PETITION TO LIST
SIX MUSSELS
UNDER THE U.S. ENDANGERED SPECIES ACT

In the Office of Endangered Species
U.S. Fish and Wildlife Service
United States Department of Interior

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October 9, 2008

WildEarth Guardians
A FORCE FOR NATURE

I. Introduction

WildEarth Guardians ("Petitioner") hereby petitions the Secretary of the Interior ("Secretary"), acting through the United States Fish and Wildlife Service ("Service"), to list the following species ("Petitioned species") as threatened or endangered under the Endangered Species Act ("ESA")[1] throughout their historic ranges:

- Southern hickorynut *(Obovaria jacksoniana)*
- Smooth pimpleback *(Quadrula houstonensis)*
- Texas pimpleback (*Quadrula petrina)*
- False spike *(Quincuncina mitchelli)*
- Mexican fawnsfoot *(Truncilla cognata)*
- Texas fawnsfoot *(Truncilla macrodon)*

Freshwater mussels are the most threatened and rapidly declining group of freshwater organisms in North America.[2] Freshwater mussels serve as barometers of aquatic ecosystem health because they are extremely sensitive to environmental disturbance. Sedimentation, channelization, impoundment of rivers, polluted runoff, changes in weather patterns, and sand and gravel mining have all contributed to the decline of freshwater mussels and to the destruction of their habitat. This Petition seeks ESA listing for six species of freshwater mussels that are rapidly disappearing from watersheds in the U.S. states of Alabama, Arkansas, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma, Tennessee, and Texas and in Mexico.

In order to protect the Petitioned species in the United States, the Secretary should list these species as either Endangered or Threatened throughout their historic ranges, within the United States and internationally. This Petition also requests the designation of critical habitat for each of these species. Many of the Petitioned species reside along the United States-Mexico border, thus necessitating both national and international protection. As discussed more fully below, each species qualifies for listing under the ESA.[3] This Petition will explain the ESA listing process, present the "best scientific and commercial data available" regarding the Petitioned species, provide relevant information about each of these species, and explain why each species should be listed as Endangered or Threatened under the ESA.

II. ESA Listing Process

Through the ESA, Congress mandated that all threatened and endangered species and the ecosystems on which these species depend be granted federal protection.[4] Congress clearly intends the ESA to protect both the species and the ecosystems of which

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[1]16 U.S.C. § 1533.
[2]Christopher M. Taylor and Caryn C. Vaughn, *Impoundments and the Decline of Freshwater Mussels: a Case Study of an Extinction Gradient*, 13 CONSERVATION BIOLOGY 912 (1999).
[3]16 U.S.C. § 1533.
[4]The sole exception is pest insects, which are defined as those "species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man." 16 U.S.C.A. § 1532(6).

they are a part.[5] The ESA reflects congressional recognition of the aesthetic, ecological, educational, historical, recreational, and scientific value of species,[6] and the fact that our nation's wildlife and plants are becoming increasingly imperiled due to "economic growth and development untempered by adequate concern and conservation."[7]

The Supreme Court has held that the ESA is "the most comprehensive legislation for the preservation of endangered species ever enacted by any nation."[8] The Supreme Court further noted that "[t]he plain intent of Congress in enacting this statute was to halt and reverse the trend towards species extinction, whatever the cost. This is reflected not only in the stated policies of the Act, but in literally every section of the statute."[9]

Despite its strength as a biodiversity protection statute, the ESA cannot protect a species until the species is "listed" under the Act. Listing is a critical first step in the ESA's system of species protection.[10] No matter how imperiled a species might be, it does not receive any substantial protection under the ESA unless it is officially listed as threatened or endangered.[11] As a result, Congress aptly described Section 4 of the ESA, 16 U.S.C. § 1533, the section setting forth the listing process, as "[t]he cornerstone of effective implementation of the [ESA]."[12]

The ESA defines the term "species" broadly to include full species and "any subspecies of fish or wildlife or plant and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature."[13] A species is "endangered" if it "is in danger of extinction throughout all or a significant portion of its

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[5]Congress has consistently supported ecosystem protection throughout the legislative history of the ESA. Rosmarino, Nicole J. 2002. "Endangered Species Act Under Fire: Controversies, Science, Values, and the Law." Ph.D. Dissertation, University of Colorado at Boulder.
[6]16 U.S.C.A. § 1531(a)(3).
[7]16 U.S.C.A. § 1531(a)(1).
[8]*Tennessee Valley Authority v. Hill*, 437 U.S. 153, 180 (1978).
[9]437 U.S. at 184.
[10]Once a species is listed under the ESA, significant arrays of statutory protections apply. For example, Section 7 of the ESA requires all federal agencies to "insure" that their actions neither "jeopardize the continued existence" of any listed species nor "result in the destruction or adverse modification" of its critical habitat. 16 U.S.C. § 1536(a)(2). Section 9 prohibits, among other things, "any person" (including federal or state agencies as well as individuals) from "taking" endangered species. 16 U.S.C. § 1538(a)(1)(B). "Taking" is broadly defined to include, in addition to actions that directly harm individuals of the species, habitat modification that adversely affects the species. 16 U.S.C. § 1532(19); 50 C.F.R. § 17.3. Other provisions require the Secretary to designate critical habitat for listed species, 16 U.S.C. § 1533(a)(3), require the Service to "develop and implement" recovery plans for listed species, 16 U.S.C. § 1533(f), authorize the Service to acquire land for the protection of listed species, 16 U.S.C. § 1534, and make federal funds available to states to assist in their efforts to preserve and protect threatened and endangered species, 16 U.S.C. § 1535(d).
[11]*See e.g., Federation of Fly Fishers v. Daley*, 131 F.Supp.2d 1158, 1163 (N.D.Cal. 2000) ("[L]isting is critically important because it sets in motion the [ESA's] other provisions, including the protective regulation, consultation requirements, and recovery efforts.").
[12]S.Rep. No. 418, 97th Cong., 2d Sess. at 10; *see also* H.Rep. No. 567, 97th Cong., 2d Sess. at 10 ("The listing process under Section 4 is the keystone of the [ESA]").
[13]16 U.S.C. § 1532(16).

range."[14] A species is "threatened" if it "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."[15]

A. ESA's Listing Requirements

To determine whether a species warrants listing as threatened or endangered, the Service must consider whether the species is imperiled based on any of the following 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.[16]

Most importantly, in its evaluation of each of these listing factors the Service must reach its determination "solely on the basis of the best scientific and commercial data available."[17]

While a species need meet only one of the above factors, the Petitioned species each meet one or more listing factor, are biologically endangered or threatened, and therefore warrant ESA listing.

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[14]16 U.S.C. § 1532(6).
[15]16 U.S.C. § 1532(20).
[16]16 U.S.C. § 1533(a)(1).
[17]Any interested person can begin the listing process by filing a petition to list a species with the Service. 16 US.C. § 1533(b)(1)A); 50 C.F.R. § 424.14(a). Upon receipt of a petition to list a species, the Service has 90 days to the maximum extent practicable to make a finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A); 50 C.F.R. § 424.14(b)(1). This threshold determination is commonly called a 90-day finding. If the Service makes a positive 90-day finding, it must promptly publish the finding in the Federal Register and commence a status review of the species. 16 U.S.C. § 1533(b)(3)(A). After issuing a positive 90-day finding, the Service has 12 months from the date it received the petition to make one of three findings: (1) the petitioned action is not warranted; (2) the petitioned action is warranted; or (3) the petitioned action is warranted but presently precluded by work on other pending proposals for listing species of higher priority. 16 U.S.C. § 1533(b)(3)(B); 50 C.F.R. § 424.14(b)(3). This second determination is commonly known as a 12-month finding. If the Service finds that listing the species is warranted, it must publish a proposed rule to list the species as endangered or threatened in the Federal Register. 16 U.S.C. § 1533(b)(5). Absent a "substantial disagreement regarding the sufficiency or accuracy of the available data," 16 U.S.C. § 1533(b)(6)(B)(i), the Service must either publish a final rule listing the species as threatened or endangered or withdraw the proposed rule. 16 U.S.C. § 1533(b)(6)(A). A "substantial disagreement" over the "sufficiency or accuracy of the available data" affords the Service only one 6-month extension of this deadline. 16 U.S.C. § 1533(b)(6)(B)(i).

B. Listing Decisions Must be Based on "the Best Scientific and Commercial Data Available."

Most importantly, in evaluating each of the listing factors, the ESA specifically requires that the Secretary make listing determinations based on the best scientific and commercial data available.[18] The ESA does not state that any specific amount of data is needed in order to list a species. Therefore, incomplete scientific evidence is not a bar to listing. In cases of incomplete data, such as for some of the species in this Petition, the Secretary must still rely on the best data available to make listing decisions. This Petition provides those data.

III. This Petition Provides the Best Available Science

Relying on a range of scientific sources, this Petition provides the best available science, which demonstrates the need to list the six mussels under the ESA. This Petition relies on the World Conservation Union ("IUCN") Red List and independent scientific sources. The IUCN is a global network of over 110 government agencies, 800 non-governmental conservation organizations, and 10,000 scientists from all over the world. The IUCN supports and develops cutting-edge conservation science and ranks species according to threats on its Red List of Threatened Species.[19] This Petition also relies on NatureServe conservation rankings and underlying data.[20] Stein et al. 2000 describe the red lists developed by the IUCN's Species Survival Commission as more conservative than NatureServe's ranking system. For instance, the IUCN places emphasis on projected threats and is more likely than NatureServe to place a taxon in the "data deficient" category in the absence of such data.[21]

NatureServe considers abundance, distribution, population trends, and threats in ranking species.[22] These factors are analogous to the ESA's listing factors described above.[23] Similarly, NatureServe's listing definitions are analogous to the ESA's listing definitions of Endangered and Threatened species. NatureServe defines "critically imperiled" (G1) species as species that are at very high risk of extinction due to extreme rarity, very steep declines, or other factors.[24] This definition mirrors the ESA's definition of "endangered" species.[25] Similarly, NatureServe defines "imperiled" (G2) species as those species at high risk of extinction due to very restricted range, very few populations

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[18] 16 U.S.C. § 1533 (b)(1)(A).
[19] IUCN, *An Overview of the IUCN Red List*, available at: http://www.iucnredlist.org/info/programme (last visited May 20, 2008).
[20] *See* Table A below for a list of NatureServe's classifications of the petitioned species.
[21] Stein, Bruce A., Lynn S. Kutner, and Jonathan S. Adams. 2000. *Precious Heritage: the Status of Biodiversity in the United States*. Oxford University Press at p. 112.
[22] NatureServe, *Global Conservation Status Definitions*, available at http://www.natureserve.org/explorer/ranking.htm#globalstatus (last visited May 20, 2008).
[23] 16 U.S.C. § 1533(a)(1)(A-E).
[24] NatureServe, *Global Conservation Status Definitions*.
[25] The ESA defines an "endangered" species as one that is "in danger of extinction throughout all or a significant portion of its range." 16 U.S.C. § 1532(6).

(often 20 or fewer), steep declines, or other factors.[26] This definition is similar to the ESA's definition of "threatened" species.[27] Therefore, although the terms are different, NatureServe's definitions are the functional equivalents of the ESA's definitions. Another ranking (GH) equates to "possibly extinct" defined as "Missing; known from only historical occurrences but still some hope of rediscovery."[28] Table A, below, states each of the Petitioned species' degree of imperilment according to NatureServe.

Table 1: NatureServe Classification of Petitioned Species

Name	NatureServe Classification
Southern hickorynut	G2
Smooth pimpleback	G2
Texas pimpleback	G2
False spike	GH
Mexican fawnsfoot	G1
Texas fawnsfoot	G2

Importantly, the Service considers NatureServe an authoritative source of species conservation information.[29] Rather than re-state and duplicate the information already contained in this authoritative database, the Petitioner hereby incorporate by reference all analysis, references, and documentation provided by NatureServe on the species at issue, including all data and analysis underlying NatureServe's conservation status and classification schemes. This information is easily available to the Service on the Internet.

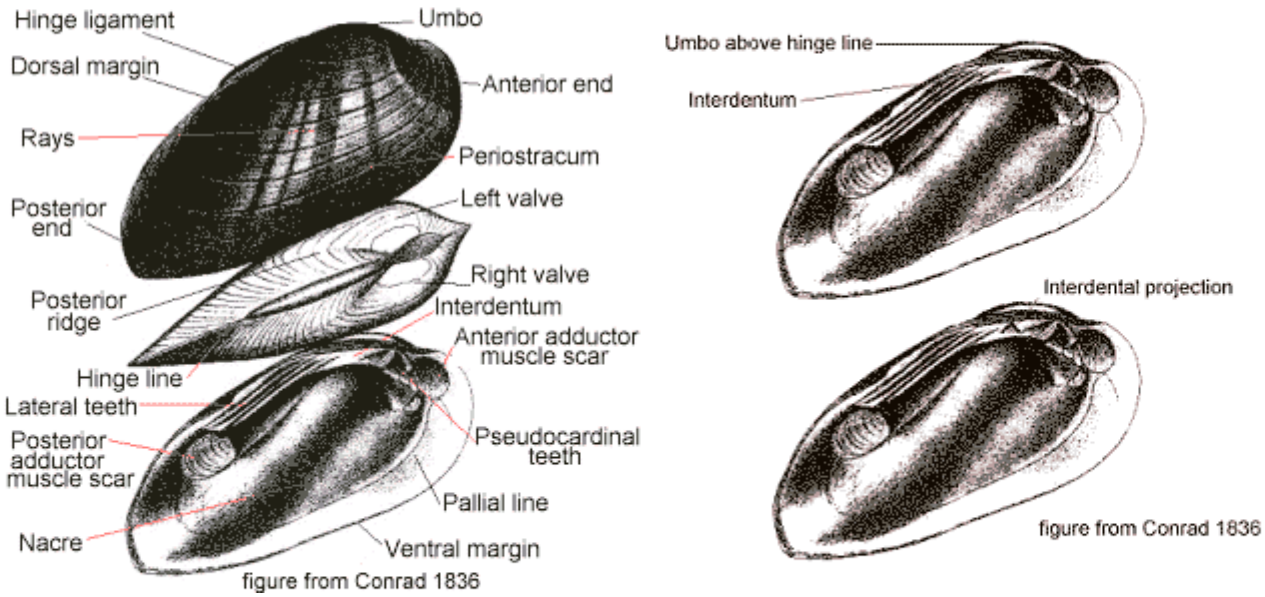
Together, the IUCN, independent scientific sources, and NatureServe data in this Petition constitute the "best scientific and commercial data available" to the Secretary concerning the Petitioned species.

IV. Freshwater Mussels Generally

Freshwater mussels are extremely sensitive to environmental disturbance, and therefore act as barometers of aquatic ecosystem health. The information in the following two sections, "freshwater mussel biology" and "freshwater mussel habitat" applies to all of the Petitioned species. The following diagram depicts the shell anatomy of freshwater mussels.

[26] NatureServe, *Global Conservation Status Definitions*.
[27] The ESA defines a "threatened" species as one that is "likely to become endangered within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1532 (20).
[28] NatureServe, *Global Conservation Status Definitions*.
[29] This language is included on webpages for every listed U.S. species in the U.S. Fish and Wildlife Service's online Threatened and Endangered Species System (TESS). See: endangered.fws.gov.

Figure 1: Shell Anatomy



Source: http://www.ncwildlife.org/pg07_wildlifespeciescon/pg7b1a.htm

A. Freshwater Mussel Biology

Freshwater mussels are essential components of aquatic ecosystems. As filter feeders, they improve water quality by removing phytoplankton and suspended matter from the water column.[30] As freshwater mussels feed on algae, bacteria, and organic particles suspended by the river's flow, they improve the overall health of the river system.[31] Freshwater mussels improve plankton production by removing phytoplankton, and affect nutrient dynamics of the aquatic ecosystem through excretion and biodeposition.[32] Furthermore, freshwater mussels release nutrients from the sediment to the water column and increase water and oxygen content in sediments through bioturbation.[33]

Freshwater mussels typically have parasitic larvae that require a host for a portion of their life cycle; however, several species may be able to transform to the juvenile stage without a host.[34] During the spawning season mature male mussels release sperm into

[30] Lyubov E. Burlakovaa and Alexander Y. Karatayev, *The Effect of Invasive Macrophytes and Water Level Fluctuations on Unionids in Texas Impoundments*, 586 HYDROBIOLOGIA 291 (2007).
[31] Robert G. Howells, Texas Parks and Wildlife Department of Inland Fisheries Division, Presentation at the Wildlife Diversity Conference at Texas State University: Freshwater Mussels: Species of Concern (August 2004a).
[32] Burlakovaa & Karatayev 2007 at 291.
[33] *Id.*
[34] NatureServe Comprehensive Report for *Pleurobema riddellii*

the water column.[35] Fertilization occurs as mature females filter water during feeding and respiration. The fertilized eggs reside within pouches of the female's gills, where they metamorphose from an embryo into the larval form known as glochidium. Fully developed glochidia released into the water column must find an appropriate host and attach to the proper location on the host, often gills or fins, or die. Encysted glochidia remain on the host until transformation to the juvenile stage when they drop to the substrate.[36]

Most freshwater mussel species rely on fish as hosts, although a few species utilize amphibians or metamorphose without a host.[37] Each species of freshwater mussel relies on a specific host species, and glochidia can only parasitize that species.[38] Glochidia that encounter the incorrect host species are rejected by the host's immune system, usually within a few days. Thus, the continued recruitment of freshwater mussel species is dependent on the continued presence of host species.[39]

B. Freshwater Mussel Habitat

While a mussel can move by extending a muscular foot between its valves, their range of movement is limited and they tend to stay in place for extended periods of time.[40] Adult mussels remain partially embedded in the bottom of a body of water (substrate) for most of their lives.[41] Mussels can move vertically (burrowing deeper into sediment) and horizontally, but such movement plays little role in distribution of the species as a whole. Dispersal patterns are attributed to stream size, surface geology, and distribution by host fish during spawning periods.[42]

Because of their limited range of movement, they are extremely vulnerable to human activities that disturb their substrate habitat.[43] Mussels in streams occur chiefly in flow refuges, or relatively stable areas that display little movement of particles during flood events.[44] Freshwater mussels do not live in headwater springs as there is little to

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http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=pleurobema+riddellii (last visited May 20, 2008).
[35]http://www.ncwildlife.org/pg07_wildlifespeciescon/pg7b1a.htm.
[36]*Id*.
[37]NatureServe Comprehensive Report for *Pleurobema riddellii*.
[38]Wendell R. Haag and Melvin L. Warren, Jr., *Host Fishes and Reproductive Biology of 6 Freshwater Mussel Species from the Mobile Basin, USA*, 16 JOURNAL OF NORTH AMERICAN BENTHOLOGICAL SOCIETY 576 (1997).
[39]*Id*.
[40]Keiji Iwasaki, Masami Hinoue, Yumiko Uryu, *Laboratory experiments on Behaviour and Movement of a Freshwater Mussel, Limnoperna Fortunei (Dunker)*, 62 JOURNAL OF MALACOLOGICAL STUDIES 327 (1996).
[41]*Id*.
[42]NatureServe Comprehensive Report for *Quadrula petrina*
http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=quadrula+petrina (last visited May 20, 2008).
[43]Robert G. Howells, Texas Parks and Wildlife Department, Heart of the Hills Fisheries Science Center, Freshwater Mussels of the San Marcos-Blancos River Basin: History and Status (March 2004b).
[44]NatureServe Comprehensive Report for *Pleurobema riddellii*.

eat and the areas are not thermally stable.[45] The most stable ecosystem for freshwater mussels is free-flowing rivers and streams with stable riverbeds and streambeds comprised of mud, sand, and gravel.[46] Freshwater mussel populations are most successful where water velocities are high enough to prevent excessive buildup of silt on the riverbed, and they generally cannot live on muddy or unconsolidated sandy bottom rivers or streams alone.[47] For freshwater mussels to survive, river bottoms need to be rock, gravel, or firm sand.[48]

V. Species Accounts

The following table summarizes the species accounts below (Table 2).

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[45]Howells 2004b.
[46]NatureServe Comprehensive Report for *Pleurobema riddellii*.
[47]Taylor & Vaughn 1999 at 912, 913.
[48]Burlakovaa & Karatayev 2007 at 291, 292.

Table 2: Summary of Individual Species Accounts for Petitioned Species

Common Name	Scientific Name	Threats
Southern hickorynut	*Obovaria jacksoniana*	•Siltation and smothering •Habitat destruction •Inadequate regulatory measures •Climate change impacts
Smooth pimpleback	*Quadrula houstonensis*	•Siltation and smothering •Habitat destruction •Inadequate regulatory measures •Climate change impacts
Texas pimpleback	*Quadrula petrina*	•Dewatering and stranding •Habitat destruction •Inadequate regulatory measures •Climate change impacts
False spike	*Quincuncina mitchelli*	•Development •Habitat destruction •Inadequate regulatory measures •Climate change impacts
Mexican fawnsfoot	*Truncilla cognata*	•Siltation and smothering •Dewatering and stranding •Habitat destruction •Inadequate regulatory measures •Climate change impacts
Texas fawnsfoot	*Truncilla macrodon*	•Siltation and smothering •Dewatering and stranding •Habitat destruction •Inadequate regulatory measures •Climate change impacts

A. Southern Hickorynut *(Obovaria jacksoniana)*

(From R.G. Howells)[49]

(From R.G. Howells)

1. Description

Southern hickorynuts have smooth, ovate shells that are nearly straight from beak to post-point, which is about half the height of the shell.[50] The mussels are light to dark brown, often with fine green rays.[51] They have a low umbonal ridge, with a very narrow posterior.[52] Southern hickorynuts have a double set of teeth in the left valve, but only a single set in the right valve. The mussels' laterals are not very large.[53] Southern hickorynuts have broad and low beaks raised above the hinge line, and shallow cavities.[54]

2. Distribution and Range

Historically, southern hickorynuts were found from Alabama west to eastern Texas, and in the Mississippi embayment as far north as southeastern Missouri.[55] They are similar in appearance to the Alabama hickorynut (*Obovaria unicolor*) and the Ouachita Creekshell (*Villosa arkansasensis*), which leads to confusion between the species in the western Mobile Basin. Currently, southern hickorynuts only occur in Mississippi within the Mississippi River south and Big Black River drainages, although archaeological remains were found in the Yazoo drainage.[56] A single, small population also inhabits southeast Texas.[57] The species is also known to exist in the Ouachita and

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[49]Note that this range map may not include all Arkansas occurrences. Dark grey shading indicates speciments that appeared to be this species at the time the map was drawn.
[50]NatureServe Comprehensive Report for *Obovariara jacksoniana*, http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=obovaria+jacksoniana (last visited May 20, 2008).
[51]Rare Animals of Louisiana – Southern Hickorynut, http://www.wlf.louisiana.gov/pdfs/experience/naturalheritage/rareanimal/southernhickorynut.pdf (last visited Mar. 11, 2008).
[52]NatureServe Comprehensive Report for *Obovariara jacksoniana*.
[53]*Id.*
[54]Robert G. Howells, Raymond W. Neck & Harold D. Murray, FRESHWATER MUSSELS OF TEXAS 86 (Tx. Parks and Wildlife Dep't Inland Fisheries Div. 1996).
[55]*Id.*
[56]*Id.*
[57]Howells 2004a.

White River systems of Arkansas.[58] There are separate disjunct populations of southern hickorynuts in southeastern Missouri and southwestern Tennessee.[59]

3. Life History

Scientists know very little about how southern hickorynuts reproduce. In Louisiana and Alabama the glochidia have been reported in October, however, the species' fish host remains unknown.[60] Southern hickorynuts are usually found in streams and rivers with a moderate current, often in medium-sized gravel.[61] The mussels are rather sessile with only limited movement in the substrate, but some passive downstream movement occurs when southern hickorynuts are displaced from the substrate during floods.[62]

4. Abundance and Trends

Southern hickorynuts are declining at a short-term global rate of 10-30 percent. The species is now uncommon to rare throughout its historic range and is ranked as G2 or "imperiled" by NatureServe. Recently, two sites in Alabama were found barren of southern hickorynuts. The mussels were reported absent from the Cahaba River and are extirpated from the Tombigbee River. The species' range has also declined greatly in Louisiana. They were once found in over sixteen different rivers and bayous, but are now likely limited to a few occurrences.[63]

Southern hickorynuts are presently known within four rivers in Oklahoma: the Kiamichi River, Little River, Mountain Fork River, and the uppermost reaches of the Poteau River.[64] The species may also reside in the Glover River, but that is a source of some debate.[65] In Missouri, they are found in only three locations, including the Whitewater River in Cape Girardeau County and Cane Creek in Butler County.[66] Southern hickorynuts are likely extirpated from the St. Francis and Black River basins in Missouri, and in Tennessee they are only found in the Hatchie River.[67] The mussels also occur in southern portions of the Mississippi Interior Basin in Pearl River and the Yalebrusha River, Mississippi. Sixteen specimens were found in the Village Creek drainage in southeast Texas in 2001-2002. This discovery constituted the first report of living specimens in Texas since 1990.[68]

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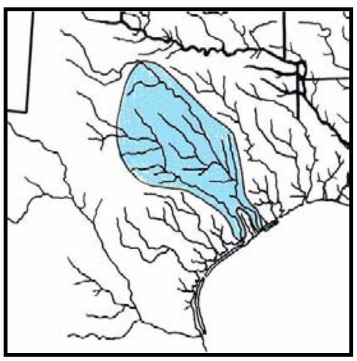
[58]NatureServe Comprehensive Report for *Obovariara jacksoniana*.
[59]Howells 2004a.
[60]Rare Animals of Louisiana – Southern Hickorynut.
[61]NatureServe Comprehensive Report for *Obovariara jacksoniana*.
[62]*Id.*
[63]*Id.*
[64]*Id.*
[65]*Id.* ("Recent surveys of the Glover River by Vaughn … did not find this species but noted that *Obovaria jacksoniana* and *Villosa arkansasensis* can only be reliably separated by using tissue morphology and it may be that what Vaughn identified as *V. arkansasensis*, Valentine and Stansbery … called *O. jacksoniana*." (citations omitted)).
[66]NatureServe Comprehensive Report for *Obovariara jacksoniana.*
[67]*Id.*
[68]*Id.*

Other than the living specimens Bordelon and Harrel (2004)[69] reported in Village Creek in southeast Texas (this report only addressed living specimens), other surveys of eastern Texas waters in 2005-2007 failed to find any other southern hickorynut specimens that were alive or recently dead in Texas waters.[70]

5. Threats

Southern hickorynuts are threatened by the loss of habitat as a result of siltation and by the addition of pollutants to streams and rivers.[71]

B. Smooth Pimpleback *(Quadrula houstonensis)*



(From R.G. Howells)

(From R.G. Howells)

1. Description

The external coloration of smooth pimplebacks range from dark brown to black, and internally they are white.[72] The shells of smooth pimplebacks are subquadrate to nearly round, solid, and approximately 65 mm in length. They are slightly to moderately inflated, and the beaks are elevated well above the hinge line. Smooth pimplebacks generally have an unsculptured and smooth disc with the occasional pustule.[73]

[69] Bordelon, V.L., and R.C. Harrel. 2004. Freshwater mussels (Bivalvia: Unionidae) of the Village Creek drainage basin in Southeast Texas. The Texas Journal of Science 56(1):63-72. See also Howells, R.G. 2003. Distributional surveys of freshwater bivalves in Texas: progress report for 2002. Texas Parks and Wildlife Department, Management Data Series 214, Austin; and Howells, R.G. 2006. Statewide freshwater mussel survey. Final Report, State Wildlife Grants Program, Texas Parks and Wildlife Department, Austin.
[70] Howells 2006; Karatayev, A.Y., and L.E. Burlakova. 2007. East Texas mussel survey. Final Report, State Wildlife Grants Program, Texas Parks and Wildlife Department, Austin; Ford, N.B., and M.E. May. Undated. A Survey of Abundance and Species Diversity of Freshwater Mussels (Unionidae) in Three Reserve Areas on the Sabine River in Northeast Texas. Department of Biology, University of Texas at Tyler, Tyler; and Pers. comm. Robert G. Howells, July 2008.
[71] Rare Animals of Louisiana – Southern Hickorynut.
[72] NatureServe Comprehensive Report for *Quadrula houstonensis* http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=quadrula+houstonensis (last visited May 20, 2008).
[73] *Id.*

2. Distribution and Range

Smooth pimplebacks are native to the Brazos and Colorado River drainage basins of central Texas.[74]

3. Life History

The glochidial host for smooth pimplebacks remains unknown.[75] They prefer small to moderate size streams and rivers as well as moderate size reservoirs and have been found on mud, sand, and gravel in water as shallow as 3 to 4 cm. While smooth pimplebacks can survive in low-flow areas they appear intolerant of dramatic water level fluctuations, scoured bedrock substrates, and shifting sand substrate.[76]

4. Abundance and Trends

Smooth pimplebacks are listed as G2 or "imperiled" by NatureServe and are not considered abundant at any of the sites where living specimens were documented within the past 25 years.[77] In 1978, scouring floods left limited numbers of smooth pimplebacks in central Texas. Since that time living or very recently dead specimens have been documented at several sites in the central Brazos River drainage, several sites on the Little Brazos River, one site on the San Saba River, several locations on the Leon River, and in one reservoir in the central Colorado River drainage. However, drought conditions in the Leon River in the 1980s caused extensive mussel loss, and no living or recently dead specimens have been found in the San Saba River in about ten years. A single living individual was recently found in the Navasota River in Texas.[78] A 1993 chemical dump in the Little Brazos River eliminated much of the river's unionid[79] population.[80]

Small numbers of smooth pimplebacks are still present in the Brazos River drainage between Hood and Brazos counties, and small numbers may persist in the Colorado River drainage in Highland Lakes and the Colorado County area.[81] N. Ford reported finding additional living specimens in the Waco area of the Brazos River drainage.[82] N. Ford and Bob Howells also found living smooth pimplebacks at two sites in the Leon River (Brazos drainage) in May 2006. While the researchers had anticipated returning to these sites to obtain more detailed data, no funding was available to do so.[83]

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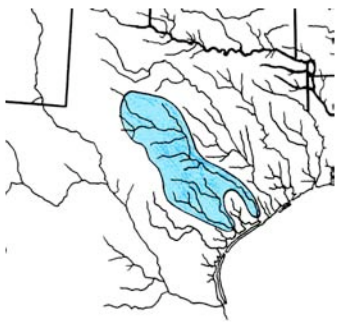
[74] Howells 2006.
[75] NatureServe Comprehensive Report for *Quadrula houstonensis*.
[76] *Id.*
[77] *Id.*
[78] *Id.*
[79] Freshwater mussels in North America are all members of one of two families, Unionidae or Margaritiferidae. Margaret Mulvey, et al, *Conservation Genetics of North American Freshwater Mussels Amblema and Megalonaias*, 11 CONSERVATION BIOLOGY 868, 869 (1997). All of the petitioned species are of the Unionidae family and are occasionally referred to as "unionids."
[80] NatureServe Comprehensive Report for *Quadrula houstonensis*.
[81] Howells 2004a.
[82] Pers. comm., Robert G. Howells.
[83] *Id*.

5. Threats

Smooth pimplebacks are threatened by environmental decline associated with increased human development, and concomitant poor land and water management practices continue to cause concern for the security of this species.[84] The species has declined in areas where other species have endured, suggesting that it is impacted by as-yet undefined issues. Recent losses associated with pollution, flooding, and droughts indicate the species' fragility. Smooth pimplebacks are not a state or federally protected species.[85]

C. Texas Pimpleback *(Quadrula petrina)*



(From R.G. Howells)

(From R.G. Howells)

1. Description

The external coloration of Texas pimplebacks ranges from tan to brown.[86] They occasionally have yellow and bright green distinctive markings and appear somewhat glossy.[87]

2. Distribution and Range

Texas pimplebacks are endemic to the Guadalupe and Colorado River systems of central Texas.[88]

3. Life History

The glochidial host for Texas pimplebacks remains unknown. They generally inhabit mud, gravel, and sand substrates, in low-flow areas.[89]

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[84]NatureServe Comprehensive Report for *Quadrula houstonensis*.
[85]*Id.*
[86]NatureServe Comprehensive Report for *Quadrula petrina* http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=quadrula+petrina (last visited May 20, 2008).
[87]*Id.*
[88]*Id.*

4. Abundance and Trends

Texas pimplebacks are listed as G1 or "imperiled" by NatureServe as the species has experienced a dramatic reduction in range. Surveys by the Texas Parks and Wildlife Department (TPWD) have found Texas pimplebacks extant at only a handful of sites.[90] Since Heart of the Hills Fisheries Science Center in Ingram, Texas began mussel work in 1992, Texas pimplebacks have been found alive at only four locations: a site on the San Saba River west of Menard, a Runnels County creek north of Ballinger, the Concho River near Paint Rock, and the upper San Marcos River near its confluence with the Blanco River.[91] Moreover, these populations are far from secure. The Runnels County population may have been eliminated by dewatering, scouring, and over-collecting: no live specimens were found during a 2005-2006 survey in the San Saba River, and only a single living specimen has been discovered on the San Marcos in recent years.[92]

Recent surveys of central Texas rivers (2006) concluded: (1) no new living or recently dead specimens have been found in the Colorado River upstream of Lake Buchanan; (2) the Elm Creek, Runnels County, sites have been examined several times following scouring floods, drought-related dewatering, and apparent over-collecting, and no living or recently dead specimens were documented; (3) no living specimens were found in 2005 in the San Saba River, Menard County, but this site may still support the species; (4) 8 living specimens were found at the Concho River site, Concho County, indicating survival following severe dewatering earlier; and (5) no additional living specimens have been reported in the upper San Marcos River.[93]

5. Threats

As evidenced above, dewatering poses a serious threat to Texas pimplebacks. In 1999, evidence of a Texas pimpleback population was found in the Colorado River, but the site was not detected until the mussels had already been killed by dewatering.[94] The extant Concho River population occurs in a no-harvest sanctuary on the Concho River.[95]

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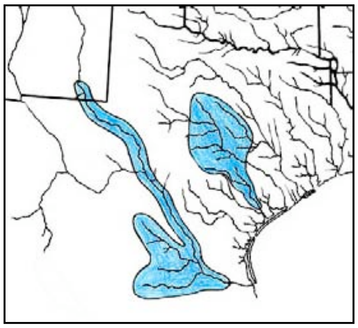
[89]NatureServe Comprehensive Report for *Quadrula petrina*.
[90]*Id.*
[91]Robert G. Howells, Status of Freshwater Mussels of the Rio Grande, with Comments on Other Bivalves (Texas Parks and Wildlife Department 2001).
[92]*Id.*
[93]Howells 2006.
[94]Howells 2001; Pers. comm., Robert G. Howells, July 2008.
[95]NatureServe Comprehensive Report for *Quadrula petrina*.

D. False Spike *(Quincuncina mitchelli)*



(From R.G. Howells)

(From R.G. Howells)

1. Description

Externally, false spikes are tawny-brown to dark brown or black and are sometimes rayed with olive-yellow or olive-green markings on the posterior slope.[96] The species' nacre is white.[97] False spikes' shells are moderately thick and range from subsolid to solid.[98] They have a posterior ridge that is broadly rounded, and a disk that is sculptured with parallel, ripple-like ridges from the posterior ridge onto the posterior slope and central region of the disk.[99] The species' beak cavities are moderately deep and the pseudocardinal teeth[100] are heavy and triangular, while the lateral teeth are relatively short and straight.[101]

2. Distribution and Range

Historically, false spikes are known from two disjunct populations, one in the Rio Grande system in New Mexico, Texas, and Mexico; and the other in the Brazos, Colorado, and Guadalupe River systems of central Texas.[102] False spikes were once common in central Texas.[103]

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[96]Howells 2001.
[97]*Id*. "Nacre" refers to the inner surface of a mussel's shell.
[98]Howells 2001.
[99]*Id.*
[100]Pseudocardinal teeth are the compact, often triangular, tooth-like structures along the hinge line of each valve closest to the anterior end of the shell.
http://www.ncwildlife.org/pg07_wildlifespeciescon/pg7b1a.htm (last visited May 27, 2008).
[101]Howells 2001.
[102]NatureServe Comprehensive Report for *Quincuncina mitchelli*
http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=quincuncina+mitchelli (last visited May 20, 2008); Howells 2006.
[103]NatureServe Comprehensive Report for *Quincuncina mitchelli*.

3. Life History

The species' glochidial host remains unknown. While there is little information pertaining to false spikes available, they probably inhabited medium to large river substrates of varying mixtures of mud, sand, gravel, and cobble.[104] Specimens from central Texas were known to inhabit gravel bars.[105]

4. Abundance and Trends

False spikes are listed as "possibly extinct" by NatureServe[106] and as "critically endangered" by the IUCN Red List.[107] They have not been seen alive in Texas since the mid-1970s. After many years of failing to find living or recently dead specimens, two recently dead valves were found in April 2000 in the lower San Marcos River, a tributary of the Guadalupe River.[108] This and other Central Texas sites have been visited a number of times since, including 2005-2006, but no additional specimens have been located.[109]

5. Threats

False spikes are in severe decline. As they were known to inhabit the Rio Grande drainage basin the dramatic modification of the entire lower Rio Grande over the past 100 years has negatively impacted the species. In Central Texas, heavy overgrazing in the mid to late 1800s resulted in loss of terrestrial vegetative cover and soils. Subsequently, when rains fell, runoff increased, as did scouring of riverbeds. Prior to 1900, the upper Guadalupe River, for example, never saw a rise over 6 feet. Currently, 20-foot rises are regularly observed. River bottoms have often been scoured to bedrock and cobble, and rock is an unacceptable unionid habitat as a rule. In the late 1970s, there was an extensive drought in Central Texas, followed by massive, scouring floods from 1978-1981. As a result, false spike largely vanished and other endemic Central Texas unionids became very rare.[110] Continued development and modification of the region, not to mention treaty-related increases in human activity and the associated negative environmental impacts, do not bode well for the species' future.[111]

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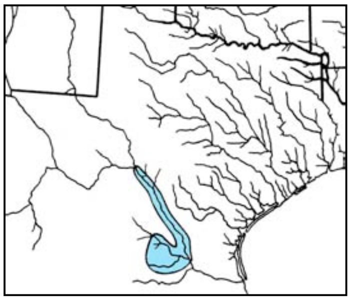
[104]*Id.*
[105]Howells 2001.
[106]NatureServe Comprehensive Report for *Quincuncina mitchelli* at www.natureserve.org. Visited May 20, 2008.
[107]*Id.*
[108]Howells 2001; 2006.
[109]Pers. comm. Robert G. Howells, July 2008.
[110]*Id.*
[111]NatureServe Comprehensive Report for *Quincuncina mitchelli*.

E. Mexican fawnsfoot *(Truncilla cognata)*



(From R.G. Howells) (From R.G. Howells)

1. Description

Externally, Mexican fawnsfoot mussels are yellow-green to gray-green and occasionally have darker rays.[112] The mussels' nacre is white. They have an elliptical shell that is approximately 45 mm in length and relatively thin but solid and only slightly inflated. Male Mexican fawnsfoots have a more pointed posterior than females. The mussels' beaks are elevated but narrow, and they have a shallow beak cavity. The lateral teeth of the Mexican fawnsfoot are thin and relatively short, and the pseudocardinal teeth are triangular and compressed. The disk is unsculptured.[113]

2. Distribution and Range

Historically, the species was endemic to the main channel of the Rio Grande,[114] and it has been documented in the lower Pecos River near Del Rio, Texas; downstream to Laredo County, Texas; and through the Rio Salado of Nuevo Leon and Tamaulipas, Mexico.[115]

3. Life History

The species' glochidial host and habitat preferences remain unknown. Environmental modifications of the Rio Grande and its tributaries in both Texas and Mexico have been so extensive that it is difficult to clearly define required or preferred habitats.[116] As the Mexican fawnsfoot has not been discovered in reservoirs they are likely intolerant of impoundment and probably prefer flowing streams and rivers with sand or gravel substrates.[117]

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[112] NatureServe Comprehensive Report for *Truncilla cognata* http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=truncilla+cognata (last visited May 20, 2008).
[113] *Id.*
[114] *Id.*
[115] Howells 2004a.
[116] NatureServe Comprehensive Report for *Truncilla cognata.*
[117] *Id.*

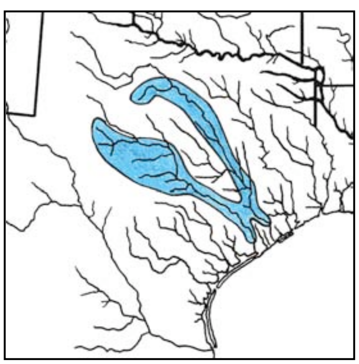
4. Abundance and Trends

This species is listed as G1 or "critically imperiled" by NatureServe.[118] Most mussel species in the Rio Grande have declined over the past century, many dramatically, and the range of the Mexican fawnsfoot appears greatly reduced.[119] Collections of only two living specimens found in recent decades have been published, both in the Webb County, Texas stretch of the lower Rio Grande.[120] The 2002 discoveries near Laredo marked the first living documentation of the species in three decades.[121]

5. Threats

The species is endemic to the Rio Grande, and, as such, much of its habitat lies along the Texas-Mexico border. Trade and development along the Texas-Mexico border has had extensive environmental impacts on areas already extensively modified ecologically.[122] The two living Mexican fawnsfoots discovered near Laredo, Texas are in a North American Free Trade Agreement redevelopment area.[123] The living and recently dead specimens reported in published literature to date occur at or near the Laredo-Webb County area where border fence construction has been proposed and such activity could result in negative ecological impacts on this and other mussels.[124] In addition, the general fragility of the Rio Grande aquatic ecosystem and ecological alterations to date are likely a cause of the current extreme rarity of this species. [125]

F. Texas Fawnsfoot *(Truncilla macrodon)*



(From R.G. Howells)

(From R.G. Howells)

[118]*Id.*
[119]Howells 2006.
[120]*Id.*
[121]NatureServe Comprehensive Report for *Truncilla cognata*.
[122]*Id.*
[123]Howells 2004a.
[124]Pers. comm. Robert G. Howells, July 2008.
[125]NatureServe Comprehensive Report for *Truncilla cognata*.

1. Description

Externally, Texas fawnsfoot mussels range from gray-green, greenish-brown, orange-brown, to dark brown, often with greenish rays, zig-zags, or chevrons.[126] This mussel's nacre is white. They have ovate to long ovate shells that are slightly compressed. Males have more pointed posteriors than females, and they have a shell length of at least 55 mm that ranges from thin to moderately thick, and subsolid to solid. The Texas fawnsfoot has unsculptured disks with slightly elevated beaks and shallow beak cavities. The lateral teeth are relatively short and the pseudocardinal teeth are triangular and compressed.[127]

2. Distribution and Range

Historically, the Texas fawnsfoot is known from the Colorado and Brazos river drainages of Central Texas. Little is known about the species' habitat, but they appear to prefer rivers and larger streams. As living specimens have not been found in reservoirs, Texas fawnsfoots are likely intolerant of impoundments. The species probably prefers sand, gravel, and perhaps sandy-mud bottoms in moderate flows.[128]

3. Life History

The glochidial host remains unknown.[129]

4. Abundance and Trends

The Texas fawnsfoot is ranked as "imperiled" by NatureServe.[130] Texas Mussel Watch discovered seven living specimens in the Brazos River in 2004.[131] Heart of the Hills Fisheries Science Center in Ingram, Texas has found only five living specimens since 1992.[132] Perhaps only about 300 specimens may have been documented since this species was described in 1859.[133] No living or recently dead specimens have been found in the Colorado River basin since the discovery of a recently dead specimen in the central Colorado River above Lake Buchanan in August 2000.[134] The entire stretch of river where these mussels had been found had become dry at that time, and all area mussels were lost. This site was not previously recognized as a Texas fawnsfoot site, and it also supported a previously unrecognized population of Texas pimplebacks. Both populations were eliminated just before being discovered, and none have been documented since.

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[126]NatureServe Comprehensive Report for *Truncilla macrodon* http://www.natureserve.org/explorer/servlet/NatureServe?searchSciOrCommonName=Truncilla+macrodon (last visited May 20, 2008).
[127]*Id.*
[128]*Id.*
[129]*Id.*
[130]*Id.*
[131]*Id.*; Howells 2004a.
[132]Howells 2004a.
[133]Pers. comm. Robert G. Howells, September 2008.
[134]Howells 2000; Robert G. Howells, Biostudies: Status of Texas Unionids: Including Species of Concern, New Regulations and Sanctuaries (March 2007).

Other unionid species that had been present in the area will eventually reinvade from reservoir populations up- and down-stream, but given that neither Texas fawnsfoot or Texas pimpleback are know to inhabit impoundments, these two mussels have likely been completely lost in the area.[135]

5. Threats

Continued environmental degradation and modification within the species' range is a constant threat to the Texas fawnsfoot. Aquatic habitat modification from widely ranging terrestrial sources continues to be a major threat, as does dewatering during droughts and scouring flooding during times of intense precipitation.[136]

VI. Analysis of ESA Listing Factors

Pursuant to Section 4 of the ESA, 16 U.S.C. § 1533, the Secretary is required to list a species under the ESA if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range.[137] In making this decision, the Secretary must analyze the species' status based on the five listing factors. A species needs to meet only one of these factors to qualify for ESA listing. Each of the Petitioned species qualifies for listing under three of the factors: habitat degradation and loss; inadequate regulatory mechanisms; and other factors (climate change). Because three of the factors affect all of the Petitioned species, the Petitioner discusses these three specifically applicable factors below.

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

The Petitioned species all face pressure from some form of habitat destruction.[138] Sedimentation, channelization, impoundment of rivers, changes in weather patterns, sand and gravel mining, and chemical run-off, all threaten the Petitioned species' habitat. The Petitioned species' habitat is further threatened by the complex issues surrounding the United States-Mexico border. While the particularized impact of habitat destruction varies by species, all of the Petitioned species face current harm related to destruction, modification, or curtailment of their habitat.

1. Sand and Gravel Mining

Sand and gravel mining has devastating effects on the riverbeds that serve as freshwater mussel habitat. Mussel species that prefer gravel and sand substrate are especially susceptible to this type of mining as it involves removing large amounts of

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[135] Pers. comm. Robert G. Howells, July 2008.
[136] NatureServe Comprehensive Report for *Truncilla macrodon*.
[137] Under 16 U.S.C. § 1532(16), the term "species" includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.
[138] *See* Table 1.

substrate from water bottoms.[139] Mining often occurs at multiple times and at multiple sites along a river, resulting in chronic and cumulative impacts.[140] Mining alluvial material from or near a riverbed directly impacts channel geometry, bed elevation, substrate composition and stability, depth, velocity, turbidity, sediment transport, stream discharge and temperature.[141]

Gravel extraction projects generally require diversion of the river or stream, and, consequently, have the potential to leave mussels stranded in the former riverbed, eventually causing death.[142] Sand and gravel mining also significantly increase erosion by causing "headcuts"[143] that travel up the river channel, resulting in extensive habitat destruction miles upstream of the original site.[144] When sand and gravel are mined in excess of natural replenishment by upstream transport of sediments the riverbed becomes degraded at the site as well as upstream and downstream.[145] Gravel mining also increases suspended sediment, sediment transport, water turbidity and gravel siltation in the river.[146] Sediment clogs mussels' gills, causing reduced feeding efficiency and smothering.[147] Suspended sediment also reduces light available for photosynthesis, and, thus interferes with the production of algae and plankton that mussels rely on for a food source.[148] Furthermore, in polluted rivers, sand and gravel mining can resuspend and redistribute pollutants already present in river sediment. Sedimentation from a gravel mining operation on a Texas stream reduced benthic macroinvertebrate abundances by 97 percent at the site and 50 percent two miles downstream, but abundances became "normal" three miles downstream.[149]

2. Dredging and Channelization

Dredging to create and maintain navigation channels and canals has much the same impact as sand and gravel mining, i.e. death or injury to freshwater mussel populations in the dredged area and destruction of suitable habitat.[150] Dredging operations drag mussels across the riverbed, thereby smothering or crushing mussels in

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[139]*See* Michael J. Roell, *Sand and Gravel Mining in Missouri Stream Systems: Aquatic Resource Effects and Management Alternatives* (Missouri Department of Conservation June 1999) (describing how sand and gravel mining destabilizes streambeds).
[140]National Marine Fisheries Service, National Gravel Extraction Guidance, at 2. Online at: http://swr.nmfs.noaa.gov/hcd/gravelsw.htm (visited September 8, 2008).
[141]*Id.* at 3.
[142]*Id.* at 7 (discussing the stranding and entrapment of fish due to low-flow periods).
[143]Roell 1999: Headcutting is a form of extreme upstream erosion caused by gravel and sand extraction in river beds. Headcutting mobilizes substantial quantities of sediment that move long distances upstream into tributaries, causing extensive habitat destruction for miles upstream of the original extraction point.
[144]Jayne Brim Box & Joann Mossa, *Sediment, Land Use, and Freshwater Mussels: Prospects and Problems*, 18 J. N. AM. BENTHOLOGICAL SOC'Y 99, 103-104 (1999).
[145]National Marine Fisheries Service, National Gravel Extraction Guidance at 3.
[146]*Id.* at 3.
[147]Box & Mossa 1999.
[148]*Id.*
[149]Roell 1999.
[150]David C. Aldridge, *The Impacts of Dredging and Weed Cutting on a Population of Freshwater Mussels (Bivalvia: Unionidae),* 95 BIOLOGICAL CONSERVATION 247, 247 (2000); Box & Mossa 1999.

the process.[151] Furthermore, by disturbing the substrate, redistributing sediment, causing silt and other suspended materials to travel downstream, and reducing photosynthesis, channelization destroys mussel habitat beyond the immediate dredge area.[152] One researcher has noted that, "The process of dredging and channelization may be catastrophic" to mussels.[153]

3. Impoundments, Water Fluctuation, and Sedimentation

Dams and other impoundments (collectively "impoundments") create artificial and unnatural conditions that many freshwater mussel species cannot tolerate. There is indisputable and overwhelming evidence that impoundments are detrimental to aquatic life and most mussels in particular.[154] Even below impoundments benthic diversity in general is reduced.[155] Considerable stream lengths are essential to overcoming the effects of impoundment on mussel populations.[156] Almost without exception rivers that have been impounded have lost or altered mussel fauna.[157]

The habitat created by artificial impoundment is not analogous to a naturally occurring pool within a river.[158] Impoundments typically become deeper toward their downstream end, whereas natural pools are deepest toward their middle and then become shallower forming runs and riffles. Thus, water flows differently through pools and impoundments, and the hydrologic differences cause faunal differences.[159]

There is ample evidence that most freshwater mussel species cannot survive when their habitat is modified by impoundment.[160] In still water, current velocity decreases causing silt accumulation, stagnation, and the accumulation of pollutants and nutrient-poor water.[161] As water velocity decreases and water loses it ability to carry sediment the old river channel is transformed into a sediment trap. Consequently, mussels that cannot adapt to the soft substrate are smothered, especially on the upstream side of dams where the substrate may be composed of mud mixed with rubbish.[162] The change of a riverbed from sand, gravel, or cobblestone to one overlain with silt causes a change in the original fauna, and silt-intolerant species are eventually eliminated from the aquatic ecosystem.[163]

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[151]Aldridge 2000.
[152]*Id.*; G. Thomas Watters, *Freshwater Mussels and Water Quality: A Review of the Effects of Hydrologic and Instream Habitat Alterations*, 1999 PROCEEDINGS OF THE FIRST FRESHWATER MUSSEL CONSERVATION SOCIETY SYMPOSIUM 261, 268.
[153]Watters 1999 at 261, 268.
[154]*Id.* at 262.
[155]*Id.*
[156]Taylor & Vaughn 1999 at 912.
[157]Watters 1999 at 261, 262.
[158]*Id*. at 261.
[159]*Id*.
[160]G. Thomas Watters, *Small Dams as Barriers to Freshwater Mussels (Bivalvia, Unionoida) and their Hosts,* 75 BIOLOGICAL CONSERVATION 79 (1996).
[161]Watters 1999 at 261.
[162]*Id*.
[163]*Id*. at 262.

Furthermore, as sediment accumulates the bottom of the impoundment becomes siltier and muckier, and it becomes more difficult for juvenile mussels to find suitable substrate habitat.[164] Sediment accumulation also causes the substrate to become more acidic. Increased acidity can leach away the mussels' protective calcium shell.[165]

Generally, mussels are more abundant in shallow water. Impoundment destroys shallow water habitat, and, as few mussel species can tolerate the depth of impoundment, mussels are largely eliminated from the aquatic ecosystem.[166] Impoundment not only impacts mussels in the immediate area of the impoundment but also affects mussel populations up and downstream.[167] Impoundments prevent fish that serve as glochidial hosts from traveling up and down rivers, which impacts mussel reproduction.[168] There is evidence that a dam as low as one meter can restrict the distribution of mussel species.[169] Without recruitment otherwise healthy mussel populations will cease to exist.

Depending on the type of impoundment, water levels may fluctuate at regular intervals or at random. Low water conditions are particularly harmful to mussels.[170] In areas that experience long periods of low-flow temperature extremes and exposure can devastate mussel populations. In the tailwaters of Lake Texoma, with the impoundment of the Red River formed by the Denison Dam, several thousand mussels died when water levels dropped and the water became excessively warm.[171] Researchers have determined that "substrate subjected to 2 - 12 hours of exposure to air required more than four months to regain biomass similar to unexposed habitat."[172]

Furthermore, high velocity discharges and abrupt flow-stoppages result in riverbeds composed of large rocks and shifting sands, which is unsuitable habitat for most mussels.[173] Freshwater mussels that cannot adapt to new flow-patterns either die or, more often, become unable to reproduce.

Impoundments are not the only source of sedimentation. Combinations of intensive land use, wetland drainage, and stream channelization result in high sedimentation in rivers and streams. Increased sedimentation can also come from a variety of sources such as logging, agriculture, ranching, mining, urban development, and construction activities.[174] Sedimentation from these activities has the potential to impact mussel populations for miles up and downstream of the activity.[175]

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[164] Box & Mossa 1999.
[165] Watters 1999 at 261, 268.
[166] *Id.* at 263.
[167] Watters 1996.
[168] Watters 1999 at 261, 265.
[169] *Id.* at 265.
[170] U.S. Fish and Wildlife Service, *America's Mussels: Silent Sentinels*. Online at: http://midwest.fws.gov/Endangered/clams/mussels.html (last visited May 20, 2008).
[171] Riggs and Webb (1956) cited in Watters 1999 at 261, 265.
[172] Burlakovaa & Karatayev 2007 at 291, 290.
[173] Watters 1999 at 261, 265.
[174] Box & Mossa 1999.
[175] Watters 1999 at 261, 266.

Sedimentation inhibits photosynthesis, consequently reducing algal growth and diminishing a major mussel food source.[176] It also traps organic material in the substrate, causing oxygen depletion and thermal changes.[177] Freshwater mussel beds located near tributaries and in slow-flowing water where silt settles out are at risk of sediment burial.[178] In these areas sediment deposits can potentially smother and eliminate entire mussel populations.[179] Due to their small size, juvenile mussels are particularly susceptible to burial, and high levels of suspended solids inhibit juvenile mussel growth.[180] In a study involving 2,000 mussels of 18 different species, 25 mm of siltation caused over 90 percent mortality.[181]

When sedimentation occurs on gravel beds silt fills the small spaces between gravel and rocks where the mussels live. This results in destabilization of the river bottom, which can eliminate mussel populations.[182] As freshwater mussels are filter-feeders, increased levels of sediment in the water column can clog the mussels' digestive system. This effectively starves the mussels either directly, through clogging, or indirectly by forcing mussels to close their valves and stop feeding.[183]

4. Polluted Runoff

Because freshwater mussels are largely sedentary filter-feeders they are primary reservoirs for bioaccumulation of a number of pollutants.[184] When present at low but chronic levels, chemicals, metals, and nutrients bind with suspended sediments that settle out of the water column into the substrate where mussels live.[185] The contaminants can accumulate in mussels as they filter water for food.[186] Mussels can tolerate short-term exposure to toxic chemicals by closing their valves but cannot tolerate chronic exposure to such pollutants.[187] Juvenile mussels accumulate higher concentrations of pollutants and are the first to succumb to the effects of increased discharges.[188] Because mussels are slow to recolonize polluted watersheds it could take years for aquatic ecosystems to recover from contamination.[189]

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[176] *Id*. at 261, 263.
[177] *Id*.
[178] U.S. Fish and Wildlife Service, *Freshwater Mussels: Current Threats*. Online at: http://midwest.fws.gov/mussel/current_threats.html (last visited May 20, 2008).
[179] *Id*.
[180] Watters 1999 at 261, 264.
[181] *Id*. at 268.
[182] *Id*. at 266.
[183] M.M. Ellis, *Erosion Silt as a Factor in Aquatic Environments,* 17 ECOLOGY 29, 39-40 (1936) (describing experiments that examined the smothering effect of silt on 18 species of freshwater mussels); David W. Aldridge et al., *The Effects of Intermittent Exposure to Suspended Solids and Turbulence on Three Species of Freshwater Mussels*, 45 ENVTL. POLLUTION 17, 18 (1987).
[184] Robert B. Foster & John M. Bates, *Use of Freshwater Mussels to Monitor Point Source Industrial Discharges*, 1978 ENVIRONMENTAL SCIENCE & TECHNOLOGY 958.
[185] U.S. Fish and Wildlife Service, *Freshwater Mussels: Current Threats*.
[186] *Id*.
[187] Foster & Bates 1978 at 958 (discussing the impact of copper contamination on freshwater mussel populations).
[188] *Id*. at 960.
[189] Foster & Bates 1978 at 958, 961.

Pesticide and nutrient runoff from agriculture pollute aquatic ecosystems and threaten mussel populations. Nonpoint source pollution associated with agriculture activities is a significant problem for mussel populations and aquatic ecosystems.[190] Excess nutrients promote the rapid growth of algae and aquatic plants that disrupt water-flow over mussel beds, inhibiting feeding and reducing oxygen supply.[191] Runoff infused with pesticides has eradicated mussel populations in some areas.[192]

B. The Inadequacy of the Existing Regulatory Mechanisms

The Petitioned species are not protected by name under federal or state law, and the Petitioner is not aware of any proposed or pending state or federal regulations that would protect these species and their habitat.[193] While the TPWD has created no-harvest mussel sanctuaries these sanctuaries only protect the Petitioned species from legal harvest and offer inadequate protection from illegal harvest or environmental contamination or degradation.[194] While no-harvest sanctuaries have been designated in Texas and may include areas supporting rare species and diverse mussel assemblages, such sanctuaries are not marked with signage, are not well advertised or widely recognized, and are not always included in regulatory literature. Further no-harvest sanctuaries can only prohibit harvest, but cannot preclude other negative environmental impacts (e.g., dewatering, pollution). Although sanctuaries legally exist in Texas, poor recognition and restricted scope limits their protective success.[195]

Furthermore, not all populations of the Petitioned species occur within mussel sanctuaries. Thus, the only protection provided for populations of the Petitioned species that occur outside of mussel sanctuaries is the 2.5-inch minimum shell height required for legal mussel harvest.[196] However, limits on harvest do not protect the Petitioned species from environmental degradation.

C. Other natural or manmade factors affecting its continued existence: climate change

As a species with low adaptability and low dispersal capacity, freshwater mussels are susceptible to increased extinction rates resulting from rapid climate change.[197] Considering the fragmentation of mussel habitat caused by extensive human

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[190]Brian D. Righter, David P. Braun, Michael A. Mendelson, and Lawrence L. Master, *Threats to Imperiled Freshwater Fauna*, 11 CONSERVATION BIOLOGY 1081 (1997).
[191]Burlakovaa & Karatayev 2007 at 291, 297.
[192]*See* U.S. Fish and Wildlife Service, *Freshwater Mussels: Current Threats*.
[193]The sole exception is the southern hickorynut, which is protected in Mississippi; Mississippi Department of Wildlife and Parks, *Mississippi's Species of Greatest Conservation Need by Ecoregion*, available at: http://www.mdwfp.com/homelinks/more/Final/Appendix%208.pdf (last visited April 8, 2008).
[194]NatureServe Comprehensive Report for *Pleurobema riddellii*.
[195]Pers. comm. Robert G. Howells, July 2008.
[196]NatureServe Comprehensive Report for *Pleurobema riddellii.*
[197]*See* Gian-Reto Walther, Eric Post, Peter Convey et al, *Ecological Responses to Recent Climate Change*, 416 NATURE 389, 394 (2002).

development, many areas that may become climatically suitable due to future warming are remote from current distributions and are therefore likely to be beyond the dispersal capacity of most freshwater mussel species.[198] Recent climate changes have also increased the flood risk posed by large flood events in the western U.S.[199] More floods, alongside rapid warming, do not bode well for the future of freshwater mussel species.

In addition to the risk of flood and warmer temperatures, climate change effects already being reported in the U.S. include extended drought. The southwestern portions of the ranges of the Petitioned species may be at particular risk given documented, long-term drought, but other portions of their ranges may be at risk as well.[200]

VII. Requested Designation

According to the best available data, all of the Petitioned freshwater mussel species are imperiled or critically imperiled. To prevent their extinction and effect their recovery the Service must list the Petitioned species as Endangered or Threatened across their historic ranges. ESA protections will help protect these species from extinction and will also safeguard the ecosystems of which they are a part by preventing the degradation of watersheds relied on by countless other species. The Petitioner requests that the Service make a positive 90-day finding on this Petition and proceed with a 12-month status review for each of the Petitioned species. All of the information required to make such a finding is readily available through the scientific databases and sources incorporated into this petition. The information provided in this Petition constitutes "substantial scientific and commercial information indicating that listing may be warranted." We request that the Service act on this Petition quickly before one or more of the Petitioned species becomes extinct.

As habitat destruction and degradation are the primary threats to the Petitioned species, critical habitat designation is essential to their survival.[201] Thus, the Petitioner requests that the Secretary designate critical habitat for each of the six freshwater mussel species.

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[198] *Id.*
[199] A.F. Hamlet, D.P. Lettenmaier, *Effects of 20th Century Warming and Climate Variability on Flood Risk in the Western U.S.*, 43 WATER RESOURCES JOURNAL 2007.
[200] Discussion of climate change impacts in the southwest can be found at: Intergovernmental Panel on Climate Change. 2001. IPCC Special Report on The Regional Impacts of Climate Change An Assessment of Vulnerability. See http://www.grida.no/climate/ipcc/regional/index.htm; U.S. Global Change Research Program. 2000. US National Assessment of the Potential Consequences of Climate Variability and Change. See Sector: Water Resources at http://www.usgcrp.gov/usgcrp/nacc/water/default.htm; Smith, S.J., A.M. Thomson, N.J. Rosenburf, R.C. Izaurralde, R.A. Brown, and T.M.L. Wigley. 2005. Climate Change Impacts for the Conterminous USA: An Integrated Assessment - Part 1. Scenarios and Context. Climatic Change 69 (1): 7-25; Seager, R., M. Ting, I. Held, Y. Kushnir, J. Lu, G. Vecchi, H. Huang, N. Harnik, A. Leetmaa, N. Lau, C. Li, J. Velez, and N. Naik. 2007. Model projections of an imminent transition to a more arid climate in southwestern North America. Science 316: 1181-1184; National Science & Technology Council, Committee on Environment & Natural Resources. 2008. Scientific Assessment of the Effects of Global Change on the United States at http://www.climatescience.gov/Library/scientific-assessment/Scientific-AssessmentFINAL.pdf. Issued May 2008.
[201] *See* 16 U.S.C. § 1532(5).