# 5-YEAR REVIEW
# The Scaleshell Mussel (*Leptodea leptodon*)

## GENERAL INFORMATION

**Species:** *Leptodea leptodon*
**Date listed:** October 9, 2001
**FR citation(s):** 66 FR 51322
**Classification:** Endangered

**Lead Field Office**: Andy Roberts, Missouri Field Office
**Lead Regional Office**: Laura Ragan, Region 3
**Cooperating Field Offices**: Chris Davidson, Arkansas Field Office; Sara Schmuecker, Illinois-Iowa Field Office; Dylan Turner, South Dakota Field Office; David Martinez, Oklahoma Field Office
**Cooperating Regional Offices**: Carrie Straight, Region 4

## BACKGROUND

**Most recent status review:** Scaleshell mussel (*Leptodea Leptodon*) 5-Year Review and Evaluation March 2011 (https://www.fws.gov/midwest/endangered/clams/scaleshell/index.html).

**FR Notice citation announcing this status review:** 85 FR 53842: Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 14 Listed Animal and Plant Species, published 08/31/2020

## ASSESSMENT

**Information acquired since the last status review:** This 5-year review was conducted by the U.S. Fish and Wildlife Service's (USFWS) Missouri Field Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on 08/31/2020. We also contacted federal and state wildlife agencies within the extant range of the species to request any data or information we should consider in our review. Additionally, we conducted a literature search and a review of information in our files. From these efforts, we received recent survey reports and records of field collections from the USFWS's Arkansas, Oklahoma, and Illinois-Iowa field offices, the Missouri Department of Conservation, Michigan Department of Natural Resources, and Illinois Department of Natural Resources.

The results of this status review indicate the Scaleshell is still present, although rare, within its strong-hold populations in the Meramec, Bourbeuse, and Gasconade rivers in Missouri. It was also collected live in the last 10 years in three streams where it has been documented previously in Arkansas, Missouri, and Illinois. No other collections have been reported for the Scaleshell during the review period from 2011 to the present. A more detailed discussion of the new information acquired for this review is provided in Appendix I. Overall, the species distribution remains the same as described in our 2011 review (USFWS 2011, Appendix II) and this information does not alter our understanding of the species' current distribution. Likewise, the

evaluation of threats affecting the species under the factors in 4(a)(1) of the Act and analysis of the status of the species in the 2011 status review and recovery plan (USFWS 2010) remains an accurate reflection of the species current status.

Several conservation and recovery efforts have been initiated since the 2011 status review. In 2013, the Environmental Protection Agency (EPA) finalized the updated ammonia criteria. These criteria are applicable nationally and take into account the latest toxicity information for freshwater species, including unionid mussels (EPA 2013). The 2013 criteria incorporate scientific views received on the draft ammonia criteria (EPA 2009) and supersede EPA's previously recommended 1999 criteria (EPA 1999), which were not protective of freshwater mussels. An extensive genetic study on Scaleshell was completed by Iowa State University in 2015 (Chong and Roe 2017). The findings of this study will help inform future propagation efforts for the species, which is listed as a recovery action in the recovery plan (USFWS 2010). Two formal consultations have been completed under Section 7 of the Endangered Species Act that have resulted in reduced impacts to the Scaleshell and the availability of mitigation dollars for two Missouri streams. This included consultations with the U.S. Army Corps of Engineers on the Lower Osage River in 2017 and with the Federal Highways Administration on the Bourbeuse River in 2018. The resulting mitigation funds are now available to contribute to ongoing mussel habitat restoration in those streams. Lastly, the USFWS and the Missouri Department of Natural Resources, acting as trustees for Natural Resource Damage Assessment and Restoration, are currently working with the EPA (under Superfund authority) and the U.S. Army Corps of Engineers (USACE) (under Water Resource Development Act authority) to remediate and restore resources injured by impacts from lead mining in the Big River in southeast Missouri. The USACE efforts have recently been Congressionally authorized, which could result in over $90 million of restoration efforts focused on improving mussel habitat in the Big River into the future. Related to this effort are studies (Roberts et al. 2016) and ongoing monitoring of mussel populations and metal contaminated sediments in the Big River.

## CONCLUSION

After reviewing the best available scientific information, we conclude that the Scaleshell remains an endangered species.

**RECOMMENDATIONS FOR FUTURE ACTIONS:** The recovery actions listed in the Scaleshell Recovery Plan are still applicable (USFWS 2010). Several of the priority actions listed are related to augmenting existing populations and reintroducing the species into portions of its historical range via artificial propagation (actions 2.5 and 5.0). Progress has been made within these recovery action categories since 2010, including the development of propagation and rearing methodologies for Scaleshell (Action 2.5.2) and the determination of genetic differentiation among and within populations (Action 3.4.1) (Chong and Roe 2017). Both of these actions are considered prerequisites for implementing a propagation program. The next step in this process is for the USFWS to develop a Scaleshell propagation and reintroduction plan with state and federal partners within the extant and historical range of the species (Action 2.5.1). In this plan, the USFWS would identify streams where threats have been alleviated and population augmentation or reintroduction might be appropriate. If carried out properly, a

propagation plan could make significant progress towards recovery and meeting the downlisting criteria for the species.

**Lead Field Supervisor, Fish and Wildlife Service**

Approve KAREN HERRINGTON Digitally signed by KAREN HERRINGTON Date: 2021.03.23 13:29:13 -05'00' Date _____

*The lead Field Office must ensure coordination with other offices and regions within the range of the species to ensure that any new information they have has been adequately considered prior to the review's completion. The lead field office should document this coordination in the agency record.*

## APPENDIX I

## Summary of new information acquired on the status of the federally endangered Scaleshell Mussel (*Leptodea leptodon*) between 2011 and 2021.

When the Scaleshell was listed as endangered in 2001, it was considered extant in 14 of 55 rivers from which it occurred (USFWS 2001). These rivers included the Meramec, Bourbeuse, Big, Gasconade, and Osage rivers in Missouri; Frog Bayou and the St. Francis, Spring, South Fork Spring, South Fourche LaFave, and White rivers in Arkansas; and the Little, Mountain Fork, and Kiamichi rivers in Oklahoma. An additional six streams were listed as possibly supporting the species in Arkansas and Oklahoma including the Cossatot, Little Missouri, Saline, and Strawberry rivers, and Myatt and Gates creeks (USFWS 2011). Between 2001 and 2011, the only living specimens reported throughout its range were from the Meramec, Bourbeuse, and Gasconade rivers in Missouri. However, fresh-dead specimens had been found in the Big River in Missouri, Missouri River in South Dakota, and the Kiamichi River in Oklahoma (USFWS 2011).

Since 2011, the Scaleshell has been reported from several streams within its historical range (Table 1). In 2013, an Illinois Natural History Survey biologist found a living Scaleshell in the Illinois River (K. Lundh, U.S. Fish and Wildlife Service, pers comm., May 17, 2013). This specimen was found during exceptional conditions during which the water was drawn down in the river, causing emersion of mussel populations. Prior to this record, the Scaleshell was considered extirpated from all historical streams east of the Mississippi River (USFWS 2010). Subsequent mussel surveys in the Illinois River failed to find additional evidence of the species (EA Engineering, Science and Technology, Inc., PBC 2014; Huff & Huff, Inc. 2015; EcoAnalysts, Inc. 2020; S. Schmuecker, pers comm., September 5, 2017 and January 4, 2121; K. Cummings, Illinois Natural History Survey, pers comm., January 26, 2021). In Missouri the last known collections are from the Meramec, Bourbeuse, and Gasconade rivers in 2019, and Big River in 2013 (Roberts et al. 2016) (Table 1). It was documented with a fresh dead shell in the Lower Osage River for only the second time during monitoring efforts in 2013 (Roberts et. al. 2014). In Arkansas, three live male specimens were found in 2017 in the Strawberry River (Gonzalez 2018) and a dead specimen the South Fourche LaFave River in 2019 (Chris Davidson, USFWS, personal communication, May 1, 2020) (Table 1). These records confirm the persistence of very small Scaleshell populations in these streams.

From our data requests conducted during this review, we discovered previously unknown Scaleshell records dated prior to 2011. A fresh-dead specimen was collected in 2005 from the convergence of Big Lake Relief (aka Stateline Outlet Ditch) and Ditch #3 (outflow below Big Lake National Wildlife Refuge structure) in northeast Arkansas (Christian 2006). While this species has not been found in this waterway before, it has been documented in an oxbow lake nearby within the Big Lake National Wildlife Refuge (Bouldin et al. 2013) (Table 1). Several museum specimens have been found that represent new historical rivers for the Scaleshell in Missouri and Arkansas. John H. Britts collected a specimen in 1899 from the Niangua River in

Missouri (S. Faiman, Missouri Department of Conservation, pers com., November 1, 2016). The Nianuga River is a tributary of the Osage River where the Scaleshell was only discovered recently in 2001 (Table 1). There were several new museum specimens from Arkansas including an unnamed oxbow lake within the Big Lake National Wildlife Refuge (Mississippi County, 1974), two records with no date from the Black River, and from the Boeuf River (Chicot County, 1979) (Bouldin et al. 2013) (Table 1). The five records discussed above (including the oxbow lake specimen) increase the total number of historical Scaleshell streams from 55 to 60.

While it is difficult to assess the status and population trends of the Scaleshell mussel because of its rarity, recent collections indicate known populations are still present. The Meramec, Bourbeuse, and Gasconade rivers in Missouri are still considered the strong-hold populations for this species. In these streams, live individuals can usually be found at known sites with intense search efforts and occasionally multiple animals are found during a single search. Collections from the last 25 years from the Meramec, Bourbeuse, and Gasconade rivers show that it has been collected live almost annually during the past 25 years (except 1996, 2010, 2016, and 2017). The average number of live specimens per site was 1.9 with a range of 1-25 specimens (USFWS unpublished data, 2021). However, it is not found consistently elsewhere within its range where during the last 25 years just a few or a single live specimen can be found to represent the population in the entire stream (USFWS 2001, 2010, 2011). Since the last status review (USFWS 2011), the status of the Scaleshell remains as described in 2001--a very rare species in Missouri and only occurring sporadically elsewhere within its range.

**Literature Cited**


Bouldin. J., W.R. Posey II, J.L. Harris. 2013. Status Assessment Survey for *Leptodea leptodon* (Rafinesque 1820), the Scaleshell, in Arkansas. 19 pp. + App. Final Report to the Arkansas Game and Fish Commission, Perrytown, Arkansas.

Chong, J.P., Roe, K.J. 2017. A comparison of genetic diversity and population structure of the endangered scaleshell mussel (*Leptodea leptodon*), the fragile papershell (*Leptodea fragilis*) and their host-fish the freshwater drum (*Aplodinotus grunniens*). *Conserv Genet* **19,** 425–437 (2018). https://doi.org/10.1007/s10592-017-1015-x

Christian, A. 2006. *Potamilus Capax* Survey. Final report to the Arkansas Department of Transportation, 19 pp., Appendix A i*n* U.S. Department of Transportation, Federal Highway Administration, Arkansas State Highway and Transportation Department. 2006. Highway 18 Widening, Craighead and Mississippi Counties, Arkansas, Environmental Assessment. 158 pp. + App.

EA Engineering, Science, and Technology, Inc., PBC. 2014. Freshwater Mussel Survey in the Illinois River near the Dresden Nuclear Station (RM 271-272.5). Final report prepared for Exelon Generation Company, LLC. Warrenville, Illinois. 30 pp.

EcoAnalysts, Inc. 2020. Unionid survey for the proposed Illinois and Michigan Oil fleeting project, Illinois River, Grundy County, Illinois. Final report to the Illinois and Michigan Oil, LLC. 26 pp.

Gonzalez, I.S. 2018. Water Quality and Freshwater Mussel Assemblages in the Strawberry River Watershed, Arkansas. Masters Thesis for Arkansas State University. 153 pp. + App..

Huff & Huff, Inc. 2015. Mussel Survey. Illinois River Near Unincorporated Grundy County, Illinois. Final report prepared for J.F. Brennan, Inc.. Ottawa, Illinois. 6 pp. + App..

Roberts, A.D., J. Hundley, D. Mosby, A. Rosenberger, K.L. Bouska, B. Simmons, and G. Lindner. 2016. Quantitative Survey of Freshwater Mussels (Unionoidea) and Assessment of Sediment Contamination in the Big River, Missouri. Final Report for the U.S. Fish and Wildlife Service, Natural Resource Damage Assessment. 53 p. + App

Roberts, A.D., B.R. Simmons, J. Hundley, S. McMurray, and J.S. Faiman. 2014. Delineation of Mussel Beds in the Lower Osage River, Missouri. Progress Report for Project 08-6 of the Lower Osage Protection and Enhancement Program, 26 pp., Appendix IV *in* U.S. Fish and Wildlife Service. 2014. Lower Osage River Protection and Enhancement Program, 2013 Annual Report submitted to Ameren Missouri (for actions completed in 2013) 7+App.. U.S. Fish and Wildlife Service, Missouri Field Office.

United States Environmental Protection Agency. 1999. 1999 Update of ambient water quality criteria for ammonia. EPA-822-R-99-014. National Technical Information Service, Springfield, VA.

United States Environmental Protection Agency. 2009. Draft 2009 update aquatic life ambient water quality criteria for ammonia – freshwater. EPA-822-D-09-001. Office of Water, Office of Science and Technology, Washington, DC.

United States Environmental Protection Agency. 2013. Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater 2013. EPA 822-R-18-002. Office of Water Office of Science and Technology Washington, DC.

U.S. Fish and Wildlife Service. 2001. Endangered and threatened wildlife and plants; final rule to list the Scaleshell mussel as endangered. *Federal Register* 66(195) 51322-51339, October 9, 2001. https://www.fws.gov/midwest/endangered/clams/scaleshell/index.html

U.S. Fish and Wildlife Service. 2010. Scaleshell mussel recovery plan (*Leptodea leptodon*). U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 127 pp. https://www.fws.gov/midwest/endangered/clams/scaleshell/index.html

U.S. Fish and Wildlife Service. 2011. Scaleshell mussel (Leptodea leptodon) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 17 pp. https://www.fws.gov/midwest/endangered/clams/scaleshell/index.html

**Table 1**. Distribution and status of the Scaleshell (*Leptodea leptodon*) in 2010 vs. 2021 organized by watershed[1]. Records are dead specimens from museums unless otherwise noted. "-" = no new records.

| Major Watersheds | Stream Populations (tributaries indented) | State | 2010[1] | | 2021 | |
|---|---|---|---|---|---|---|
| | | | Most recent record | Counties of Occurrences | Most recent record | Counties of Occurrences |
| Mississippi River | Mississippi River mainstem | Illinois, Iowa, Wisconsin | Pre-1958 | Carroll, Hancock, Mercer (IL); Lee, Clayton, Scott (IA) | - | - |
| | Burdett's Slough | Iowa | 1890 | Muscatine | - | - |
| Minnesota River | Minnesota River | Minnesota | 1800's | Dakota | - | - |
| Iowa River Basin | Iowa River mainstem | Iowa | Pre-1944 | Johnson | - | - |
| | Cedar River | Iowa | 1882 | Linn | - | - |
| Illinois River Basin | Illinois River mainstem | Illinois | Pre-1887 | Peoria | 2013, single live specimen[2] | Grundy |
| | Sanagamon River | Illinois | Pre-1944 | Menard | - | - |
| | Pecatonica River | Illinois | Pre-1944 | Stephenson | - | - |
| Kaskaskia River Basin | Kaskaskia River mainstem | Illinois | 1921 | Washington | - | - |
| Ohio River Basin | Ohio River mainstem | Kentucky, Ohio | 1897 | Boone, Kenton (KY); Hamilton, Washington (OH) | - | - |
| | Wabash River | Illinois, Indiana | Pre-1919 | White (IL); Carroll, Posey, Tippecanoe, Vigo (IN) | - | - |
| | White River | Indiana | Pre-1919 | Marion | - | - |
| | Sugar Creek | Indiana | 1925 | Parke | - | - |
| | Green River | Kentucky | 1964 | Hart | - | - |
| | Licking River | Kentucky | Pre-1950 | unknown | - | - |
| | Scioto River | Ohio | 1838 | unknown | - | - |
| | St. Mary's River | Ohio | 1930 | unknown | - | - |
| | East Fork Little Miami River | Ohio | ~1900 | unknown | - | - |

| Major Watersheds | Stream Populations (tributaries indented) | State | 2010[1] | | 2021 | |
|---|---|---|---|---|---|---|
| | | | Most recent record | Counties of Occurrences | Most recent record | Counties of Occurrences |
| Ohio River Basin (cont.) | Cumberland River | Kentucky, Tennessee | 1964 | Cumberland, Russell (KY); Clay (TN) | - | - |
| | East Fork Obey River* | Tennessee | Pre-1941 | Maury | - | - |
| | Beaver Creek | Kentucky | 1948 | Russell | - | - |
| | Caney Fork | Tennessee | Pre-1950 | Smith | - | - |
| | Tennessee River | Alabama, Tennessee | Pre-1950 | Colbert, Lauderdale (AL), Florence, Knox (TN) | - | - |
| | Clinch River | Tennessee | Pre-1950 | Union, Anderson | - | - |
| | Holston River | Tennessee | Pre-1950 | Knox, Grainger | - | - |
| | Duck River | Tennessee | Pre-1950 | Maury | - | - |
| Meramec River Basin | Meramec River mainstem | Missouri | 2008 | Crawford, Jefferson, St. Louis | 2019, 5 live specimens, one site[3] | St. Louis |
| | Big River | Missouri | 2008 | Jefferson | 2013, 1 live specimen[4] | Jefferson |
| | Bourbeuse River | Missouri | 2007 | Franklin, Jefferson, St. Louis | 2019, 1 live specimen[3] | Franklin |
| Missouri River Basin | Missouri River mainstem | South Dakota, Missouri | 2005 | Yankton (SD), Gasconade (MO) | - | - |
| | Gasconade River | Missouri | 2007 | Gasconade, Laclede, Maries, Osage, Pulaski, Wright | 2019, one live specimen[3] | Pulaski |
| | Big Piney River | Missouri | 1981 | Pulaski | - | - |
| | Osage River | Missouri | 2001 | Osage | 2013, dead shell[5] | Cole |
| | Niangua River | Missouri | - | - | 1899[6] | Camden |
| | South Grand River | Missouri | Early 1970's | Benton | - | - |
| | Auxvasse Creek | Missouri | Late 1960's | Callaway | - | - |

| Major Watersheds | Stream Populations (tributaries indented) | State | 2010[1] | | 2021 | |
|---|---|---|---|---|---|---|
| | | | Most recent record | Counties of Occurrences | Most recent record | Counties of Occurrences |
| St. Francis River Basin | St. Francis River mainstem | Arkansas | 1985 | Cross, Lee, St. Francis | - | - |
| | Stateline Outlet and Ditch #3 | Arkansas | - | - | 2005, fresh dead specimen[7] | Mississippi |
| | Oxbow Lake, Big Lake National Wildlife Refuge | Arkansas | - | - | 1974[8] | Mississippi |
| White River Basin | White River mainstem | Arkansas | 1999 | Benton, Jackson | - | - |
| | Black River | Arkansas | - | - | No date[8] | Lawrence and Sharp |
| | James River | Missouri | Pre-1950 | Stone | - | - |
| | Spring River | Arkansas | 1991 | Lawrence, Randolph, Sharpe | - | - |
| | South Fork Spring River | Arkansas | 1990 | Fulton | - | - |
| | Myatt Creek | Arkansas | 1996 | Fulton | - | - |
| | Strawberry River | Arkansas | 1996 | Lawrence | 2017, three live specimens[9] | Sharp and Lawrence |
| | Middle Fork Little Red River | Arkansas | 1967 | Van Buren | - | - |
| Arkansas River Basin | Mulberry River | Arkansas | No date | unknown | - | - |
| | Frog Bayou | Arkansas | 1979 | Sevier | - | - |
| | Poteau River | Oklahoma | Pre-1980 | LeFlore | - | - |
| | South Fourche LaFave River | Arkansas | 1991 | Perry | 2019, one dead specimen[10] | Perry |
| Red River Basin | Kiamichi River | Oklahoma | 2004/2005, fresh-dead shells from three sites | Pushmataha | - | - |
| | Gates Creek | Oklahoma | Pre-1971 | Pushmataha | - | - |
| | Little River | Oklahoma | 1960 | McCurtain | - | - |
| | Mountain Fork | Oklahoma | Pre-1971 | McCurtain | - | - |

| Major Watersheds | Stream Populations (tributaries indented) | State | 2010[1] | | 2021 | |
|---|---|---|---|---|---|---|
| | | | Most recent record | Counties of Occurrences | Most recent record | Counties of Occurrences |
| Red River Basin (cont.) | Cassatot River | Arkansas | 1983 | Sevier | - | - |
| | Saline River | Arkansas | 1987 | Howard, Sevier | - | - |
| | Ouachita River | Arkansas | No date | Clark | 1913[8] | Clark |
| | Boeuf River | Arkansas | - | - | 1979[8] | Chicot |
| | Little Missouri River | Arkansas | 1995 | Clark | - | - |
| | Saline River | Arkansas | 1964 | Cleveland | 1975[8] | Fulton |

[1]Data summarized from U.S. Fish and Wildlife Service (2010 and 2011)
[2]K. Lundh, U.S. Fish and Wildlife Service, personal communication, May 17, 2013
[3]S. Faiman, Missouri Department of Conservation, pers com., January 25, 2021
[4]Roberts et al. (2016)
[5]Roberts et al. (2014)
[6]S. Faiman, Missouri Department of Conservation, personal communication, November 1, 2016
[7]Christian (2006)
[8]Bouldin et al. (2013)
[9]Gonzalez (2018)
[10]C. Davidson, U.S. Fish and Wildlife Service, personal communication, May 1, 2020

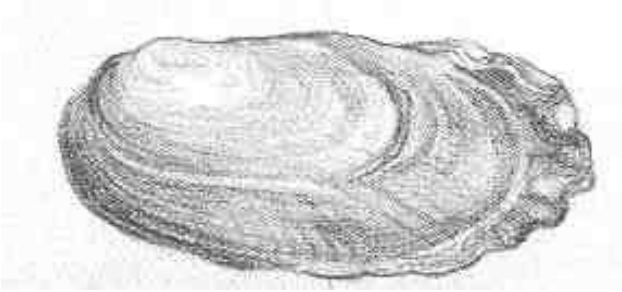
*Record listed in USFWS (2010), but cannot be confirmed at this time.

# APPENDIX II

2011 Status Review of the Scaleshell Mussel (*Leptodea leptodon*)

# Scaleshell Mussel
***(Leptodea leptodon)***

## 5-Year Review:
## Summary and Evaluation



Marilyn Oesch Rose

**U.S. Fish and Wildlife Service**
**Missouri Ecological Services Field Office**
**Columbia, Missouri**

# 5-YEAR REVIEW
# Scaleshell mussel/*Leptodea leptodon*

## 1.0 GENERAL INFORMATION

### 1.1 Reviewers

**Lead Regional Office:** Carlita Payne, Midwest Regional Office (Region 3), 612-713-5339

**Lead Field Office:** Andy Roberts, Columbia, Missouri Field Office, 573-234-2132, ext. 110

**Cooperating Field Offices:**
Chris Davidson, Conway, Arkansas Field Office (Region 4), 501-513-4481
David Martinez, Oklahoma Field Office (Region 2), 918-581-7458

**Cooperating Regional Offices:**
Wendy Brown, Southwest Regional Office (Region 2), 505-248-6664
Kelly Bibb, Southeast Regional Office (Region 4), 404-679-7132
Seth Willey, Mountain-Prairie Regional Office (Region 6), 303-236-4257

### 1.2 Methodology used to complete the review:

The U.S. Fish and Wildlife Service's (USFWS) Columbia, Missouri Field Office completed this 5-year review. Biologists in the Arkansas (Region 4) and Oklahoma (Region 2) Ecological Services Field Offices provided assistance and information for this review. The main source of information used for this status review is the scaleshell mussel recovery plan approved in February 2010 (USFWS 2010). The recovery plan contains a current compilation of information regarding status, distribution, and threats for the species. The plan also contains objective, measurable recovery criteria that are up-to-date. The recovery plan and the literature cited within the plan are on file at the Columbia, Missouri Field Office. Outside peer review was not required for this document per the 5-year review guidance (USFWS 2006) because 1) no recommendations were made, as a result of this review, to change the status of the scaleshell; 2) information used in this review has already undergone peer review; 3) scientific uncertainty of the information used is low; and 4) public interest is low. All recommendations resulting from this review are the result of thoroughly reviewing all available information on this species. The *Federal Register* notice of initiation was published on Thursday, October 4, 2007 (72 FR 56787), with a 60-day public comment period. It requested new scientific or commercial data and information that may have a bearing on the species' classification of endangered. Comments were received, evaluated, and incorporated as appropriate.

### 1.3 Background:

**1.3.1 FR Notice citation announcing initiation of this review:** 72 FR 56787, October 4, 2007

**1.3.2 Listing history**

Original Listing
**FR notice:** 66 FR 51322
**Date listed:** October 9, 2001
**Entity listed:** Species
**Classification:** Endangered

**1.3.3 Associated rulemakings**: N/A

**1.3.4 Review History:** N/A

**1.3.5 Species' Recovery Priority Number at start of 5-year review:** 2, indicating a high degree of threat and high recovery potential.

**1.3.6 Recovery Plan**

**Name of plan**: Scaleshell Mussel Recovery Plan
**Date issued**: February 2010
**Dates of previous revisions, if applicable**: N/A

## 2.0 REVIEW ANALYSIS

### 2.1 Application of the 1996 Distinct Population Segment (DPS) policy

**2.1.1 Is the species under review a vertebrate?** *No.*

### 2.2 Recovery Criteria

**2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?** *Yes*.

**2.2.2 Adequacy of recovery criteria.**

**2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?** *Yes.*

**2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?** *Yes.*

**2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:** The following recovery criteria were taken from the final scaleshell recovery plan (USFWS 2010). These recovery criteria have not been met as described below.

The scaleshell will be considered for downlisting to threatened status when the following criteria have been achieved:

1. Through protection of existing populations, successful establishment of reintroduced populations, or the discovery of additional populations, four stream populations exist, each in a separate watershed and each made up of at least four local populations located in distinct portions of the stream. Each stream population must exist in a separate watershed so that a single stochastic event, such as a toxic spill or disease outbreak, will not affect more than one of the four stream populations. This criterion is based on the available information and the best professional judgment of species experts, and may be revised based on additional biological, demographic, or genetic information obtained through Recovery Actions 3.1 and 3.4.

This criterion has not been fully met, but progress is being made. Currently, two stream populations exist in separate watersheds (Gasconade and Meramec river basins) that have at least four local populations (USWS 2010). Recovery actions 3.1 and 3.4 have been initiated and are partially complete.

2. Each local population in Criterion 1 is viable in terms of population size, age structure, recruitment, and persistence. Currently, what constitutes a viable population of the scaleshell is not known. Population viability will be defined when Action 3.4.2 (Research Population Dynamics of the Scaleshell) is completed. In the future, this criterion will be revised to incorporate the definition of population viability resulting from this recovery action (3.4.2).

This criterion has not been fully met, but progress is being made. A collaborative, two-year research project that will partially complete action 3.4.2 was funded and is scheduled to begin in 2011 between Iowa State University, Missouri Department of Conservation (MDC), and USFWS (Steve McMurray, Missouri Department of Conservation, pers. comm. 2010).

3. Threats to local populations in Criterion 1 have been identified and addressed per measurable criteria developed in Action 2.3. Currently it is not feasible to identify in this criterion the specific threats to populations and thresholds at which those threats are reduced to the level where criteria 1 and 2 are achieved.

However, the thresholds for this criterion will be defined through the implementation of key actions in the plan as follows. Step 1: identify and map present and foreseeable threats to local populations in a GIS database (Action 2.2). Step 2: Define measurable criteria for alleviating/reducing each of those threats and prioritize threats according to effects to local populations (Action 2.3). Step 3: Apply the appropriate recovery actions outlined in this plan to alleviate/reduce threats. Step 4: Track the progress of recovery implementation (Action 7.2).

This criterion has not been fully met, but progress is being made. Steps one and two (Actions 2.2 and 2.3) of criterion 3 are partially complete for the Meramec River basin (Andy Roberts, USFWS, pers. obs. 2010)

The scaleshell will be considered for removal from the protection of the Endangered Species Act when the following criteria are achieved:

1. Through protection of existing populations, successful establishment of reintroduced populations, or the discovery of additional populations, a total of eight stream populations exist, each in a separate watershed and each made up of at least four local and geographically distinct populations. At a minimum, one stream population must be located in the Upper Mississippi River Basin, four in the Middle Mississippi River Basin (two of these must exist east of the Mississippi River), and three in the Lower Mississippi River Basin. Completion of action 3.4.2 or 3.4.3 may indicate more local populations, streams, or geographical regions are required. This criterion is based on the available information and the best professional judgment of species experts, and may be revised based on additional biological, demographic, or genetic information obtained through Recovery Actions 3.1 and 3.4.

This criterion has not been met. See downlisting criterion 1 for current progress toward this criterion.

2. Each local population in Criterion 1 is viable in terms of population size, age structure, recruitment, and persistence. Currently, what constitutes a viable population of the scaleshell is not known. Population viability will be defined when Action 3.4.2 is completed. In the future, this criterion will be revised to incorporate the definition of population viability resulting from this recovery action (3.4.2).

This criterion has not been met. See downlisting criterion 2 for current progress toward this criterion.

3. Threats to local populations in Criterion 1 have been identified and addressed per measurable criteria developed in Action 2.3. Currently it is not feasible to identify in this criterion the specific threats to populations and thresholds at which those threats are reduced to the level where criteria 1 and 2 are achieved.

However, the thresholds for this criterion will be defined through the implementation of key actions in the plan as follows. Step 1: identify and map present and foreseeable threats to local populations in a GIS database (Action 2.2). Step 2: Define measurable criteria for alleviating/reducing each of those threats and prioritize threats according to effects to local populations (Action 2.3). Step 3: Apply the appropriate recovery actions outlined in this plan to alleviate/reduce threats. Step 4: Track the progress of recovery implementation (Action 7.2).

This criterion has not been met. See downlisting criterion 3 for current progress toward this criterion.

## 2.3 Updated Information and Current Species Status

### 2.3.1 Biology and Habitat

**2.3.1.1 New information on the species' biology and life history**: No new information has been obtained since the issuance of the listing rule (USFWS 2001) or the recovery plan (USFWS 2010).

**2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends**: Assessing abundance and population trends of the scaleshell is difficult because of its rarity. When the species was listed in 2001, it was known from 14 rivers in three states (USFWS 2001). These rivers include the Meramec, Bourbeuse, Big, Gasconade, and Osage rivers in Missouri; Frog Bayou and the St. Francis, Spring, South Fork Spring, South Fourche LaFave, and White rivers in Arkansas; and the Little, Mountain Fork, and Kiamichi rivers in Oklahoma. An additional six streams were listed in 2001 as possibly supporting the species in Arkansas and Oklahoma including the Cossatot, Little Missouri, Saline, and Strawberry rivers, and Myatt and Gates creeks (USFWS 2001). Since 2001, living specimens have only been found in the Meramec, Bourbeuse, and Gasconade rivers in Missouri. Fresh-dead specimens have been found in the Big River in Missouri, Missouri River in South Dakota, and the Kiamichi River in Oklahoma. In addition to the limited number of rivers it has been found since 2001, we consider extant populations to be declining because the species remains very difficult to find (even at the best known extant sites) and 60 percent of resurveyed scaleshell sites have been lost or have declined significantly (see sections 2.3.1.6 and 2.3.2.1 below) (Clarke 1987; Galbraith *et al.* 2005; Galbraith *et al.* 2008; Galbraith *et al.* 2010; Isely 1925; Mather 2005; Mehlhop and Miller 1989; MDC Mussel Database 2009; Spooner and Vaughn 2000; Valentine and Stansbery 1971). No new information is available on demographic features.

**2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)**: No new information has been obtained since the issuance of the listing rule (USFWS 2001).

**2.3.1.4 Taxonomic classification or changes in nomenclature**: No new information has been obtained since the issuance of the listing rule (USFWS 2001).

**2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.)**: Fragmentation and the loss of scaleshell sites discussed in Section 2.3.1.2 has contributed to the decline of this species. As in 2001, the Meremec, Bourbeuse, and Gasconade rivers continue to be a strong-hold for this rare species as it is still consistently found living during surveys (USFWS 2010). The Kiamichi River in Oklahoma supports a detectable population as three fresh-dead shells have been found since 2001, but the species is extremely rare in this river (see Section 2.3.2.1). However, very few specimens have been recovered in the last 50 years in the remaining streams of its historical range (Clarke 1987; Galbraith *et al.* 2005; Galbraith *et al.* 2008; Galbraith *et al.* 2010; Mather 2005; Mehlhop and Miller 1989; Spooner and Vaughn 2000; Valentine and Stansbery 1971).

**2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem)**: Several scaleshell sites known when the species was listed in the 2001 no longer appear to be suitable for mussels. These sites were also mussel beds supporting a diversity and an abundance of other mussel species. Of the 78 extant scaleshell sites, 21 have been resurveyed since 2001. Mussel beds have entirely disappeared, or significant declines have occurred at 13 (62%) of the 21 resurveyed sites (Table 1). This includes 4 of 5 revisited sites in the Meramec River, 3 of 5 revisited sites in the Bourbeuse River, and 2 of 5 revisited sites in the Gasconade River in Missouri. In Oklahoma, 4 of 5 revisited sites have been lost from the Kiamichi River (Clarke 1987; Galbraith *et al.* 2005; Galbraith *et al.* 2008; Galbraith *et al.* 2010; Isely 1925; Mather 2005; Mehlhop and Miller 1989; MDC Mussel Database 2009; Spooner and Vaughn 2000; Valentine and Stansbery 1971). The exact causes of these declines are unknown, but the lack of mussels at these sites is an indication that the areas no longer provide suitable habitat. It is doubtful that these sites will support viable scaleshell populations or support populations much longer.

**2.3.1.7 Other**: No new information has been obtained since the issuance of the listing rule (USFWS 2001).

### 2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

#### 2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Range: The scaleshell mussel was listed as a federally endangered species in 2001. At that time, the historical distribution of the species was reported to include 55 streams in 13 states including Alabama, Arkansas, Illinois, Indiana, Iowa, Kentucky, Minnesota, Missouri, Ohio, Oklahoma, South Dakota, Tennessee, and Wisconsin. The extant distribution reported in 2001 included only 14 (possibly 20) streams in Missouri, Arkansas, Oklahoma. Of these streams, only the Meramec, Bourbeuse, and Gasconade river populations in Missouri were based on more than a single or small number of specimens (USFWS 2001). These three streams continue to be a strong-hold for the species and are the only streams where it has been collected live since 2001 (MDC Mussel Database 2009). Live individuals have been collected in the Meramec, Bourbeuse, and Gasconade rivers as recently as 2009, and some new sites have been found (Table 1). However, the scaleshell mussel remains very rare in these streams and many populations still occur in small, isolated patches (USFWS 2010).

The scaleshell has been reported from three other rivers within its range since 2001, but these collections are based on dead shells. These rivers include the Kiamichi, Missouri, and Big rivers in Oklahoma, South Dakota, and Missouri respectively (Galbraith *et al.* 2005; Galbraith *et al.* 2008; Roberts *et al.* 2009; USFWS 2010). Three fresh-dead shells were collected in the Kiamichi River in Oklahoma from three different sites in 2004/2005 (Galbraith *et al.* 2005, 2008). Based on this evidence, there is likely a living population in this stream, although very rare. A single fresh-dead shell was collected in the Missouri River below Gavin's Point Dam in South Dakota in 2005 in the vicinity of another fresh-dead shell that was found in the early 1980's (USFWS 2010). Lastly, one fresh-dead shell fragment was found at a new site in the lower Big River in 2008 (Roberts *et al.* 2009).

Destruction of habitat: The major causes of habitat loss are still present in streams throughout its range including water quality degradation, sedimentation, channelization, sand and gravel mining, dredging, and impoundments (USFWS 2010). New information has been discovered with respect to water quality. In studies since 2001, mussels have been found to be very sensitive to ammonia, which is one of the most common pollutants in streams (Augspurger *et al*. 2003; Wang *et al*. 2007*a*; Wang *et al*. 2007*b*). These studies have called into question whether or not the Environmental Protection Agency's (EPA) current national water quality criteria are protective of freshwater mussels because those criteria were derived from a toxicity database predating data recently available for

freshwater mussels. The EPA is currently in the process of updating the 1999 national water quality criteria for ammonia (EPA 2009). Ammonia is a common pollutant in streams occupied by the scaleshell range-wide and is associated with both point and nonpoint sources. Ammonia is associated with animal feedlots, nitrogenous fertilizers, industrial effluents, and municipal wastewater treatment plants (Goudreau *et al*. 1993; USFWS 2010).

Declines of mussel populations in the Big River have been attributed to the effects of past and present lead mining (USFWS 2010). Recent studies have confirmed that stream sediments in the Big River are contaminated with high levels of heavy metals (e.g., lead, zinc, cadmium) as a result of lead mining in the upper portion of the watershed (Roberts *et al.* 2009). These contaminated sediments have greatly affected mussel populations in the Big River. Sites with impacted mussel communities included over 158.7 km (98.6 mi) of the river, including the reach from river mile 113 to 14.4 (Roberts *et al.* 2009). The scaleshell is known to occur at two sites in the lower 16.1 km (10 mi) (MDC Mussel Database 2009; Roberts *et al.* 2009). If contaminated sediments continue to migrate downstream, scaleshell populations in the lower Big River would be impacted, as well as populations in the Meramec River downstream from the confluence of the two rivers. The USFWS is currently monitoring mussel populations and sediment contamination in the lower 10 miles of the Big River.

**2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:** No new information has been obtained since the issuance of the listing rule regarding this factor (USFWS 2001). The scaleshell is not a commercially valuable species because of its small size and thin shell. However, over-harvesting activities that removed entire mussel beds likely impacted scaleshell populations. Today, intensive mussel collecting activity could have adverse affects on existing smaller populations because the species now occurs in isolated areas. The destruction of only a few individuals could be a contributing factor in the extirpation of some populations (USFWS 2001). As scaleshell mussels become more uncommon, the interest of scientific and shell collectors could increase. Scaleshell mussel occurrences are easily accessible and exposed during low flow periods and, therefore, are also vulnerable to take (i.e., collection) for fish bait, curiosity, or acts of vandalism. Up to five freshwater mussels per day, including scaleshell, may be legally collected in Missouri and used for fishing bait (Missouri Code of Regulations 2011). However, the low density of scaleshell mussels minimizes the likelihood of a scaleshell being collected (USFWS 2001).

**2.3.2.3 Disease predation:** No new information has been obtained since the issuance of the listing rule regarding this factor (USFWS 2001). While the large size or thick shells of some species afford protection from predators such as small mammals and fish, the small and fragile shell of the scaleshell makes it an easy and desirable prey species. Small mammals, such as muskrats and raccoons, are common predators throughout the range of this species, particularly during periods of low water. Likewise, disease and parasites have been reported to cause

major die-offs of freshwater mussels. Bacteria and protozoans persist at unnaturally high concentrations in streams with high sediment load or in water bodies affected by point source pollution, such as sewage treatment plants. Although natural predation and disease are not usually factors for stable, healthy mussel populations, they can pose a problem for scaleshell populations. Small populations are less resilient to these natural factors, and therefore, are much more threatened by them. Consequently, predation and disease could exacerbate ongoing population declines of scaleshell mussels (USFWS 2010).

**2.3.2.4 Inadequacy of existing regulatory mechanisms:** Despite the implementation of the Clean Water Act of 1972 (2010), degraded water quality still presents problems for sensitive aquatic organisms such as freshwater mussels. Point source discharges are typically regulated; however, non-point inputs such as silt, nitrogen, and other contaminants may not be sufficiently regulated, particularly those originating some distance from a waterway. Regulated point sources may also adversely affect the scaleshell. Freshwater mussels appear to exhibit more sensitivity to some pollutants than do the organisms typically used in toxicity testing such as fish and daphnids (water fleas). As a result, some of the water quality criteria established by the EPA to protect aquatic life may not be protective of mussels. Augspurger *et al*. (2003) found that the current EPA numeric criteria for ammonia may not be protective of mussels. Consequently, even those sewage treatment plants that comply with their ammonia effluent limits may still be discharging water that is toxic to unionids. Additionally, most states allow mixing zones, or zones in which numeric water quality criteria can be exceeded. Because mussels are sessile, they cannot move away from local water quality degradation. As discussed above in 2.3.2.1, the EPA is currently in the process of updating the 1999 national water quality criteria for ammonia, but this process may take years to complete. Few substances have been tested for their toxicity to mussels, and therefore, protective concentrations for the species are not yet known.

**2.3.2.5 Other natural or manmade factors affecting its continued existence:** Recent findings indicate that global climate change could pose a potential threat to the scaleshell mussel in the future. Current climate change predictions around the extent of the range of the species (i.e., Midwest) indicate warmer air temperatures, more intense precipitation events, and increased summer drying (United States Global Change Research Program [USGCRP] 2009). These changes are likely to have complex and unpredictable effects upon freshwater biota. However, some potential impacts, related to extreme low and high water events and overall temperature changes to mussel populations, are intuitive. Increased occurrence of both major flood events and drought in the Midwest would affect remaining populations of the scaleshell (Haag and Warren 2008; Hastie *et al.* 2001; Johnson *et al.* 2001). The scaleshell is particularly vulnerable to drought because the species frequently is found in shallow riffles (USFWS 2010). Additionally, the human response to drought would be increased water

withdrawal from streams for crop irrigation, further intensifying the effects of drought by decreasing water levels in streams.

Water temperatures would increase in Midwestern streams with the predicted increases in air temperatures (USGCRP 2009). More periods of drought would intensify this effect within streams, particularly in smaller streams. Because freshwater mussels are ectotherms (i.e., body temperature depends on the environment), their physiological processes and reproductive success are constrained and controlled by water temperature. Mussels appear to have varying temperature optima, which strongly influences filtration rates, excretion rates and other processes (Spooner and Vaughn 2008). Therefore, increased water temperatures would be expected to cause changes in the distribution and abundance of species, and local extirpations could occur. Species would be expected to respond differently to climate change, and therefore, it is uncertain whether or how changes in water temperature would affect the scaleshell.

Ficke *et al.* (2005) described the general potential effects of climate change on freshwater fish populations worldwide. Overall, the distribution of fish species is expected to change including range shifts and local extirpations. Because freshwater mussels are entirely dependent upon a fish host for successful reproduction and dispersal (Gordon and Layzer 1989; Parmalee and Bogan 1998; Watters 1995), any changes in local fish populations would also affect freshwater mussel populations. Therefore, mussel populations will reflect local extirpations or decreases in abundance of fish species. Species such as the scaleshell that have one or a small number of suitable fish host species would be more likely to be affected by changes in the fish community.

As the climate changes, species across the United States are expected to undergo large shifts in their range (USGCRP 2009). With increases in air temperature, the range of some species may gradually shift northward to stay within their optimal temperature. However, species like the scaleshell mussel, with limited and highly fragmented suitable habitat and populations, may have a more difficult time adjusting their ranges or may not be able to respond to changing conditions at all (USFWS 2010). Dispersal of mussel populations into more suitable regions of the country via fish hosts would be possible, provided fish host populations are thriving. Mussel populations are sometimes capable of traveling long distances while attached to their fish hosts. Freshwater drum, the host of the scaleshell, is a wide-ranging species (Priegel 1967), and therefore, may be more likely to facilitate the dispersal and colonization of the mussel into new, more favorable regions in a changing climate.

## 2.4 Synthesis

The scaleshell should continue to remain listed as an *endangered* species because it continues to decline, threats have not been ameliorated, and the criteria for downlisting to threatened have not been met. Since it was listed as an endangered species in 2001,

living or fresh-dead specimens have only been found in the Meramec, Bourbeuse, and Big rivers in Missouri, the Missouri River in South Dakota, and the Kiamichi River in Oklahoma. The Meramec, Bourbeuse, and Gasconade rivers continue to be a strong-hold for the species, but several mussel beds known to support the scaleshell in these rivers have been lost since 2001. This indicates that the scaleshell continues to decline. Habitat destruction and degradation continues to contribute to the decline of the scaleshell throughout its range. New research has shown that the scaleshell is highly sensitive to ammonia, a common pollutant throughout its range. Contaminated sediments from mineral mining operations threaten remaining populations in the lower Big River.
In sum, our current understanding of the scaleshell's status leads us to conclude that this species continues to be in danger of extinction throughout all or a significant portion its range, thereby meeting the definition of endangered under the Endangered Species Act.

## 3.0 RESULTS

### 3.1 Recommended Classification:

**____ Downlist to Threatened**
**____ Uplist to Endangered**
**____ Delist** (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ **No change is needed**

### 3.2 New Recovery Priority Number: 5

**Brief Rationale:** Threats to the scaleshell and its habitat are high and still present in streams throughout its range. The species has a low recovery potential because threats to populations occur widely throughout watersheds occupied historically. Because improvements need to take place throughout entire watersheds, a long period of time will be required before habitat improvements begin having beneficial effects on populations and associated habitat.

### 3.3 Listing and Reclassification Priority Number: NA

## 4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The scaleshell recovery plan, issued February 2010, outlines a recovery strategy with recovery actions needed to recover the species (USFWS 2010). The recovery actions, and their assigned priorities, are still appropriate in light of the new information reviewed in this 5-year review. Of the Priority-1 actions listed in the recovery plan, we recommend continuation or initiation of the following actions before the next 5-year review:

Action 1.1 Assemble a scaleshell recovery implementation team.

Action 2.1.2 Conduct searches for additional populations within historic range where the species may potentially occur.

Action 2.5 Augment and stabilize populations by artificial propagation.

Action 2.6 Conduct water quality studies.

2.6.1 Determine tolerance to various contaminants suspected to have adverse affects to the scaleshell (e.g., ammonia, chlorine, and heavy metals).

2.6.2 Conduct field studies to determine seasonal ambient exposure conditions of contaminants evaluated in Action 2.6.1.

Action 3.4 Research population biology.

3.4.1 Determine genetic differentiation among and within populations.

3.4.2 Research population dynamics of the scaleshell.

3.4.3 Determine the number of local and stream populations needed to maintain the species and the optimal geographic distribution for those populations.

Action 7.1.1 Conduct surveys to determine persistence and viability of local populations (i.e., monitor extant populations).

## 5.0 REFERENCES


Augspurger, T., A.E. Keller, M.C. Black, W.G. Cope, and F.J. Dwyer. 2003. Water quality guidance for protection of freshwater mussels (unionidae) from ammonia exposure. Environmental Toxicology and Chemistry 22(11):2569-2575.

Clarke, A.H. 1987. Status survey of *Lampsilis streckeri* Frierson (1927) and *Arcidens wheeleri* (Ortmann & Walker 1912). Ecosearch, Inc., final report to the U.S. Fish and Wildlife Service, Jackson, Mississippi. Contract No. 14-16-0004-86-057. ii + 24 pp. + 66 pp. appendix.

Clean Water Act of 1972. 2010. 33 U.S.C. § 1251 et seq. Retrieved from http://epw.senate.gov/water.pdf

Ficke, A. A., C. A. Myrick, and L. J. Hansen. 2005. Potential impacts of global climate change on freshwater fishes. World Wide Fund for Nature, Gland, Switzerland.

Galbraith H.S., D.E. Spooner, and C.C. Vaughn. 2005. *Arkansia wheeleri* monitoring in the Kiamichi River: Final report to Oklahoma Department of Wildlife Conservation.

Galbraith, H.S., D.E. Spooner, and C.C. Vaughn. 2008. Status of rare and endangered freshwater mussels in southeastern Oklahoma. The Southwestern Naturalist 53(1):45-50.

Galbraith, H.S., D.E. Spooner, and C.C. Vaughn. 2010. Synergistic effects of regional climate patterns and local water management on freshwater mussel communities. Biological Conservation 143(5):1175-1183.

Gordon, M.E. and J.B. Layzer. 1989. Mussels (Bivalvia: Unionoidea) of the Cumberland River: review of life histories and ecological relationships. U.S. Fish Wildlife Service Biological Report 89(15). 99 pp.

Goudreau, S.E., R.J. Neves, and R.J. Sheehan. 1993. Effects of sewage treatment plant effluents on mollusks and fish of the Clinch River, Virginia, USA. Hydrobiologia 252(3):211-230.

Haag, W.R. and M.L. Warren, Jr. 2008. Effects of severe drought on freshwater mussel assemblages. Transactions of the American Fisheries Society 137:1165-1178.

Hastie L.C., P.J. Boon, M.R. Young, and S. Way. 2001. The effects of a major flood on an endangered freshwater mussel population. Biological Conservation 98:107–115.

Isely, F.B. 1925. he fresh-water mussel fauna of eastern Oklahoma. Proceedings of the Oklahoma Academy of Science (1924) 4:43-118 + 2 tables.

Johnson, P.M., A.E. Liner, S.W. Golladay, and W.K. Michener. 2001. Effects of drought on freshwater mussels and instream habitat in Coastal Plain tributaries of the Flint River, southwest Georgia (July-October, 2000). Report presented to the Nature Conservancy. 30 pp.

Mather, C.M. 2005. The freshwater mussels of Oklahoma. Final report, Project T-14. Oklahoma City (Oklahoma): Oklahoma Department of Wildlife Conservation. 267 pp.

Mehlhop, P. and E.K. Miller. 1989. Status and distribution of *Arkansia wheeleri* Ortmann and Walker, 1912 (syn. *Arcidens wheeleri*) in the Kiamichi River, Oklahoma. Oklahoma Natural Heritage Inventory, report to the U.S. Fish and Wildlife Service, Tulsa, Oklahoma. Order No. 21440-88-00142. iv + 19 pp. + 84 pp. appendices.

Missouri Code of State Regulations. 2011. Title 3-Department of Conservation; Division 10-Conservation Commission; Chapter 6-Wildlife Code: Sport Fishing: Seasons, Methods, Limits; 3 CSR 10-6.610 Mussels and Clams. http://www.sos.mo.gov/adrules/csr/current/3csr/3c10-6.pdf

Missouri Department of Conservation Mussel Database (MDC Mussel Database). 2009. Database of freshwater mussel collections, sites, and habitat observations in Missouri. Missouri Department of Conservation, Columbia, Missouri.

Parmalee P.W. and A.E. Bogan. 1998. The freshwater mussels of Tennessee. 1st edition. University of Tennessee Press/Knoxville. 328 pp.

Priegel, G.R. 1967. The freshwater drum: Its life history, ecology, and management. Wisconsin Department of Natural Resources Publication 236, Madison, Wisconsin. 15 pp.

Roberts. A.D., D. Mosby, J. Weber, J. Besser, J. Hundley, S. McMurray, and S. Faiman. 2009. An assessment of freshwater mussel (Bivalvia: Margaritiferidae and Unionidae) populations in heavy metal sediment contamination in the Big River, Missouri. Final Report for the U.S. Fish and Wildlife Service, Natural Resource Damage Assessment. 110 pp.

Spooner, D.E. and C.C. Vaughn. 2000. Impact of drought conditions on a mussel bed in the Kiamichi River, southeastern Oklahoma. Ellipsaria 2(3):10-11.

Spooner, D.E. and C.C. Vaughn. 2008. A trait-based approach to species' roles in stream ecosystems: climate change, community structure, and material cycling. Oecologia 158:307-317.

U.S. Environmental Protection Agency (EPA). 2009. Draft 2009 update aquatic life ambient water quality criteria for ammonia – freshwater. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Washington, D.C. EPA-822-D-09-001.

U.S. Fish and Wildlife Service (USFWS). 2001. Endangered and threatened wildlife and plants; final rule to list the scaleshell mussel as endangered. *Federal Register* 66(195) 51322-51339, October 9, 2001.

U.S. Fish and Wildlife Service (USFWS). 2006. 5-Year Review Guidance: Procedures for Conducting 5-Year Reviews under the Endangered Species Act. U.S. Fish and Wildlife Service and National Marine Fisheries Service.

U.S. Fish and Wildlife Service (USFWS). 2010. Scaleshell mussel recovery plan (*Leptodea leptodon*). U.S. Fish and Wildlife Service, Fort Snelling, Minnesota. 127 pp.

United States Global Change Research Program (USGCRP). 2009. Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press.

Valentine, B.D. and D.H. Stansbery. 1971. An introduction to the naiads of the Lake Texoma region, Oklahoma, with notes on the Red River fauna (Mollusca: Unionidae). Sterkiana No. 42:1-40.

Wang, N., C.G. Ingersoll, I.E. Greer, D.K. Hardesty, C.D. Ivey, J.L. Kunz, W.G. Brumbaugh, F.J. Dwyer, A.D. Roberts, T. Augspurger, C.M. Kane, R.J. Neves, and M.C. Barnhart. 2007*a*. Chronic toxicity of copper and ammonia to juvenile freshwater mussels (unionidae). Environmental Toxicology and Chemistry 26(10): 2048-2056.

Wang, N., C.G. Ingersoll, D.K. Hardesty, C.D. Ivey, J.L. Kunz, T.W. May, F.J. Dwyer, A.D. Roberts, T. Augspurger, C.M Kane, R.J. Neves, and M.C. Barnhart. 2007*b*. Acute toxicity of copper, ammonia, and chlorine to glochidia and juveniles of freshwater mussels (unionidae). Environmental Toxicology and Chemistry 26(10): 2036-2047.

Watters, G.T. 1995. A guide to the freshwater mussels of Ohio, third ed. Published by the Ohio Division of Wildlife, Columbus, Ohio. 122 pp.

**Table 1**. Known sites of the scaleshell mussel (*Leptodea leptodon*) (based on living or fresh-dead shells) where local mussel communities have been lost or have declined significantly. Numbers represent local populations of scaleshell in each river (referred to as "sites") (Clarke 1987; Galbraith *et al.* 2005; Galbraith *et al.* 2008; Galbraith *et al.* 2010; Isely 1925; Mather 2005; Mehlhop and Miller 1989; MDC Mussel Database 2009; Spooner and Vaughn 2000; Valentine and Stansbery 1971).

| River | *Number of sites known at the time of listing (2001) | Number of new sites discovered since 2001 | Number of known sites resurveyed since 2001 | **Number of resurveyed sites where the complete loss or significant decline of the mussel bed has been observed |
|---|---|---|---|---|
| Meramec | 23 | 3 | 5 | 4 |
| Bourbeuse | 22 | 16 | 5 | 3 |
| Big | 1 | 1 | 1 | 0 |
| Gasconade | 28 | 5 | 5 | 2 |
| Osage | 1 | 0 | 1 | 0 |
| Missouri | 2 | 0 | 0 | 0 |
| Kiamichi | 2 | 3 | 5 | 4 |
| Total | 78 | 28 | 21 | 13 (62 %) |

*Number includes sites where living or fresh-dead specimens have been collected since 1985.

**Scaleshell sites are typically areas where other freshwater mussel species are concentrated (i.e., "mussel bed"). The presence of a mussel bed is a reflection of the quality and health of the habitat. Sites where a loss or significant decline of mussels has occurred, indicates that the habitat is no longer suitable for mussels.

## U.S. FISH AND WILDLIFE SERVICE 5-YEAR REVIEW of *Leptodea leptodon*

**Current Classification**: Endangered

**Recommendation resulting from the 5-Year Review:**

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

**Appropriate Recovery Priority Number**: 5

**Appropriate Listing/Reclassification Priority Number, if applicable**: Not applicable.

**Review Conducted By**: Andy Roberts

**FIELD OFFICE APPROVAL**:
Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 11/2/2010

**REGIONAL OFFICE APPROVAL**:
**Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Midwest Region**

Approve Lynn M Lewis Date 12/3/10

**Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Southwest Region**

Signature _____ Date 12/9/10

**Cooperating Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Southeast Region**

Acting Signature Franklin J Arnold III Date 12/9/2010

**Cooperating Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Mountain-Prairie Region**

Signature Noreen E. Walsh Date 12/10/10