Arkansas Fatmucket
(Lampsilis powellii I. Lea, 1852*)*

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
Arkansas Ecological Services Field Office
Conway, Arkansas

5-YEAR REVIEW
Arkansas Fatmucket (*Lampsilis powellii* I. Lea, 1852)

I. GENERAL INFORMATION

A. Methodology used to complete review

Public notice of the initiation of this 5-year review was given in the *Federal Register* on September 8, 2006 (71 FR 53127-53129) and a 60 day comment period was opened. During the comment period, we did not receive any additional information about Arkansas fatmucket (*Lampsilis powelllii*) other than specific information from biologists familiar with the species. This review was completed by the U. S. Fish and Wildlife Service's Arkansas Field Office. Arkansas fatmucket only occurs in the state of Arkansas. Literature and documents on file at the Arkansas Field Office were used for this review. All recommendations resulting from this review are a result of thoroughly reviewing the best available information on the Arkansas fatmucket and the reviewer's expertise as one of the leading authorities on this species. Comments and suggestions regarding the review were received from Arkansas Field Office supervisors and peer reviews from outside the Service (see Appendix A). No part of the review was contracted to an outside party.

B. Reviewers

Lead Region – Southeast Region: Nikki Lamp, (404) 679-7118

Lead Field Office – Conway, Arkansas: Chris Davidson, (501) 513-4481

C. Background

1. **Federal Register Notice initiating this review:** September 8, 2006. Endangered and Threatened Wildlife and Plants; 5-Year Review of 14 Southeastern Species. (71 FR 53127)

2. **Species Status:** Declining

3. **Recovery Achieved:** 2 = 26-50% recovery objectives achieved

4. **Listing History**
   Original Listing
   FR notice: 55 FR 12797
   Date listed: April 5, 1990
   Entity listed: Species
   Classification: Threatened

5. **Review History**
   Recovery Plan: 1992
   Recovery Data Call: annually from 2000-2013

Five-year review: November 6, 1991 (56 FR 56882)
In this review, multiple species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors or threats as they pertained to each species' recovery. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time, including no changes to the status of this mussel.

Documents containing more comprehensive summaries of the species' status are listed here to illustrate the nature of available information. For brevity and to minimize redundancy, relevant findings or observations from these and other documents are incorporated as appropriate in Section C.1. ("Updated Information and Current Species Status").

Agency Status Reviews

Harris, J.L. and M.E. Gordon. 1988. Status survey of *Lampsilis powelli* (Lea, 1852). Prepared for U. S. Fish and Wildlife Service, Jackson, MS. 43 pp. + appendices.

The U. S. Fish and Wildlife Service – Arkansas Field Office and Arkansas Game and Fish Commission (AGFC) conducted a range-wide status assessment of the Arkansas Fatmucket in 2006 and 2007. Data from this survey is available in the AGFC Mussel Database and Service files. Data collected during the status assessment is presented in this review.

Other Relevant Reviews and Documents

Gordon, M.E. and J.L. Harris. 1985. Distribution of *Lampsilis powelli* (Lea) (Bivalvia: Unionacea). The Nautilus 99(4):142-144.

Harris, J.L. and M.E. Gordon. 1987. Distribution and status of rare and endangered mussels (Mollusca: Margaritiferidae, Unionidae) in Arkansas. Journal of the Arkansas Academy of Science 41:49-55.

Harris, J.L., P.J. Rust, A.C. Christian, W.R. Posey II, C.L. Davidson, and G.L. Harp. 1997. Revised status of rare and endangered Unionacea (Mollusca: Margaritiferidae, Unionidae) in Arkansas. Journal of the Arkansas Academy of Science 51:66-89.

Harris, J.L., W.R. Hoeh, A.D. Christian, J. Walker, J.L. Farris, R.L. Johnson, and M.E. Gordon. 2004. Species limits and phylogeography of Lampsilinae (Bivalvia: Unionida) in Arkansas with emphasis on species of *Lampsilis*. Prepared for Arkansas Game and Fish Commission and U. S. Fish and Wildlife Service. 61 pp. + appendix.

Scott, M. 2004. Life history and population biology of the Arkansas fatmucket, *Lampsilis powellii* (Lea, 1852). M. S. thesis. Arkansas State University. 97 pp. + appendix.

Christian, A.D., J.L. Farris, J.L. Harris, and M. Scott. 2006. Life history and population biology of the federally threatened Arkansas fatmucket [*Lampsilis powellii* (I. Lea 1852)] and the state special concern Ouachita creekshell [*Villosa arkansasensis* (I. Lea 1862)]. Final Report submitted to U.S. Forest Service, Ouachita National Forest, Hot Springs, AR. 83 pp.

6. **Species' Recovery Priority Number at start of review (48 FR 43098)**: 8 (a species with moderate degree of threat and high recovery potential).

7. **Recovery Plan**
   Name of plan: Arkansas Fatmucket Mussel (*Lampsilis powelli*) Recovery Plan
   Date issued: February 10, 1992

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy: Not applicable. The Arkansas fatmucket is an invertebrate, and therefore, not covered by the DPS policy.

B. Recovery Plan and Criteria

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

2. **Adequacy of recovery criteria**.

   a. Does the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No.

   b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes

3. **List the recovery criteria and discuss how each has or has not been achieved.**

   The 1992 Recovery Plan (USFWS 1992) for Arkansas fatmucket includes three recovery criteria. Each recovery criterion and the extent to which each has or has not been met is discussed below.

(1) *There are viable populations in the Ouachita River, South Fork Ouachita River, Alum, Middle, and North Forks Saline River, and main stem Saline River*.

Scott (2004) and Christian et al. (2006) surveyed 30 Arkansas fatmucket sites from Harris and Gordon (1988) and three additional sites not previously explored. Arkansas fatmucket numbers were significantly reduced across 29 sites compared to the numbers collected by Harris and Gordon (1988). These surveys provide the first statistical documentation of a range-wide decline of Arkansas fatmucket since federal listing in 1990. However, no specific information assessing population viability exists. Therefore, this criterion has not been achieved at this time.

(2) *The habitat for these populations is fully protected*. A range-wide Safe Harbor Agreement (SHA) is currently (2013) under review by the Service. Pending final permit approval, implementation is expected to begin in 2014. This criterion has not been met. The recovery plan defines "fully protected" as the implementation of protective measures, such as land management standards and guidelines for mussel habitat management, to ensure populations of this species remain at or greater than the levels required for a viable population. Protection will extend into the watershed, including public and private lands, to the point where activities in the watershed no longer negatively affect the stream. We will not meet the criterion when the SHA is approved. If the SHA is successfully implemented over its duration and the landowner enrollment goals are achieved, we would likely meet the criterion assuming there are no significant threats to habitat from unenrolled properties.

(3) Viable population levels are maintained for a period of at least 20 years. This criterion has not been met (see criterion 1).

The recovery plan defines a viable population as a population with the reproductive capability to sustain itself without immigration of individuals from another population.

These recovery criteria are inadequate in that they are subjective and only somewhat measurable. This review includes a recommendation to revise these criteria to be more measurable. Each of these three recovery criteria implicitly addresses one or more of the threats identified in the final listing rule. The final listing rule determined the following four listing factors to be significant for this species: the present or threatened destruction, modification or curtailment of habitat (factor A); overutilization for commercial, recreational, scientific, or educational purposes (factor B); the inadequacy of existing regulatory mechanisms (factor D); and other natural or manmade factors affecting the species' continued existence (factor E). With respect to listing factor A, the following specific threats were identified: impoundments, channel alteration, gravel dredging, sedimentation, and water quality

degradation. With respect to listing factor B, overcollection was identified as a threat to the species. With respect to factor D, lack of regulatory protections afforded to this species was identified as a threat. With respect to Factor E, population isolation and lack of genetic diversity due to limited geographic distribution were listed as threats. There is no evidence to support that factor B poses a current threat to this species. The remaining three factors still pose a threat to the species. The final listing rule determined that listing factor C (disease or predation) was not applicable to the species.

Recovery Tasks

Task 1.1 Use legislation to protect habitat

The Arkansas Department of Environmental Quality (ADEQ) has designated the four forks of the Saline River, Caddo River, South Fork Ouachita River, and mainstem Ouachita River upstream of Lake Ouachita as ecologically sensitive waterbodies (APCEC 2007). These same rivers, with the exception of the Ouachita River and South Fork Ouachita River, also are designated as extraordinary resource water bodies (APCEC 2007). These designations under ADEQ's Regulation 2 provide for more stringent water quality criteria, restrict certain activities that may degrade water quality or habitat (*e.g.,* instream gravel mining), and provide higher priority for receiving technical and financial assistance for voluntary watershed and water quality protection projects. Regulation 2 is established pursuant to the Arkansas Water and Air Pollution Control Act and the Clean Water Act. However, more stringent water quality criteria (particularly related to ammonia) are still needed to protect mussels.

Task 1.2 Develop and implement a plan to protect habitat

This task will be accomplished through the completion of Tasks 3.1 and 3.3 (see below).

Tasks 2.1-2.3 are complete as detailed below.

Task 2.1 Characterize habitat

Preferred habitat types for adult Arkansas fatmucket have been described by Harris and Gordon (1988), Harris (1994), Scott (2004), and Christian et al. (2006). Harris and Gordon (1988) reported four microhabitat types that include: 1) long pools with cobble and rock as primary substrate types, 2) backwater areas downstream of peninsulas or islands covered with water willow (*Justicia americana*) and with cobble and sand as the dominant substrate, 3) slow moving pools upstream from water willow islands with sand, gravel, and cobble substrate, and 4) overflow, secondary channel pools, and tributary confluence areas with sand, cobble, and some rock substrate. Since Arkansas fatmucket habitat is fragmented and sporadic, it is extremely difficult, if not impossible, to quantify the total amount of microhabitat available versus inhabited (historical and current) by Arkansas fatmucket. Harris (1994) states that microscale substrate preference

is not easily discernable for Arkansas fatmucket. This also makes determination of reliable population estimates difficult.

Task 2.2 Determine associate species

Many surveys have documented associate mussel species, composition, and population dynamics in the upper Ouachita River basin (Harris and Gordon 1988, Brown and Brown 1989, Harris 1989, 1991, 1994, 1999, Burns and McDonnel 1992a, 1992b, Harris et al. 1992, Johnston et al. 1993, Davidson and Clem 2002, 2004, Davidson and Gosse 2003, Scott 2004, Christian et al. 2006).

Task 2.3 Develop life history data

Scott (2004) and Christian et al. (2006) determined reproductive patterns, including fish host identification and refined artificial propagation techniques, for Arkansas fatmucket. Black basses (*Micropterus punctulatus, M. salmoides* and *M. dolomieu*) were the optimal fish hosts, while other sunfish (Centrarchidae) appear to be marginal hosts with a low percent (less than one percent) of successfully transforming juveniles (Scott 2004, Christian et al. 2006).

An age and growth analysis has not been conducted on the Arkansas fatmucket. However, size frequency distribution of populations can provide a good indicator of population status as it relates to age distribution. Several surveys have provided size frequency data for Arkansas fatmucket (Harris and Gordon 1988, Harris 1989, 1991, 1994, 1999; Burns and McDonnel 1992a, 1992b; Harris et al. 1992; Scott 2004; Christian et al. 2006). Scott (2004) and Christian et al. (2006) most recently reported measured lengths ranging from 26.9 mm to 125.5 mm compared to 58.7 mm to 122.5 mm by Harris and Gordon (1988). Mean size measurements for all collected Arkansas fatmucket specimens (n = 137) as 86.9 ± 14.9 mm in length, 34.3 ± 6.7 mm in width, and 49.8 ± 8.1 mm in depth were also reported (Harris and Gordon 1988). A 2006/2007 survey conducted by the U.S. Fish and Wildlife Service and AGFC reported similar results (length = 89.3 ± 8.8 mm, width = 33.7 ± 4.1 mm, height = 50.8 ± 5.3 mm; n = 55). Sex ratio at survey sites was skewed approximately 2:1 toward males (Scott 2004 and Christian et al. 2006).

Harris et al. (2004) investigated the limits and phylogeography of Lampsilinae in Arkansas with emphasis on species of *Lampsilis*. The *Lampsilis siliquoidea/powellii* group (Group B) was well supported as a monophyletic group. However, specimens identified as Arkansas fatmucket did not form a monophyletic group, and the sequence divergence between *L. powellii* and *L. siliquoidea* was relatively slight. This interpretation of mtDNA evidence did not support species-level distinction for Arkansas fatmucket.

As part of a phase two study conducted in 2007 using additional mtDNA and nuclear DNA sequences, the genetic data from *Lampsilis powellii* and *L. siliquoidea* showed relatively low genetic divergence. However, some of the *L. powellii* mtDNA haplotypes were not found in any of the *L. siliquoidea*. These

observations are consistent with the hypothesis that *L. powellii* is a valid species that is currently experiencing mtDNA introgression due to limited interspecific hybridization with *L. siliquoidea* (Hoeh and Breton 2012).

Task 3.1 Develop plan to restore historic habitat

A recent conservation action plan for the upper Saline River basin, identified strategies necessary to conserve existing biodiversity, established clear monitoring needs for the watershed, and identified resources available to complete these tasks (DeClerk et al. 2006). The Nature Conservancy (TNC) received a State Wildlife Grant from the AGFC in August 2007 to begin development of a programmatic Safe Harbor Agreement for the upper Ouachita River basin (includes entire species range) to protect, enhance, and restore current and historic Arkansas fatmucket habitat. A final plan (agreement) is expected to be submitted to the U. S. Fish and Wildlife Service in 2014.

Task 3.2 Develop plan for reestablishing mussel populations

This task has not been accomplished. However Scott (2004) and Christian et al. (2006) have determined reproductive patterns, including fish host identification, and refined artificial propagation techniques for the Arkansas fatmucket.

Task 3.3 Implement plan to restore historic habitat

Conservation strategies outlined in DeClerk et al. (2006) are being implemented by several natural resource agencies and organizations in the upper Saline River watershed. Implementation of the programmatic Safe Harbor Agreement for the Arkansas fatmucket is predicted to begin approximately 18 months following submission to the U.S. Fish and Wildlife Service.

Task 3.4 Implement plan to reestablish population in historic habitat

This task has not been initiated.

Task 4.1 Determine minimum population levels

This task has not been initiated.

Task 4.2 Develop plan to monitor populations

The Service and AGFC assessed the range-wide status of Arkansas fatmucket populations in 2007.

Biological monitoring will be a required component of the programmatic Safe Harbor Agreement. Therefore, TNC is currently working to develop a unified monitoring plan, which will be a critical component to executing the Safe Harbor Agreement, and is expected to be complete in 2015.

Task 4.3 Implement monitoring plan

A monitoring plan should be developed and implemented by early 2015 as part of the programmatic Safe Harbor Agreement currently being prepared by TNC. Refer to Task 4.2.

C. Updated Information and Current Species Status

1. Biology and Habitat

a. Spatial distribution, abundance and population trends

The Arkansas fatmucket is endemic to the Ouachita Mountains region of Arkansas. Prior to the status assessment conducted by Harris and Gordon (1988), the known range of Arkansas fatmucket was restricted to 10 localities in the Ouachita River basin; one in the upper Ouachita River, two in the South Fork Ouachita River, two in the Caddo River, and five in the Saline River and forks (Gordon and Harris 1985). The historic range of this species likely included the Caddo River from Norman, Arkansas, to the confluence with the Ouachita River (approximately 64 river miles [rm]); South Fork Caddo River (approximately 4 rm); Ouachita River from the confluence of the Caddo River upstream to near Mena, Arkansas (approximately 160 rm); South Fork Ouachita River (approximately 29 rm); Alum Fork Saline River (approximately 53 rm); Middle Fork Saline River (approximately 30 rm); North Fork Saline River (approximately 22 rm); South Fork Saline River (approximately 15 rm); Saline River from its formation to U.S. Highway 270 (approximately 44 rm); and Hurricane Creek upstream of U.S. Highway 167 (approximately 18 rm).

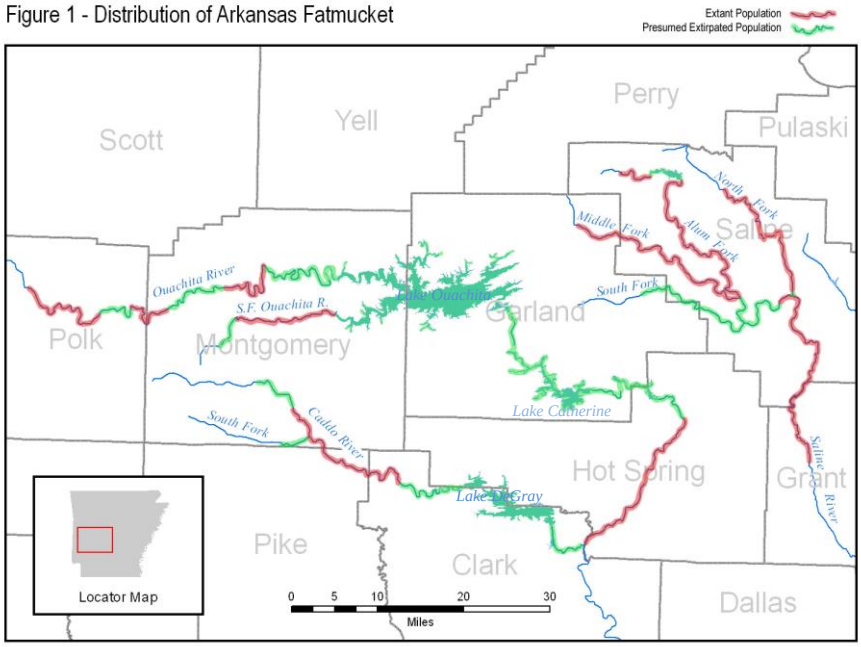
The current known range is restricted to the Caddo River from the confluence of Collier Creek (between Norman and Caddo Gap, Arkansas) to Arkansas Highway 84 (near Amity, Arkansas; 24.3 rm); Ouachita River from near the confluence of Chances Creek to the confluence of Polk Creek (16.2 rm); Ouachita River from near the confluence of Snake Creek to Hole In The Ground Creek (7.8 rm); Ouachita River from Arkansas Highway 379 to U. S. Highway 270 (12.5 rm); Ouachita River from Interstate 30 to Arkansas Highway 222 (15 rm); South Fork Ouachita River from Montgomery County Road 17 to the inundation pool of Lake Ouachita (14.3 rm); Middle Fork Saline River from Arkansas Highway 7 to its confluence with the Alum Fork Saline River (30.2 rm); Alum Fork Saline River from Love Creek to the inundation pool of Lake Winona (5.6 rm); Alum Fork Saline River from Lake Winona Dam downstream to the Middle Fork Saline River confluence (28.0 rm); Alum Fork Saline River from the North Fork Saline River confluence upstream approximately 6.0 rm; North Fork Saline River from Arkansas Highway 9 to Arkansas Highway 5 (21.7 rm); Saline River from its formation downstream to U.S. Highway 270 (43.6 rm). Extant Arkansas fatmucket populations have been presumably extirpated from approximately 87 rm range-wide since listing, representing a 28 percent reduction in occupied stream reaches (Figure 1).

Scott (2004) and Christian et al. (2006) surveyed 30 Arkansas fatmucket sites from Harris and Gordon (1988) and three additional sites not previously explored. A total of 137 Arkansas fatmucket specimens were collected from 19 of 33 surveyed sites. Arkansas fatmucket numbers were significantly reduced across 29 sites compared to the numbers collected by Harris and Gordon (1988). These surveys provide the first statistical documentation of a range wide decline of Arkansas fatmucket since federal listing in 1990.

Scott (2004) and Christian et al. (2006) focused their survey effort on previously documented Arkansas fatmucket sites from Harris and Gordon (1988). In 2006 and 2007, the U.S. Fish and Wildlife Service, AGFC, and U.S. Forest Service conducted a range wide status assessment focused on determining current distribution and abundance. Results from this survey yielded 15 new sites (South Fork Ouachita River [1], Caddo River [1], Ouachita River [1], Middle Fork Saline River [3], Alum Fork Saline River [9]) not previously documented within the Arkansas fatmucket range.

The Service collected two live mussels representing two species in their 2006 status survey in the South Fork Saline River. No Arkansas fatmucket specimens were collected in 2006. This represents a major decline since the Burns and McDonnell (1992a) survey when 94 mussels representing 15 species were collected from 10 sites in the South Fork Saline River, including 21 live Arkansas fatmucket specimens.

Figure 1 - Distribution of Arkansas Fatmucket



Harris (1989) found five live Arkansas fatmucket specimens at one site downstream of Lake DeGray in the Caddo River (Figure 2). In addition to the Arkansas fatmucket specimens, Harris (1989) found 53 live mussels representing 12 species were reported from two sites in this reach of the Caddo River. Harris and Doster (1992) collected 159+ live mussels representing 12 species from two sites downstream of Interstate 30, but no Arkansas fatmucket specimens were collected. A 2007 survey of the Caddo River from Lake DeGray dam to the Ouachita River failed to locate any live Arkansas fatmucket specimens and found only one live mussel (Figure 3). The catastrophic decline of mussels in this reach of the Caddo River is attributed to the construction and operation of Lake DeGray Dam and its subsequent effects on habitat quality downstream of the dam.

Burns and McDonnell (1992a, 1992b) reported live Arkansas fatmucket specimens from 15 of 24 sites surveyed in the North Fork Saline River during 1991 and 1992 (Figure 2). A comprehensive survey of the North Fork Saline River conducted in 2006 and 2007 found live Arkansas fatmucket specimens at only 1 of 15 historic sites and no new sites (Figure 2). The apparent, catastrophic decline of the North Fork Saline River population is unexplained, but likely a result of illegal gravel mining, increased urban development, and other land use activities.

While the Arkansas fatmucket populations remain extant in most of the historic stream reaches in the Middle Fork Saline River, South Fork Ouachita River, and Ouachita River, the number of localities and Arkansas fatmucket abundance at those localities has decreased since federal listing. In the South Fork Ouachita River, increased channel instability in the upper reaches is obvious and presumed to be the reason for the extirpation of mussels. This includes a long-term monitoring site (Site 1) described by Harris (1994). Land use activities have severely degraded habitat from Harris' (1994) Site 2 to U.S. Highway 270. No live Arkansas fatmucket were found in this reach during 2007 surveys. Brown and Brown (1989) reported the first declines in Arkansas fatmucket in the South Fork Ouachita River due to increased sedimentation from dam construction on a tributary. This finding was later confirmed by Harris (1991). Harris et al. (1992) relocated 44 Arkansas fatmucket at U.S. Highway 270, but the 2007 surveys reported only four live Arkansas fatmucket from the relocation site. Arkansas fatmucket remains extant at three disjunct localities in the South Fork Ouachita River, but abundance in 2007 was less than reported in the early 1990s.

Figure 2 - Live and fresh dead occurrences of Arkansas Fatmucket, 1981-1996

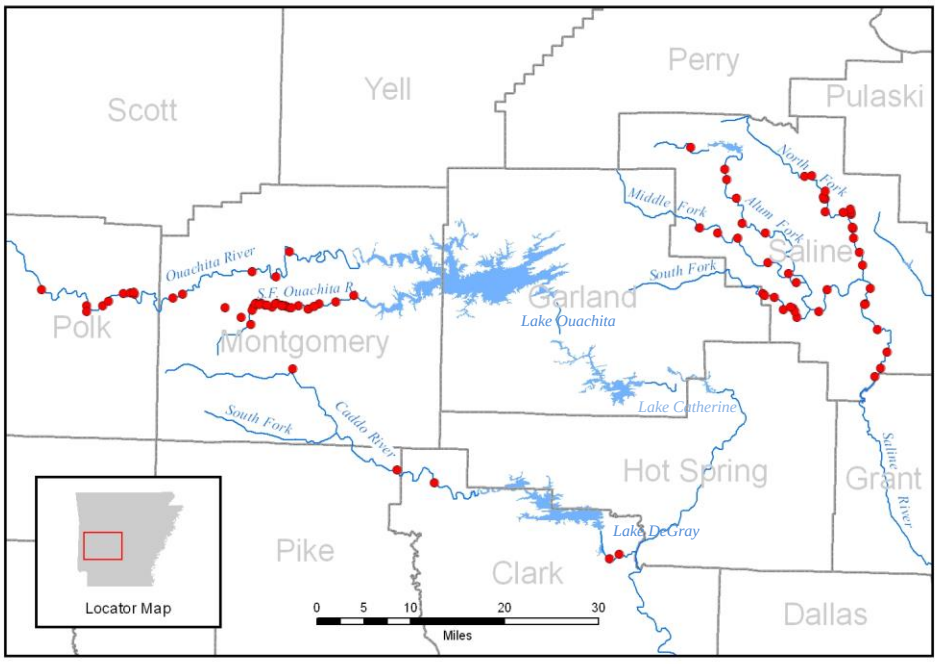
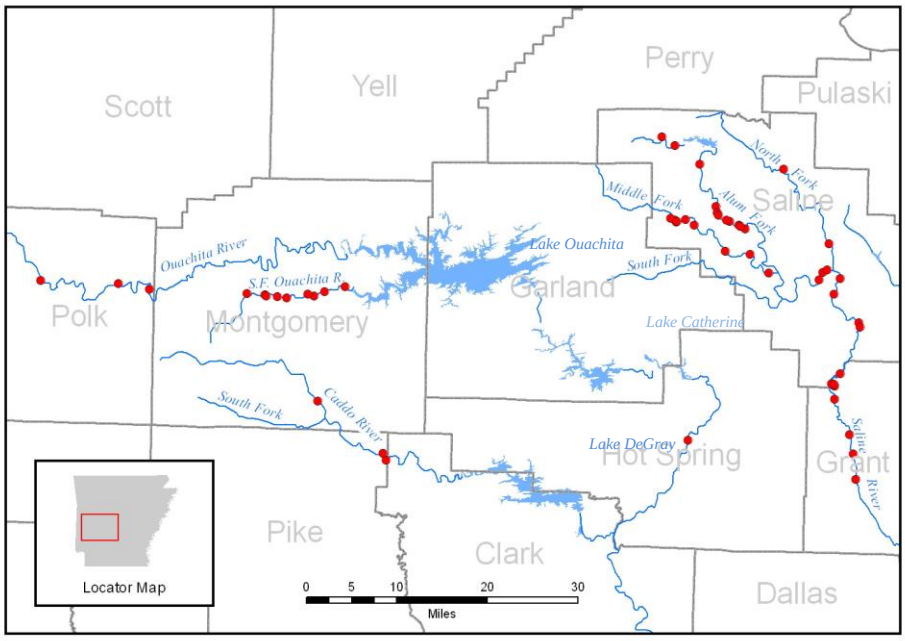


Figure 3 - Live occurrences of Arkansas Fatmucket since 1997



In the Ouachita River, Arkansas fatmucket populations were never believed to be large. The species, however, was widely distributed upstream of

Lake Ouachita at the time of federal listing. One live Arkansas fatmucket was collected during 2007 surveys. Two other sites upstream of Lake Ouachita are considered extant based on Scott (2004) and Christian et al. (2006). However, the three extant sites upstream of Lake Ouachita are represented collectively by six individuals. Only one live specimen was found downstream of Interstate 30 by Harris (1999), but this population, while considered extant (Figure 1), may be functionally extinct. Land use activities and widespread gravel mining activities are believed to be the primary sources of population declines in the Ouachita River.

The distribution and number of live occurrences of Arkansas fatmucket in the Middle Fork Saline River are similar when comparing to the time periods 1981 to 1996 and 1997 to 2006 (Figures 2 and 3). Harris and Gordon's (1988) Site MFSR03 supported one of the largest Arkansas fatmucket meta-populations, but by 2003 had been extirpated (Christian et al. 2006). Arkansas fatmucket abundance also declined at all sites in the Middle Fork Saline River during the same time period (Christian et al. 2006). Scott (2004), Christian et al. (2006), and the U.S. Fish and Wildlife Service 2006 (C. Davidson, pers. comm. 2007) survey of the Middle Fork discovered four previously undocumented Arkansas fatmucket sites, but abundance was low at all sites.

The largest and only stable extant Arkansas fatmucket populations occur in the Alum Fork Saline River and mainstem Saline River. With increased distance between occupied habitat, reduced abundance, and continuing or increasing threats to Arkansas fatmucket, populations outside the Alum Fork Saline River and Saline River may become extirpated in the next 10 – 20 years.

Appendix B provides a summary of literature on the Arkansas fatmucket.

b. Demographic characteristics

Scott (2004) and Christian et al. (2006) analyzed 137 Arkansas fatmucket specimens from the Saline and Ouachita river systems for sex, size, and gravidity status. Sex ratio was skewed towards males (50 females, 87 males), but it did not deviate significantly from the expected 1:1 ratio. No age structure data exists for this species. Mean size measurements for all Arkansas fatmucket specimens examined during Scott's research were 86.9 ± 14.9 mm in length, 34.3 ± 6.7 mm in width, and 49.8 ± 8.1 mm in depth. Males are significantly larger than females with a mean size 5.87 mm longer, 0.18 mm wider, and 1.35 mm deeper (Scott 2004, Christian et al. 2006). A 2006/2007 rangewide survey conducted by the U.S. Fish and Wildlife Service and AGFC reported similar results (length = 89.3 ± 8.8 mm, width = 33.7 ± 4.1 mm, height = 50.8 ± 5.3 mm; n = 55).

The reproductive cycle of the Arkansas fatmucket is similar to that of other native freshwater mussels. Males release sperm into the water column; the sperm are then taken in by the females through their siphons during feeding and respiration. The females retain the fertilized eggs in their gill marsupium until the larvae (glochidia) fully develop. The female releases her glochidia when a suitable fish host attacks the gill marsupium.

The Arkansas fatmucket is gravid from March through October (Scott 2004). Scott (2004) and Christian et al. (2006) tested 26 fish species and one amphibian, the Red River mudpuppy (*Necturus maculosus louisianensis*) for their potential as suitable host. Glochidia successfully transformed on sunfishes (Centrarchidae), with greatest success occurring with the spotted bass (*M. punctulatus*) and largemouth bass (*M. salmoides*; Table 1).

Table 1. Suitable fish host from Scott's (2004) fish host suitability trials for the Arkansas fatmucket (*Lampsilis powellii*).

Scientific Name	Common Name
Ambloplites ariommus	Shadow Bass
Lepomis cyanellus	Green Sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear Sunfish
Micropterus dolomieu	Smallmouth Bass
Micropterus punctulatus	Spotted Bass
Micropterus salmoides	Largemouth Bass

c. Habitat

Harris and Gordon (1988) identified four microhabitats for the Arkansas fatmucket: (1) pool segments between riffles with the substrate comprised primarily of cobble with sand and gravel interspersed and sufficient current to keep fine silt particles swept clean; (2) backwater areas downstream of islands or peninsulas covered with American water willow (*Justicia americana*); (3) pools upstream of water willow islands with depositional substrates consisting of sand, gravel, and cobble; and (4) overflow and secondary channels with permanent and backwater ponds located at the confluence of minor tributaries. No additional occupied habitat types have been identified since Harris and Gordon (1988).

2. Five-Factor Analysis (threats)

a. Present or threatened destruction, modification or curtailment of its habitat or range:

In the upper Saline River watershed, several new threats have been identified since listing in the upper Saline River watershed (DeClerk et al. 2006).

- A landscape level analysis of major land use changes within the watershed between 1986 and 2004 quantified changes in the watershed and determined anthropogenic impacts. Results indicate that:

    - The largest change (47 percent increase) in landscape classification was the increasing urbanization of the watershed characterized by the expansion of Benton and Hot Springs Village into rural areas. DeClerk et al (2006) ranked housing and urban development as the number one threat to the upper Saline River watershed.

    - There was an increase in golf course coverage by 231 percent within Hot Springs Village.

    - Pine-dominated forest increased by 24 percent with a corresponding decrease in the natural mixed woods forest matrix by 22 percent. This change is indicative of increasing timber production activities.

  Changing land uses may lead to altered hydrology and stream geomorphology characteristics and increased pollutant inputs (*e.g.*, sedimentation, nutrients, and other contaminant from storm water runoff).

- Unrestricted cattle access into streams, water withdrawal for agricultural and recreational purposes (*i.e.*, golf courses), lack of adequate riparian buffers, construction and maintenance of county roads, and non-point source pollution arising from a broad array of activities, particularly rapid urbanization around Benton and Hot Springs Village, continue to increase and degrade suitable habitat for Arkansas fatmucket in the upper Saline River watershed.

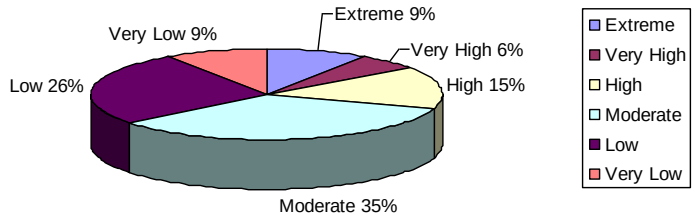
- Instream gravel mining in the South Fork Saline River is the primary source for the decline of Arkansas fatmucket and many other mussels. Instream gravel mining is also suspected as a cause of mussel declines in the Middle Fork Saline River.

- Eroding stream banks are depositing sediment in downstream reaches resulting in a reduction of habitat quantity and quality. Figure 4 provides an evaluation of bank erosion for approximately 40 miles of the Middle Fork Saline River.

- There are 19 impoundments located within the upper Saline River watershed. Nine new dams have been constructed in the Middle Fork Saline River watershed in conjunction with development of

Hot Springs Village (the largest gated community in the world). The expansion of water withdrawals, diversions, and impoundments is suspected to be one contributing factor to increases in elevated turbidity level during storm events, soil erosion/sediment instability and hydrologic alteration. Hydrologic alterations are a large contributing factor in geomorphic instability in the four forks of the Saline River. U.S. Geological Survey gaging stations on the Middle Fork Saline River exhibited an increasing trend in the annual number of zero-flow days (1986 – 2004), a trend consistent with increased consumptive water withdrawals within the tributary watersheds.

Figure 4
Range of Bank Erosion Hazard Index Values
Middle Fork Saline River



DeClerk et al. 2006

One new dam was constructed on Big Cedar Creek, a tributary to South Fork Ouachita River. The Big Cedar Creek reservoir resulted in the first documented catastrophic decline of Arkansas fatmucket in the South Fork Ouachita River circa 1989 due to increased sedimentation during construction.

- Instream gravel mining is also suspected of contributing to mussel declines in the Ouachita River and in headwater tributaties of the Caddo River, as well as the river proper. Gravel mining activities have resulted in numerous stream reaches with increased channel instability, increased sedimentation and altered instream habitat. The Service investigated a 2006 incident of illegal gravel mining in the Ouachita River at Cherry Hill. Over one hundred fresh dead mussels were collected in the spoils material. While this was a documented Arkansas fatmucket site, no fresh dead Arkansas fatmucket specimens were recovered during the investigation. The Service collected 19 individuals representing five species (no Arkansas fatmucket) at this site one year later (2007) compared to 73 individuals representing 11 species including one Arkansas fatmucket in 1988 (Harris and Gordon 1988).

- Urban development and farming practices that do not protect the vegetated stream corridors on private lands in and near Glenwood have led to unstable banks resulting in increased erosion and sedimentation in the Caddo River and its tributaries. The Service documented numerous "muddy" tributaries draining into the Caddo River following storm events during 2007 mussel surveys, while numerous others remained generally clear to slightly turbid.

  Harris (1994) described microhabitat and mussel community population estimates at Site 1 in South Fork Ouachita River. Arkansas fatmucket population estimates for this site in 1990 and 1993 were 31 ± 38 and 10 ± 19, respectively. No live mussels were encountered at this site in 2007, and increased deposition due to geomorphic alteration was believed to be the primary cause for the decline. Land use practices adjacent to the South Fork Ouachita River between Arkansas Highway 379 and U.S. Highway 270 have decreased forested riparian habitat subsequently leading to bank destabilization and increased sedimentation, nutrients and channel instability.

b. Overutilization for commercial, recreational, scientific, or educational purposes:
There is no evidence to suggest that overutilization is a threat.

c. Disease or predation:
Muskrats (*Ondatra zibethicus*) and several aquatic turtle species are known to prey on Arkansas fatmucket.

d. Inadequacy of existing regulatory mechanisms:
The adequacy of regulatory mechanisms has increased due to the Arkansas Department of Environmental Quality designation of streams inhabited by Arkansas fatmucket as extraordinary resource and ecologically sensitive waterbodies. These designations restrict certain instream gravel mining activities (ADEQ Regulation 15.403) and have more stringent water quality criteria. The protections afforded by ADEQ Regulation are essentially the same for both designations (extraordinary resource and ecologically sensitive waterbodies). There is a process for project proponents to apply for waivers (Short-term Activity Authorization) to exceed water quality criteria in these waterbodies. Projects like pipeline crossing usually receive waivers for 30 days. Despite regulations, illegal instream gravel mining occurs and is a threat to this species (as discussed above).

The Clean Water Act has been a vital piece of legislation in helping improve water quality in many locations (*e.g.*, regulating municipal and industrial discharges) and should continue to help alleviate and reduce

non-point source pollutants if fully utilized. However, lack of enforcement of these regulations by the U.S. Army Corps of Engineers, Environmental Protection Agency, and Arkansas Department of Environmental Quality continues to be a problem. In addition, more stringent water quality criteria (particularly for ammonia) are still needed to adequately protect mussels.

e. Other natural or manmade factors affecting its continued existence: The majority of the remaining Arkansas fatmucket populations are generally small and becoming more geographically isolated. The patchy distributional pattern of stream populations in short stream reaches makes them much more susceptible to extirpation due to the low potential for recolonization from other populations. Single catastrophic events, such as toxic chemical spills or other stochastic events, could cause the extirpation of any of these small, isolated Arkansas fatmucket occurrences. Increasing levels of isolation make natural repopulation of any extirpated population improbable without human intervention. Population isolation also prohibits the natural interchange of genetic material between populations.

The likelihood is high Arkansas fatmucket populations in the Ouachita and Caddo Rivers are below the effective population size (EPS– the number of individuals in a population who contribute offspring to the next generation), based on restricted distribution and populations only represented by a few individuals, and achieving the EPS is necessary for a population to adapt to environmental change and maintain long-term viability. Isolated populations eventually are extirpated when population size drops below the EPS or threshold level of sustainability (Soulé 1980). Evidence of recruitment in these populations is scant, making recruitment reduction or outright failure suspect. These populations may be experiencing the bottleneck effect of not attaining the EPS. Without genetic interchange, small, isolated populations could be slowly expiring, a phenomenon termed the extinction debt (Tilman *et al.* 1994). Even given the absence of existing or new anthropogenic threats, disjunct populations may be lost as a result of current below-threshold effective population size. Additionally, evidence indicates that general habitat degradation continues to decrease habitat patch size, further contributing to the decline of these mussel populations.

Various invasive aquatic species (*e.g.*, Asian clam (*Corbicula fluminea*)) are firmly established in the range of the Arkansas fatmucket. Increases in Asian clam populations have been noted by surveyors in recent years in degraded streams such as the Middle Fork Saline River. Arkansas Game and Fish Commission recently introduced a Tennessee strain smallmouth bass in the upper Ouachita River for recreational purposes. It is currently unknown whether Tennessee strain smallmouth bass are suitable host fish

for Arkansas fatmucket. The replacement or diffusion of native Ouachita River smallmouth bass genetics with the Tennessee strain may reduce host availability for Arkansas fatmucket. However, the implications of stocking Tennessee strain smallmouth bass in the Ouachita River are unknown at this time.

D. Synthesis

At the time of listing in 1990, Arkansas fatmucket was extant in the Ouachita River upstream of Lake Ouachita, South Fork Ouachita River upstream of Lake Ouachita, Alum Fork Saline River, Middle Fork Saline River, North Fork Saline River, Saline River upstream of the Fall Line, and Caddo River. No additional stream populations have been discovered since 1991. However, there have been range extensions within the Ouachita and Saline rivers. Harris (1999) found one live Arkansas fatmucket in the Ouachita River near Social Hill, Arkansas. Davidson and Clem (2002) found live Arkansas fatmucket in the Saline River near U.S. Highway 270, extending the known range in the Saline River by 26 rm (downstream).

While extant populations of Arkansas fatmucket occur throughout most of the historic range, significant population declines and reduced distribution have been documented since listing. Catastrophic population declines have resulted in the extirpation of Arkansas fatmucket from the South Fork Saline River. The Caddo River, Ouachita River, South Fork Ouachita River, Middle Fork Saline River, and North Fork Saline River have experienced and continue to experience population declines with extirpation of Arkansas fatmucket from several stream reaches. Increasingly small and isolated populations are becoming more susceptible to stochastic events and ongoing and/or increasing anthropogenic impacts.

Without continued and immediate efforts to restore historic habitat, conserve existing habitat, and subsequently augment and reintroduce populations in areas experiencing population decline or extirpation, this species will likely become extirpated across much of its range in the next 10 to 20 years. The Alum Fork Saline River and Saline River appear to be the only stream populations that are currently stable, but these populations are faced with encroaching urbanization from nearby cities.

A number of factors continue to affect extant populations and/or limit recovery of the species. Urbanization into rural areas of the upper Saline River and Caddo River watersheds continues to increase and is suspected to be a primary source of habitat and water quality degradation. The expansion of consumptive water withdrawals, diversions, and impoundments is suspected to be another contributing factor to increases in elevated turbidity level during storm events, soil erosion/sediment instability, and hydrologic alteration in the upper Saline River watershed. Development or urban sprawl, land use practices and instream gravel mining that are detrimental to the health and viability of streams have increased throughout the Arkansas fatmucket range and have contributed to population declines in all extant

populations except the Saline River. Extant populations vary in levels of protection, and effects of these threats on the species may be difficult to alleviate. Encouraging private landowners, corporations, and local, state, and federal governments to be more proactive in implementing conservation measures that benefit both terrestrial and aquatic habitats in these watersheds is critical.

Characteristics of population demographics (*e.g.,* suitable habitat, male to female sex ratio) are better understood now than at the time of listing. Primary and secondary suitable host fish have been identified and successful propagation techniques have been developed for the Arkansas fatmucket. These techniques will be extremely valuable in recovery efforts with increasing need to conduct population augmentations or reintroductions. However, information on the age structure of Arkansas fatmucket populations and status of host fish is lacking at this time. These are important population biology issues that need to be determined.

No new information has become available for this review that indicates that threats to the species have been sufficiently curtailed to show that the Arkansas fatmucket should be delisted. To the contrary, new information has become available since listing that indicates that threats to the species have and continue to increase, (*i.e.*, Arkansas fatmucket distribution is becoming increasingly disjunct in smaller numbers and there has been a significant range-wide decline in Arkansas fatmucket populations).

Given increases in threats and decreases in population range and size, we conclude that the Arkansas fatmucket is in danger of extinction throughout all or a significant portion of its range and therefore should be reclassified as endangered.

III. RESULTS

A. Recommended Classification:
The Arkansas fatmucket should be reclassified to endangered.

B. New Recovery Priority Number __5___

The degree of threat to the Arkansas fatmucket is high because there is a continual threat to its habitat (*e.g.,* land use practices that are detrimental to habitat and water quality, illegal activities such as gravel mining, and habitat fragmentation). The recovery potential is low because the species' biology is well understood as well as ecological factors affecting the biology. However,we still need more information to better determine age structure of Arkansas fatmucket populations.

C. Listing and Reclassification Priority Number:
Reclassification (from Threatened to Endangered) Priority Number: 2 [indicating a high degree of threat that is imminent]

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. The recovery plan should be revised to include downlisting and delisting criteria and better address the five factors.

2. Finalize and implement the range-wide, programmatic Safe Harbor Agreement for Arkansas fatmucket.

4. Determine age structure of extant Arkansas fatmucket populations.

5. Implement high priority strategic actions outlined by DeClerk (2006).

6. Determine status of suitable host fish (*e.g*., how their distribution matches the distribution of Arkansas fatmucket?).

7. Determine habitat requirements of suitable host fish, condition/status of habitat (*e.g.*, pristine, degraded), and restoration/protection needs.

8. Actively use the U.S.D.A. Natural Resources Conservation Service's Farm Bill program and the Service's Partners for Fish and Wildlife Program to foster a working partnership with landowners, municipalities, industry, NGOs, and state and federal agencies to address and minimize threats.

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U. S. Fish and Wildlife Service – Arkansas Field Office and Arkansas Game and Fish Commission conducted a range-wide status assessment of the Arkansas fatmucket in 2006 and 2007. No report has been prepared at this time. However, data collected during the status assessment is presented in this review. C. Davidson, pers. comm. 2007.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Arkansas Fatmucket (*Lampsilis powellii*)

Current Classification _Threatened___

Recommendation resulting from the 5-Year Review

____ **Downlist to Threatened**
_X_ **Uplist to Endangered**
____ **Delist**
____ **No change is needed**

Appropriate Listing/Reclassification Priority Number _2

Review Conducted By Chris Davidson, USFWS Arkansas Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 5/17/2013

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 12/12/13

Appendix A
Peer Review

A draft copy of this 5-year review was sent to the following knowledgeable individuals for their review and comment:

Bill Posey, Malacologist
Arkansas Game and Fish Commission

Betty Crump, Stream Ecologist
U. S. Forest Service

Dr. John Harris, Assistant Division Head, Environmental Division
Arkansas Highway and Transportation Department

Results of Peer Review

Bill Posey provided minor editorial changes.

Betty Crump provided minor editorial comments and changes.

John Harris provided minor editorial comments and changes. In addition to these comments, he provided four unpublished reports with Arkansas fatmucket data that had not been previously considered in the status review and photographs of *Lampsilis* specimens from the Little Missouri River and Mountain Fork Little River basins that resemble Arkansas fatmucket.

The Little Missouri River report was added to the summary of literature pertaining to Arkansas fatmucket but is not discussed elsewhere in the status review because no Arkansas fatmucket specimens were collected during the survey. However, Mike Mather's collection at the University of Oklahoma Department of Science and Arts contains several specimens that resemble Arkansas fatmucket from the Antoine River, a tributary to the Little Missouri River. Since it is unclear whether these specimens are *Lampsilis powellii*, *L. siliquoidea*, or an undescribed *Lampsilis* species and it would represent a substantial range expansion, a decision was made to exclude the information from further discussion until more conclusive information can be obtained regarding these specimens or others from the Little Missouri River basin.

The U.S. Forest Service's report on the Ozark-Ouachita Highlands – Aquatic Conditions also was added to the summary of literature, but it does not provide much direct mention of Arkansas fatmucket. It was distributional in nature and covered areas of the Ouachita Mountain region and drainages outside Arkansas.

Two Arkansas Highway and Transportation Department reports provided by John Harris include important information on the status of Arkansas fatmucket in the Caddo River. These are discussed further in the 5-year review.

Appendix B
A Summary of Literature Relevant to Arkansas Fatmucket

Prior to listing under the Endangered Species Act:

Johnson (1980) monograph includes distributional information based on published accounts and some museum material.

Gordon and Harris (1985) examined museum specimens, published accounts, and recent collections to better delineate the known distribution of Arkansas fatmucket.

Harris and Gordon (1987) considered Arkansas fatmucket a state threatened species restricted to upper portions of the Saline and Ouachita rivers and Caddo River.

Harris and Gordon (1988) represent the first comprehensive status survey of Arkansas fatmucket. They sampled 139 localities in the upper Ouachita River, Saline River, Caddo River and Little Missouri River basins. Arkansas fatmucket was present at 36 of 95 localities (151 live individuals) that yielded native mussels. The distribution and status included the Alum Fork Saline River (population estimate [PE] 5,000 – 10,000), Middle Fork Saline River (PE 5,000 – 10,000), North Fork Saline River (PE < 1,000), Saline River from confluence of four forks to Tull, AR (PE 1,000 – 5,000), South Fork Ouachita River (PE 5,000 – 10,000), Ouachita River upstream of Lake Ouachita (PE 1,000 – 5,000), and Caddo River (PE < 1,000 individuals). Four microhabitats were identified during this survey.

Brown and Brown (1989) focused on gathering more information on Arkansas fatmucket populations in the Ouachita National Forest, specifically the South Fork Ouachita River and Alum Fork Saline River drainage basins. Thirteen (13) live Arkansas fatmucket were collected from four sites in the South Fork Ouachita River and one site in the Alum Fork Saline River. Live Arkansas fatmucket specimens were restricted to the South Fork Ouachita River upstream of Big Cedar Creek. Data from this report provided the first evidence of catastrophic population declines throughout the South Fork Ouachita River. Heavy sedimentation downstream of Big Cedar Creek was identified as a factor affecting distribution within the lower South Fork Ouachita River.

Harris (1989) surveyed approximately one mile of the Caddo River extending downstream from the DeGray Reservoir Reregulating Dam. Five live Arkansas fatmucket specimens were collected from one site (relative abundance = 8.7 percent).

Since listing under the Endangered Species Act:

Harris (1991) surveyed approximately 1.4 stream miles in the South Fork Ouachita River Project that was proposed to be inundated by construction of a Soil Conservation Service project. Two live Arkansas fatmucket specimens were collected during this survey and abundance was determined to be very low within this reach. This survey also confirmed the issues with sedimentation discussed in Brown and Brown (1989).

Burns & McDonnell, Inc. (1992a) surveyed 18 locations on the North Fork Saline River, including three historic locations, from the confluence of Turkey Creek to Arkansas Highway 5. Arkansas fatmucket (28 live individuals) was collected from 66 percent of the sites. Two historic sites, AR Highway 5 and Steel Bridge Road, were no longer inhabited by the species.

Burns & McDonnell, Inc. (1992b) surveyed the North Fork Saline River from Kanis Road to the Turkey Creek confluence; Hurricane Creek from Hurricane Lake Spillway to Bauxite Junction; the South Fork Saline River from near Lonsdale, AR to the confluence with the Alum Fork Saline River; the Alum Fork Saline River from Lake Winona Spillway downstream approximately 2 river miles; and Ouachita River from the Cherry Hill Access to the Pine Ridge Access.

Harris *et al.* (1992) relocated 44 Arkansas fatmucket specimens due to the planned replacement of the functionally obsolete, substandard bridge crossing the South Fork Ouachita River on U. S. Highway 270 in Mt. Ida, Arkansas.

Harris and Doster (1992) surveyed the Caddo River from 100 feet upstream to 1,500 feet downstream of Interstate 30. No Arkansas fatmucket specimens were collected within the survey area.

Johnston *et al.* (1993) surveyed four streams in the Alum Fork Saline River drainage for mussels as part of an ecosystem level project aimed at understanding the effects of forest management practices on aquatic systems. No Arkansas fatmucket specimens were collected.

Harris (1994) conducted a microhabitat and population analysis of Arkansas fatmucket in South Fork Ouachita River at two sites. Arkansas fatmucket population estimates at Site 1 were 31 ± 38 and 10 ± 19 for 1990 and 1993, respectively. Population estimates for Site 2 were 48 ± 68 and 20 ± 39 for 1991 and 1993, respectively. Fifty-seven Arkansas fatmucket specimens were tagged during the mark-recapture portion of this study.

Arkansas Highway and Transportation Department (1994) conducted a mussel survey from approximately 50 meters upstream of Clark County Road 218 to 500 meters downstream of Arkansas Highway 84. Ninety-six mussels representing 15 species were encountered during the survey. This includes two live and one fresh dead Arkansas fatmucket specimens.

Harris *et al.* (1997) re-evaluated the status of Arkansas' rare and endangered mussels.

Harris (1999) evaluated the types of mussels present downstream of Carpenter-Remmel Project (FERC hydroelectric facility) in the Ouachita River. A total of 119 sites were surveyed and 28 sites had mussel aggregations. A single specimen of Arkansas fatmucket was found in the study area.

U.S. Department of Agriculture, Forest Service. 1999. Ozark-Ouachita Highlands Assessment: aquatic conditions. Report 3 of 5. Gen. Tech. Rep. SRS-33. Ashville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 317 pp.

Davidson and Clem (2002) surveyed 98.7 rm of the Saline River from near Tull, Arkansas to Arkansas Highway 15. Nine new Arkansas fatmucket sites were discovered, extending the known range 26 rm downstream.

Davidson and Gosse (2003) surveyed approximately 2.5 rm of the Saline River near the confluence of Holly Creek. The objective was to locate mussel beds and document species composition and community estimates. Arkansas fatmucket was found at two of five sites. The population estimate for Site B2 was 19 ± 40 individuals.

Davidson and Clem (2004) surveyed 50.6 rm of the Saline River from Arkansas Highway 15 to Felsenthal National Wildlife Refuge. No Arkansas fatmuckets were collected from the lower Saline River.

Scott (2004) determined the relative abundance and population demographics of Arkansas fatmucket, examined reproductive biology, identified suitable fish host, and characterized and assessed habitat use.

Christian and Harris (2004) conducted a comprehensive mussel survey of the Little Missouri River. No Arkansas fatmucket specimens were discovered, but this negative data is significant because the University of Oklahoma Science and Arts collection contains several specimens from the Antoine River (a tributary to the Little Missouri River) that appear to be Arkansas fatmucket based on morphological characteristics.

Christian *et al.* (2006) conducted studies of Arkansas fatmucket status within its known range, made habitat assessments of mussel beds and surrounding habitat, compared identified fish hosts with species distribution.

U. S. Fish and Wildlife Service with cooperation from Arkansas Game and Fish Commission and U. S. Forest Service conducted a range-wide status assessment of Arkansas fatmucket in 2006 and 2007.