dams are a threat to the Texas fawnsfoot.

Sedimentation

For general information on the effects of sedimentation on freshwater mussels, please refer to ''Sedimentation'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.*

As with other freshwater mussel species, the Texas fawnsfoot is also threatened by sedimentation. The dominant land use in the Colorado River basin is grazing (Hersh 2007, p. 11); soil compaction from intensive grazing may reduce infiltration rates and increase runoff, and trampling of riparian vegetation increases the probability of erosion (Armour *et al.* 1994, p. 10; Brim Box and Mossa 1999, p. 103). Additionally, much of the Brazos River basin is grazed or farmed for row crops, which can contribute large amounts of sediment to the basin (Brazos River Authority 2007, p. 4). Reservoir construction in the upper portion of the basin has been attributed with the erosion and subsequent sedimentation of the lower river (USGS 2001, p. 30), as sediment-poor tailwaters scour the riverbanks below the dam and deposit sediment farther downstream. In 2004, sedimentation was high enough in the Brazos River below Possum Kingdom Reservoir to cause residents to raise concerns to the Brazos River Authority (Brazos River Authority 2006, p. 2). Elevated suspended sediment levels have been reported throughout the basin (Brazos River Authority 2006, p. 8).

The LCRA TSC is proposing to construct two new 345-kV electric transmission line facilities between Tom Green (in the Colorado River basin near San Angelo) and Kendall Counties (in the Guadalupe River basin north of San Antonio) to provide electrical power to accommodate increased demand (Clary 2010, p. 1). One of the proposed project lines would cross the San Saba River, which contains one of the more numerous Texas fawnsfoot populations. The proposed project could negatively affect Texas fawnsfoot habitat by clearing land within the riparian zone and may increase sediment runoff into the San Saba River (Clary 2010, p. 9). Similar activities to accommodate Texas population growth and demands are expected to be undertaken across the species' range and will likely lead to additional sources of sediment in the streams inhabited by the Texas fawnsfoot.

The City of Austin lies within the Colorado River basin, and 3.9 million people live within the Brazos River basin (Brazos River Authority 2007, p. 1). The range of the Texas fawnsfoot receives sediment from agriculture, urbanization, and sand and gravel mining. Sedimentation will continue to threaten the Texas fawnsfoot in the foreseeable future.

Dewatering

River dewatering can occur in several ways: anthropogenic activities such as surface water diversions and groundwater pumping, and natural events, such as drought, which can result in mussels stranded in previously wetted areas. This is a particular concern below reservoirs, whose water levels are managed for various purposes that can cause water levels in the reservoir or downstream to rise or fall in very short periods of time, such as when hydropower facilities release water during peak energy demand periods.

Drought can also severely impact Texas fawnsfoot populations. Central Texas, including the Colorado and Brazos River basins, experienced a major drought in the late 1970s (Lewis and Oliveria 1979, p. 243). Near record dry conditions in 2008 followed by a pattern of below-normal rainfall during the winter and spring of 2009 led to one of the worst droughts in recorded history for most of central Texas, including the range of the Texas fawnsfoot (Nielsen-Gammon and McRoberts 2009, p. 2). This drought's severity was exacerbated by abnormally high air temperatures, a likely effect of climate change, which has already increased average air temperatures in Texas by at least 1 °C (1.8 °F) (Nielsen-Gammon and McRoberts 2009, p. 22). Instream flows throughout the Colorado River basin during this drought were significantly reduced (USGS 2011c, p. 1), and Texas fawnsfoot populations in areas with reduced water levels may have been negatively affected. Central Texas is currently experiencing another extreme drought, with rainfall between October 2010 and July 2011 being the lowest on record during those months (LCRA 2011c, p. 1); the effects of this drought are being observed but are not yet fully known. Droughts result in a decrease in water depth and flow velocity, which reduces food and oxygen delivery. As droughts persist, mussels face hypoxia, elevated water temperature and, ultimately, stranding (Golladay *et al.* 2004, p. 501).

We do not know the extent of the impacts of stream dewatering on the Texas fawnsfoot; however, because several populations are small and isolated, the loss of numerous individuals at a site can have dramatic consequences to the population. Hydropower facilities, construction, and drought are occurring throughout the range of the Texas fawnsfoot; therefore, the effects of dewatering are ongoing and unlikely to decrease, resulting in significant threats to the Texas fawnsfoot.

Sand and Gravel Mining

For general information on the effects of sand and gravel mining on freshwater mussels, please refer to ''Sand and Gravel Mining'' in Factor A under *Five-Factor Evaluation for Texas Fatmucket.*

The Brazos River has a long history of sand mining, particularly in the lower river, and channel morphology changes have been attributed to destabilization due to instream sand mining in the area (USGS 2001, p. 27). The removal of sand from within the river creates sediment traps during periods of high flow, which causes scouring and erosion downstream (USGS 2001, p. 27). A gravel dredging operation in the Brazos River has been documented as depositing sediment as far as 1.6 km (1 mile) downstream (Forshage and Carter 1973, p. 697). Accelerated stream bank erosion and downcutting of streambeds are common effects of instream sand and gravel mining, as is the mobilization of fine sediments during sand and gravel extraction (Roell 1999, p. 7).

Within the current range of Texas fawnsfoot, TPWD has issued permits for four sand mining activities in the Brazos River basin (Austin, Bosque, and Fort Bend Counties) (TPWD 2004, p. 1; 2007b, p. 1; 2008b, p. 1; 2010b, p. 1). All of the permits allow for the repeated removal of sand and gravel at various locations within a stream. The lower Brazos River, near where these mining activities are occurring, contains a small Texas fawnsfoot population.

The Texas fawnsfoot population in the lower Brazos River is likely threatened by sand and gravel mining. These activities occur over a long period of time, destabilizing habitat both upstream and downstream, which decreases the likelihood of recolonization after the activity has been completed. Therefore, the effects of sand and gravel mining are an ongoing threat to the Texas fawnsfoot.

Chemical Contaminants

For general information on the effects of chemical contaminants on freshwater mussels, please refer to ''Chemical Contaminants'' under Factor A under Five-Factor *Evaluation for Texas Fatmucket.*

As with other freshwater mussels, the Texas fawnsfoot is also affected by chemical contaminants. TCEQ data for 2010 indicated that 26 of the 98 assessed water bodies within Colorado River basin and 81 of approximately 124 assessed water bodies within Brazos River basin did not meet surface water quality standards and were classified as 303(d) impaired Water Bodies (Texas Clean Rivers Program 2010a, p. 5; TCEQ 2010c, pp. 1–106). These water bodies were impaired with dissolved solids, nitrites, nitrates, bacteria, low dissolved oxygen, aluminum, sulfates, selenium, chloride, orthophosphorus, phosphorus, Chlorophyll a, and low pH associated with agricultural, urban, municipal, and industrial runoff. Of these, nitrates and low dissolved oxygen pose a threat to Texas fawnsfoot, as discussed above.

In 2010, crude oil overflowed into Keechi Creek in Leon County, a tributary to Navasota River (National Response Center 2010, p. 2). This location is upstream of one of the few remaining Texas fawnsfoot populations. Numerous other spills have occurred within the range of the Texas fawnsfoot. These can occur from on site accidents (tank, pipeline spills) or from tanker truck accidents within watersheds occupied by Texas fawnsfoot. For example, oil has spilled into the Brazos River a number of times. As much as 320,000 L (84,000 gal) of crude oil was spilled in the Brazos River in 1991 (Associated Press 1991, p. 1). In June 2010, flooding of holding ponds adjacent to oil drilling operations leaked oil into Thompson Creek and subsequently into the Brazos River. Also, in July 2010, oil pipelines burst and released approximately 165 barrels of crude oil into the upper Brazos River (Joiner 2010, p. 1).

Agricultural pesticides and emerging contaminants are likely also present in streams inhabited by Texas fawnsfoot. There are 53 wastewater treatment plants permitted to discharge into the Brazos River basin (Valenti and Brooks 2008, p. 12); the outfalls from these treatment plants have not been tested to determine if they contain contaminants of note.

Chemical contaminants, such as oil, ammonia, copper, mercury, nutrients, pesticides, and other compounds are currently a threat to the Texas fawnsfoot. The species is vulnerable to acute contamination from spills as well as chronic contaminant exposure, which is occurring rangewide.

Summary of Factor A

The reduction in numbers and range of the Texas fawnsfoot is primarily the result of the long-lasting effects of habitat alterations such as the effects of impoundments, sedimentation, sand and gravel mining, and chemical contaminants. Impoundments occur throughout the range of the species and have far-reaching effects both up- and downstream. Both the Colorado and Brazos River systems have experienced a large amount of sedimentation from agriculture, sand and gravel mining, and urban development. Sand and gravel mining affects Texas fawnsfoot habitat by increasing sedimentation and channel instability downstream and causing headcutting upstream. Chemical contaminants have been documented throughout the range of the species and may represent a significant threat to the Texas fawnsfoot. Based upon our review of the best commercial and scientific data available, we conclude that the present or threatened destruction, modification, or curtailment of its habitat or range is an immediate and ongoing threat of high magnitude to the Texas fawnsfoot.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.

The Texas fawnsfoot is not a commercially valuable species and has never been harvested in Texas as a commercial mussel species (Howells 2010d, pp. 9–10). Some scientific collecting occurs but is not likely to be a significant threat to the species because it occurs only rarely. However, handling mussels can disturb gravid females and result in glochidial loss and subsequent reproductive failure. Additionally, handling has been shown to reduce shell growth across mussel species, including several species of *Lampsilis* (Haag and Commens-Carson 2008, pp. 505–506). Repeated handling by researchers may adversely affect Texas fawnsfoot individuals, but these activities are occurring rarely and are not likely to be a threat to populations. Handling for scientific purposes contributes to the long-term conservation of the species.

We do not have any evidence of risks to the Texas fawnsfoot from overutilization for commercial, recreational, scientific, or educational purposes, and we have no reason to believe this factor will become a threat to the species in the future. Based upon the best scientific and commercial information available, we conclude that overutilization for commercial, recreational, scientific, or educational purposes does not pose a significant threat to the Texas fawnsfoot rangewide.

Factor C. Disease and Predation.

Disease

Little is known about disease in freshwater mussels. However, disease is believed to be a contributing factor in documented mussel die-offs in other parts of the United States (Neves 1987, pp. 11–12). Diseases have not been documented or observed during any studies of Texas fawnsfoot.

Predation

Raccoons will prey on freshwater mussels stranded by low waters or deposited in shallow water or on bars following flooding or low water periods (Howells 2010c, p. 12). Predation of Texas fawnsfoot by raccoons may be occurring occasionally but there is no indication it is a significant threat to the status of the species.

Some species of fish feed on mussels, such as common carp, freshwater drum, and redear sunfish, all of which are common throughout the range of Texas fawnsfoot (Hubbs *et al.* 2008, pp. 19, 45, 53). Common species of flatworms are voracious predators of newly metamorphosed juvenile mussels of many species (Zimmerman *et al.* 2003, p. 30). Predation is a normal factor influencing the population dynamics of a healthy mussel population; however, predation may amplify declines in small populations primarily caused by other factors.

Summary of Factor C

Disease in freshwater mussels is poorly known, and we do not have any information indicating it is a threat to the Texas fawnsfoot. Additionally, predation is a natural ecological interaction and we have no information indicating the extent of any predation is a threat to populations of Texas fawnsfoot. Based upon the best scientific and commercial information available, we conclude that disease or predation is not a threat to the Texas fawnsfoot.

Factor D. The Inadequacy of Existing Regulatory Mechanisms.

Existing regulatory mechanisms that could have an effect on threats to the Texas fawnsfoot include State and Federal laws such as Texas Threatened and Endangered Species regulations and freshwater mussel sanctuaries, State and Federal sand and gravel mining regulations, and regulation of point and non-point source pollution. For more information on the effects of State and Federal laws on the threats to freshwater mussels in central Texas, please refer to Factor D under *Five-Factor Evaluation for Texas Fatmucket.*

Summary of Factor D

Despite State and Federal laws protecting the species and water quality, the Texas fawnsfoot continues to decline due to the effects of habitat destruction, poor water quality, contaminants, and other factors. The regulatory measures described in Factor D under *Five-Factor Evaluation for Texas Fatmucket* have been insufficient to significantly reduce or remove the threats to the Texas fawnsfoot. Based upon our review of the best commercial and scientific data available, we conclude that the lack of existing regulatory mechanisms is an immediate threat of moderate magnitude to the Texas fawnsfoot.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence.

Natural and manmade factors that threaten the Texas fawnsfoot include climate change, population fragmentation and isolation, and nonnative species.

Climate Change

For general information on the effects of climate change on freshwater mussels in central Texas, please refer to ''Climate Change'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* Because the range of the Texas fawnsfoot has been reduced to isolated locations, many with low population numbers, in small rivers and streams, the Texas fawnsfoot is vulnerable to climatic changes that could decrease the availability of water.

The disjunct nature of the remaining Texas fawnsfoot populations, coupled with the limited ability of mussels to migrate, makes it unlikely that Texas fawnsfoot can adjust their range in response to changes in climate (Strayer 2008, p. 30). Climate change could affect the Texas fawnsfoot through the combined effects of global and regional climate change, along with the increased probability of long-term drought. Climate change exacerbates threats such as habitat degradation from prolonged periods of drought, increased water temperature, and the increased allocation of water for municipal, agricultural, and industrial use. Climate change may be a significant stressor that exacerbates existing threats by increasing the likelihood of prolonged drought. As such, climate change, in and of itself, may affect the Texas fawnsfoot, but the magnitude and imminence of the effects remain uncertain. Based upon our review of the best commercial and scientific data available, we conclude that the effects of climate change in the future will likely exacerbate the current and ongoing threats of habitat loss and degradation caused by other factors, as discussed above.

Population Fragmentation and Isolation

For general information on the effects of population fragmentation and isolation on freshwater mussels in central Texas, please refer to ''Population Fragmentation and Isolation'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* As with many freshwater mussels, most of the remaining populations of the Texas fawnsfoot are small and geographically isolated and thus are susceptible to genetic drift, inbreeding depression, and random or chance changes to the environment, such as toxic chemical spills (Watters and Dunn 1995, pp. 257–258) or dewatering. Historically, the Texas fawnsfoot was once widespread throughout much of the Colorado and Brazos River systems when few natural barriers existed to prevent migration (via host species) among suitable habitats. The extensive impoundment of the Colorado and Brazos River basins has fragmented Texas fawnsfoot populations throughout these river systems.

Small Texas fawnsfoot populations, including those in the Brazos River, Clear Fork Brazos River, Navasota River, and Deer Creek, may be below the minimum population size required to maintain population viability into the future. These populations are more vulnerable to extirpation since they are less likely to be able to recover through recruitment from events that reduce but do not extirpate populations. Additionally, these small populations are more vulnerable to extirpation from stochastic events, as the lack of connectivity among populations does not permit nearby populations to recolonize areas affected by intense droughts, toxic spills, or other isolated events that result in significant mussel dieoffs. While the small, isolated populations do not represent an independent threat to the species, the situation does substantially increase the risk of extirpation from the effects of all other threats, including those addressed in this analysis, and those that could occur in the future from unknown sources.

Based upon our review of the best commercial and scientific data available, we conclude that fragmentation and isolation of small remaining populations of the Texas fawnsfoot are occurring and are ongoing threats to the species throughout all of its range; these threats will continue. Further, stochastic events may play a magnified role in extirpation of small, isolated populations.

Nonnative Species

For general information on the effects of nonnative species on freshwater mussels in central Texas, please refer to ''Nonnative Species'' in Factor E under *Five-Factor Evaluation for Texas Fatmucket.* As with other freshwater mussels, the Texas fawnsfoot is threatened by nonnative species. Various nonnative aquatic species pose a threat to the Texas fawnsfoot, including golden algae, zebra mussels, and black carp. Of these, golden algae has been responsible for killing more than two million fish in the Colorado River since 1989 (TPWD 2010a, p. 1). Although mussel kills due to golden algae have not been recorded, we expect golden algae to negatively affect mussel populations through loss of host fish and direct toxicity. Zebra mussels and black carp do not currently occur within the range of the Texas fawnsfoot, although both are found in Texas and could be introduced to the Brazos and Colorado Rivers in the future. Based on population responses of other mussel species that overlap with zebra mussels and black carp in similar river conditions, we conclude that the introduction of zebra mussels or black carp into the range of smooth pimpleback would be devastating to the species.

Based upon our review of the best commercial and scientific data available, we conclude that golden algae is an ongoing threat to the Texas fawnsfoot, and other nonnative species, such as zebra mussels and black carp, are a potential threat to the Texas fawnsfoot that is likely to increase as these exotic species expand their occupancy within the range of the Texas fawnsfoot.

Summary of Factor E

The effects of climate change, while difficult to quantify at this time, are likely to exacerbate the current and ongoing threat of habitat loss caused by other factors, and the small sizes and fragmented nature of the remaining populations render them more vulnerable to extirpation. In addition, nonnative species, such as golden algae, currently threaten the Texas fatmucket, and the potential introduction of zebra mussels and black carp are potential future threats. Based upon our review of the best commercial and scientific data available, we conclude that other natural or manmade factors are immediate threats of moderate magnitude to the Texas fawnsfoot.

Finding for Texas Fawnsfoot

As required by the Act, we considered the five factors in assessing whether the Texas fawnsfoot is threatened or endangered throughout all of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the Texas fawnsfoot. We reviewed the petition, information available in our files, and other available published and unpublished information, and we consulted with recognized Texas fawnsfoot experts and other Federal and State agencies.

This status review identifies threats to the Texas fawnsfoot attributable to Factors A, D, and E. The primary threat to the species is from habitat destruction and modification (Factor A) from impoundments, which scour riverbeds, thereby removing mussel habitat, decrease water quality, modify stream flows, and restrict fish host migration and distribution of freshwater mussels. Additional threats under Factor A include sedimentation, dewatering, sand and gravel mining, and chemical contaminants. Also, most of these threats may be exacerbated by the current and projected effects of climate change (discussed under Factor E). Threats to the Texas fawnsfoot are not being adequately addressed through existing regulatory mechanisms (Factor D). Because of the limited distribution of this endemic species and its lack of mobility, these threats are likely to lead to the extinction of the Texas fawnsfoot in the foreseeable future.

On the basis of the best scientific and commercial information available, we find that the petitioned action to list the Texas fawnsfoot under the Act is warranted. We will make a determination on the status of the species as threatened or endangered when we complete a proposed listing determination. When we complete a proposed listing determination, we will examine whether the species may be endangered or threatened throughout all of its range or whether the species may be endangered or threatened in a significant portion of its range. However, as explained in more detail below, an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

We reviewed the available information to determine if the existing and foreseeable threats render the Texas fawnsfoot at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the Act is warranted. We determined that issuing an emergency regulation temporarily listing the species is not warranted for the Texas fawnsfoot at this time, because we have not identified a threat or activity that poses a significant risk, such that losses to the species during the normal listing process would endanger the continued existence of the entire species. However, if at any time we determine that issuing an emergency regulation temporarily listing the Texas fawnsfoot is warranted, we will initiate this action at that time.

Listing Priority Number for Texas Fawnsfoot

The Service adopted guidelines on September 21, 1983 (48 FR 43098), to establish a rational system for utilizing available resources for the highest priority species when adding species to the Lists of Endangered and Threatened Wildlife and Plants or reclassifying species listed as threatened to endangered status. These guidelines, titled ''Endangered and Threatened Species Listing and Recovery Priority Guidelines'' address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates).

As a result of our analysis of the best available scientific and commercial information, we have assigned the Texas fawnsfoot an LPN of 2, based on our finding that the species faces threats that are of high magnitude and are imminent. These threats include habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants; other natural or manmade factors such as climate change, small, isolated populations, and nonnative species; and the fact that the threats to the species are not being adequately addressed by existing regulatory mechanisms. Our rationale for assigning the Texas fawnsfoot an LPN of 2 is outlined below.

We consider the threats that the Texas fawnsfoot faces to be high in magnitude. Habitat loss and degradation from impoundments, sedimentation, sand and gravel mining, and chemical contaminants are widespread throughout the range of the Texas fawnsfoot and profoundly affect its habitat. Remaining populations are small, isolated, and highly vulnerable to stochastic events.

Under our LPN guidelines, the second criterion we consider in assigning a listing priority is the immediacy of threats. We consider the threats to the Texas fawnsfoot as described under Factors A, D, and E in the *Five-Factor Evaluation for Texas Fawnsfoot* section to be imminent because these threats are ongoing and will continue in the foreseeable future. Habitat loss and destruction has already occurred and will continue as the human population continues to grow in central Texas. The Texas fawnsfoot populations may already be below the minimum viable population requirement, which would cause a reduction in the number of populations and an increase in the species' vulnerability to extinction. These threats are exacerbated by climate change, which will increase the frequency and magnitude of droughts. Therefore, we consider these threats to be imminent.

Thirdly, the Texas fawnsfoot is a valid taxon at the species level and, therefore, receives a higher priority than subspecies, but a lower priority than species in a monotypic genus. Therefore, we assigned Texas fawnsfoot an LPN of 2. We will continue to monitor the threats to the Texas fawnsfoot and the species' status on an annual basis, and should the magnitude or imminence of the threats change, we will revisit our assessment of the LPN.

While we conclude that listing the Texas fawnsfoot is warranted, an immediate proposal to list this species is precluded by other higher priority listings, which we address in the Preclusion and Expeditious Progress section below. Because we have assigned the Texas fawnsfoot an LPN of 2, work on a proposed listing determination for the species is precluded by work on higher priority listing actions with absolute statutory, court-ordered, or court-approved deadlines and final listing determinations for those species that were proposed for listing with funds from Fiscal Year (FY) 2011. This work includes all the actions listed in the tables below under Preclusion and Expeditious Progress.

Preclusion and Expeditious Progress

Preclusion is a function of the listing priority of a species in relation to the resources that are available and the cost and relative priority of competing demands for those resources. Thus, in any given fiscal year (FY), multiple factors dictate whether it will be possible to undertake work on a listing proposal regulation or whether promulgation of such a proposal is precluded by higher priority listing actions.

The resources available for listing actions are determined through the annual Congressional appropriations process. The appropriation for the Listing Program is available to support work involving the following listing actions: Proposed and final listing rules; 90-day and 12-month findings on petitions to add species to the Lists of Endangered and Threatened Wildlife and Plants (Lists) or to change the status of a species from threatened to endangered; annual ‘‘resubmitted’’ petition findings on prior warranted-but-precluded petition findings as required under section 4(b)(3)(C)(i) of the Act; critical habitat petition findings; proposed and final rules designating critical habitat; and litigation-related, administrative, and program-management functions (including preparing and allocating budgets, responding to Congressional and public inquiries, and conducting public outreach regarding listing and critical habitat). The work involved in preparing various listing documents can be extensive and may include, but is not limited to: Gathering and assessing the best scientific and commercial data available and conducting analyses used as the basis for our decisions; writing and publishing documents; and obtaining, reviewing, and evaluating public comments and peer review comments on proposed rules and incorporating relevant information into final rules. The number of listing actions that we can undertake in a given year also is influenced by the complexity of those listing actions; that is, more complex actions generally are more costly. The median cost for preparing and publishing a 90-day finding is $39,276; for a 12-month finding, $100,690; for a proposed rule with critical habitat, $345,000; and for a final listing rule with critical habitat, $305,000.

We cannot spend more than is appropriated for the Listing Program without violating the Anti-Deficiency Act (see 31 U.S.C. 1341(a)(1)(A)). In addition, in FY 1998 and for each fiscal year since then, Congress has placed a statutory cap on funds that may be expended for the Listing Program, equal to the amount expressly appropriated for that purpose in that fiscal year. This cap was designed to prevent funds appropriated for other functions under the Act (for example, recovery funds for removing species from the Lists), or for other Service programs, from being used for Listing Program actions (see House Report 105–163, 105th Congress, 1st Session, July 1, 1997).

Since FY 2002, the Service's budget has included a critical habitat subcap to ensure that some funds are available for other work in the Listing Program (‘‘The critical habitat designation subcap will ensure that some funding is available to address other listing activities’’ (House Report No. 107–103, 107th Congress, 1st Session, June 19, 2001)). In FY 2002 and each year until FY 2006, the Service has had to use virtually the entire critical habitat subcap to address court-mandated designations of critical habitat, and consequently none of the critical habitat subcap funds have been available for other listing activities. In some FYs since 2006, we have been able to use some of the critical habitat subcap funds to fund proposed listing determinations for high-priority candidate species. In other FYs, while we were unable to use any of the critical habitat subcap funds to fund proposed listing determinations, we did use some of this money to fund the critical habitat portion of some proposed listing determinations so that the proposed listing determination and proposed critical habitat designation could be combined into one rule, thereby being more efficient in our work. At this time, for FY 2011, we plan to use some of the critical habitat subcap funds to fund proposed listing determinations.

We make our determinations of preclusion on a nationwide basis to ensure that the species most in need of listing will be addressed first and also because we allocate our listing budget on a nationwide basis. Through the listing cap, the critical habitat subcap, and the amount of funds needed to address court-mandated critical habitat designations, Congress and the courts have in effect determined the amount of money available for other listing activities nationwide. Therefore, the funds in the listing cap, other than those needed to address court-mandated critical habitat for already listed species, set the limits on our determinations of preclusion and expeditious progress.

Congress identified the availability of resources as the only basis for deferring the initiation of a rulemaking that is warranted. The Conference Report accompanying Public Law 97–304 (Endangered Species Act Amendments of 1982), which established the current statutory deadlines and the warranted-but-precluded finding, states that the amendments were ‘‘not intended to allow the Secretary to delay commencing the rulemaking process for any reason other than that the existence of pending or imminent proposals to list species subject to a greater degree of threat would make allocation of resources to such a petition [that is, for a lower-ranking species] unwise.’’ Although that statement appeared to refer specifically to the ‘‘to the maximum extent practicable’’ limitation on the 90-day deadline for making a ‘‘substantial information’’ finding, that finding is made at the point when the Service is deciding whether or not to commence a status review that will determine the degree of threats facing the species, and therefore the analysis underlying the statement is more relevant to the use of the warranted-but-precluded finding, which is made when the Service has already determined the degree of threats facing the species and is deciding whether or not to commence a rulemaking.

In FY 2011, on April 15, 2011, Congress passed the Full-Year Continuing Appropriations Act (Pub. L. 112–10), which provides funding through September 30, 2011. The Service has $20,902,000 for the listing program. Of that, $9,472,000 is being used for determinations of critical habitat for already listed species. Also $500,000 is appropriated for foreign species listings under the Act. The Service thus has $10,930,000 available to fund work in the following categories: Compliance with court orders and court-approved settlement agreements requiring that petition findings or listing determinations be completed by a specific date; section 4 (of the Act) listing actions with absolute statutory deadlines; essential litigation-related, administrative, and listing program-management functions; and high-priority listing actions for some of our candidate species. In FY 2010, the Service received many new petitions and a single petition to list 404 species. The receipt of petitions for a large number of species is consuming the

Service's listing funding that is not dedicated to meeting court-ordered commitments. Absent some ability to balance effort among listing duties under existing funding levels, the Service is only able to initiate a few new listing determinations for candidate species in FY 2011.

In 2009, the responsibility for listing foreign species under the Act was transferred from the Division of Scientific Authority, International Affairs Program, to the Endangered Species Program. Therefore, starting in FY 2010, we used a portion of our funding to work on the actions described above for listing actions related to foreign species. In FY 2011, we anticipate using $1,500,000 for work on listing actions for foreign species, which reduces funding available for domestic listing actions; however, currently only $500,000 has been allocated for this function. Although there are no foreign species issues included in our high-priority listing actions at this time, many actions have statutory or court-approved settlement deadlines, thus increasing their priority. The budget allocations for each specific listing action are identified in the Service's FY 2011 Allocation Table (part of our record).

For the above reasons, funding proposed listing determinations for the Texas fatmucket, golden orb, smooth pimpleback, Texas pimpleback, and Texas fawnsfoot is precluded by court-ordered and court-approved settlement agreements, listing actions with absolute statutory deadlines, and work on proposed listing determinations for those candidate species with a higher listing priority (*i.e.,* candidate species with LPNs of 1).

Based on our September 21, 1983, guidelines for assigning an LPN for each candidate species (48 FR 43098), we have a significant number of species with a LPN of 2. Using these guidelines, we assign each candidate an LPN of 1 to 12, depending on the magnitude of threats (high or moderate to low), immediacy of threats (imminent or nonimminent), and taxonomic status of the species (in order of priority: monotypic genus (a species that is the sole member of a genus); species; or part of a species (subspecies, or distinct population segment)). The lower the listing priority number, the higher the listing priority (that is, a species with an LPN of 1 would have the highest listing priority).

Because of the large number of high-priority species, we have further ranked the candidate species with an LPN of 2 by using the following extinction-risk type criteria: International Union for the Conservation of Nature and Natural Resources (IUCN) Red list status/rank, Heritage rank (provided by NatureServe), Heritage threat rank (provided by NatureServe), and species currently with fewer than 50 individuals, or 4 or fewer populations. Those species with the highest IUCN rank (critically endangered), the highest Heritage rank (G1), the highest Heritage threat rank (substantial, imminent threats), and currently with fewer than 50 individuals, or fewer than 4 populations, originally comprised a group of approximately 40 candidate species (''Top 40''). These 40 candidate species have had the highest priority to receive funding to work on a proposed listing determination. As we work on proposed and final listing rules for those 40 candidates, we apply the ranking criteria to the next group of candidates with an LPN of 2 and 3 to determine the next set of highest priority candidate species. Finally, proposed rules for reclassification of threatened species to endangered species are lower priority, because as listed species, they are already afforded the protections of the Act and implementing regulations. However, for efficiency reasons, we may choose to work on a proposed rule to reclassify a species to endangered if we can combine this with work that is subject to a court-determined deadline.

With our workload so much bigger than the amount of funds we have to accomplish it, it is important that we be as efficient as possible in our listing process. Therefore, as we work on proposed rules for the highest priority species in the next several years, we are preparing multi-species proposals when appropriate, and these may include species with lower priority if they overlap geographically or have the same threats as a species with an LPN of 2. In addition, we take into consideration the availability of staff resources when we determine which high-priority species will receive funding to minimize the amount of time and resources required to complete each listing action.

As explained above, a determination that listing is warranted but precluded must also demonstrate that expeditious progress is being made to add and remove qualified species to and from the Lists of Endangered and Threatened Wildlife and Plants. As with our ''precluded'' finding, the evaluation of whether progress in adding qualified species to the Lists has been expeditious is a function of the resources available for listing and the competing demands for those funds. (Although we do not discuss it in detail here, we are also making expeditious progress in removing species from the list under the Recovery program in light of the resource available for delisting, which is funded by a separate line item in the budget of the Endangered Species Program. So far during FY 2011, we have completed delisting rules for three species.) Given the limited resources available for listing, we find that we are making expeditious progress in FY 2011 in the Listing Program. This progress included preparing and publishing the following determinations:

FY 2011 COMPLETED LISTING ACTIONS

Publication date	Title	Actions	FR Pages
10/6/2010	Endangered Status for the Altamaha Spinymussel and Designation of Critical Habitat.	Proposed Listing Endangered	75 FR 61664–61690
10/7/2010	12-Month Finding on a Petition to list the Sacramento Splittail as Endangered or Threatened.	Notice of 12-month petition finding, Not warranted.	75 FR 62070–62095
10/28/2010	Endangered Status and Designation of Critical Habitat for Spikedace and Loach Minnow.	Proposed Listing Endangered (uplisting)	75 FR 66481–66552
11/2/2010	90-Day Finding on a Petition to List the Bay Springs Salamander as Endangered.	Notice of 90-day Petition Finding, Not substantial.	75 FR 67341–67343
11/2/2010	Determination of Endangered Status for the Georgia Pigtoe Mussel, Interrupted Rocksnail, and Rough Hornsnail and Designation of Critical Habitat.	Final Listing Endangered	75 FR 67511–67550
11/2/2010	Listing the Rayed Bean and Snuffbox as Endangered	Proposed Listing Endangered	75 FR 67551–67583

FY 2011 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR Pages
11/4/2010	12-Month Finding on a Petition to List Cirsium wrightii (Wright's Marsh Thistle) as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 67925–67944
12/14/2010	Endangered Status for Dunes Sagebrush Lizard	Proposed Listing Endangered	75 FR 77801–77817
12/14/2010	12-Month Finding on a Petition to List the North American Wolverine as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 78029–78061
12/14/2010	12-Month Finding on a Petition to List the Sonoran Population of the Desert Tortoise as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 78093–78146
12/15/2010	12-Month Finding on a Petition to List *Astragalus microcymbus* and *Astragalus schmolliae* as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	75 FR 78513–78556
12/28/2010	Listing Seven Brazilian Bird Species as Endangered Throughout Their Range.	Final Listing Endangered	75 FR 81793–81815
1/4/2011	90-Day Finding on a Petition to List the Red Knot subspecies *Calidris canutus roselaari* as Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 304–311
1/19/2011	Endangered Status for the Sheepnose and Spectaclecase Mussels.	Proposed Listing Endangered	76 FR 3392–3420
2/10/2011	12-Month Finding on a Petition to List the Pacific Walrus as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 7634–7679
2/17/2011	90-Day Finding on a Petition to List the Sand Verbena Moth as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR 9309–9318
2/22/2011	Determination of Threatened Status for the New Zealand-Australia Distinct Population Segment of the Southern Rockhopper Penguin.	Final Listing Threatened	76 FR *9681–9692*
2/22/2011	12-Month Finding on a Petition to List *Solanum conocarpum* (marron bacora) as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 9722–9733
2/23/2011	12-Month Finding on a Petition to List Thorne's Hairstreak Butterfly as Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 9991–10003
2/23/2011	12-Month Finding on a Petition to List *Astragalus hamiltonii, Penstemon flowersii, Eriogonum soredium, Lepidium ostleri,* and *Trifolium friscanum* as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded & Not Warranted.	76 FR 10166–10203
2/24/2011	90-Day Finding on a Petition to List the Wild Plains Bison or Each of Four Distinct Population Segments as Threatened.	Notice of 90-day Petition Finding, Not substantial.	76 FR 10299–10310
2/24/2011	90-Day Finding on a Petition to List the Unsilvered Fritillary Butterfly as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 10310–10319
3/8/2011	12-Month Finding on a Petition to List the Mt. Charleston Blue Butterfly as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 12667–12683
3/8/2011	90-Day Finding on a Petition to List the Texas Kangaroo Rat as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR 12683–12690
3/10/2011	Initiation of Status Review for Longfin Smelt	Notice of Status Review	76 FR 13121–13122
3/15/2011	Withdrawal of Proposed Rule to List the Flat-tailed Horned Lizard as Threatened.	Proposed rule withdrawal	76 FR *14210–14268*
3/15/2011	Proposed Threatened Status for the Chiricahua Leopard Frog and Proposed Designation of Critical Habitat.	Proposed Listing Threatened; Proposed Designation of Critical Habitat.	76 FR 14126–14207
3/22/2011	12-Month Finding on a Petition to List the Berry Cave Salamander as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 15919–15932
4/1/2011	90-Day Finding on a Petition to List the Spring Pygmy Sunfish as Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR 18138–18143
4/5/2011	12-Month Finding on a Petition to List the Bearmouth Mountainsnail, Byrne Resort Mountainsnail, and Meltwater Lednian Stonefly as Endangered or Threatened.	Notice of 12-month petition finding, Not Warranted and Warranted but precluded.	76 FR *18684–18701*
4/5/2011	90-Day Finding on a Petition to List the Peary Caribou and Dolphin and Union population of the Barren-ground Caribou as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR *18701–18706*
4/12/2011	Proposed Endangered Status for the Three Forks Springsnail and San Bernardino Springsnail, and Proposed Designation of Critical Habitat.	Proposed Listing Endangered; Proposed Designation of Critical Habitat.	76 FR 20464–20488
4/13/2011	90-Day Finding on a Petition to List Spring Mountains Acastus Checkerspot Butterfly as Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR *20613–20622*
4/14/2011	90-Day Finding on a Petition to List the Prairie Chub as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR *20911–20918*
4/14/2011	12-Month Finding on a Petition to List Hermes Copper Butterfly as Endangered or Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR *20918–20939*
4/26/2011	90-Day Finding on a Petition to List the Arapahoe Snowfly as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR *23256–23265*

FY 2011 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR Pages
4/26/2011	90-Day Finding on a Petition to List the Smooth-Billed Ani as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 23265–23271
5/12/2011	Withdrawal of the Proposed Rule to List the Mountain Plover as Threatened.	Proposed Rule, Withdrawal	76 FR 27756–27799
5/25/2011	90-Day Finding on a Petition to List the Spot-tailed Earless Lizard as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR 30082–30087
5/26/2011	Listing the Salmon-Crested Cockatoo as Threatened Throughout its Range with Special Rule.	Final Listing Threatened	76 FR 30758–30780
5/31/2011	12-Month Finding on a Petition to List Puerto Rican Harlequin Butterfly as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR *31282–31294*
6/2/2011	90-Day Finding on a Petition to Reclassify the Straight-Horned Markhor (*Capra falconeri jerdoni*) of Torghar Hills as Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR *31903–31906*
6/2/2011	90-Day Finding on a Petition to List the Golden-winged Warbler as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR *31920–31926*
6/7/2011	12-Month Finding on a Petition to List the Striped Newt as Threatened.	Notice of 12-month petition finding, Warranted but precluded.	76 FR *32911–32929*
6/9/2011	12-Month Finding on a Petition to List *Abronia ammophila, Agrostis rossiae, Astragalus proimanthus, Boechera* (*Arabis*) *pusilla,* and *Penstemon gibbensii* as Threatened or Endangered.	Notice of 12-month petition finding, Not Warranted and Warranted but precluded.	76 FR *33924–33965*
6/21/2011	90-Day Finding on a Petition to List the Utah Population of the Gila Monster as an Endangered or a Threatened Distinct Population Segment.	Notice of 90-day Petition Finding, Not substantial.	76 FR *36049–36053*
6/21/2011	Revised 90-Day Finding on a Petition to Reclassify the Utah Prairie Dog From Threatened to Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR 36053–36068
6/28/2011	12-Month Finding on a Petition to List *Castanea pumila* var. *ozarkensis* as Threatened or Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 37706–37716
6/29/2011	90-Day Finding on a Petition to List the Eastern Small-Footed Bat and the Northern Long-Eared Bat as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR 38095–38106
6/30/2011	12-Month Finding on a Petition to List a Distinct Population Segment of the Fisher in Its United States Northern Rocky Mountain Range as Endangered or Threatened with Critical Habitat.	Notice of 12-month petition finding, Not warranted.	76 FR 38504–38532
7/12/2011	90-Day Finding on a Petition to List the Bay Skipper as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR 40868–40871
7/19/2011	12-Month Finding on a Petition to List *Pinus albicaulis* as Endangered or Threatened with Critical Habitat.	Notice of 12-month petition finding, Warranted but precluded.	76 FR *42631–42654*
7/19/2011	Petition to List Grand Canyon Cave Pseudoscorpion ..	Notice of 12-month petition finding, Not warranted.	76 FR *42654–42658*
7/26/2011	12-Month Finding on a Petition to List the Giant Palouse Earthworm (*Drilolerius americanus*) as Threatened or Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 44547–44564
7/26/2011	12-Month Finding on a Petition to List the Frigid Ambersnail as Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR 44566–44569
7/27/2011	Determination of Endangered Status for *Ipomopsis polyantha* (Pagosa Skyrocket) and Threatened Status for *Penstemon debilis* (Parachute Beardtongue) and *Phacelia submutica* (DeBeque Phacelia).	Final Listing Endangered, Threatened	76 FR 45054–45075
7/27/2011	12-Month Finding on a Petition to List the Gopher Tortoise as Threatened in the Eastern Portion of its Range.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 45130–45162
8/2/2011	Proposed Endangered Status for the Chupadera Springsnail (*Pyrgulopsis chupaderae*) and Proposed Designation of Critical Habitat.	Proposed Listing Endangered	76 FR *46218–46234*
8/2/2011	90-Day Finding on a Petition to List the Straight Snowfly and Idaho Snowfly as Endangered.	Notice of 90-day Petition Finding, Not substantial.	76 FR *46238–46251*
8/2/2011	12-Month Finding on a Petition to List the Redrock Stonefly as Endangered or Threatened.	Notice of 12-month petition finding, Not warranted.	76 FR *46251–46266*
8/2/2011	Listing 23 Species on Oahu as Endangered and Designating Critical Habitat for 124 Species.	Proposed Listing Endangered	76 FR *46362–46594*
8/4/2011	90-Day Finding on a Petition to List Six Sand Dune Beetles as Endangered or Threatened.	Notice of 90-day Petition Finding, Not substantial and substantial.	76 FR 47123–47133
8/9/2011	Endangered Status for the Cumberland Darter, Rush Darter, Yellowcheek Darter, Chucky Madtom, and Laurel Dace.	Final Listing Endangered	76 FR *48722–48741*
8/9/2011	12-Month Finding on a Petition to List the Nueces River and Plateau Shiners as Threatened or Endangered.	Notice of 12-month petition finding, Not warranted.	76 FR *48777–48788*

FY 2011 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR Pages
8/9/2011	Four Foreign Parrot Species [crimson shining parrot, white cockatoo, Philippine cockatoo, yellow-crested cockatoo].	Proposed Listing Endangered and Threatened; Notice of 12-month petition finding, Not warranted.	76 FR *49202–49236*
8/10/2011	Proposed Listing of the Miami Blue Butterfly as Endangered, and Proposed Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly.	Proposed Listing Endangered Similarity of Appearance.	76 FR *49408–49412*
8/10/2011	90-Day Finding on a Petition to List the Saltmarsh Topminnow as Threatened or Endangered Under the Endangered Species Act.	Notice of 90-day Petition Finding, Substantial	76 FR *49412–49417*
8/10/2011	Proposed Listing of the Miami Blue Butterfly as Endangered, and Proposed Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly.	Proposed Listing Endangered and Similarity of Appearance.	76 FR *49408–49412*
8/10/2011	Emergency Listing of the Miami Blue Butterfly as Endangered, and Emergency Listing of the Cassius Blue, Ceraunus Blue, and Nickerbean Blue Butterflies as Threatened Due to Similarity of Appearance to the Miami Blue Butterfly.	Emergency Listing Endangered and Similarity of Appearance.	76 FR *49542–49567*
8/11/2011	Listing Six Foreign Birds as Endangered Throughout Their Range.	Final Listing Endangered	76 FR 50052–50080
8/17/2011	90-Day Finding on a Petition to List the Leona's Little Blue Butterfly as Endangered or Threatened.	Notice of 90-day Petition Finding, Substantial	76 FR 50971–50979
9/01/2011	90-Day Finding on a Petition to List All Chimpanzees (*Pan troglodytes*) as Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR 54423–54425
9/6/2011	12-Month Finding on Five Petitions to List Seven Species of Hawaiian Yellow-faced Bees as Endangered.	Notice of 12-month petition finding, Warranted but precluded.	76 FR 55170–55203
9/8/2011	12-Month Petition Finding and Proposed Listing of *Arctostaphylos franciscana* as Endangered.	Notice of 12-month petition finding, Warranted; Proposed Listing Endangered.	76 FR 55623–55638
9/8/2011	90-Day Finding on a Petition to List the Snowy Plover and Reclassify the Wintering Population of Piping Plover.	Notice of 90-day Petition Finding, Not substantial.	76 FR 55638–55641
9/13/2011	90-Day Finding on a Petition to List the Franklin's Bumble Bee as Endangered.	Notice of 90-day Petition Finding, Substantial	76 FR
9/13/2011	90-Day Finding on a Petition to List 42 Great Basin and Mojave Desert Springsnails as Threatened or Endangered with Critical Habitat.	Notice of 90-day Petition Finding, Substantial and Not substantial.	76 FR

Our expeditious progress also includes work on listing actions that we funded in FY 2010 and FY 2011 but have not yet been completed to date. These actions are listed below. Actions in the top section of the table are being conducted under a deadline set by a court. Actions in the middle section of the table are being conducted to meet statutory timelines, that is, timelines required under the Act. Actions in the bottom section of the table are high-priority listing actions. These actions include work primarily on species with an LPN of 2, and, as discussed above, selection of these species is partially based on available staff resources, and when appropriate, include species with a lower priority if they overlap geographically or have the same threats as the species with the high priority. Including these species together in the same proposed rule results in considerable savings in time and funding, when compared to preparing separate proposed rules for each of them in the future.

ACTIONS FUNDED IN FY 2010 AND FY 2011 BUT NOT YET COMPLETED

Species	Action
Actions Subject to Court Order/Settlement Agreement	
4 parrot species (military macaw, yellow-billed parrot, red-crowned parrot, scarlet macaw) [5]	12-month petition finding.
4 parrot species (blue-headed macaw, great green macaw, grey-cheeked parakeet, hyacinth macaw) [5].	12-month petition finding.
Longfin smelt	12-month petition finding.
Actions with Statutory Deadlines	
Casey's june beetle	Final listing determination.
5 Bird species from Colombia and Ecuador	Final listing determination.
Queen Charlotte goshawk	Final listing determination.
Ozark hellbender [4]	Final listing determination.
Altamaha spinymussel [3]	Final listing determination.
6 Birds from Peru & Bolivia	Final listing determination.

ACTIONS FUNDED IN FY 2010 AND FY 2011 BUT NOT YET COMPLETED—Continued

Species	Action
Loggerhead sea turtle (assist National Marine Fisheries Service)[5]	Final listing determination.
2 mussels (rayed bean (LPN = 2), snuffbox No LPN)[5]	Final listing determination.
CA golden trout[4]	12-month petition finding.
Black-footed albatross	12-month petition finding.
Mojave fringe-toed lizard[1]	12-month petition finding.
Kokanee—Lake Sammamish population[1]	12-month petition finding.
Cactus ferruginous pygmy-owl[1]	12-month petition finding.
Northern leopard frog	12-month petition finding.
Tehachapi slender salamander	12-month petition finding.
Coqui Llanero	12-month petition finding/Proposed listing.
Dusky tree vole.	12-month petition finding.
Leatherside chub (from 206 species petition)	12-month petition finding.
Platte River caddisfly (from 206 species petition)[5]	12-month petition finding.
3 Texas moths (*Ursia furtiva, Sphingicampa blanchardi, Agapema galbina*) (from 475 species petition).	12-month petition finding.
3 South Arizona plants (*Erigeron piscaticus, Astragalus hypoxylus, Amoreuxia gonzalezii*) (from 475 species petition).	12-month petition finding.
14 parrots (foreign species)	12-month petition finding.
Mohave Ground Squirrel[1]	12-month petition finding.
Western gull-billed tern	12-month petition finding.
OK grass pink (*Calopogon oklahomensis*)[1]	12-month petition finding.
Ashy storm-petrel[5]	12-month petition finding.
Honduran emerald	12-month petition finding.
Eagle Lake trout[1]	90-day petition finding.
32 Pacific Northwest mollusks species (snails and slugs)[1]	90-day petition finding.
Spring Mountains checkerspot butterfly	90-day petition finding.
10 species of Great Basin butterfly	90-day petition finding.
404 Southeast species	90-day petition finding.
American eel[4]	90-day petition finding.
Aztec gilia[5]	90-day petition finding.
White-tailed ptarmigan[5]	90-day petition finding.
San Bernardino flying squirrel[5]	90-day petition finding.
Bicknell's thrush[5]	90-day petition finding.
Sonoran talussnail[5]	90-day petition finding.
2 AZ Sky Island plants (*Graptopetalum bartrami* & *Pectis imberbis*)[5]	90-day petition finding.
I'iwi[5]	90-day petition finding.
Humboldt marten	90-day petition finding.
Desert massasauga	90-day petition finding.
Western glacier stonefly (*Zapada glacier*)	90-day petition finding.
Thermophilic ostracod (*Potamocypris hunteri*)	90-day petition finding.
Sierra Nevada red fox[5]	90-day petition finding.
Boreal toad (eastern or southern Rocky Mtn population)[5]	90-day petition finding.
Alexander Archipelago wolf[5]	90-day petition finding.
High-Priority Listing Actions	
20 Maui-Nui candidate species[2] (17 plants, 3 tree snails) (14 with LPN = 2, 2 with LPN = 3, 3 with LPN = 8).	Proposed listing.
8 Gulf Coast mussels (southern kidneyshell (LPN = 2), round ebonyshell (LPN = 2), Alabama pearlshell (LPN = 2), southern sandshell (LPN = 5), fuzzy pigtoe (LPN = 5), Choctaw bean (LPN = 5), narrow pigtoe (LPN = 5), and tapered pigtoe (LPN = 11))[4].	Proposed listing.
Umtanum buckwheat (LPN = 2) and white bluffs bladderpod (LPN = 9)[4]	Proposed listing.
Grotto sculpin (LPN = 2)[4]	Proposed listing.
2 Arkansas mussels (Neosho mucket (LPN = 2) & Rabbitsfoot (LPN = 9))[4]	Proposed listing.
Diamond darter (LPN = 2)[4]	Proposed listing.
Gunnison sage-grouse (LPN = 2)[4]	Proposed listing.
Coral Pink Sand Dunes Tiger Beetle (LPN = 2)[5]	Proposed listing.
Lesser prairie chicken (LPN = 2)	Proposed listing.
4 Texas salamanders (Austin blind salamander (LPN = 2), Salado salamander (LPN = 2), Georgetown salamander (LPN = 8), Jollyville Plateau (LPN = 8))[3].	Proposed listing.
5 SW aquatics (Gonzales Spring Snail (LPN = 2), Diamond Y springsnail (LPN = 2), Phantom springsnail (LPN = 2), Phantom Cave snail (LPN = 2), Diminutive amphipod (LPN = 2))[3].	Proposed listing.
2 Texas plants (Texas golden gladecress (*Leavenworthia texana*) (LPN = 2), Neches River rose-mallow (*Hibiscus dasycalyx*) (LPN = 2))[3].	Proposed listing.
4 AZ plants (Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*) (LPN = 3), Fickeisen plains cactus (*Pediocactus peeblesianus fickeiseniae*) (LPN = 3), Lemmon fleabane (*Erigeron lemmonii*) (LPN = 8), Gierisch mallow (*Sphaeralcea gierischii*) (LPN = 2))[5].	Proposed listing.
FL bonneted bat (LPN = 2)[3]	Proposed listing.
3 Southern FL plants (Florida semaphore cactus (*Consolea corallicola*) (LPN = 2), shellmound applecactus (*Harrisia* (=*Cereus*) *aboriginum* (=*gracilis*)) (LPN = 2), Cape Sable thoroughwort (*Chromolaena frustrata*) (LPN = 2))[5].	Proposed listing.

ACTIONS FUNDED IN FY 2010 AND FY 2011 BUT NOT YET COMPLETED—Continued

Species	Action
21 Big Island (HI) species[5] (includes 8 candidate species—6 plants & 2 animals; 4 with LPN = 2, 1 with LPN = 3, 1 with LPN = 4, 2 with LPN = 8).	Proposed listing.
12 Puget Sound prairie species (9 subspecies of pocket gopher (*Thomomys mazama* ssp.) (LPN = 3), streaked horned lark (LPN = 3), Taylor's checkerspot (LPN = 3), Mardon skipper (LPN = 8))[3].	Proposed listing.
2 TN River mussels (fluted kidneyshell (LPN = 2), slabside pearlymussel (LPN = 2))[5]	Proposed listing.
Jemez Mountain salamander (LPN = 2)[5]	Proposed listing.

[1] Funds for listing actions for these species were provided in previous FYs.
[2] Although funds for these high-priority listing actions were provided in FY 2008 or 2009, due to the complexity of these actions and competing priorities, these actions are still being developed.
[3] Partially funded with FY 2010 funds and FY 2011 funds.
[4] Funded with FY 2010 funds.
[5] Funded with FY 2011 funds.

We have endeavored to make our listing actions as efficient and timely as possible, given the requirements of the relevant law and regulations, and constraints relating to workload and personnel. We are continually considering ways to streamline processes or achieve economies of scale, such as by batching related actions together. Given our limited budget for implementing section 4 of the Act, these actions described above collectively constitute expeditious progress.

Texas fatmucket, golden orb, smooth pimpleback, Texas pimpleback, and Texas fawnsfoot will be added to the list of candidate species upon publication of this 12-month finding. We will continue to evaluate these species as new information becomes available. Continuing review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

We intend that any proposed listing determination for Texas fatmucket, golden orb, smooth pimpleback, Texas pimpleback, and Texas fawnsfoot will be as accurate as possible. Therefore, we will continue to accept additional information and comments from all concerned governmental agencies, the scientific community, industry, or any other interested party concerning this finding.

References Cited

A complete list of references cited is available on the Internet at *http://www.regulations.gov* and upon request from the Clear Lake Ecological Services Field Office (see **ADDRESSES**).

Authors

The primary authors of this notice are the staff members from the Southwest Region of the U.S. Fish and Wildlife Service.

Authority

The authority for this section is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: September 26, 2011.

Rowan W. Gould,

Acting Director, Fish and Wildlife Service.

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