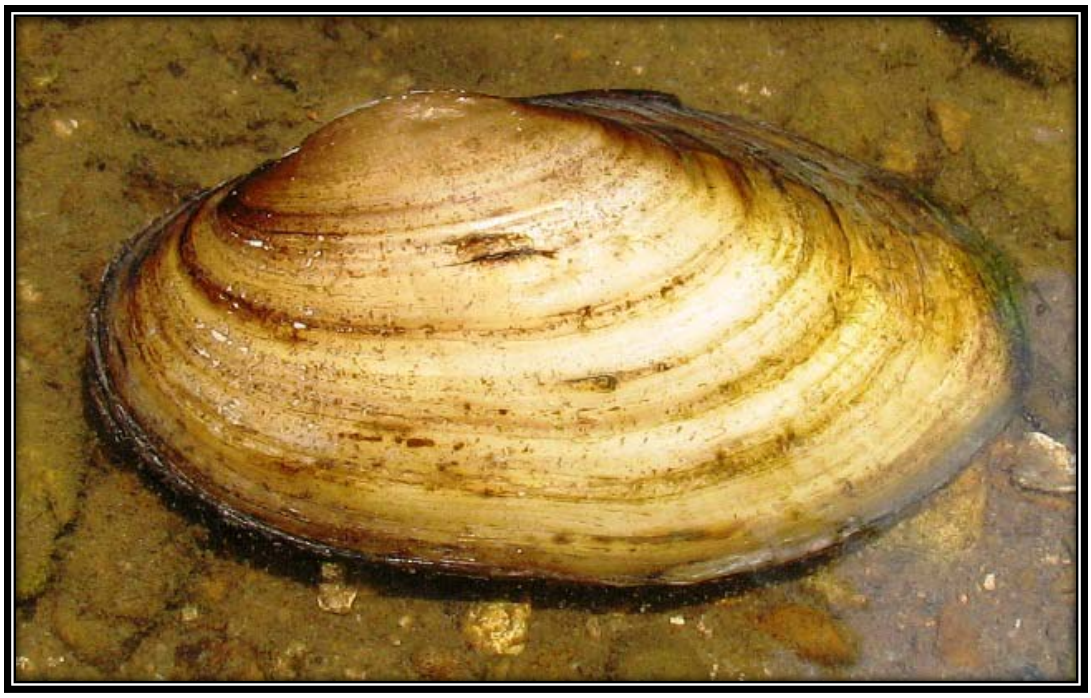
Alabama Lampmussel
(*Lampsilis virescens*)

5-Year Review:
Summary and Evaluation



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U.S. Fish and Wildlife Service
Southeast Region
Alabama Ecological Services Field Office
Daphne, Alabama

August 2012

5-YEAR REVIEW

Alabama Lampmussel / *Lampsilis virescens*

I. GENERAL INFORMATION

A. Methods used to complete the review:

This review was completed by the Alabama Ecological Services (ES) Field Office, Daphne, Alabama. The primary sources of information used in this analysis were the 1976 final listing rule (41 FR 24062), peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts. All literature and documents used for this review are on file at the Alabama ES Field Office. All recommendations resulting from this review are the result of thoroughly reviewing the best available information on the Alabama lampmussel (lampmussel). Comments and suggestions regarding this review were received from peer reviewers from outside the U.S. Fish and Wildlife Service (Service). See Appendix A for a summary of peer reviewer comments. No part of the review was contracted to an outside party. In addition, this review was announced to the public on April 9, 2010 (75 FR 18233) with a 60-day comment period. Comments received were evaluated and incorporated as appropriate.

B. Reviewers

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C. Background

Federal Register Notice citation announcing initiation of this review: 75 FR 18233, April 9, 2010.

Species status: Uncertain (2011 Recovery Data Call). Data suggests severely imperiled.

Recovery achieved: 1 (0-25% recovery objectives achieved)

Listing history:
Original Listing
FR notice: 41 FR 24062
Date listed: June 14, 1976
Entity listed: species
Classification: endangered

Associated rulemakings:
Experimental Population, Non-Essential, June 14, 2001, 66 FR 32250;
ETWP; Establishment of Nonessential Experimental Population Status for 16 Freshwater Mussels and 1 Freshwater Snail (Anthony's Riversnail) in the Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL

Experimental Population, Non-Essential, August 21, 2001, 66 FR 43808;
ETWP; Establishment of Nonessential Experimental Population Status for 16 Freshwater Mussels and 1 Freshwater Snail (Anthony's Riversnail) in the Free-Flowing Reach of the Tennessee River below the Wilson Dam, Colbert and Lauderdale Counties, AL; Correction

Review History:
Recovery Data Call**:** 1998-2011
Recovery Plan: 1985

Species' Recovery Priority Number at start of 5-year review (48 FR 43098): 5. This number indicates a high degree of threat, and a low recovery potential.

Recovery Plan or Outline
Name of plan or outline: "A Recovery Plan for the Alabama Lamp Pearly Mussel *Lampsilis virescens* (Lea, 1858)"
Date issued: July 2, 1985

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy:

The Act defines species as including any subspecies of fish, wildlife, or plant, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPSs to only vertebrate species of fish and wildlife. Because the species under review is an invertebrate, the DPS policy is not applicable and will not be addressed further in this review.

B. Recovery Criteria

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

b. Adequacy of recovery criteria.

a) Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? No. Given that the recovery plan is over 25 years old, recent survey data are not incorporated into the recovery criteria. The plan also lacks recent published and unpublished scientific information on the lampmussel's life history and its habitat.

b) 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)? No. Although the population/habitat protection criterion address listing factor A (the present or threatened destruction , modification, or curtailment of habitat or range), the recovery criteria do not address factors D and E (inadequacy of existing regulatory mechanisms, or other natural or manmade factors affecting the species' continued existence).

c. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

According to the recovery plan, the following criteria must be met to delist the lampmussel:

1. **A viable population[1] of *Lampsilis virescens* exists in the Paint Rock River above the impounded portion in Wheeler Reservoir, upstream to and including Larkin Fork, Estill Fork, and Hurricane Creek tributaries. This population should be distributed within this stream such that it is unlikely a single adverse event would result in the total loss of that population.**

   The most recent mussel surveys in the Paint Rock River (PRR) system (Figure 1) were conducted by the Alabama Department of Conservation and Natural Resources (ADCNR) between June and August of 2008 (Fobian et al. 2008). A total of 47 sites were surveyed, 42 within the PRR mainstem and 5 sites in the Estill

[1] The recovery plan defines a viable population as, "a reproducing population that is large enough to maintain sufficient genetic variation to enable it to evolve and respond to natural habitat changes" (USFWS 1985).

Fork. Thirty-nine species of mussels were collected live or fresh-dead (FD). The lampmussel was collected live at three sites, two in the PRR and one within Estill Fork. In addition, FD individuals were collected at two sites, weathered dead at one site, and a relic shell at one site within the mainstem of the PRR. Based on Fobian et al. (2008), the lampmussel was found at 10.64% of the sites; however, it represented only 0.22% of the overall species abundance.

Prior to Fobian et al. (2008), the last extensive mussel survey of the PRR mainstem was completed in 1991 (Ahlstedt 1998), and the last extensive surveys within the headwaters of the system were completed in 1995 (McGregor and Shelton 1995) and 2002 (Godwin 2002). McGregor and Shelton (1995) found one live Alabama lampmussel during their study in the PRR mainstem; relic shells were found in Hurricane Creek and Estill Fork. Godwin failed to collect any live Alabama lampmussels during his study (Godwin 2002), while Ahlstedt (1998) found only one FD and one relict specimen in Estill Fork.

Other miscellaneous surveys (as recorded in the Alabama ES Field Office species database, museum, or Heritage databases) have recorded a small number of additional records between 1980 to present in the PRR mainstem, Estill Fork or Hurricane Creek. No records from Larkin Fork have been documented since the late 1960s.

In April of 2010, staff of the ADCNR's Alabama Aquatic Biodiversity Center (AABC) surveyed a site in the PRR just north of Hollytree, Jackson County, Alabama, for the purpose of collecting lampmussel brood stock for culturing activities at the AABC (T. Fobian, unpublished data). A total of seven individuals were collected (4 males and 3 females), two of which were gravid females that were transported back to AABC for culture work. Glochidia were extracted and the brood females were tagged and returned back to the site in May of 2010. In April 2011, AABC staff returned to this site for additional brood stock collection. While three gravid females were collected, only two females were transported back to AABC for culture work as one of the females was a tagged recapture from the 2010 propagation work and not utilized (P. Johnson, unpublished data). Glochidia were extracted and the brood females were tagged and returned back to the site in June of 2011.

In September of 2010, two FD lampmussels were collected by Service and The Nature Conservancy (TNC) biologists from

Hurricane Creek, near Bishop Cove, in a shell midden (pile of dead shells, usually left by raccoon or muskrat) while conducting fish surveys (A. Ford 2011, pers. obs.).

In the portions of the upper PRR drainage where the lampmussel still occurs (Figure 1), it is usually uncommon and rare (Ahlstedt 1998). Ahlstedt (1998) noted that perturbations in these streams during recent years may have already reduced some of the only known extant populations of this species to relict status. Godwin (2002) stated that "extinction may be imminent".

The lampmussel, when collected from the Estill Fork, Hurricane Creek, or upper Paint Rock, is usually collected in low densities. The other tributary mentioned in the criterion above, Larkin Fork, may no longer support lampmussels as none have been reported from the tributary since the 1960s. While the lampmussel appears to remain reproductively viable within the remaining streams, population bottlenecks may have reduced genetic variation. As such, the population might not fully meet the criterion of being genetically viable (i.e., maintaining "sufficient genetic variation to enable it to evolve and respond to natural habitat changes", as defined in the Recovery Plan).

2. **Through introductions and/or discoveries of new populations, a viable population is established in each of two additional streams within the historical range of this species. The population in each stream must be distributed such that a single adverse event would be unlikely to eliminate *Lampsilis virescens* from the river system. For these populations, surveys must show that three year classes exist including an adult year class naturally produced within each of the population centers and two younger year classes naturally produced within each of the population centers.**

A population of the lampmussel was recently (April 4, 2011) rediscovered in the upper Emory River (Dinkins et al. 2012) near the community of Gobey in Morgan County, Tennessee (Figure 2). The discovery was the first confirmed Alabama lampmussel collection in the upper Emory system since the late 1920s (Dinkins et al. 2012). From April 4, 2011 to January 24, 2012, a total of 47 live and/or FD lampmussels were collected at 13 locations spanning 11.3 river miles (18.2 kilometers (km)) of the upper Emory River (Figure 2), immediately upstream of the confluence with the Obed River (Dinkins et al. 2012). A length frequency histogram of the lampmussels collected during the Emory River surveys indicates recent recruitment, with five to six age classes

present with length frequencies ranging between 35 millimeters (mm) (n=3) and 72 mm (n=1) (Dinkins et al. 2012).

Two attempts at propagation and culture (Johnson 2004; P. Johnson unpublished data; Fobian and Johnson 2010; Johnson 2011; Johnson and Hubbs 2010, 2012) have been made since 2004 (Figure 3).

In 2004, the Tennessee Aquarium Research Institute collected brood stock (from the PRR near Princeton, Alabama), cultured, and released a total of 1,654 individuals (1,179 in July 2004, 475 in August 2004) into the Estill Fork, Jackson County, Alabama (Johnson 2004, P. Johnson unpublished data). The status of these cohorts is not known (P. Johnson pers. comm. 2011).

In 2010 and 2011, AABC staff visited sites within the PRR (Jackson County, Alabama) and acquired brood stock for propagation and reintroduction work (Fobian and Johnson 2010; Johnson 2011; Johnson and Hubbs 2010, 2012). Glochidia were extracted from the gravid females, and host fish were infested via aerial suspension; juvenile mussels began to metamorphose approximately 18 days later (T. Fobian pers. comm. 2011).

A total of 660 juvenile lampmussels were stocked at two sites in the lower PRR mainstem in 2010: 330 at a site near the town of Paint Rock, Jackson County, Alabama, and 330 at a site near Butler Mill in Marshall/Madison County, Alabama (Fobian and Johnson 2010, T. Fobian unpublished data). In addition, 430 individuals were stocked in the Elk River below Harm's Mill near Fayetteville, Lincoln County, Tennessee in 2010, with an additional 540 individuals stocked in 2011 (Johnson and Hubbs 2010, 2012). In 2011, 1,036 individuals were stocked in Bear Creek, Colbert County, Alabama (Johnson 2011). The 2010 reintroduction sites have been evaluated and all indications suggest that the species is persisting at all locations (P. Johnson unpublished data).

While the lampmussel population within the Emory River appears to be stable, our current knowledge of the species' range in the Emory River is incomplete at this time. The lampmussel has only been collected within a single 11.3 mile stretch of the Emory River mainstem and as such, is at risk from of a single adverse event and does not currently meet the above criterion as a viable population. Additional surveys are needed to document any fringe populations within adjacent tributaries.

The 2010 cohorts in the lower PRR and Elk Rivers have shown early evidence of persistence in preliminary follow-up surveys (P. Johnson unpublished data). However, before the criterion of a viable population can be met, the reintroduced populations must demonstrate that three year classes exist, including an adult year class naturally produced within each of the population centers and two younger year classes naturally produced within each of the population centers.

3. The species and its habitat in each stream are protected from foreseeable anthropogenic and natural threats.

The Alabama lampmussel, at present, is restricted to the upper reaches and tributaries of the PRR watershed and to the upper Emory River mainstem. Considerable effort has been made over the last decade to identify and repair degraded areas in the PRR watershed (Figure 1). Development in this area is relatively low and many of the land use practices (row crop and pasture) have remained unchanged over the last several decades (Godwin 1995). The Emory River was historically degraded by land use practices, including coal mining, oil and gas drilling/exploration, and timber harvesting (Dinkins et al. 2012). Currently, timber harvest and natural gas extractions continue in the Emory River drainage, however, no coal mines have operated in approximately 20 years (Dinkins et al. 2012).

The majority of the PRR watershed is rural and in private ownership and has little proposed urban development (Barbour 2003). The land use cover (Figure 4) is predominately forest: 89.9% in the upper watershed and 62.2% in the lower watershed. Agricultural production (row crop and pasture) makes up 32.5% of the land cover in the lower watershed and 9.1% in the upper watershed (Barbour 2003). While the total percentage of agricultural lands is relatively low in the upper watershed (where the lampmussel is extant), agricultural land is usually adjacent to flowing water when present (Barbour 2003).

The lampmussel population that was rediscovered in 2011 occurs within a large portion of the upper Emory River drainage that is owned by the Emory River Land Company (Dinkins et al. 2012) and is primarily forested (Figure 5). This population within the Emory River is further protected by a 5,000 acres (ac) (2,023.4 hectares (ha)) tract owned by TNC in the headwaters of the Emory River just upstream of the lampmussel habitat. In the same area there is also an 11,000 ac (4,451.6 ha) tract purchased by TNC and

the State of Tennessee as part of the 2007 “Connecting the Cumberlands” project (Simmons 2011, TNC 2011).

Godwin (1995) identified non-point source pollution impacts within the PRR watershed. The most prevalent impacts were lack of riparian vegetation (47%), livestock intrusion (19%), and vehicle fording sites (14%). Other impacts included: sedimentation from mining, off-road vehicle use in streams, cropland erosion, timber harvest, dumping, sewage, logjams, construction, and drainage pipe discharges into the streams.

Beginning in 2001, TNC and ADCNR began acquiring land for nature preserves, wildlife management areas (Alabama Forever Wild), and conservation easements (Figure 6). TNC currently owns and manages two preserves in Jackson County: Sharp and Bingham Mountains Preserve (3,400 ac (1,376 ha)) and the Roy B. Whitaker Preserve (323 ac (131 ha)). TNC has also acquired and transferred several properties to the ADCNR including: the Walls of Jericho (12,500 ac (5,059 ha) in Alabama, 9,000 ac (3,642 ha) in Tennessee), Henshaw Cove (1,579 ac (639 ha)), and the Sims/Swaim/Johnson Walls of Jericho additions (539 ac (218 ha)) (D. Fears pers. comm. 2011). Conservation easements are held by the Alabama Land Trust on approximately 1,000 acres of land within the PRR watershed (D. Fears pers. comm. 2011).

The Natural Resource Conservation Service (NRCS) has a project specifically targeting the PRR and its two primary headwater streams (Estill Fork and Hurricane Creek) (NRCS 2011). Under this program, property owners adjacent to the PRR or one of its main tributaries are encouraged to enter into a Wetland Reserve Program (WRP) easement (30 year or permanent easement). The program restores cropland, pastureland, fallow land, or forestland by planting hardwood trees to reduce erosion and sediment in the stream, as well as minimize pesticides and excess nutrients in the streams (NRCS 2011).

In addition to the WRP, NRCS also administers several other conservation programs (e.g., Environmental Quality Incentives Program, Wildlife Habitat Incentive Program, etc.) under the Farm Bill that directly benefits aquatic species. The following conservation program practices (S. Weaver pers. comm. 2011) were implemented, between 2000 to 2010, by the NRCS in the Estill Fork, Hurricane Creek, and Larkin Fork drainages: cattle access control (4 sites, 69 ac (28 ha)), conservation cover (i.e., perennial vegetative cover) (1 site, 1 ac (0.4 ha)), forage and biomass planting (8 sites, 93 ac (38 ha)), prescribed grazing (10

sites, 175 ac (71 ha)), residue management, no-till/strip-till farming (2 sites, 36 ac (15 ha)), riparian forest buffer (2 sites, 6.3 ac (2.5 ha)), streambank and shoreline protection (2 sites, 607 feet (ft) (185 meters (m))), tree/shrub establishment (2 sites, 57 ac (23 ha)), cattle watering facility (5 sites, benefiting 75 ac (30 ha)), wetland restoration (1 site, 62.2 ac (25 ha)), and wetland wildlife habitat management (4 sites, 67.5 ac (27.3 ha)).

Multiple restoration and enhancement projects (Figure 6) have been conducted in the PRR basin by multiple agencies (e.g., FWS, NRCS, and ADCNR) and non-profit environmental groups (e.g., TNC) over the past decade. Projects have included: streambank stabilization, riparian restoration, low water crossings, cattle exclusionary fencing, alternate water source development, and stream channel restoration (i.e., restoring natural meanders) (D. Fears pers. comm. 2011). During this time, TNC has participated in 24 of these projects (Figure 6) (D. Fears pers. comm. 2011). The FWS Partners for Fish and Wildlife Program has participated in approximately 12 of these projects.

Both native populations of lampmussel, the upper PRR and upper Emory River, occur in rural areas dominated by forested land in private and public ownership with little to no urban development. While a majority of the watershed is maintained or managed in a natural or forested state, agriculture is the predominant stream-side land use and poses a more direct threat to water quality in these drainages. While we have made significant progress in meeting this recovery criterion, the species is still threatened by non-point source pollution from agricultural runoff and other impacts from agricultural operations (e.g., cattle access to streams and fording sites for vehicles; see discussion under Five-Factor Analysis (a.) below). Continued and increased partnerships with private landowners to implement conservation practices are vital to eliminating this threat.

C. Updated Information and Current Species Status

a. Biology and Habitat

a) Biology and Life History:

The Alabama lampmussel is a medium sized freshwater mussel usually measuring less than 75 millimeters (mm; ~3 inches (in.)) in length with a moderately thick/moderately inflated shell that is often tawny to greenish yellow, with white nacre (Williams et al.

2008). It historically occurred in small creeks to large rivers; however, at present, it only seems to persist in small to moderate-sized streams in areas of slow to moderate current within sand and gravel substrates. The lampmussel has also been found in areas with stands of water willow (*Justicia americana*) (Williams et al. 2008).

This species is a long-term brooder and is gravid from late summer or autumn into the following summer (Williams et al. 2008). Work led by Dr. Paul Johnson at the Tennessee Aquarium Research Institute and staff at AABC has led to successful transformations of lampmussels on several different fish species in the family Centrarchidae, including rock bass (*Ambloplites rupestris*), green sunfish (*Lepomis cyanellus*), bluegill sunfish (*L. macrochirus*), smallmouth bass (*Micropterus dolomieu*), spotted bass (*M. punctulatus*), largemouth bass (*M. salmoides*), and redeye bass (*M. coosae*) (P. Johnson unpublished data, Fobian and Johnson 2010, Johnson and Hubbs 2010). The banded sculpin (*Cottus carolinae*) was also reported as a potential host (P. Johnson unpublished data).

b) Abundance/population trends, demographic features or trends:

There are several different rankings that have been applied to the lampmussel. NatureServe (Heritage Ranking System) assigned this species a global ranking of G1. The states of Alabama and Tennessee give the lampmussel their highest priority ranking (S1; Alabama Natural Heritage Program 2007, TDEC 2009). These rankings indicate that the species is critically imperiled, and at very high risk of extinction due to extreme rarity (often 5 or fewer populations). A review of imperiled wildlife in Alabama by Mirarchi et al. (2004) indicates that the lampmussel is a Priority 1 species and a species of highest conservation concern.

The Alabama lampmussel is restricted to the headwaters of the PRR (Figure 1) (USFWS 1985) and the upper Emory River (Figure 2) (Dinkins et al. 2012) and has only been collected in low numbers in recent surveys (McGregor and Shelton 1995, Ahlstedt 1998, Godwin 2002, Fobian et al. 2008, Dinkins et al. 2012). For additional information on the species' abundance and population trends refer to Section II.B.c.1. and Section II.B.c.2 of this review.

c) Genetics, genetic variation, or trends in genetic variation:

The Alabama lampmussel is relatively uncommon, even among the best remaining populations, so genetic flow and diversity is a concern. In order to minimize genetic diversity concerns in regard to culture and reintroductions into historic habitat, AABC will utilize as many different females for juvenile production as possible (Fobian and Johnson 2010, Johnson and Hubbs 2010). Further augmentations at reintroduction sites will attempt to utilize new brood stock from the source stream (M. Buntin pers. comm. 2011).

Additionally, the AABC will continue to preserve genetic material from excess glochidia and propagated cohorts (i.e., individuals that do not survive) for later use per the Services' policy regarding the controlled propagation of species under the Endangered Species Act (USFWS and NOAA 2000). For example, the AABC has provided the U.S. Geological Survey (USGS) and the University of Florida material from four different mussels in 2009 (yellow sandshell (*L. teres*), wavy-rayed lampmussel (*L. fasciola*), rainbow (*Villosa iris*), and Alabama rainbow (*V. nebulosa*)) for mitotyping (method to determine maternal lineage through analysis and classification of mitochondrial DNA haplotypes) to verify the actual number of males that fertilized the females used in culture trials (Fobian and Johnson 2010, Johnson and Hubbs 2010).

The population of lampmussels in the Emory River were genetically confirmed by Moyer and Ferguson (2011, 2012) after specimens from the Emory River were shown to be genetically more similar to lampmussels in the PRR than other morphologically similar species (pocketbook (*L. ovota*), wavy-rayed lampmussel (*L. fasciola*), and fluted shell (*Lasmigona costata*)) found in the Emory River (Moyer and Ferguson 2011). Maximum parsimony and Bayesian phylogenetic methods revealed strong support for a clade consisting of the two populations (Emory River and PRR), indicating the individuals collected from the Emory River were indeed the Alabama lampmussel (Moyer and Ferguson 2012).

d) Taxonomic classification or changes in nomenclature:

A member of the freshwater mussel family Unionidae, the Alabama lampmussel was originally described as *Unio virescens* (Lea, 1858). The type locality is the Tennessee River at Tuscumbia, Colbert County, Alabama (Figure 7) (Ortmann 1918, Parmalee and Bogan 1998). Parmalee and Bogan (1998)

summarized the synonomy of the Alabama lampmussel; it has been considered a member of the genera *Unio, Margaron, Lampsilis, and Ligumia* at various times in history. It was first considered a member of the genus *Lampsilis* by Simpson in 1900 (Parmalee and Bogan 1998).

No changes to taxonomic classification or nomenclature have occurred since this species was listed. Nomenclature is consistent and follows that in Turgeon et al. (1998).

e) Spatial distribution, trends in spatial distribution, or historic range:

The Alabama lampmussel historically (Table 1) occurred from the headwaters in eastern Tennessee downstream to Muscle Shoals in northwestern Alabama (Mirarchi 2004, Williams et al. 2008). It was known to occur in the PRR (Jackson Co., AL), Bear Creek (Colbert Co., AL), Little Bear Creek (Franklin Co., AL), a tributary to Bear Creek, Spring Creek (Colbert Co., AL), and Anderson Creek (Lauderdale Co., AL), a tributary to the Elk River (Ortmann 1918, Ortmann 1925, Isom and Yokley 1968, Isom and Yokley 1973) in northern Alabama, and the Emory River (Roane and Morgan counties, TN), and Coal Creek (Anderson Co., TN), a tributary to the Clinch River (Ortmann 1918, Ortmann 1925), in eastern Tennessee.

It has been eliminated throughout a majority of its historic range, and is now restricted to only the upper reaches of the PRR system, Jackson County, Alabama, and potentially into Franklin County, Tennessee (Parmalee and Bogan 1998), and in the upper Emory River, Morgan County, Tennessee (Dinkens et al. 2012).

Table 1. Literature records of *Lampsilis virescens*

River	Reference
Tennessee River	Lea (1858) Lea (1860) Lea (1870) Ortmann (1918) Stansbery (1964) Ortmann (1925)
Spring Creek	Lewis (1876) Call (1885) Ortmann (1918) Ortmann (1925)
Bear Creek System	Ortmann (1918) Ortmann (1925) Isom and Yokley (1968)
Paint Rock System	Isom, Yokley, and Gooch (1973) Ortmann (1918) Ortmann (1925) Stansbery (1970a) Stansbery (1971)
Beech Creek	Lewis (1876)
Emory River System	Ortmann (1918) Ortmann (1925)
Coal Creek	Ortmann (1918) Ortmann (1925)

Source: USFWS 1985

f) Habitat or ecosystem conditions:

The Emory River lies in the Ridge and Valley physiographic province. It is a tributary to the lower Clinch River, which empties into the Tennessee River at Tennessee River Mile 567.5, near Kingston, Tennessee.

The PRR flows southwest 60 miles (mi; 96.6 kilometers (km)) along the southern edge of the Cumberland Plateau physiographic province before it enters the Tennessee River (TRM 343.2); the last 13 river miles are within the impounded reaches of Wheeler Reservoir (Ahlstedt 1998, Fobian et al. 2008). The PRR watershed is sparsely populated and encompasses 458 square mi (Fobian et al. 2008). Karst is the dominant landscape with about 760 known caves within the watershed (Godwin 2002). The upper PRR lies predominantly within the Tuscumbia Limestone geologic formation while the lower PRR lies primarily within Monteagle Limestone.

The PRR generally contains streamside zones that are well to moderately forested (Godwin 2002). The upper sections of the PRR are primarily narrow floodplains that are forested along the

streams with slopes that may rise as much as 300 m (984 ft) above the streams (Godwin 2002), while lower reaches primarily consist of wide alluvial river valley floodplains with narrow riparian zones adjacent to pastures and row crops (Godwin 2002, Fobian et al. 2008). The PRR is surrounded by forested mountains with heavy agricultural production in the adjacent floodplain, primarily for soybeans, cotton, corn, milo, and beef cattle (Ahlstedt 1998, Fobian et al. 2008).

Godwin (Godwin 1995, Godwin 2002) describes stream habitat conditions within the PRR watershed, and his notes are paraphrased below:

> The PRR and tributaries (Estill Fork, Hurricane Creek, and Larkin Fork) are generally shallow with depths less than a meter; however depth will range from a few centimeters in riffles to over a meter in pools. Substrates are coarse sand, gravel, cobble, and bedrock. Water clarity ranges from very clear in the headwater portions to turbid in the lower reaches of the mainstem. The channel widths are often around ten meters in width, but may exceed 30 meters in the lower sections of the PRR. Generally the water is slow flowing, but water in the headwaters may be swift in places. Large pools in the mainstem are sluggish. Flow is greatly diminished and may at times flow upstream at the lower end of the PRR due to the difference within the water levels in the reservoir and the river. Pools and riffles alternate throughout the drainage basin, and beds of water willow (*Justicia americana*) are interspersed in shallow and riffle areas.

D. Five-Factor Analysis

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

Human-related activities continue to impact both the upper Emory River and PRR systems. The upper PRR and upper Emory River occur in rural areas dominated by forested land (Figure 4, 5) in private and public ownership with little to no urban development. While a majority of the watershed is maintained or managed in a natural or forested state, the areas that are actively managed for agriculture are quite often located adjacent to the streams and pose a more direct threat to water quality in these streams.

Although development has occurred in the PRR watershed, it has been relatively low compared to other areas in the Tennessee Valley (Barbour 2003). However ,one of the most damaging may be the channelization projects of the 1960s, which involved extensive stream channelization and removal of snags and riverbank timber in the mainstem PRR, Larkin Fork, Estill Fork, and Hurricane Creek (Barbour 2003). Ahlstedt (1998) noted that riffle and shoal habitats have never recovered from that event and continue to be aggravated by non-point source pollution associated with agricultural runoff. The mussel fauna may continue to decline until measures are taken to reduce these stream perturbations (Ahlstedt 1998).

In 1995, Godwin reported 100 potential non-point source impacts at 85 sites. Of the 100 impacts, 75 impacted sites were within the PRR, 18 in Estill Fork, five in Hurricane Creek, and two within Larkin Fork. The most common impact was lack of riparian vegetation (47%), followed by cattle access to the stream (19%) and fording sites for agricultural vehicles (14%). Other documented impacts were sedimentation from mining and off-road vehicles (4% each), cropland erosion and timber harvest sites (3% each), and dumping of debris (2%). Godwin (1995) noted single occurrences of the following potential impacts: sewage inflow, major logjam, siltation from construction, and drainage pipe, during the survey.

Lampmussel habitat has also been disturbed and degraded by unauthorized removal of creek gravel from within the stream channel at several locations within the PRR drainage basin (D. Fears pers. comm. 2011).

Between 1999 and 2010, the FWS consulted (under Section 7 of Endangered Species Act (ESA)) informally on 16 projects within the PRR drainage. Projects included bridge replacements, new water lines, and creation of recreational trails; however, the majority (12 projects) involved habitat enhancement or bank stabilization that resulted in beneficial actions. Follow-up monitoring from these consultations has been limited.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

The Alabama lampmussel is not known to have any commercial value and overutilization has not been a problem. Based on the best available data, overutilization is not believed to be a threat at this time. However, because of the species' rarity any inadvertent collection could be a threat and could disturb natural reproduction.

c. Disease or predation:

Diseases of freshwater mussels are practically unknown. Grizzle and Brunner (2009) indicate that while some parasites and bacteria have been

found in freshwater bivalves, these do not appear to be infectious between individuals. Only one viral disease has been documented, occurring in a Chinese species, the Chinese pearl mussel (*Hyriopsis cumingii*).

While information is limited, measures are being taken in the propagation of freshwater mussels to limit their risk to disease, especially when hatchery reared animals are being released into the wild. For propagation activities at the AABC, groundwater is the only source water used because it likely contains fewer pathogens than surface water (Fobian and Johnson 2010, Johnson and Hubbs 2010). To further reduce the risk of pathogens, all the water in mussel grow-out ponds is exchanged every 60 days, and no resident native mussels occur on site. Adult brood stock are segregated from juveniles to lessen the chance of introducing disease from the brood stock's native stream. No other mussel culture facility has reported any disease issues in a hatchery environment, and the propagated Alabama lampmussels have grown rapidly in culture systems and appear healthy (Fobian and Johnson 2010, Johnson and Hubbs 2010).

Several animals sympatric with the Alabama lampmussel are known to eat freshwater mussels. The muskrat (*Ondatra zibethicus*) is probably the most common mammal predator of freshwater mussels and piles of shells are often seen near muskrat dens and feeding stations (Parmalee and Bogan 1998). Other mammals like mink (*Mustela vison*), raccoons (*Procyon lotor*), and river otters (*Lutra canadensis*) are also known to predate on mussels. Some birds (especially waterfowl) and turtles are known to feed on mussels; and freshwater drum (*Aplodinotus grunniens*) feed almost exclusively on them (Parmalee and Bogan 1998). These natural predators have evolved with the Alabama lampmussel; they appear to be randomly opportunistic in their foraging, usually foraging on whatever mussel or clam (e.g., the exotic Asian clam) is most prevalent and easy to obtain.

d. Inadequacy of existing regulatory mechanisms:

The Alabama lampmussel is afforded protections against take under Section 9 of the ESA, by the State of Alabama under their Invertebrate Species Regulation (Alabama Administrative Code 220-2-.98), and in Tennessee by the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act (1974) (Tennessee Code Annotated 70-8-101 through 70-8-112). While the Alabama lampmussel may have species protections afforded it by both state and Federal governments, most people are unaware of its presence and protected status and fail to take any additional precautionary measures to aid in the recovery of this species. Impacts still exist such as lack of riparian vegetation, cattle access to the stream, and fording sites for agricultural vehicles.

The Clean Water Act (CWA) is the primary federal law in the United States governing water pollution. One primary role of the CWA is to regulate the point source discharge of pollutants to surface waters. This is regulated by the permit process with a permit from the National Pollutant Discharge Elimination System (NPDES). The NPDES permit process is usually delegated by the Environmental Protection Agency (EPA) to its state cohort; in Alabama this authority has been delegated to the Alabama Department of Environmental Management (ADEM) and in Tennessee to the TDEC. Currently ADEM (Alabama Administrative Code, Title 22, Section 22-22-1 et seq.) and TDEC (Tennessee Code Annotated, 69-3-101 et seq.) require that discharges not exceed state water quality standards. Since there is no information on the species' sensitivity to common pollutants, Federal (e.g., CWA) and state water quality laws may or may not be protective of the Alabama lampmussel.

Section 303d of the CWA requires each state to list its polluted water bodies and to set priorities for their clean up with a watershed restoration action plan called a "Total Maximum Daily Load" (TMDL) for each impaired water body. Currently Guess Creek (a tributary to the PRR) has been identified as impaired for water quality under Section 303d under the CWA. Guess Creek was listed for unknown toxicity, organic enrichment (carbonaceous biological oxygen demand (CBOD), nitrogenous biological oxygen demand (NBOD)) and pathogens associated with unknown sources and pasture grazing.

Section 404 of the CWA regulates the discharge of dredged or fill material into waters of the United States, including wetlands. Any activities in waters of the United States are regulated under this program, and often include fill related to development, such as water resource projects, infrastructure development, and mining projects.

Section 26a of the Tennessee Valley Authority (TVA) Act requires TVA's approval be obtained prior to the construction, operation, or maintenance of any dam, appurtenant works, or other obstruction affecting navigation, flood control, or public lands or reservations along or in the Tennessee River or any of its tributaries. Within these Tennessee River drainages, TVA's Section 26a permits are usually applied for concurrently with the Army Corps of Engineers (ACOE) Section 404 permits.

Section 7 of the ESA requires Federal agencies to ensure that their activities, in consultation with the Service, are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitats. While a single project (e.g., Section 404 or Section 26a permit) will usually not jeopardize the continued existence of the Alabama lampmussel, the collective encroachment on the Alabama lampmussel's

finite habitat may have a larger impact and is usually not assessed on a permit-by-permit basis.

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is intended to protect against "unreasonable human health or environmental effects." While pesticides are usually tested on standard biological test media for toxicity testing, this toxicity information may not relate well to the lampmussel. Commercial applicators must also be tested and permitted on the proper application of pesticides, but applicators may not necessarily be aware of the presence of the lampmussel in the watersheds where pesticides are being applied.

Regardless of the Federal or state regulatory mechanism, enforcement of these regulations is necessary to provide the intended protections. Quite often enforcement is inadequate.

e. Other natural or manmade factors affecting its continued existence:

Natural factors such as drought can potentially threaten the continued existence of the Alabama lampmussel. Natural droughts can potentially have negative impacts on water quality (e.g., dissolved oxygen) and waste dissemination of point source discharges. Droughts may also reduce the amount of habitat available to mussels by dewatering habitat, and may also lead to direct mortality by stranding mussels. Drought may also fragment sections of stream into isolated pools, eliminating the required flow regime.

Since the lampmussel's range is restricted to the PRR and Emory River drainages, human-induced random events such as toxic spills could also jeopardize the lampmussel if pollutants are spilled within creeks or rivers in either drainage. A kill associated with a major spill in the upper tributaries could potentially reduce the occupied range by at least half.

Fish barriers, such as those caused by poorly designed road crossings, can limit fish movement, as well as distribution of freshwater mussels. In 2010, the Service assessed over 51 river mi (82 km) in the PRR basin and identified five high priority road crossings that likely function as fish barriers (B. Bouthillier, pers. comm. 2011). Three of these crossings were at locations known to support lampmussels, and therefore, are likely limiting lampmussel distribution by restricting movement of fish hosts. These barriers may also impact instream and riparian habitat by altering flow direction and velocity, leading to scour holes and bank collapse (D. Fears pers. comm. 2011).

E. Synthesis

The Alabama lampmussel continues to be threatened by its highly restricted range and continued impacts to its habitat. Its range is limited to the upper reaches of the PRR and Emory River drainages. However, the species has been recently reintroduced into the lower PRR, Bear Creek, and into the Elk River in Tennessee to expand its range. Follow-up surveys need to be conducted to document survival and reproductive success of these reintroduction sites; however, preliminary surveys suggest this species is surviving at these sites.

Habitat destruction or modification is presently the greatest threat to this species. Since agriculture is the predominant stream-side land use and has the potential to impact water quality in the drainages where Alabama lampmussel is found, partnerships with private landowners to implement conservation practices, easements, and/or best management practices on their properties are vital to the continued existence of the lampmussel.

Based on the preceding information in this review, we believe that downlisting the Alabama lampmussel from endangered to threatened, or reassigning a new recovery priority number, is not warranted at this time. This assessment is based on our current knowledge of the species' life history, its limited distribution, and remaining threats to its habitat.

III. RESULTS

A. Recommended Classification: No change is needed.

IV. RECOMMENDATION FOR FUTURE ACTIONS

- Continue working with local landowners to preserve the integrity of stream banks and riparian zone, and mitigate problem areas by utilizing cost-shares and other conservation initiatives.
- Conduct systematic population monitoring of extant and reintroduced populations including the documentation of potential threats.
- Specific life history and habitat needs have not been well documented; examine unknown components of life history and ecology, especially as it relates to host fish identification.
- Revise and update the recovery plan for the species to stress the importance of propagation/culture, enhancing our knowledge of basic biological processes (host fish identification, life history), and identify reintroduction as a primary recovery objective.
- Develop a contingency plan to respond to a spill or natural disaster within occupied habitat.

- Provide public outreach and education for the Alabama lampmussel, targeting property owners and farmers along the extant range.
- Continue to develop new partnerships and utilize conservation initiatives with landowners along the riparian habitats and within the recharge zone of the PRR drainage basin.
- Conduct genetic and histology research to support fitness of propagation and culture work.
- Conduct a detailed analysis of habitat requirements, including physiochemical parameters of the stream habitat used by the Alabama lampmussel.
- Encourage EPA and ADEM to develop water quality criteria for pollutants based on responses of native mollusk species, including the Alabama lampmussel.

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Peer-Reviewers

Mr. Bill Bouthillier, Fishery Biologist
USFWS, Warm Springs National Fish Hatchery, Warm Springs, GA

Mr. Doug Fears, Paint Rock River Program Director
TNC, Paint Rock, AL

Mr. Jim Godwin, Zoologist
Alabama Natural Heritage Program, Auburn University, Auburn, AL

Dr. Paul D. Johnson, Program Supervisor
ADCNR, Alabama Aquatic Biodiversity Center, Marion, AL

Mr. Stuart McGregor, Aquatic Biologist
Geological Survey of Alabama (GSA), Tuscaloosa, AL

Provided new/updated information

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Natural Resources Conservation Service, Auburn, AL

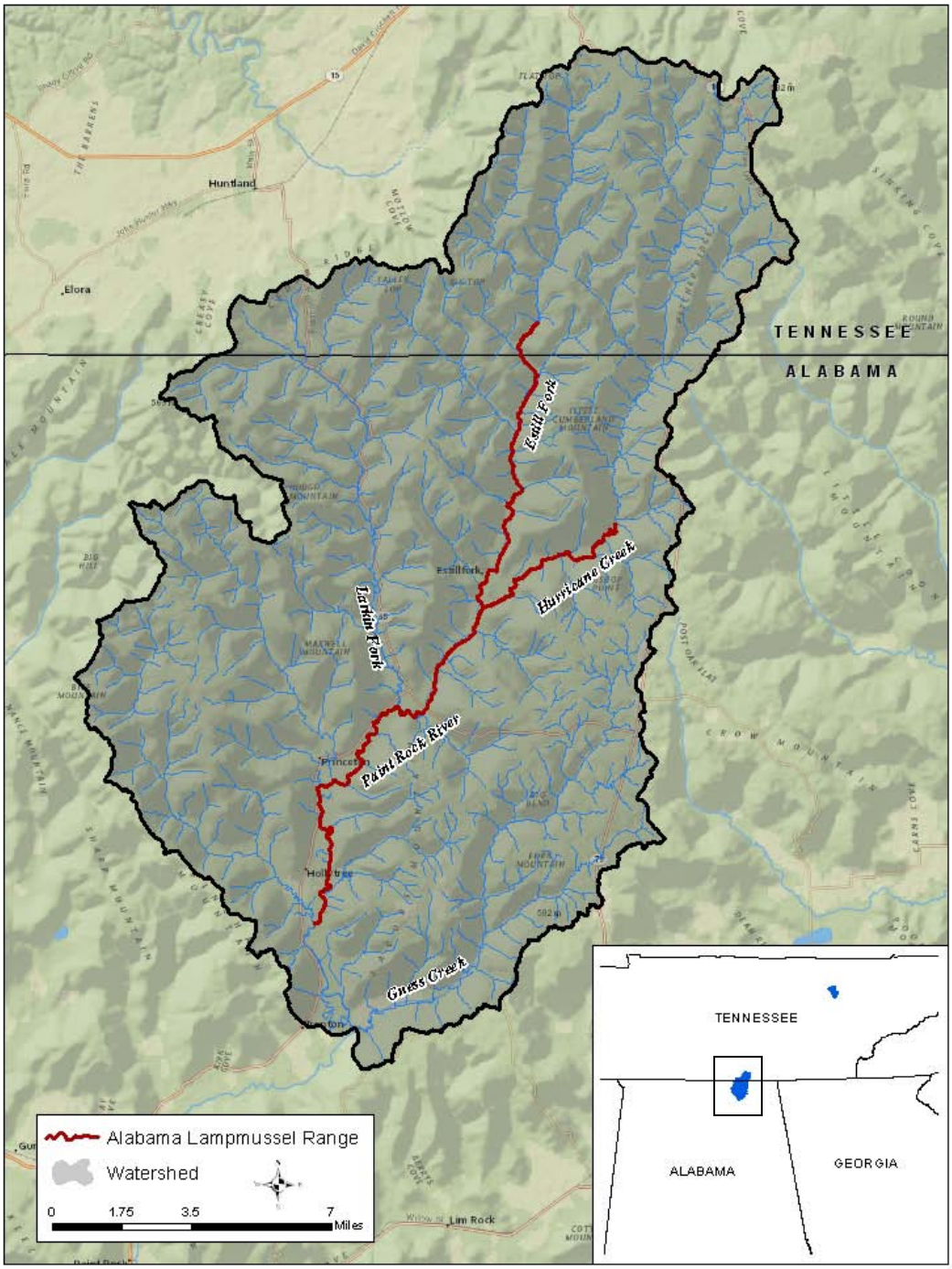

Figure 1. Known range of the Alabama lampmussel (*Lampsilis virescens*) within the Paint Rock River watershed. Created by the USFWS Alabama Ecological Services Field Office (August 2012).

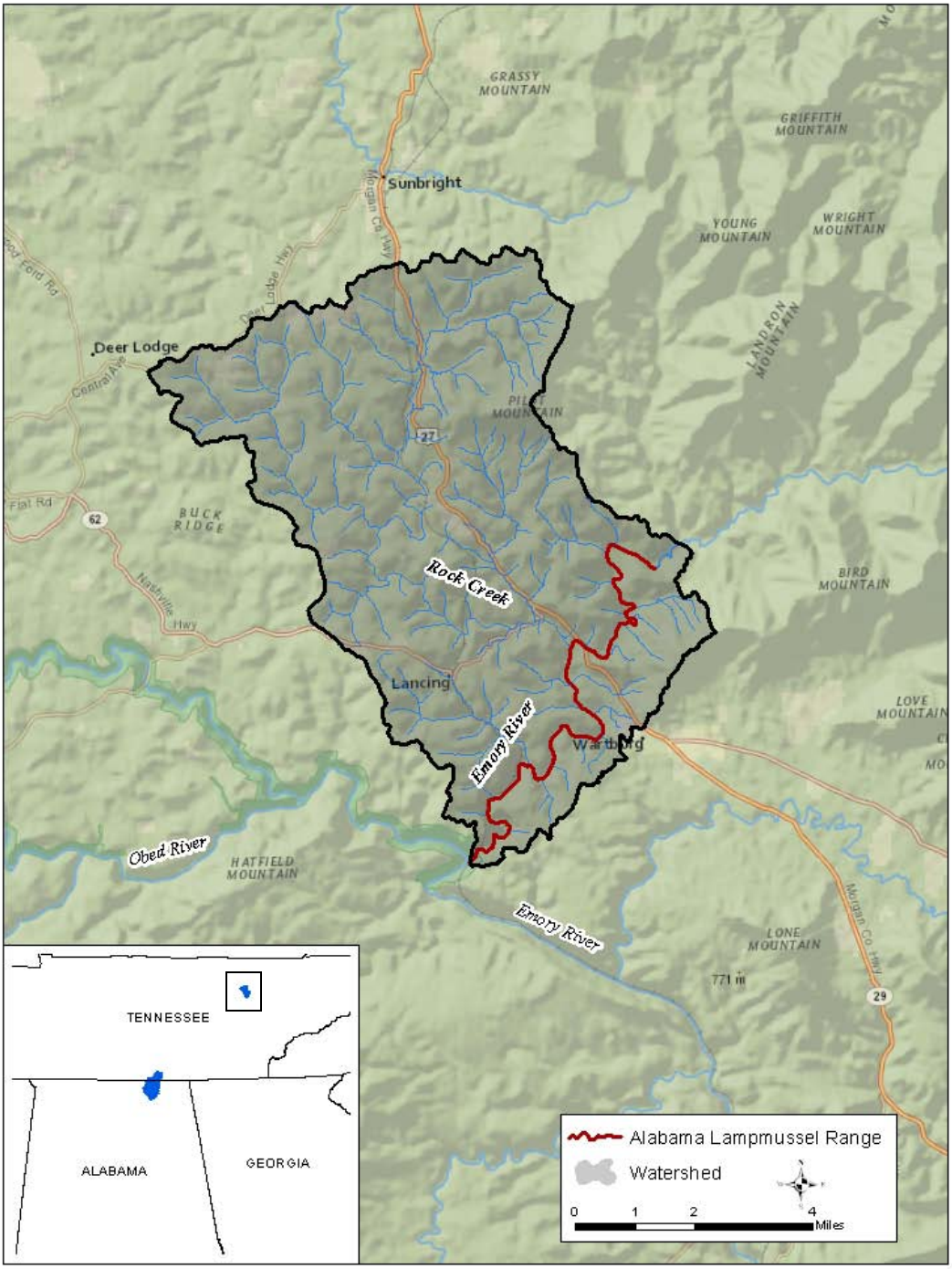

Figure 2. Known range of the Alabama lampmussel (*Lampsilis virescens*) within the Emory River watershed, Morgan County, Tennessee. Created by the USFWS Alabama Ecological Services Field Office (August 2012).

Photo Credit: ADCNR, Alabama Aquatic Biodiversity Center

Figure 3. Alabama lampmussel culture work (2010) at the ADCNR Alabama Aquatic Biodiversity Center in Marion, Alabama.
(A.) Juveniles cultured in hatchery pond within a suspended upwelling system.
(B.) AABC biologist (Todd Fobian) tagging juveniles prior to release.
(C.) Tagged juvenile Alabama lampmussel being released at relocation site.

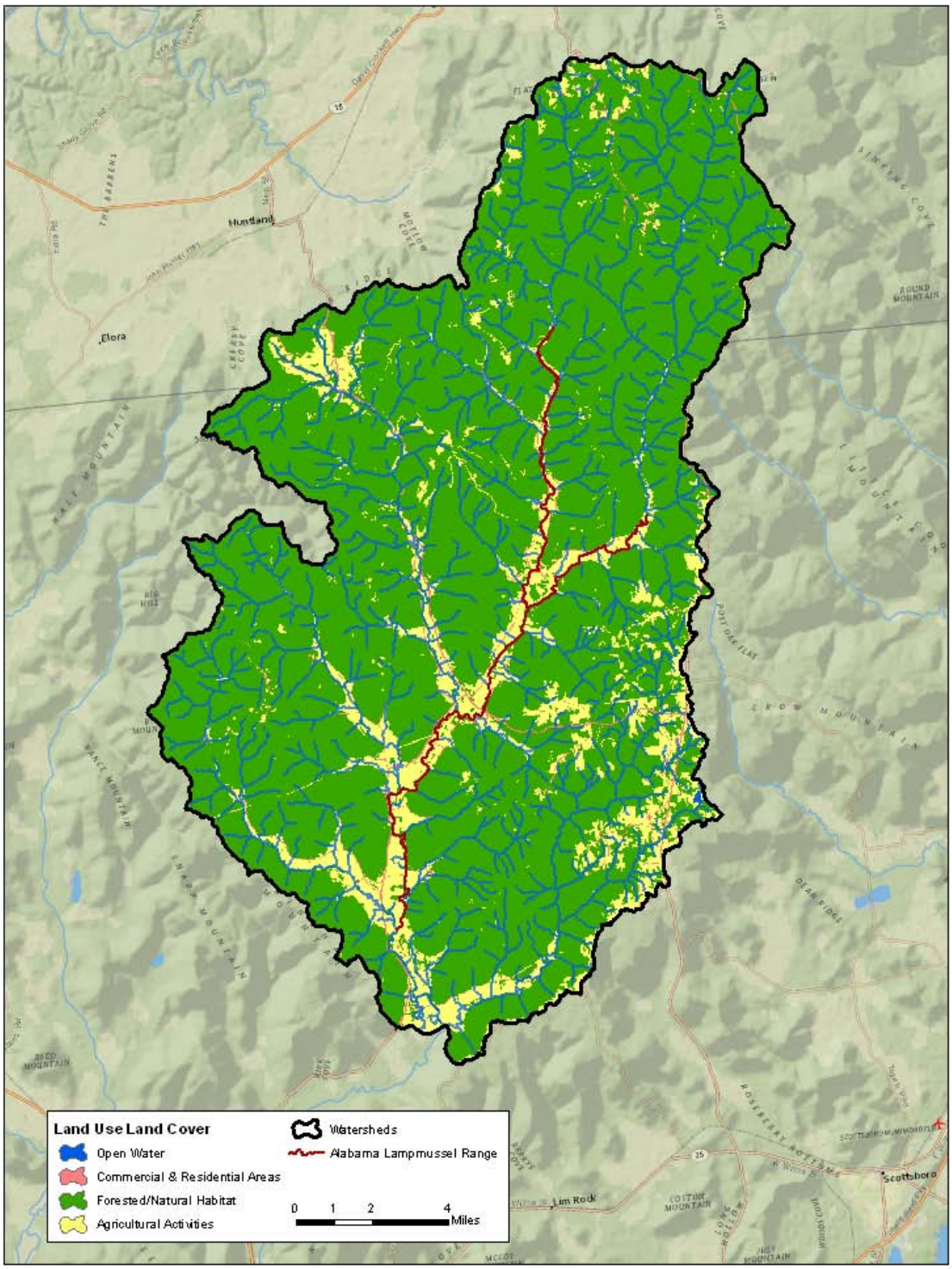

Figure 4. Land use and land cover within the Paint Rock River watershed. Created by the USFWS Alabama Ecological Services Field Office (August 2012).

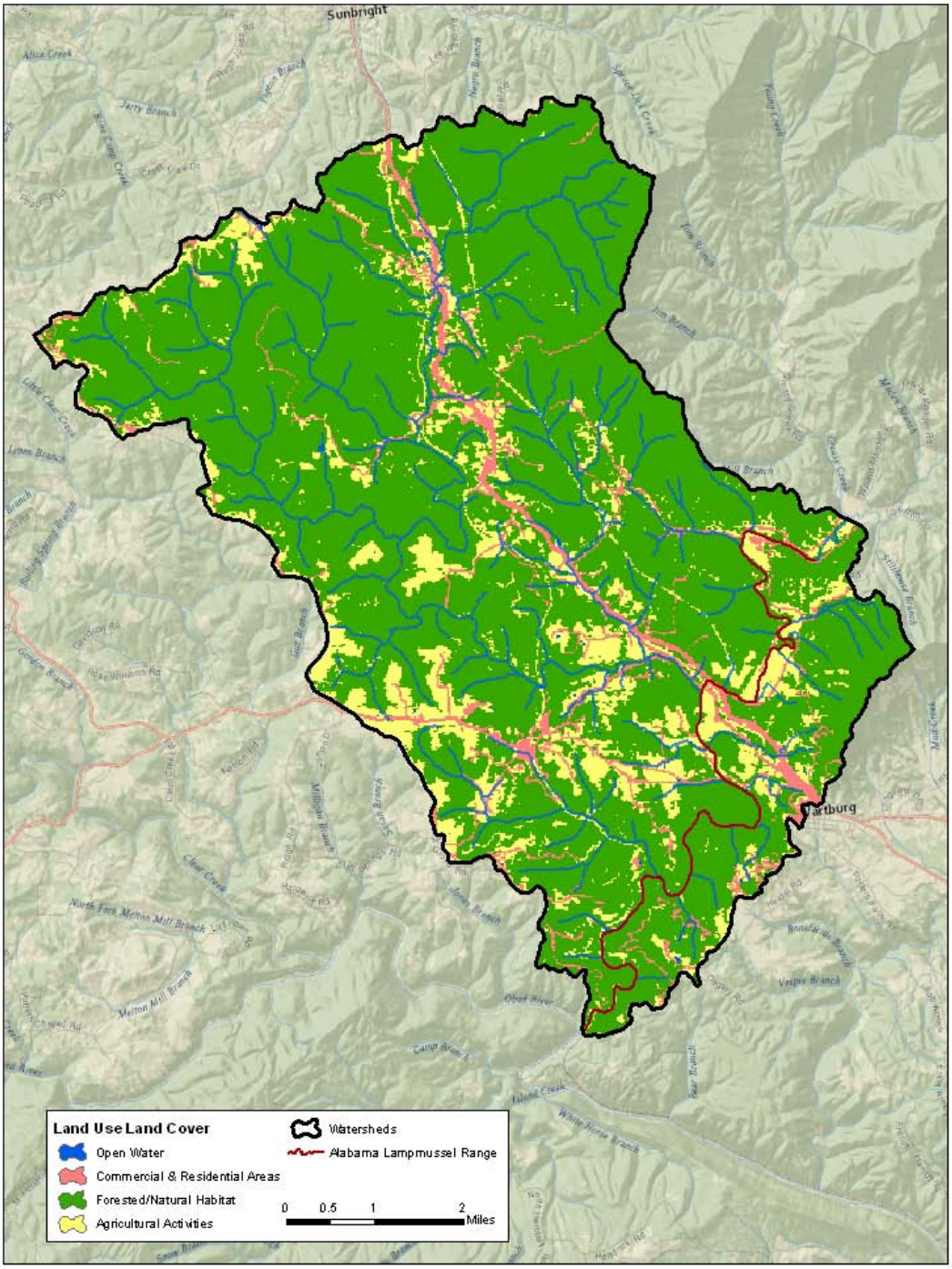

Figure 5. Land use and land cover within the Emory River watershed. Created by the USFWS Alabama Ecological Services Field Office (August 2012).

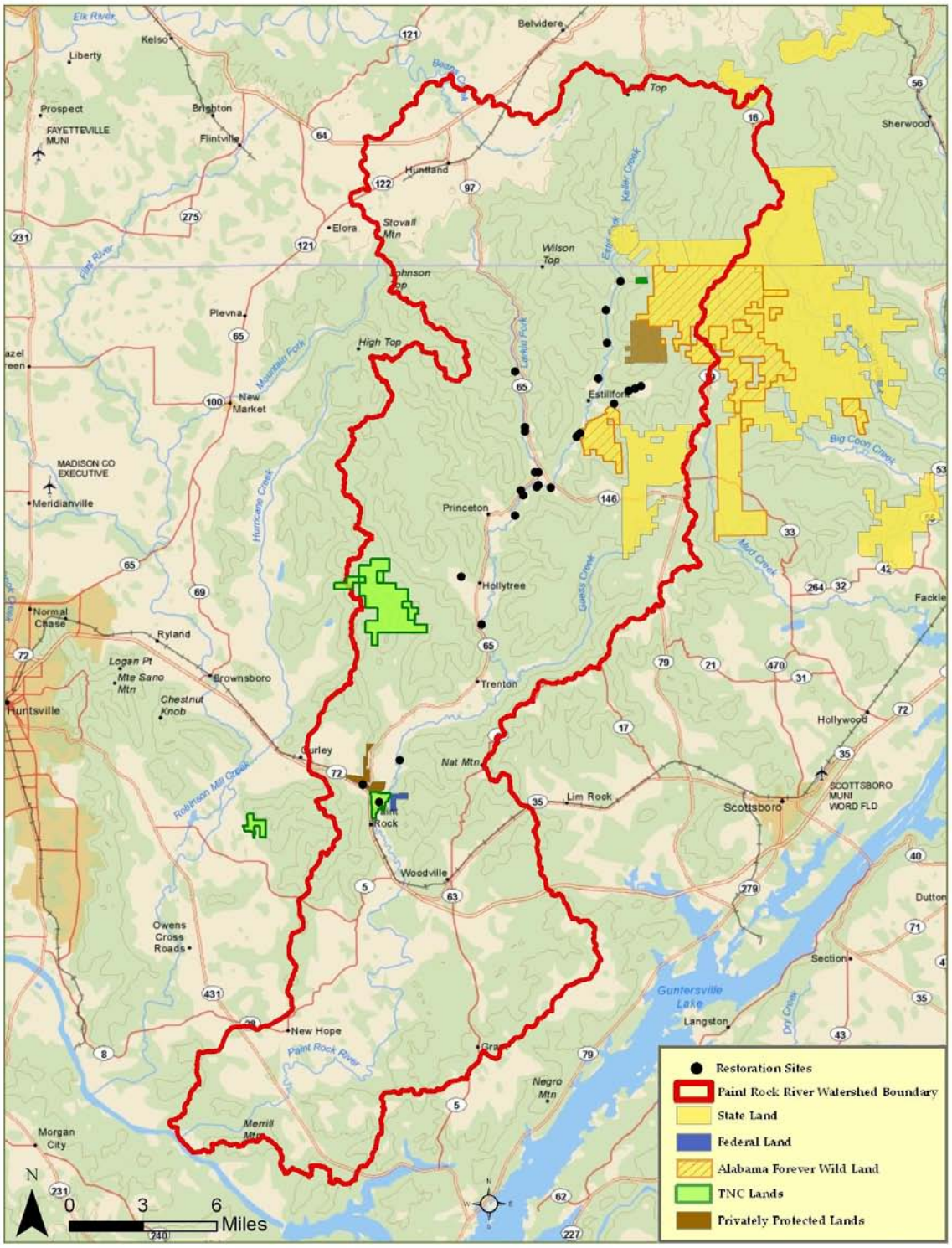

Figure 6. Protected lands and restoration sites within the Paint Rock River Watershed. Created by Georgia Pearson, The Nature Conservancy (February 2011).

Photo Credit: Daniel Graf, Smithsonian Institution Department of Invertebrate Zoology

Figure 7. Type specimen of the Alabama lampmussel collected from the Tennessee River at Tuscumbia, Alabama, located in the Smithsonian National Museum of Natural History (USNM 84927).

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of the Alabama Lampmussel (*Lampsilis virescens*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

__X__ No change needed

Review Conducted By: Anthony D. Ford, USFWS Alabama ES Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 8-23-2012

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

for **Lead Regional Director, Fish and Wildlife Service**

Approve _____ Date 8/28/12

APPENDIX A: Summary of peer review for the 5-year review of the Alabama Lampmussel (*Lampsilis virescens*)

A. Peer Review Method: see below

B. Peer Review Charge:
Requests were made to each peer reviewer of the 5-year review via personal phone conversation and email request (March 18, 2011).

We chose peer reviewers based on their expertise and the broad knowledge that they could offer in giving a complete and thorough review. Each reviewer was asked to give a complete review with focus on areas of personal expertise.

Mr. Bill Bouthillier is a fisheries biologist with the USFWS Warm Springs National Fish Hatchery. Mr. Bouthillier is a principle investigator on an assessment of fish barriers in the Paint Rock River watershed.

Mr. Doug Fears is the Program Director for TNC Paint Rock River Office. Mr. Fears has intimate knowledge of the Paint Rock River watershed, including land manager responsibilities for two TNC nature preserves. Mr. Fears has firsthand knowledge of impacts to the watershed and has developed a good rapport and working relationship with many of the private landowners within the watershed.

Mr. Jim Godwin is a zoologist with the Alabama Natural Heritage Program. Mr. Godwin has conducted multiple surveys within the PRR watershed including an extensive survey of rare and federally protected mussels.

Dr. Johnson is the program supervisor of the ADCNR's Alabama Aquatic Biodiversity Center (AABC) and is a recognized mollusk expert. Dr. Johnson also has broad ranging knowledge and experience in mollusk propagation and reintroduction.

Mr. Stuart McGregor is a malacologist with the Geological Survey of Alabama. Mr. McGregor has expert knowledge of mussels in Alabama and has extensive survey experience in the PRR drainage.

C. Summary of Peer Review Comments/Report

Mr. Bill Bouthillier, USFWS, Warm Springs National Fish Hatchery, Warm Springs, GA: Mr. Bouthillier summarized the fish passage survey work conducted in the PRR basin during 2010. He expressed concern that the barriers identified during that survey effort may be a threat to the lampmussel by restricting movement of its fish hosts.

Mr. Doug Fears, TNC, Paint Rock River Program Director, Paint Rock, AL: Mr. Fears referenced a follow-up survey by Jim Godwin in 2003/2004 to his previous effort (Godwin 2002) that produced three live lampmussels (2 gravid females and 1 male). This survey was reported in the Alabama Natural Heritage Program 2004 Annual Report.

Mr. Fears also provided comment that the species range figure in the draft document does not display the newly introduced populations within the lower PRR and Elk River. Also, he identified gravel dredging as an additional threat in the basin and expounded on the threats associated with instream fish barriers.

Mr. Jim Godwin, Alabama Natural Heritage Program, Auburn University, Auburn, AL: Majority of comments were editorial corrections/suggestions.

Dr. Paul D. Johnson, ADCNR, Alabama Aquatic Biodiversity Center, Marion, AL: Majority of comments were editorial corrections/suggestions.

Mr. Stuart McGregor, Geological Survey of Alabama, Tuscaloosa, AL: Majority of comments were editorial corrections/suggestions.

Copies of reviewer comments are available upon request from the Alabama Ecological Services Field Office.

D. Response to Peer Review

Mr. Bill Bouthillier, USFWS, Warm Springs National Fish Hatchery, Warm Springs, GA: Agreed with all comments and incorporated.

Mr. Doug Fears, TNC, Paint Rock River Program Director, Paint Rock, AL: The gravid lampmussels collected by Mr. Godwin in 2004 were transported from the field to the Tennessee Aquarium Research Institute and were used as brood stock for propagation effort detailed in Johnson 2004 and documented in Section II.B.c.2. We decided not to include the two newly reintroduced populations in the figures (Figure 1, 2) depicting the current extant range of the lampmussel because these reintroductions have not displayed the natural reproductive success required by the recovery plan to be considered viable populations as defined in the second recovery criterion (USFWS 1985). Agreed with all other comments and incorporated.

Mr. Jim Godwin, Alabama Natural Heritage Program, Auburn University, Auburn, AL: Agreed with all comments and incorporated.

Dr. Paul D. Johnson, ADCNR, Alabama Aquatic Biodiversity Center, Marion, AL: Agreed with all comments and incorporated.

Mr. Stuart McGregor, Geological Survey of Alabama, Tuscaloosa, AL: Agreed with all comments and incorporated.