Finelined Pocketbook (*Hamiota (=Lampsilis) altilis*)
Orangenacre Mucket (*Hamiota (=Lampsilis) perovalis*)
Alabama Moccasinshell (*Medionidus acutissimus*)
Coosa Moccasinshell (*Medionidus parvulus*)
Southern Clubshell (*Pleurobema decisum*)
Dark Pigtoe (*Pleurobema furvum*)
Southern Pigtoe (*Pleurobema georgianum*)
Ovate Clubshell (*Pleurobema perovatum*)
Triangular Kidneyshell (*Ptychobranchus greenii*)

5-Year Review:
Summary and Evaluation

Little Canoe Creek near Steele Alabama, along St. Clair/Etowah County line. *Photo Credit: Todd Fobian, ADCNR.*

U.S. Fish and Wildlife Service
South Atlantic – Gulf Region (Region 2)
Alabama Ecological Services Field Office
Daphne, Alabama

5-YEAR REVIEW

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I. GENERAL INFORMATION

A. Methodology used to complete the review:

This review was completed by the lead recovery biologist in the Alabama Ecological Services Field Office (ALFO), Daphne, Alabama. In conducting this 5-year review, we relied on the best available information pertaining to historical and current distributions, life histories, genetics, habitats, and potential threats to these species. We announced initiation of this review on September 23, 2014 and requested information from the public in a published *Federal Register* notice with a 60-day comment period (79 FR 56821). The primary sources of information for this analysis included, the final listing rule for these species under the Endangered Species Act (Act) (58 FR 14330), the separate critical habitat designation in 2004 (69 FR 40084), Mobile River Basin Aquatic Ecosystem Recovery Plan (USFWS 2000), the previous 5-Year Review (USFWS 2008), peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts.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 ALFO. The completed draft review was sent to cooperating Service Field Offices (GA, TN, and MS) for their review. Comments and suggestions regarding this review were also received from three peer reviewers from outside the U.S. Fish and Wildlife Service (USFWS or Service). See Appendix A for a summary of peer reviewer comments. Public comments were also received and incorporated as appropriate, see Appendix A for a summary of those comments. No part of the review was contracted to an outside party.

B. Reviewers

Lead Region:
South Atlantic-Gulf & Mississippi-Basin, Atlanta, GA: Kelly Bibb (404) 679-7132

Lead Field Office:
Alabama Ecological Services, Daphne, AL: Anthony Ford (251) 441-5838

Cooperating Field Offices:
Mississippi Ecological Services, Jackson, MS: Paul Hartfield (601) 321-1125
Georgia Ecological Services, Athens, GA: Robin Goodloe (706) 208-7504
Tennessee Ecological Services, Cookeville, TN: Warren Stiles (931) 525-4977

C. Background

Federal Register Notice citation announcing initiation of this review:
79 FR 56821, September 23, 2014.

Species status:

Finelined Pocketbook: Improving
Orangenacre Mucket: Stable
Alabama Moccasinshell: Stable
Coosa Moccasinshell: Declining
Southern Clubshell: Improving
Dark Pigtoe: Declining
Southern Pigtoe: Declining
Ovate Clubshell: Stable
Triangular Kidneyshell: Stable

Recovery achieved (1-4): 1= 0-25%; 2= 26-50%; 3= 51-75%; 4= 76-100% species recovery objectives achieved

Finelined pocketbook: 2
(new tributary populations identified, new life history work, propagation and reintroduction efforts, robust Tallapoosa River and upper Coosa River Basin populations)

Orangenacre mucket: 2
(new tributary populations identified, new life history work, propagation and reintroduction efforts, robust Sipsey Fork populations)

Alabama moccasinshell: 2
(new tributary populations identified, new life history work, propagation and reintroduction efforts, robust Sipsey Fork, Buttahatchee River, and Sipsey River populations)

Coosa moccasinshell: 1
(new life history work, propagation and reintroduction effort into lower Little Cahaba, small Ark Population established, effort can't be sustained due to lack of reliable broodstock)

Southern clubshell: 3
(rediscovered in the Cahaba River watershed, new tributary populations identified, new life history work, habitat improvements (dam removals, flow restoration (Coosa River-Weiss Bypass), and water quality improvements (Cahaba River WWTP upgrades)), robust populations within the Conasauga

River, Sipsey River, Coosa River (Weiss Bypass), Big Canoe Creek, Cahaba River, Bogue Chitto Creek, Bull Mountain Creek, and Buttahatchee River)

Dark pigtoe: 1
(rediscovered in the Locust Fork)

Southern pigtoe: 1

Ovate clubshell: 1

Triangular kidneyshell: 1
(new life history work, propagation and ongoing systematic review)

Listing history:
Original Listing
FR notice: 58 FR 14330
Date listed: March 17, 1993
Entity listed (species, subspecies, DPS): all listed as species
Classification (threatened or endangered):
threatened: finelined pocketbook, orangenacre mucket, Alabama moccasinshell
endangered: Coosa moccasinshell, southern clubshell, dark pigtoe, southern pigtoe, ovate clubshell, and triangular kidneyshell.

Associated rulemakings: Designation of Critical Habitat for Three Threatened Mussels and Eight Endangered Mussels in the Mobile River Basin: 1 July 2004: 69 FR 40083

Review History:
Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we did a recovery data call that included status recommendations such as "Declining or Unknown" for these mussels. We continue to show that species status recommendation as part of our 5-year reviews. The most recent evaluation for these mussels was completed in 2008.

Recovery Plan: 2000
5-Year Reviews: 2008

Species' Recovery Priority Number at start of review (48 FR 43098):

Finelined pocketbook – 8
Orangenacre mucket - 8
Alabama moccasinshell - 8
Coosa moccasinshell – 5
Southern clubshell - 8
Dark pigtoe - 5
Southern pigtoe - 5
Ovate clubshell - 5
Triangular kidneyshell – 8

[The number 5 reflects a high degree of threat, low recovery potential for a species; and 8 reflects a moderate degree of threat, high recovery potential for a species.]

Recovery Plan
Name of plan: Mobile River Basin Aquatic Ecosystem Recovery Plan
Date issued: November 17, 2000

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 are invertebrates, 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? No.

These species have a final, approved recovery plan, however, recovery criteria were not specified for any of the 9 mussels because of the extent of their decline, habitat loss and fragmentation, population isolation, and continuing impacts on their habitats. Protecting surviving populations of the mussels along with their river and stream habitats was the primary recovery objective, to be measured by the continued persistence of the mussel populations over time, and the discovery of previously unknown populations. Other obstacles to recovery and the development of recovery criteria were a lack of information on habitat and life history needs, host fish identification, and management options. Increasing this information and developing management technology were benchmarks for measuring progress toward

recovery. Draft recovery criteria have been developed and are currently under review.

C. Updated Information and Current Species Status

a. Biology and Habitat

a) Biology and Life History:

Finelined Pocketbook (Figure 1)

The finelined pocketbook is suboval in shape and can grow to 117 mm (millimeters) in length (Williams *et al.* 2008). It is yellow-brown to blackish and occurs in small creeks to large rivers. It has been found in sand, gravel, and gravel-cobble substrates without heavy silt deposits (Williams *et al.* 2008). The ventral margin of the shell is angled posteriorly in females, resulting in a pointed posterior margin. The periostracum is yellow-brown to blackish and has fine rays on the posterior half. The nacre is white, becoming iridescent posteriorly. The finelined pocketbook can be distinguished from a similar species, the orangenacre mucket, by its more elongate shape, thinner shell, white nacre, pointed posterior, and ray ornamentation (68 FR 14752).

The finelined pocketbook is bradytictic (long-term brooder), with females releasing glochidia either as superconglutinates, conglutinates, or a demibranch display from March through May (Haag *et al.*, 1995, MRBMRC 2010). Redeye bass (*Micropterus coosae*), Alabama bass (*M. henshalli*), spotted bass (*M. puctulatus*), largemouth bass (*M. salmoides*), and green sunfish (*Lepomis cyanellus*) have been identified as suitable hosts (Haag *et al.*, 1999, MRBMRC 2010).

Orangenacre Mucket (Figure 2)

The orangenacre mucket is a medium-sized mussel, up to 90 mm in length. The shell is oval in shape, moderately thick, and inflated. The posterior margin of the shell of mature females is obliquely truncate (shortened). The nacre is usually colored orange, rose, pink, or occasionally white. The periostracum varies from yellow to dark reddish brown, and with or without green rays (68 FR 14752).

The orangenacre mucket is bradytictic, with females releasing glochidia as superconglutinates from March through May, with releases appearing concentrated in early April ((Haag *et al.* 1995, Hartfield and Butler 1997, MRBMRC 2010)). Redeye bass, Alabama bass, spotted bass, and largemouth bass have been identified as suitable host fish for the orangenacre mucket (Haag and Warren 1997, MRBMRC 2010).

Alabama Moccasinshell (Figure 3)

The Alabama moccasinshell is a small, delicate species, measuring up to 55 mm in length (Williams *et al.* 2008). The shell is narrowly elliptical, and thin, with a well-developed acute posterior ridge that terminates in an acute point on the posterior ventral margin. The posterior slope is finely corrugated. The periostracum is yellow to brownish yellow, with broken green rays across the entire surface of the shell. The thin nacre is translucent along the margins and salmon-colored in the umbos (beak cavity) (68 FR 14752).

Alabama moccasinshell females are gravid from October to June. This species lives completely embedded in stream bottoms for most of the year. Gravid females migrate to the surface of the stream bottom between March and June, anchor themselves to gravel by a byssal thread (protein thread), and lie exposed, displaying a black mantle lure apparently to attract potential host fish (Haag and Warren 2001). Blackspotted topminnows (*Fundulus olivaceus*), Tuskaloosa darter (*Etheostoma douglasi*), Redspot darter (*E. artesiae*), Gulf darter (*E. swaini*), redfin darter (*E. whipplei*), blackbanded darter (*Percina nigrofaciata*), naked sand darter (*Ammocrypta beani*), southern sand darter (*A. meridiana*), johnny darter (*E. nigrum*), speckled darter (*E. stigmaeum*), saddleback darter (*Percina vigil*), and logperch (*P. caprodes*) have been identified as suitable host fish (Haag and Warren (1997, 2001) and Williams *et al.* 2008).

Additionally, the Alabama Aquatic Biodiversity Center conducted culture trials in 2015 and 2016 with the Alabama moccasinshell; they determined during Conasauga brood stock host trials that bronze darter (*Percina palmaris*) is a good host and that blackbanded darter and greenbreast darter (*Ethostoma jordani*) are poor hosts. They also determined during Buttahatchee River brood stock host fish trials that blackbanded darter, greenbreast darter and banded sculpin (*Cottus carolinae*) are good hosts and blackspotted topminnow is a poor host (Johnson 2018).

Coosa Moccasinshell (Figure 4)

The Coosa moccasinshell is a small species measuring up to 58 mm in length (Williams *et al.* 2008). The shell is thin and fragile, elongate and elliptical to rhomboidal in outline. The posterior ridge is inflated and smoothly rounded, terminating in a broadly rounded point; the posterior slope is finely corrugated. The periostracum is light to dark brown and raying is usually not visible. The nacre is greenish-gray, and may occasionally lighten around the ventral shell margin (68 FR 14752).

Coosa moccasinshells are usually burrowed completely in the stream bottom. Because this species is apparently closely related to the Alabama moccasinshell, gravid females of this species are likely to migrate to the surface of the stream bottom during spring glochidial release periods similar to the Alabama moccasinshell (68 FR 14752). The AABC conducted host trials in 2012, 2014, and 2015 for the Coosa moccasinshell. These trials indicate that bronze darters and Mobile logperch are good hosts. Greenbreast darters and blackbanded darters are marginal hosts and Warrior bridled darter (*Percina sp cf. macrocephala*) is a poor host (Johnson 2018).

Southern Clubshell (Figure 5)

The southern clubshell is a medium sized mussel with lengths up to 93 mm long (Williams *et al.* 2008), with a thick shell, and heavy hinge plate and teeth. The shell outline is roughly rectangular, produced posteriorly with the umbos usually terminal to the anterior margin. The posterior ridge is moderately inflated and ends abruptly with little development of the posterior slope at the dorsum of the shell. The periostracum is yellow to yellow-brown with occasional green rays or spots on the umbo in young specimens (68 FR 14752).

Gravid southern clubshell females with mature glochidia have been collected in June and July. Glochidia are released in well-formed conglutinates orange or white in coloration (Haag and Warren 2001). Blacktail shiner (*Cyprinella venusta*), Alabama shiner (*C. callistia*), and tricolor shiner (*C. trichroistia*) have been identified as fish host (Haag and Warren 2001, P. Johnson pers. comm. 2002). However, a small host trial by the AABC in 2010 showed the blacktail shiner to be poor hosts (Johnson 2018).

Dark Pigtoe (Figure 6)

The dark pigtoe is a small to medium sized mussel, occasionally reaching up to 60 mm in length. The shell is oval in outline, and moderately inflated. Beaks are located in the anterior portion of the shell. The posterior ridge is abruptly rounded and terminates in a broadly rounded, subcentral, posterior point. The periostracum is dark, reddish brown with numerous and closely spaced, dark growth lines. The hinge plate is wide and the teeth are heavy and large, especially in older specimens. The nacre approaches white in the umbos, and is highly iridescent on the posterior margin (68 FR 14752).

This species is gravid in June and releases glochidia in peach to pink-colored conglutinates (Haag and Warren 1997). The largescale stoneroller (*Campostoma oligolepis*), Alabama shiner, blacktail shiner, creek chub

(*Semotilus atromaculatus*), and blackspotted topminnow have been confirmed as suitable hosts (Haag and Warren 1997). However, the AABC conducted a small trial in 2015 with brood stock from the Locust Fork on a mixed batch of potential shiner hosts: Alabama shiners, blacktail shiners, and tricolor shiners, and produced only nine juveniles indicating that all were poor hosts (Johnson 2018).

Southern Pigtoe (Figure 7)

The southern pigtoe is a small to medium-sized mussel measuring up to 65 mm in length (Williams *et al.* 2008). The shell is elliptical to oval in outline and somewhat compressed. The posterior slope is smoothly rounded. The pseudocardinal teeth (protrusions on the dorsal interior surface of the shell) are small but well-developed, and the nacre is white. The periostracum is yellow to yellow-brown. Growth lines are numerous and may be dark brown. Small specimens may have green spots at the growth lines along the posterior ridge and near the umbo (68 FR 14752).

The southern pigtoe occurs in riffles, runs, and shoals of medium creeks to large rivers in sand and gravel substrates and is a short-term brooder, gravid during spring and early summer (Williams *et al.* 2008). The Alabama shiner, blacktail shiner, and tricolor shiner have been reported as hosts for this species (MRBMRC 2010). However, attempts in 2010 and 2015 to culture this species, found the blacktail shiner to be a poor host, producing only 49 juveniles from 31 infested blacktail shiners (Johnson 2018).

Ovate Clubshell (Figure 8)

The ovate clubshell is a small to medium-sized mussel reaching lengths up to 60 mm (Williams *et al.* 2008). The shell is oval to elliptical in shape, and has nearly terminal, inflated umbos. The posterior ridge is well-developed, broadly rounded, and often concave. The posterior slope is produced well beyond the posterior ridge. Periostracum color varies from yellow to dark brown, and occasionally has broad green rays that may cover most of the umbo and posterior ridge. The nacre is white to bluish white (68 FR 14752).

The ovate clubshell occurs in riffles, runs, and shoals of small creeks to large rivers, usually in sand and gravel substrates (Williams *et al.* 2008). Gravid females of this species have been observed in June and July. Host fishes for this species are unknown, but other *Pleurobema* spp. are known to use members of the shiner family Cyprinidae (68 FR 14752, Haag and Warren 2003).

Triangular Kidneyshell (Figure 9)

The triangular kidneyshell is oval to elliptical in outline, and can reach between 85-100 mm in length (Williams *et al.* 2008). The shell is moderately compressed, and may be flattened ventral to the umbos. The posterior ridge is high, rounded and the posterior slope is moderately steep. The pseudocardinal teeth are heavy, and the laterals are heavy, straight to slightly curved and short. The periostracum is tawny to brown, usually without rays, but when present are thin, sparse, and usually confined to the posterior slope (Williams *et al.* 2008).

The triangular kidneyshell occurs in shoal habitats in small creeks to large rivers, usually in sand and gravel substrates (Williams *et al.* 2008). It is a long-term brooder gravid from autumn to the following spring or summer (Haag and Warren 1997). Glochidia are packaged into conglutinates that mimic small aquatic fly larvae (Hartfield and Hartfield 1996) or fish eggs (Haag and Warren 1997). Suitable fish hosts have been identified as Warrior darter, Tuskaloosa darter, blackbanded darter and logperch (Haag and Warren 1997). The AABC cultured Cahaba River brood stock in 2014 and found the blackbanded darter, greenbreast darter and Mobile logperch to be good hosts (Johnson 2018).

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

Finelined Pocketbook

There is little trend data available for the finelined pocketbook outside of the monitoring by the U.S. Forest Service in streams under its jurisdiction within the Talladega National Forest (Warren *et al.* 2004, Krause *et al.* 2012, and Moran 2010-2018). Finelined pocketbook has been estimated to occur at densities of 0-0.3 individuals/m^2 in Shoal Creek (Krause *et al.* 2012). These and other surveys usually find small and localized populations and with low densities. Gangloff (2003) noted that while populations in National Forest headwater streams appear to be stable, other populations may be limited or declining due to agriculture and mining operations. Gangloff and Feminella (2007) found the finelined pocketbook to be widely distributed in Coosa and Tallapoosa tributaries, occurring at 25 of 46 semi-quantitative sites and around 16 qualitative sites, but was seldom abundant (around 1-2 mussels per 50 meters of stream). During a 2005 survey of 30 locations in the Conasauga River, Tennessee and Georgia, 9 finelined pocketbook were collected from 8 locations (Johnson *et al.* 2005). The Nature Conservancy monitored freshwater mussels and snails (quantitatively and qualitatively) in the Cahaba River at a restoration site (i.e., Marvel Slab) from 2005-2010 and found the finelined pocketbook only in low densities (0.03/m^2) or 2 or less individuals per timed search effort over that time (Freeman 2011). However, the Ellijay River and Boardtown Creek population (Gilmer

County, GA) appears to be a substantial, reproducing population, and an extension of the previously known range. This is the first population to be located upstream of Carters Lake on the Coosawattee River in Georgia (J. Wisniewski pers. comm. 2019). Additionally, the species has also been recently discovered to occur within approximately 10 km of Shoal Creek in the Etowah River Basin, Georgia, the only known population to occur upstream of Lake Allatoona, Etowah River, Georgia (J. Wisniewski pers. comm. 2019).

New tributary populations have been documented since listing, these include: Shades Creek (Shelby/Bibb Counties, Alabama); both Little Canoe creeks (upper and lower Big Canoe Creek watershed) (St. Clair and St. Clair/Etowah County, AL); Chestnut Creek (Chilton County, Alabama); Ellijay River and its tributary, Boardtown Creek (Gilmer County, GA); Shoal Creek, (Cherokee County, GA); Hubbard Creek (Clay County, Alabama); Horse Creek (Talledega County, Alabama); Bobo Creek (Cleburne County, Alabama); Sandy and Little Sandy Creeks (Chambers County, Alabama); Cossey Branch (Macon County, Alabama); Euharlee Creek (Bartow/Polk County, Georgia); Little River, Little Creek, Beach Creek, Brooks Creek, and Watermill Creek (Haralson County, Georgia) (citations in spatial distribution section below). The once robust population of finelined pocketbook in Chewacla Creek (Lee County, Alabama), immediately downstream of Lake Ogletree, has declined significantly since 2003 and has not been documented in the recent surveys (Webber 2018).

Orangenacre Mucket

Most populations of the orangenacre mucket are small and localized where they are found. Trend data is generally lacking, but is available from the National Forest Service, where the orangenacre mucket continues to be one of the most common mussels in the Forest Service's Bankhead National Forest monitoring (Moran 2010, 2011, 2012, 2013, 2015, 2016, 2017, 2018). Even though the Sipsey Fork and its tributary populations continue to be the most robust, Haag and Warren (2008) documented significant declines following the 2000 drought when orangenacre mucket abundance declined in density between 0.19-0.79 individuals/m^2, in pre-drought (1993) versus post-drought (2001 or 2002) scenarios. Severe drought remains a continued threat to populations within small creeks (small drainage areas), as they may not be able to remain wetted during these events, and even may be more susceptible to secondary effect of drought (i.e., low dissolved oxygen, warm temperatures, and high biological oxygen demand) (Haag and Warren 2008).

The orangenacre is not believed to have lost any known populations since the time of listing, but a few new tributary populations have been

discovered from the lower Tombigbee and Alabama drainages, including Bogue Chitto Creek (Choctaw County, Alabama); Limestone Creek and Big Flat Creek (Monroe County, Alabama), and Big Swamp Creek (Lowndes County, Alabama) (AST 2016 and 2019, Fobian *et al.* 2013, and A Ford, pers. observ. 2010). Orangenacre mucket has also been stocked into Tallatchee Creek (Monroe County, Alabama) (Johnson 2012c and 2018) and multiple Locust Fork sites (Blount and Jefferson Counties, Alabama) (Johnson 2014 and 2018).

Alabama Moccasinshell

Except for the Sipsey Fork, Buttahatchee River, and Sipsey River, populations of Alabama moccasinshell are relatively small and localized. A recent qualitative survey by the U.S. Forest Service in Brushy Creek found 29 individual Alabama moccasinshell out of 58 total mussels (Moran 2017). Gangloff (2015) in 2013-2014 found the Alabama moccasinshell to be one of the most frequently encountered mussels among his samples in the Buttahatchee River Drainage. The Alabama moccasinshell totaled 107 individuals and were found among 15 of 18 sites at a mean density of $0.44/m^2$. Gangloff (2015) stated that they appear to have increased in relative abundance during the last three decades. Dr. Carla Atkinson (University of Alabama) quantitatively sampled 12 sites in the Sipsey River in 2016 and found a robust population. Alabama moccasinshell was among the most common mussels surveyed with densities ranging between $0.29\text{-}2.55/m^2$ among 12 sites (C. Atkinson pers. comm. 2018).

New tributary populations have been discovered in both Trussels Creek (Greene County, Alabama) (McGregor and Haag 2004) and Wilson Creek (Lamar County, Alabama) (Buntin *et al.* 2015). Small culture/host trials have been successfully conducted recently (2015 and 2016) for this species using Conasauga River and Buttahatchee River brood stock, though no stockings have taken place to date (Johnson 2018).

Coosa Moccasinshell

The total distribution of the Coosa moccasinshell is less than 8 stream miles of the Conasauga River and Holly Creek combined (Johnson 2012a). The frequency of collection of Coosa moccasinshell has declined in both tributaries where it is known to survive (Johnson and Evans 2000, P. Johnson, pers. comm. 2018). The species was found at 3 sites out of 31 localities surveyed on the Conasauga River, and at 2 of 7 localities searched on Holly Creek during a 2005 survey effort in and adjacent to the Cherokee and Chattahoochee National Forests (Johnson *et al.* 2005). Evidence of limited recruitment was observed in the Conasauga River in 2005, but recent recruitment has not been observed in Holly Creek

(MRBMRC 2010). Recent efforts to collect brood stock from the Conasauga River by AABC has become more difficult and has required significant agency staff and effort, indicating a decline in numbers (Johnson pers. comm. 2018). While the Coosa moccasinshell is believed extirpated from Alabama, reintroductions are underway in the Little Cahaba River (Bibb County, Alabama) by the AABC using Conasauga River brood stock (Johnson 2012a, 2018, Shelton-Nix 2017).

Southern Clubshell

The southern clubshell is relatively common to abundant and appears to be wider spread and contain stronger densities since its time of listing. The strongest populations can be found in localized reaches of the Conasauga River, Coosa River (Weiss Bypass), Big Canoe Creek, Cahaba River, Bogue Chitto Creek, Bull Mountain Creek, Buttahatchee River, and Sipsey River (Devries 2012, Devries and Stoeckel 2018, Fobian *et al.* 2017, Buntin 2017, Hamstead 2013, Gangloff 2015, Buntin *et al.* 2017, C. Atkinson pers. comm. 2018, J. Wisniewski pers. comm. 2019). The southern clubshell was collected at 10 of 31 randomly selected mainstem Conasauga River occupancy survey sites sampled in 2016 from the headwaters of the Conasauga downstream to its confluence with the Coosawattee River. The reach of the Conasauga River from Beaverdale downstream to approximately Resaca (Georgia) had relatively high densities of live animals and abundant shell material of multiple year classes (J. Wisniewski pers. comm. 2019). In 2000, the average density at four sites in the Coosa River below Weiss Dam was 0.19/m^2 with the highest site resulting in a density of 0.5/m^2 (Herod *et al.* 2001). A resampling of the confluence with Terrapin Creek, in 2011 and 2017, resulted with densities of 0.64 and 1.33/m^2 and 0.60 and 0.53/m^2, respectively (DeVries 2012, Devries and Stoeckel 2018). The AABC conducted quantitative monitoring efforts for southern clubshell in 2014; two sites sampled in lower Big Canoe Creek (St. Clair County, Alabama) yielded 0.53 and 0.8/m^2 respectfully, Bogue Chitto Creek (Dallas County, Alabama) yielded densities of 0.44/m^2, and Cahaba River (Bibb County, Alabama) yielded densities of 0.5/m^2 (Buntin 2017). The southern clubshell was the most abundant mussel species at nine sites in Bull Mountain Creek where it compromised 41.6 percent (n=563) of the total catch (Hamstead 2013). In the Buttahatchee River drainage, Alabama and Mississippi, the southern clubshell was the third most frequently encountered mussel with a mean density of 0.41/m^2. The highest densities of southern clubshell were recorded by Dr. Carla Atkinson (University of Alabama) in the Sipsey River, where 12 sites were quantitatively sampled in 2016. This effort reported over 2,900 southern clubshell collected with densities ranging between 0.36-17.71/m^2 among sites (C. Atkinson pers. comm. 2018). These data indicate these eight populations are robust and are likely increasing.

Dark Pigtoe

The dark pigtoe has seen declines to the species since the time of listing. The most robust population remains to be the Sipsey Fork (Winston/Lawrence Counties, Alabama), where it continues to show viability with recent recruitment and being composed of multiple age classes (Moran 2015). However, significant declines were documented within Bankhead National Forest in the Sipsey Fork and its tributaries (Flannagin Creek and Rush Creek) following the severe drought in 2000 (Haag and Warren 2008). Densities of dark pigtoe dropped from 0.12 to 0 individuals/m^2 in Flannagin Creek, 0.08 to 0 individuals/m^2 in Rush Creek, and 0.48 to 0.18 individuals/m^2 in Sipsey Fork. The dark pigtoe also went from being one of the most abundant mussel species (4^{th} most abundant out of 15 total species) during sampling from 1991 to 1996 (26 individuals), to only one individual being found (out of 61 sampling sites) during the 2008 survey effort (McGregor and Wynn 2008). The species has been recently rediscovered (2014) from the Locust Fork (Blount County, Alabama), and brood stock was collected from this site for a host fish trial in 2015, but only minimum success was had, producing only 10 juveniles (Johnson 2018).

Southern Pigtoe

All populations of southern pigtoe appear to be small and localized. The most robust population of southern pigtoe is Shoal Creek (Cleburne County, Alabama) located in an isolated 10 km reach in Talladega National Forest between Sweetwater and Highrock Lakes (MRBMRC 2010). Warren *et al.* (2004) had previously estimated the Shoal Creek population size to be 800 individuals in 2003, but this population seems to have declined in recent years due to recent exceptional drought conditions in 2007-2008 and 2017 (United States Drought Monitor 2019 (https://droughtmonitor.unl.edu), J. Moran and P. Johnson pers. comm. 2019). Biologists were unable to estimate density during a 2011 follow-up survey due to the lack of animals found during quantitative sampling; however, qualitative searches did indicate low relative abundance (collecting only two individuals) (Krause *et al.* 2012). New tributary occurrences have been documented in Armuchee Creek (Floyd County, Georgia), Terrapin Creek (Calhoun County, Alabama), Yellowleaf Creek (Shelby County, Alabama), and Hatchet Creek (Coosa County, Alabama) since listing (Gangloff 2005; Buntin 2015; Johnson 2018; USFWS Alabama Field Office database). While attempts to culture this mussel were made in 2010 and 2015, these attempts were only of limited success, producing only 49 juveniles.

Ovate Clubshell

The Sipsey River (Tuscaloosa, Greene, and Pickens County, Alabama) has the most robust populations (MRDMRC 2010), and is locally common at some locations in the lower Sipsey River (McCullagh *et al.* 2002), where recent (2016) surveys recorded densities between 0-0.2 individuals/m^2 (C. Atkinson pers. comm. 2018). During a 2013-2014 survey of the Buttahatchee River drainage (Alabama and Mississippi), a total of 28 ovate clubshell were found at 13 of 35 sites (qualitative samples) and was the 10^{th} most encountered out of 27 total mussel species, but was only detected in 3 of 389 quadrats for a mean density of 0.03/m^2 (Gangloff *et al.* 2015). Several juvenile Pleurobema perovatum were found at a site in Wilson Creek (Lamar County, Alabama), indicative of a healthy, reproducing population (Buntin *et al.* 2015). Additionally, tributary populations have been discovered in several Tombigbee River tributaries, including East Fork Tombigbee River and Bull Mountain Creek (Itawamba County, Mississippi), Trussels Creek (Greene County, Alabama), and Wilson Creek (Lamar County, Alabama) (Buntin et al. 2015); the Cahaba River tributary, Oakmulgee Creek (Dallas County, Alabama); and several Alabama River tributaries, McCalls and Sturdivant Creek (Wilcox County, Alabama) and Tallatchee Creek (Monroe County, Alabama).

Triangular Kidneyshell

The triangular kidneyshell is currently stable and not believed to have lost any known populations since the time of listing, although occupancy in the Locust Fork has diminished substantially (P. Johnson pers. comm. 2019). The most robust population is in the Cahaba River (Jefferson/Bibb/Shelby Counties, Alabama), where densities have been found up to 0.25 individuals/m^2 (P. Johnson pers. comm. 2018). The Sipsey Fork population was also believed to be healthy until the 2000 drought, when the predrought densities were documented at 0.88 individuals/m^2, but postdrought were measured at 0.18 individuals/m^2 (Haag and Warren 2008). Recent surveys seem to indicate that the Sipsey Fork population continues to be stable (Moran 2013, 2015). The triangular kidneyshell was cultured in 2014 using Cahaba River brood stock and several darters were identified as good hosts, but no stockings have taken place (Johnson 2018).

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

Finelined Pocketbook

There is little genetic information available on the species. A phylogenetic analysis of nucleotide sequences of the mitochondrial 16S

ribosomal RNA and the first subunit of the cytochrome oxidase *c* genes failed to resolve the finelined pocketbook and orangenacre mucket into reciprocally monophyletic groups (Roe *et al.* 2001). This genetic data indicates that until more is known, future captive rearing and propagation of these species should be protective of their genetic integrity by not mixing populations, and completing reintroductions with animals propagated with nearest available brooders in the same major watershed. Any recovery work should maintain drainage structure across basins (e.g., Coosa, Cahaba, and Tallapoosa). The AABC has deposited genetic vouchers from propagated animals from Shoal Creek, Cleburne County and Cahaba River, Bibb County specimens with the USGS Caribbean Science Center, Gainesville, Florida and the University of Michigan Museum of Zoology in Ann Arbor, Michigan.

Orangenacre Mucket

No data genetic variation or trends are available. A phylogenetic analysis of the finelined pocketbook and orangenacre mucket suggests that future captive rearing and propagation of these species should be protective of their genetic integrity by not mixing populations, and completing reintroduction work utilizing nearest available brood stock, or re-establishing extirpated populations from appropriate geographical sources (see finelined pocketbook, above). The AABC has deposited genetic vouchers from propagated animals from both Sipsey Fork and Limestone Creek specimens with the USGS Caribbean Science Center, Gainesville, Florida and the University of Michigan Museum of Zoology in Ann Arbor, Michigan.

Alabama Moccasinshell

The Alabama moccasinshell was included in a phylogenetic analysis of the relationships of North American Lampsilini, using the 16s rDNA gene; however, it provided no information on conservation genetics of the species. A comparison of the Tombigbee River basin populations with the sole remaining Conasauga River population remains a priority. The AABC has deposited genetic vouchers from propagated animals with the USGS Caribbean Science Center, Gainesville, Florida and the University of Michigan Museum of Zoology in Ann Arbor, Michigan.

Coosa Moccasinshell

There is no genetic information currently available for the Coosa moccasinshell, although the AABC has deposited cultured voucher specimens, from the Conasauga River, Polk County, Tennessee in the USGS Caribbean Science Center in Gainesville, Florida and at the University of Michigan Museum of Zoology in Ann Arbor, Michigan.

Southern Clubshell

Populations of southern clubshell from the Coosa River (Cherokee County, Alabama), Chewacla Creek (Macon County, Alabama) and Sipsey River (Pickens County, Alabama) have been compared by sequencing a portion of the mitochondrial cytochrome oxidase I gene (Lydeard *et al.* 2000). Genetic variation was evident but low between the three different drainage populations, for the one gene tested.

Dark Pigtoe

Campbell *et al.* (2008) noted molecular results indicate that the dark pigtoe is part of a large clade centered in the western Mobile Basin, not closely related to other Coosa River *Pleurobema*. Campbell *et al.* (2008) also documented minimal genetic divergence between *Pleurobema rubellum* and *P. furvum,* with analyzed mitochondrial and nuclear genes less divergent than would be expected from intraspecies comparisons, indicating they may represent ecophenotypes of a single species (Campbell *et al.* 2008). However, this analysis compared two individuals from Brushy Creek (Sipsey Fork tributary) and it is unclear if these specimens (a mature adult and juvenile) represented one species or two species (P. Hartfield pers. comm. 2019). P. Hartfield (the collector of both specimens) considered both individuals to be *P. furvum* (P. Hartfield pers. comm. 2019). Therefore, further genetics work is warranted to clarify the relationship of these two species.

Southern Pigtoe

A genetic analysis of *Pleurobema* species from the Mobile River Basin was conducted using a portion of the mitochondrial and nuclear DNA (Campbell *et al.* 2008). This analysis found that southern pigtoe and Canoe Creek clubshell (*P. athearni*) were closely related species. The molecular divergence was minimal, mitochondrial differences were lower than the average for interspecies comparisons and higher than average for intraspecies comparison, but their distinct morphology further supports that they are distinct species (Campbell *et al.* 2008).

Ovate Clubshell

A genetic analysis of *Pleurobema* species from the Mobile River Basin was conducted using a portion of the mitochondrial cytochrome oxidase I gene (Lydeard *et al.* 2000). A specimen of ovate clubshell from the Sipsey River was included in the study and was found genetically distinct from other *Pleurobema* species. A specimen in the study from the Coosa River tentatively identified as ovate clubshell was genetically different

from the Sipsey River specimen, and clustered more closely with other Coosa River endemics. Campbell *et al.* (2008) also noted that molecular results indicate that the ovate clubshell is part of a large clade centered in the western Mobile Basin and not closely related to Eastern Mobile Basin (Coosa River) *Pleurobema.*

Triangular Kidneyshell

Roe (2013) conducted a phylogenetic analysis of the genus *Ptychobranchus*, finding that two specimens from different Mobile River Basin drainages were reciprocally monophyletic, but was unable to resolve whether the two clades represented two distinct species, given the limited samples sizes. He suggested additional work needed to be completed for genetic support of species status. The AABC has deposited genetic vouchers from propagated animals with the USGS Caribbean Science Center, Gainesville, Florida and the University of Michigan Museum of Zoology in Ann Arbor, Michigan.

d) Taxonomic classification or changes in nomenclature:

Finelined Pocketbook and Orangenacre Mucket

The previous 5-year review (Service 2008) noted that the finelined pocketbook and orangenacre mucket, were placed into a new freshwater mussel genus, *Hamiota,* by Roe and Hartfield (2005). The new genus hasbeen recognized within recent taxonomic publications (e.g., Williams *et al.* 2008, Williams et al. 2017). The Service expects to complete a formal name change under 50 CFR 17.11 in the near future.

Alabama Moccasinshell, Coosa Moccasinshell, and Southern Clubshell

No changes to taxonomic classification or nomenclature have occurred since this species was listed. Nomenclature is consistent and follows that in Williams *et al.* (2017).

Dark Pigtoe

Pleurobema rubellum and *P. furvum* were synonymized under *P. rubellum* by Williams *et al.* (2008 and 2017) based upon shell characters and a genetic analysis by Campbell *et al.* (2008) (see Genetics, genetic variation, or trends in genetic variation, above). This synonymy has since been recognized in other publications (e.g., Williams *et al.* 2017, Shelton-Nix 2017), and will require a correction under 50 CFR 17.11 which the Service expects to do in the near future.

Southern Pigtoe and Ovate Clubshell

No changes to taxonomic classification or nomenclature have occurred since this species was listed. Nomenclature is consistent and follows that in Williams *et al.* (2017).

Triangular Kidneyshell

Williams *et al.* (2008, 2017) elevated *P. foremanianus* from synonymy with *P. greenii*. This would have the effect of reducing the range of *P. greenii* by more than 50%. However, in Roe's (2013) phylogenetic analysis of the genus *Ptychobranchus*, he was unable to resolve whether the geographical populations in the Mobile River Basin represented distinct species. Further analysis is needed before a formal distinction can be made.

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

Finelined Pocketbook

The finelined pocketbook was historically reported from the Tombigbee, Black Warrior, Cahaba, Alabama, Tallapoosa, and Coosa Rivers and many of their tributaries in Alabama, Georgia, Mississippi, and Tennessee. Williams *et al.* (2008) reports that the finelined pocketbook occurs in the eastern portion of the Mobile Basin from the Coosa River drainage headwaters downstream to Claiborne, Monroe County, Alabama. Williams *et al.* (2008) also suggests that while some specimens from the Black Warrior and Tombigbee drainages look very similar to the finelined pocketbook, their identity remains unresolved.

The finelined pocketbook continues to survive in the upper Cahaba River and its tributaries Shades Creek (Shelby/Bibb Counties, Alabama), Sixmile Creek (Bibb County, Alabama), and Little Cahaba River (Jefferson/Shelby/Bibb Counties, Alabama). It also continues to survive in the Coosa River (Elmore County, Alabama to Floyd County, Georgia) and its tributaries, including, Ellijay River and its tributary, Boardtown Creek (Gilmer County, GA), Shoal Creek, (Cherokee County, GA), Duck Creek (Walker County, Georgia), Armuchee Creek (Floyd County, Georgia), Euharlee Creek (Bartow/Polk County, Georgia), Conasauga River (Murray/Whitfield County, Georgia; Polk/Bradley County, Tennessee), and Holly Creek (Murray County, Georgia), Terrapin Creek and South Fork Terrapin Creek (Cleburne County, Alabama), Big Canoe Creek (St. Clair County, Alabama) and its tributary Little Canoe Creek (Etowah/St. Clair County, Alabama), Chestnut Creek (Chilton County, Alabama); Yellowleaf Creek and its tributary Muddy Prong (Shelby County, Alabama); Kelly Creek and its tributary Shoal Creek (Shelby/St.

Clair County, Alabama); Choccolocco Creek (Calhoun County, Alabama) and it tributary Cheaha Creek (Talladega/Clay County, Alabama) and its tributaries Hubbard Creek, Clay County, Alabama and Horse Creek Talledega County); Shoal Creek (Cleburne County, Alabama), Hatchet Creek (Coosa/Clay County, Alabama), and Tallasahatchee Creek (Talladega County, Alabama); and the Tallapoosa River and tributaries, including Uphapee Creek (Macon County, Alabama), Choctafaula Creek (Macon/Lee County, Alabama), Bobo Creek (Cleburne County, Alabama), Sandy and Little Creeks (Chambers County, Alabama); Chewacla Creek (Macon/Lee County, Alabama) its tributary Cossey Branch (Macon County, Alabama), Opintlocco Creek (Macon County, Alabama), Cane and Little Cane Creeks (Cleburne County, Alabama), Muscadine Creek (Cleburne County, Alabama); Big Creek, Little River, Little Creek, Beach Creek, Brooks Creek, and Watermill Creek (Haralson County, Georgia), and McClendon Creek (Paulding County, Georgia). Populations are small and localized within these streams (Buntin *et al.* 2015; Dinkins 2008; Dodd *et al.* 1986; Evans, 2001; Feminella and Gangloff 2000; Fobian *et al.* 2017; Freeman 2011; Gangloff 2005; Gangloff 2018; Gangloff and Feminella 2007; Golder Associates 2008; Haag *et al.* 1999; Herod *et al.* 2001; Irwin *et al.* 1998; Johnson 2018; Johnson *et al.* 2005; Johnson and Evans, 2000; McGregor 1993; McGregor *et al.* 2000; Moran 2011, 2012, 2013, 2014, 2017; Pierson, 1991a, 1992b, 1993; Shepard *et al.* 1994; Williams and Hughes 1998; Wynn *et al.* 2016; N. Johnson pers. comm. 2015; J. Wisniewski pers. comm. 2019).

The finelined pocketbook has also been successfully reintroduced in the Little River, Cherokee County, Alabama, by the Alabama Department of Conservation and Natural Resources, Alabama Aquatic Biodiversity Center (AABC) (Johnson 2012b, Johnson 2018). In 2012, 184 finelined pocketbooks from Shoal Creek, Cleburne Co., Alabama progeny were released into Little River (Cherokee County). These were monitored in July 2013, July 2015, August 2016, and September 2018 and found to be persisting at the site (Johnson 2018). An additional release of Shoal Creek animals was completed in Little River in September 2018 (Johnson 2018). Finelined pocketbook mussels from Cahaba River stock were also cultured in 2014, while a small number of these animals remain in pond culture at AABC, no stockings have taken place as of 2018 (Johnson 2018).

Orangenacre Mucket

The orangenacre mucket was historically known from the Alabama, Tombigbee, Black Warrior, and Cahaba Rivers and their tributaries in Alabama and Mississippi. Williams *et al.* (2008) reported that the orangenacre mucket occurs in the Alabama, Black Warrior and Tombigbee River drainages. In the Black Warrior, it only occurs above the Fall Line. Williams *et al.* (2008) also suggests that while some

specimens from the Cahaba, Coosa and Tallapoosa River drainages look very similar to the orangenacre mucket, their final identity remains unresolved.

The species has disappeared from the mainstem Tombigbee, Black Warrior, and Alabama Rivers, but continues to survive in Tombigbee tributaries, including the Buttahatchee River (Lowndes/Monroe County, Mississippi; Lamar County, Alabama), and East Fork Tombigbee River (Itawamba/Monroe County, Mississippi), Luxapalila Creek and tributaries Yellow Creek (Monroe County, Mississippi; Lamar County, Alabama) and Cut Bank Creek (Lamar County, Alabama), Sipsey River (Greene/Pickens/Tuscaloosa County, Alabama), Coalfire, Lubbub, and Trussels Creeks (Pickens County, Alabama), and Bogue Chitto Creek (Choctaw County, Alabama); Black Warrior River tributaries, including North River (Tuscaloosa/Fayette County, Alabama) and its tributary Clear Creek (Fayette County, Alabama), Locust and Blackburn Forks of the Black Warrior River (Blount County, Alabama), Sipsey Fork of the Black Warrior (Winston/Lawrence County, Alabama) and tributaries Thompson, Flannagin, and Borden Creeks (Lawrence County, Alabama), and Caney, North Fork Caney, Brushy, Capsey, Rush, Brown, and Beech Creeks (Winston/Lawrence County, Alabama); Cahaba River (Bibb/Jefferson/Shelby County, Alabama) and Little Cahaba River (Bibb/Shelby County, Alabama); and Alabama River tributaries Big Flat Creek (Monroe County, Alabama), Limestone Creek (Monroe County, Alabama) and Bogue Chitto Creek (Dallas County, Alabama). (AST Environmental 2016; Buntin *et al.* 2015; Dodd *et al.* 1986; Fobian *et al.* 2013; Gangloff 2015; Haag and Warren 2001; Hartfield and Bowker 1992; Hartfield and Jones 1989, 1990; Jones 1991; Jones and Majure 1999; McGregor 1992; McGregor *et al.* 1996; McGregor 2000; McGregor *et al.* 2000; McGregor and Pierson 1999; Miller 2000; Moran 2010, 2011, 2012, 2013, 2015, 2016, 2017; Pierson 1991a, b, 1992a; Shepard *et al.* 1998; USFWS 2011; Vittor and Associates 1993; Warren and Haag 1994; Yokley 2001).

In 2012, the orangenacre mucket was successfully reintroduced into Tallatchee Creek, Monroe County, Alabama by the AABC from Limestone Creek, Monroe Co., Alabama, brood stock (Johnson 2012c). Follow-up monitoring in 2013, 2014, and 2018 found multiple tagged individuals (original release), including gravid females (Johnson 2018). In 2014, 1,870 orangenacre mucket mussels (Black Warrior brood stock) were also stocked by AABC into multiple sites in the Locust Fork with an additional 192 individuals stocked in 2015 (Wallstown site). These releases have yet to be monitored for survival or reproductive success (Johnson 2018).

Alabama Moccasinshell

The Alabama moccasinshell was historically known from the Alabama, Tombigbee, Black Warrior, Cahaba, and Coosa Rivers and their tributaries in Alabama, Mississippi, Georgia, and Tennessee. The species has disappeared from the mainstems of all of these rivers, but continues to survive in Tombigbee River tributaries, including Bull Mountain Creek (Itawamba County, Mississippi), Trussels Creek (Greene County, Alabama), Luxapalila Creek (Lowndes County, Mississippi) including Yellow Creek (Lowndes County, Mississippi; Lamar County, Alabama) and tributary Wilson Creek (Lamar County, Alabama); Buttahatchee River (Lowndes/Monroe County, Mississippi, Lamar County, Alabama), and tributary Sipsey Creek (Monroe County, Mississippi), Lubbub Creek (Pickens County, Alabama) and its tributary Bear Creek (Pickens County, Alabama), and Sipsey River (Greene/Pickens County, Alabama); Black Warrior River tributaries, including Fivemile Creek (Hale County, Alabama) and the Sipsey Fork and tributaries (Winston/Lawrence County, Alabama); and the Conasauga River (Polk Co., TN) and its tributary, Holly Creek (Murray Co., GA) in the Coosa River drainage (Buntin *et al.* 2015; Dodd *et al.*1986; Evans 2001; Gangloff 2015; Hartfield and Bowker 1992; Hartfield and Jones 1989, 1990; Johnson *et al.* 2005; Johnson and Evans 2000; Jones 1991; Jones and Majure 1999; McGregor 1992; McGregor *et al.* 1996; McGregor 2000; McGregor *et al.* 2000; Moran 2016, 2017; MRBMRC 2010; MS Museum of Natural Science collection record 1984–2001; Pierson 1991a, b; USFWS 2011; Warren and Haag 1994; Yokley 2001; and C. Atkinson pers. comm. 2018).

The AABC conducted small culture trials for this species in 2015 and 2016 with brood stock from the Conasauga River and the Buttahatchee River. No stockings of this species have taken place to date, and as of 2018, the species remains in culture at the AABC (Johnson 2018).

Coosa Moccasinshell

The Coosa moccasinshell has been historically reported from the Cahaba River, the Sipsey Fork of the Black Warrior River, and the Coosa River, and their tributaries, in Alabama, Georgia, and Tennessee. Since this species was listed, its presence has been confirmed only in the Conasauga River (Murray/Whitfield County, Georgia; Bradley County, Tennessee), and its tributary, Holly Creek (Murray County, Georgia) (Johnson and Evans, 2000, Johnson *et al.* 2005; MRDMRC 2010; and Williams and Hughes 1998).

Its total distribution is believed to be less than 8 stream miles in the Conasauga River and Holly Creek combined (Johnson 2012a). It has

apparently been eliminated from the Cahaba and Black Warrior River drainages, as well as from the Coosa River and many of its tributaries.

The Coosa moccasinshell (59 individuals transformed in 2011) was reintroduced back into the Little Cahaba River in September 2012 from Conasauga River (Polk County, Tennessee) brood stock. This reintroduction was monitored in July 2013 and multiple tagged individuals were recovered (Johnson 2012a, 2018). AABC conducted additional mussel propagation with the Coosa moccasinshell in 2014 (1,931 juveniles metamorphosed) and 2015 (6,061 juveniles metamorphosed) (Johnson 2018).

Southern Clubshell

With the exception of the Tensaw/Mobile River, the southern clubshell was formerly known from every major river system in the Mobile River Basin, including the Alabama, Tombigbee, Black Warrior, Cahaba, Tallapoosa, and Coosa Rivers and many of their tributaries in Mississippi, Alabama, Georgia, and Tennessee. Southern clubshell continues to inhabit the East Fork Tombigbee River (Itawamba/Monroe County, Mississippi), Bull Mountain Creek (Itawamba County, Mississippi), Buttahatchee River (Lamar County, Alabama, Monroe/Lowndes County, Mississippi), Luxapalila and Yellow Creeks (Lowndes County, Mississippi), Bogue Chitto Creek (Pickens County, Alabama, Lubbub Creek and its tributary Bear Creek (Pickens County, Alabama), and Sipsey River (Greene/Pickens/Tuscaloosa County, Alabama) in the Tombigbee drainage; a short reach of the Alabama River and Bogue Chitto Creek (Dallas County, Alabama); Cahaba River and its tributary Shultz Creek (Bibb County, Alabama); Uphappee Creek and Chewacla Creek (Macon County, Alabama) in the Tallapoosa drainage; Coosa River (Weiss Bypass) below Weiss Dam (Cherokee County, Alabama), below Logan Martin Dam (Calhoun/St. Clair County, Alabama), and below Jordan Dam (Elmore County, Alabama), and tributaries Yellowleaf Creek (Shelby County, Alabama), Kelly Creek (Shelby County, Alabama), Big Canoe Creek (St. Clair County, Alabama) and both Little Canoe creeks (St. Clair and Etowah/St. Clair County, Alabama, respectively), Terrapin Creek (Cherokee County, Alabama), and Conasauga River (Murray/Whitfield County, Georgia) (Alabama Department of Conservation and Natural Resources/U.S. Fish and Wildlife Service collection records, 1998, 1999; Buntin 2017; Buntin *et al.* 2015; Devries 2012; Devries and Stoeckel 2018; Dinkins 2008; Evans 2001; Feminella and Gangloff 2000; Gangloff 2005; Gangloff 2015; Gangloff and Feminella 2007; Golder Associates 2008; Fobian *et al.* 2017; Hartfield and Bowker 1992; Hartfield and Jones 1989, 1990; Herod *et al.* 2001; Johnson *et al.* 2005; Jones 1991; Jones and Majure 1999; McGregor 1993, 1999; McGregor *et al.* 1996; Miller 2000;

Miller and Hartfield, 1988; Pierson, 1991a, b; Wynn *et al.* 2016; Yokley 2001; and Wisniewski pers. comm. 2019).

Dark Pigtoe

The historic distribution of the dark pigtoe was probably restricted to the Black Warrior River system above the fall line. Since listing, the presence of the dark pigtoe has been confirmed in the Black Warrior River drainage from Sipsey Fork and its tributaries Caney, Borden, Flannagin, Brushy, Brown, Rush, and Capsey Creeks (Winston/Lawrence County, Alabama); North River and its tributary Clear Creek (Fayette County, Alabama); and from Locust Fork (Blount County, Alabama) (Alabama Malacological Research Center, *in litt.,* 1996; Dodd *et al.* 1986; McGregor 1992; McGregor *et al.* 2013; McGregor and Wynn 2008; Moran 2010, 2011, 2012, 2013, 2015, 2017; Pierson 1992a; Shepard *et al.* 1998; USFWS 2011; Vittor and Associates 1993; Warren and Haag 1994).

McGregor *et al.* (2013) reported a weathered dead shell of a possible dark pigtoe from Davis Creek, a direct tributary to the Black Warrior River, near Tuscaloosa, Alabama. AABC collected gravid females from the Locust Fork upstream of the Wallstown Bridge site, in Blount County, Alabama, as brood stock for a small host suitability trial in 2015 (Johnson 2018, P. Johnson per comm. 2018)

Southern Pigtoe

The historic range of the southern pigtoe included the Coosa River and its tributaries in Alabama, Georgia, and Tennessee. The species is currently known to survive in the following Coosa River tributaries: Conasauga River (Murray/Whitfield County, Georgia, Bradley/Polk County, Tennessee), Holly Creek (Murray County, Georgia), Armuchee Creek (Floyd County, Georgia), Shoal Creek (Cleburne County, Alabama), Big Canoe Creek (St. Clair County, Alabama), Terrapin Creek (Calhoun County, Alabama), Yellowleaf Creek (Shelby County, Alabama), Hatchet Creek (Coosa County, Alabama); and Cheaha Creek (Talladega County, Alabama) (Buntin *et al.* 2015; Edelman *et al.* 2015; Evans 2001; Feminella and Gangloff 2000; Gangloff 2005; Gangloff and Feminella 2007; Golder Associates 2008; Johnson 2006; Johnson and Evans 2000; Johnson *et al.* 2005; Johnson 2018; Krause *et al.* 2012; Moran 2011, 2017; Pierson 1992b, 1993; Williams and Hughes 1998, Wynn *et al.* 2016).

Ovate Clubshell

The ovate clubshell was historically distributed in the Tombigbee, Black Warrior, Alabama, Cahaba, and Coosa Rivers and their tributaries in Mississippi and Alabama; and in Chewacla, Uphapee and Opintlocco

Creeks in the Tallapoosa River drainage, Alabama. It has since disappeared from the Black Warrior and Coosa drainages, as well as the mainstem Tombigbee River and Uphapee and Opintlocco Creeks. Currently, the species is known to survive in several Tombigbee River tributaries, including East Fork Tombigbee River (Itawamba County, Mississippi), Bull Mountain Creek (Itawamba County, Mississippi), Buttahatchee River (Lowndes/Monroe County, Mississippi, Lamar County, Alabama), Trussels Creek (Greene County, Alabama), Luxapalila Creek and its drainage tributaries Yellow Creek (Lowndes County, Mississippi) and Wilson Creek (Lamar County, Alabama), Sipsey River (Greene/Pickens/Tuscaloosa County, Alabama), Sucarnoochee River (Sumter County, Alabama), and Coalfire Creek (Pickens/Lamar County, Alabama); Cahaba River (Bibb County, Alabama) and its tributary Oakmulgee Creek (Dallas County, Alabama); Alabama River tributaries, McCalls Creek (Wilcox County, Alabama), Sturdivant Creek (Wilcox County, Alabama) and Tallatchee Creek (Monroe County, Alabama); and Chewacla Creek (Macon County, Alabama) in the Tallapoosa River drainage (Butin *et al.* 2015; Campbell *et al.* 2005; Dodd *et al.* 1986; Feminella and Gangloff 2000; Gangloff 2011; Gangloff 2015; Hartfield and Bowker 1992; Hartfield and Jones 1990; Hamstead 2013; Johnson *et al.* 2006b; Jones 1991; McGregor 1992; McGregor 1993; McGregor *et al.* 1996; McGregor 2000; McGregor and Garner 2004; Miller 2000; Pierson, 1991a, b; Williams *et al.* 2008; Yokley 2001).

Triangular Kidneyshell

The triangular kidneyshell is endemic to the Alabama, Cahaba, Coosa, and Tallapoosa, Black Warrior and Tombigbee River drainages (Williams *et al.* 2008). It is currently known extant in isolated reaches of the Coosa River drainage and in the Cahaba River above the Fall Line (Williams *et al.* 2008). It is presently known to inhabit Cahaba River (Jefferson/Bibb/Shelby County, Alabama), Little Cahaba River (Jefferson/Shelby County, Alabama), and Little Cahaba River (Bibb County, Alabama); and Coosa River below Logan Martin Dam near Elliot Island, (St. Clair/Talladega County, Alabama) and Coosa tributaries Yellowleaf Creek (Shelby County, Alabama, Kelly Creek (Shelby County, Alabama), Big Canoe Creek (St. Clair County, Alabama), Little Canoe Creek (St. Clair County, Alabama), Conasauga River (Murray/Whitfield County, Georgia, Polk County, Tennessee), Coosawattee River (Gordon County, Georgia), and Oostanaula River (Floyd/Gordon County, Georgia). It is also currently known to inhabit the Sipsey Fork and its tributaries Flannagin Creek, Borden Creek, Bushy Creek, Capsey Creek, Rush Creek, Collier Creek (Winston/Lawrence County, Alabama) and Locust Fork (Jefferson/Blount County, Alabama) and Coalfire Creek (Pickens County, Alabama) of the Black Warrior River drainage. Populations are small and localized (Dinkins 2008; Dinkins and Hughes 2011; Feminella and

Gangloff 2000; Forbian *et al.* 2017; Gangloff 2005; Gangloff 2011; Gangloff 2018; Gangloff and Feminella 2007; Golder Associates 2008; Johnson *et al.* 2006b; Johnson 2006; Johnson 2018; Johnson *et al.* 2005; McGregor and Garner 2004; MRBMRC 2010; Vittor 2011; Wynn *et al* 2016; Dodd *et al.* 1986; Evans 2001; Feminella and Gangloff 2000; Gangloff 2016; Haag and Warren 1997; Johnson and Evans 2000; McGregor 1992; McGregor *et al.* 2000; Moran 2013, 2015; Shepard *et al.* 1994, 1998; Warren and Haag 1994; Williams and Hughes 1998; USFWS 2011; and Williams *et al.* 2008).

f) Habitat or ecosystem conditions:

All nine mussels inhabit sand/gravel/cobble shoals with moderate to strong currents in small to medium sized streams/rivers within the Mobile River Basin. Suitable habitats and water quality, free of excessive sedimentation and other pollutants, are required. Watershed-specific threats continue to negatively impact these mussel species. These threats include: 1) coal mining activities (e.g., Locust Fork, Cahaba River, Buttahatchee River); 2) oil and gas exploration (e.g., Cahaba River, Big Canoe Creek); 3) water withdrawal (i.e., Altoona, Locust Fork, Cahaba, upper Coosa River basin); 4) hypolimnetic discharges (e.g., Altoona, Carters, Henry Neely, Martin, Thurlow, Yates); 5) poor water quality due to insufficient releases from dams (i.e., all Mobile River Basin tail waters); 6) instream aggregate mining (e.g., lower Alabama River); 7) navigation channel maintenance activities (e.g., Alabama River, Tombigbee River basin) (MRBMRC 2010); (8) agricultural practices that degrade water quality by increasing nutrients, herbicide/surfactant compounds, and hormones in surface waters (i.e., Conasauga); (9) hydropeaking dams that alter downstream flow conditions, water temperatures, and dissolved oxygen (i.e., Coosawattee and Etowah); (10) increasing urban development that degrades water quality and stream geomorphology (i.e., Conasauga, Coosawattee and Etowah Rivers) (U.S. Fish and Wildlife Service 2019); and (11) climate change, which is expected to result in more frequent and extreme dry and wet years in the Southeast over the next century (Mulholland *et al.* 1997, Ingram *et al.* 2013).

However, some habitat restoration and preservation activities have taken place in recent years. In 2014, minimum flow to a 20-mile section of the Coosa River below Weiss Dam (i.e., Weiss Bypass) was restored by the Alabama Power Company, returning the river to a more natural regime. This flow restoration benefits the existing population of southern clubshell located downstream of the dam and will allow reintroduction of several endangered mussel species that were extirpated from this reach. In the Conasauga basin of Georgia and Tennessee, the headwaters are protected by the U.S. Forest Service's Management Plan, and joint efforts by conservation partners have permanently protected and/or restored more

than 4,000 acres along the mainstem within designated critical habitat for most of these mussels. In 2017, NRCS designated the Conasauga as a Working Lands for Wildlife landscape and is providing additional funds and manpower to improve water quality and aquatic habitat in the basin. Outreach efforts are underway to educate farmers about best management practices to reduce nutrient and herbicide transport to surface waters, and within five years, we anticipate nutrient trading and methane digestion programs will be active. Extensive research has been conducted to identify stressors to aquatic systems in the Conasauga and Etowah basins, including evaluation of water quality and algal blooms in the mainstem, response of aquatic species to stormwater runoff and other stressors associated with urbanizing areas, identification of Conasauga tributaries delivering the greatest nutrient and contaminant loads, and evaluation of Conasauga environmental estrogens and intersex fish. Conservation partners are using these and other data to prioritize parcels in both basins for future stream restoration and land acquisition.

The Alabama Rivers and Streams Network (ARSN) is a group of non-profit organizations, private companies, state and federal agencies and concerned citizens that recognize the importance of clean water and working together to maintain healthy water supplies and investigate water quality, habitat conditions, and biological quality in rivers and streams and make these findings to the public (www.alh2o.org/). Much of the suitable habitat for these mussels has been designated as a Strategic Habitat Unit (SHU) by the ARSN for the purpose of facilitating and coordinating watershed management and restoration efforts, as well as focus funding to address habitat and water quality issues (Wynn *et al.* 2016, Wynn *et al.* 2018). In total, ARSN has outlined a total of 60 SHUs or Strategic River Reach Units (SRRUs) where conservation activities are critical for the management, recovery, and restoration of populations of rare fishes, mussels, snails, and crayfishes in Alabama or adjacent states with joint drainage of these watersheds. The SHU project was developed for species restoration and enhancement.

In the Upper Coosa basin in Georgia and Tennessee, conservation partners, including state and federal agencies, academia, and non-profit organizations, hold bimonthly calls to identify research and management needs and inform partners about ongoing restoration efforts. Larger meetings that include local government, industry, and landowners are scheduled periodically to identify future research needs, develop/refine long-term management strategies, prioritize tracts for management, and inform the public about the basins' resources.

Watershed assessment plans will be developed for each of these watersheds. To date, assessments have been completed for the North River, Big Canoe Creek, Terrapin Creek systems (O'Neil *et al.* 2010,

Wynn *et al.* 2016, Bearden *et al.* 2019). These assessments are being used by multiple federal, state, and non-government organizations (NGO) to contribute to restoration projects and targeted land acquisitions that will improve habitat and water quality for at risk and listed species like these mussels.

Recent habitat improvements have included dams and stream barriers removal projects in these SHUs and SRRUs as part of the ARSN process. Several species of these mussels have benefited by the removal of these structures. Recent dam removals have included the Cahaba River, Big Canoe Creek, Tallapoosa River, and Sucarnoochee River which are all within designated critical habitat for these mussels.

Table 1: Dam removals that have taken place within the Mobile River Basin.

Watershed	River	Dam Removed	Location	Removal
Black Warrior River				
	Turkey Creek	Shadow Lake	Jefferson County, Alabama	2013
Cahaba River				
	Cahaba River	Marvel Slab	Bibb County, Alabama	2004
	Shades Creek	Rail Car Removal	Bibb County, Alabama	2011
Coosa River				
	Big Canoe Creek	Goodwin's Mill	St. Clair County, Alabama	2013
Tallapoosa River				
	Tallapoosa River	Howle and Turner	Cleburne County, Alabama	2019
Tombigbee River				
	Sucarnoochee River	Livingston Dam	Sumter County, Alabama	2018

D. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

The known ranges of the finelined pocketbook, orangenacre mucket, southern clubshell, ovate clubshell, Alabama moccasinshell, dark pigtoe, southern pigtoe, and triangular kidneyshell have all expanded by adding new tributary

populations since listing. However, these newly discovered populations are usually small, and fragmented from each other. The range of the Coosa moccasinshell has remained the same since listing; however, numbers have declined in the Conasauga River since listing (Johnson and Evans 2000). The primary cause of curtailment of range and fragmentation of habitat for all of these mussel species has been contributed to the historic construction of dams and impoundment of large reaches of major river channel (58 FR 14330). Although most of these actions took place in the past, the impacted conditions and habitat continue to affect the species. In recent years, some improvements have been made to improve riverine conditions. For example, flow improvements have been made by below Weiss Dam on the Coosa River that benefit existing populations of southern clubshell located downstream of the dam.

Other potential causes of habitat and range curtailment include dredging, mining, and historical or episodic pollution events (58 FR 14330), sedimentation, increased nutrients, urbanization, loss of *Podostemum* and riparian buffers, and climate change. The results of dredging (i.e., headcutting) continues to affect mussel populations in some Tombigbee River tributaries. Coal mining activities continue to expand within the Locust Fork, Cahaba River, and Buttahatchee River basins impacting water quality and habitat conditions.

Pollution and water quality impairments continue to be a factor at most sites as well. Many stream segments that support these species, or streams feeding into their habitats, including some areas designated as critical habitat, are not currently supporting EPA recognized designated uses (e.g., Conasauga River, Oostanaula River, Holly Creek, Locust Fork, North River, Cahaba River, etc.) (GEPD 2016, ADEM 2018). For example, in the Conasauga River, even back as far as 1995, water quality was visibly declining (as evidenced by decreasing water clarity) downstream from the TN Hwy 74 bridge, (Freeman 1995). Extensive mats of benthic algae were observed in 2000 and 2001 along a 28-mile reach of the Conasauga from TN Hwy 74 downstream past Tibbs Bridge (Freeman and Wenger 2001, Freeman *et al.* 2007). Studies in the Conasauga River mainstem over the last two decades have also documented a decline in *Podostemum* (an aquatic plant that attaches to rocks and provide good habitat and well as serving as a food source for many aquatic animals) and an increase in occurrence of algal and diatom mats at particular shoals (Freeman and Freeman 2019),

Johnson (2010) reported that the Locust Fork, near Kimberly, Alabama, appeared to have been negatively affected by eutrophic conditions that developed after the 2003 release of the plicate rocksnail (*Leptoxis plicata*). Johnson noted an "orange flocculent" developing over the previously clean cobble-boulder substrate at the site the following year (Johnson 2010). A TMDL has recently been prepared for the Locust Fork for nutrients (ADEM

2017), the orangenacre mucket, dark pigtoe, and the triangular kidneyshell should benefit from any water improvement resulting from this new regulation

More than 10 studies have been conducted on the Cahaba River regarding biological communities and water quality conditions, siltation from urbanized land areas and eutrophication due to nutrient loading from municipal wastewater sources and nonpoint sources were mentioned as the primary causes (Thom *et al.* 2013). However, water quality has seen improvements since recent wastewater treatment upgrades have been completed (Thom *et al.* 2013, P. Johnson pers. comm. 2018). Reducing pollutants in the Cahaba benefits the finelined pocketbook, ovate clubshell, southern clubshell, and triangular kidneyshell.

O'Neil *et al.* (2010) reported that habitat and water quality conditions have declined in some North River subwatersheds over the past 30 years and parallels a decline in stream biology and in the mussel population. O'Neil *et al.* (2015) evaluated sedimentation risk from 135 paved and unpaved roads in the North River, and found 25.9 percent were considered at high risk for sedimentation, and 36.3 percent at moderate risk. Significant declines of the dark pigtoe have occurred in this watershed since this species was listed (McGregor and Wynn 2008, O'Neil *et al.* 2010).

Currently, surviving populations of these mussel species remain vulnerable to habitat degradation and loss, population isolation, and the cumulative effects of land use activities on aquatic environments (U.S. Fish and Wildlife Service 2000).

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

Overutilization does not appear to be a factor in the status of these mussel species.

c. Disease or predation:

Disease is not currently known to be a threat to the status of these species.

Predation on mussels by some species of fish like freshwater drum (*Aplodinatus grunniens*) and freshwater catfish (Ictaluridae) have been well documented, but these fish also have a symbiotic relationship, serving as hosts for many species of mussels (Parmalee and Bogan 1998, Tiemann *et al.* 2011). Raccoon (*Procyon lotor*), mink (*Neovision vison*), otter (*Lontra canadensis*), common muskrat (*Ondatra zibethicus*), and some species of birds are also known to utilize mussels as food, the muskrat probably being the most common mammal predator (Parmalee and Bogan 1998, Williams *et al.* 2008). Edelman *et al.* (2015) documented muskrat predation in Shoal

Creek by examining shell remains in muskrat middens and found muskrats foraged on all six native mussel species in Shoal Creek, including the finelined pocketbook and southern pigtoe. Predation, especially by muskrats could influence local community structure of native mussels, and could be of greater concern in highly restricted populations of imperiled species with low population size (Warren *et al.* 2004, Edelman *et al.* 2015). Localized control of muskrat populations at Shoal Creek should be considered given the declining status and low densities of the southern pigtoe.

d. Inadequacy of existing regulatory mechanisms:

These mussels are 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), Tennessee by the Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act (1974) (Tennessee Code Annotated 70-8-101 through 70-8-112), Georgia under their Taking of Nongame Species (2010) provisions (Georgia Code Title 27-1-28 (2010) 27-1-28), and Mississippi under their Nongame and Endangered Species Conservation Act (1974) (Mississippi Code Annotated § 49-5-101 to 49-5-119).

Each state within the species range also assigns a rank using the State Ranking System, as defined in Alabama's State Wildlife Action Plan. The state ranking for one state within the species range may not be the same for others, as the populations within each state may carry different degrees of imperilment. Alabama has assigned the following state ranks to these mussels: southern pigtoe, ovate clubshell, dark pigtoe, triangular as S1 (critically imperiled); finelined pocketbook, orangenacre mucket, Alabama moccasinshell, and southern clubshell as S2 (imperiled); and Coosa moccasinshell as SX (presumed extirpated) (ANHP 2017). Mississippi has ranked the status of the orangenacre mucket, Alabama moccasinshell, southern clubshell, and ovate clubshell as S1 (MMNS 2015). Georgia has ranked the Coosa moccasinshell, southern clubshell, southern pigtoe, and rayed kidneyshell as S1 and the finelined pocketbook as S2 (Albanese *et al.* 2015). While the state of Tennessee has ranked the Alabama moccasinshell, Coosa moccasinshell, southern pigtoe, and rayed kidneyshell as S1, finelined pocketbook as S1S2 (critically imperiled-imperiled), and ovate clubshell as SH (historical-possibly extirpated) (Withers 2016).

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. Consultation with the Service is required by federal agencies on projects that may impact endangered or threatened species or critical habitat and recommendations are made to minimize potential impacts. Also, projects that do not have a federal nexus may go undetected by the Service because

consultation is not required. Multiple smaller actions may also collectively magnify into larger concerns. If Section 7 review is initiated on a federal action, and the status and presence of these snails are identified prior to construction, measures are usually not taken unless the action rises to the level of formal consultation, which means that the action "may adversely affect" the species.

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 cohorts. In Alabama, this authority has been delegated to the Alabama Department of Environmental Management (ADEM), in Tennessee, to the Tennessee Department of Environment and Conservation (TDEC), in Georgia, to the Georgia Department of Natural Resources, Environmental Protection Division (EPD), and in Mississippi to the Mississippi Department of Environmental Quality (MDEQ).

Current State and Federal regulations regarding pollutants are assumed to be protective of freshwater mollusks; however, these species may be more susceptible to some pollutants than test organisms commonly used in bioassays. In other instances, a pollutant may not have water quality criteria, such as sodium dodecyl sulfate, a common surfactant used in multiple industrial and household uses. A recent toxicity studies by Gibson *et al.* (2016) looked at the toxicity of sodium dodecyl sulfate on federally threatened and petitioned mussels and snails including the orangenacre mucket. The orangenacre mucket was sensitive to this compound with an EC_{50} value of 6,102 µg/L, while the threatened round rocksnail (*Leptoxis ampla*) had an even greater sensitivity with an EC_{50} value of 26 µg/L.

In a review of the effects of eutrophication on mussels, Patzner and Muller (2001) noted that stenoecious (narrowly tolerant) species disappear as waters become more eutrophic. Strayer (2014) also suggests that extreme eutrophication may decrease food quality and may prevent juvenile recruitment. Other studies have also suggested that early life stages of mussels are sensitive to inorganic chemicals such as chlorine, metals, and ammonia (Keller and Zam 1991, Goudreau *et al.* 1993, Jacobson *et al.* 1993, Augspurger *et al.* 2003, Wang *et al.* 2007a, 2007b). Therefore, a lack of adequate research and data continues to prevent existing authorities, such as the Clean Water Act from being fully utilized to protect all federally listed aquatic resources, particularly mollusks.

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. TMDLs establish the maximum amount of a pollutant that a water body can assimilate without causing exceedances of water quality standards.

Section 404 under the CWA is administered by the U.S. Army Corps of Engineers (COE) and 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. While a single project will usually not jeopardize the continued existence of these mussels, the cumulative effects on their finite habitat may have a larger impact and is usually not assessed on a permit-by-permit case either due to no federal nexus or no combined assessment of all project impacts.

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 media (e.g., honey bees, daphnia, bluegill sunfish, rainbow trout, mice) for toxicity, this information may not relate well to these listed mussels. 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 listed mussels in or adjacent to an application area.

The Federal Power Act (FPA) (16 U.S.C. 791-828c; Chapter 285, June 10, 1920; 41 Stat. 1063 as amended by P.L. 104-66, December 21, 1995; 109 Stat. 718) provides for cooperation between the Federal Energy Regulatory Commission (Commission) and other Federal agencies, including resource agencies, in licensing and relicensing. In 1986, amendments were added to the FPA, entitled the Electric Consumers Protection Act (ECPA) that mandated several fish and wildlife provisions. Therefore, from 1986 forward, each new license or re-license is to include conditions to protect, mitigate and enhance fish and wildlife affected by the project. These conditions are to be based on recommendations received pursuant to the Fish and Wildlife Coordination Act from the Fish and Wildlife Service, the National Marine Fisheries Service, and State fish and wildlife agencies (16 U.S.C. 803(j)(1)). Some populations of the southern clubshell and finelined pocketbook are afforded protection under the FPA because they reside in areas that are influenced by FERC licensed hydropower projects (e.g., southern clubshell within the Weiss Bypass).

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

Climate change can influence freshwater mussel habitat by increasing or decreasing water temperatures and precipitation patterns that increase flooding, prolong droughts, or reduce stream flows (Nobles and Zhang 2011).

An increase in the number of days with heavy precipitation over the next 25 to 35 years is expected to increase across the Mobile River Basin (https://science2017.globalchange.gov/chapter/7/). As mentioned in the Poff *et al.* (2002) report on Aquatic Ecosystems and Global Climate Change, impacts of climate change on aquatic systems can potentially include:

- Increases in water temperatures that may alter fundamental ecological processes, thermal suitability of aquatic habitats for resident species, and their geographic distribution.
- Changes and shifts in seasonal patterns of precipitation and runoff, which can alter the hydrology of stream systems, affecting species composition and ecosystem productivity. Aquatic organisms are sensitive to changes in frequency, duration, and timing of extreme precipitation events such as floods or droughts, potentially resulting in interference of reproduction. Further, increased water temperatures and seasonally reduced streamflow can alter many ecosystem processes, including increases in nuisance algal blooms.
- Cumulative or synergistic impacts that can occur when considering how climate change may be an additional stressor to sensitive freshwater systems, which are already adversely affected by a variety of other human impacts, such as altered flow regimes and deterioration of water quality.
- Adapting to climate change may be limited for some aquatic species depending on their life history characteristics and resource needs. Reducing the likelihood of significant impacts would largely depend on human activities that reduce other sources of ecosystem stress to ultimately enhance adaptive capacity, which could include, but not be limited to: maintaining riparian forests, reducing nutrient loading, restoring damaged ecosystems, minimizing groundwater and stream withdrawal, and strategically locating any new reservoirs to minimize adverse effects.
- Changes in presence or combinations of native and nonnative, invasive species could result in specific ecological responses to changing climate conditions that cannot be easily predicted at this time. These types of changes (e.g., increased temperatures that are more favorable to a nonnative, invasive species compared to a native species) can result in novel interactions or situations that may necessitate adaptive management strategies.
- Shifts in mussel community structure, which can stem from climate-induced changes in water temperatures since sedentary freshwater mussels have limited refugia from disturbances such as droughts and floods, and since they are thermo-conformers whose physiological processes are constrained by water temperature within species-specific thermal preferences (Galbraith *et al.* 2010).

Drought, combined with limited habitat and small population sizes can potentially threaten these mussels, especially those located in small drainages (e.g., dark pigtoe in the Sipsey Fork or southern pigtoe in Shoal Creek). Haag and Warren (2008) found that impacts from severe drought were correlated to watershed size, with small streams suffering declines of 65-83%, while the larger streams (larger buffering capacity) showed less significant change in pre- and postdrought abundances. Droughts can 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 through dewatering and that may also cause direct mortality by stranding mussels. Drought may also fragment sections of stream into isolated pools. However, in some cases, droughts can also concentrate host fish and therefore, increase the probability of glochidia (larval mussel) to host contact.

Human-induced random events such as toxic spills could also impact populations if pollutants are spilled within a given drainage. Colonial Pipeline Company recently (2016) had two separate spills associated with a pipeline rupture and pipeline explosion adjacent to the Cahaba River in Shelby County, Alabama (USEPA 2016 and 2017). While no product (336,000 gallons of gasoline) made it into the Cahaba River, due primarily to drought conditions, significant spills continue to be a threat and could have devastating effects to populations of these mussels.

Poorly designed road crossings, can often lead to excessive sedimentation and fish barriers that can limit fish movement as well as distribution of freshwater mussels, and can create excessive sediment loading in receiving streams, destroying mussel habitat and populations. Recent surveys at 135 paved and unpaved roads in the North River drainage documented 27 fish barriers and 35 sites of high risk of sedimentation (O'Neil *et al.* 2015). Similar surveys in the Big Canoe Creek system also documented 15 crossings at high risk of sedimentation and 20 sites with significant fish barriers (Wynn *et al.* 2016).

E. Synthesis

Finelined Pocketbook: Improving

The finelined pocketbook is believed to be improving overall. The species remains widespread, even though most populations are relatively small and localized (MRBMRC 2010). Several new tributary populations have been discovered in the Cahaba, Coosa, and Tallapoosa watersheds since the recovery plan (USFWS 2000). These include Shades Creek (Shelby/Bibb Counties, Alabama); both Little Canoe creeks (upper and lower Big Canoe Creek watershed) (St. Clair and St. Clair/Etowah County, AL); Chestnut Creek (Chilton County, Alabama); Ellijay River and its tributary, Boardtown Creek (Gilmer County, GA); Shoal Creek, (Cherokee County, GA); Hubbard Creek (Clay

County, Alabama); Horse Creek (Talladega County, Alabama); Bobo Creek (Cleburne County, Alabama); Sandy and Little Sandy Creeks (Chambers County, Alabama); Cossey Branch (Macon County, Alabama); Euharlee Creek (Bartow/Polk County, Georgia); Little River, Little Creek, Beach Creek, Brooks Creek, and Watermill Creek (Haralson County, Georgia) (citations in "spatial distribution section" below). The Ellijay River and Boardtown Creek population (Gilmer County, GA) appears to be a substantial, reproducing population, and an extension of the previously known range. This is the first population to be located upstream of Carters Lake on the Coosawattee River in Georgia (J. Wisniewski pers. comm. 2019). Additionally, the species has also been recently discovered to occur within approximately 10 km of Shoal Creek in the Etowah River Basin, Georgia, the only known population to occur upstream of Lake Allatoona, Etowah River, Georgia (J. Wisniewski pers. comm. 2019). The once robust population of finelined pocketbook in Chewacla Creek (Lee County, Alabama), immediately downstream of Lake Ogletree, has declined significantly, since 2003, and has not been documented in the recent surveys (Webber 2018). Propagation techniques have been developed and propagates produced from Little Cahaba and Shoal Creek brood stock (Johnson 2018) for future reintroductions. Shoal Creek stock have been successfully reintroduced into Little River (Cherokee County, Alabama) (Johnson 2012b, AABC 2018).

Orangenacre Mucket: Stable

The orangenacre mucket is currently stable as it remains widespread and the species not believed to have lost any known populations since the time of listing. A few tributary populations have been discovered since the recovery plan in the lower Tombigbee and Alabama drainages (USFWS 2000), including Bogue Chitto Creek (Choctaw County, Alabama); Limestone Creek and Big Flat Creek (Monroe County, Alabama), and Big Swamp Creek (Lowndes County, Alabama) (AST 2016 and 2019, Fobian *et al.* 2013, and A Ford, pers. observ. 2010). Propagation techniques have been developed and stockings have occurred in Tallatchee Creek (Johnson 2012c and 2018) and multiple Locust Fork sites (Blount and Jefferson Counties, Alabama) (Johnson 2014 and 2018). Subsequent monitoring has continued to documented presence of these reintroduced animals, including gravid females at the Tallatchee Creek site, but has not yet documented natural recruitment (Johnson 2018).

Alabama Moccasinshell: Stable

The Alabama moccasinshell is currently stable and not believed to have lost any known populations since the time of listing. Additionally, tributary populations have been discovered in both Trussels Creek (Greene County, Alabama) (McGregor and Haag 2004) and Wilson Creek (Lamar County, Alabama) (Buntin *et al.* 2015). Sipsey Fork, Buttahatchee River, and Sipsey River populations appear to be robust. Gangloff (2015) stated the Buttahatchee River Drainage appears to have increased in relative abundance during the last three decades.

Alabama moccasinshell was among the most common mussels surveyed with densities ranging between 0.29-2.55/m^2 among 12 sites (C. Atkinson pers. comm. 2018). Small culture/host trials have been successfully conducted recently (2015 and 2016) for this species using Conasauga River and Buttahatchee River brood stock, though no stockings have taken place to date (Johnson 2018).

Coosa Moccasinshell: Declining

While no populations have been lost since the listing (USFWS 2003), populations of this species are very small and highly localized. It is currently restricted to only about 3 km in Holly Creek (Murray County, Georgia) and 4 km in the Conasauga River (Polk County, Tennessee) (MRBMRC 2010). Mean relative abundance of Coosa moccasinshell between 2002 and 2005 at Holly Creek was 0.5% (Johnson *et al.* 2005). The species has remained in low abundance during more recent surveys (P. Johnson pers. comm. 2018). Host trials and propagation have been conducted using Conasauga River brood stock; and reintroductions into the Little Cahaba River (Bibb County, Alabama) took place in September 2012 (Johnson 2012a, 2018). This reintroduction has been monitored (2013) and released individuals were persisting (Johnson 2018).

Southern Clubshell: Improving

The status of the southern clubshell has improved since the time of listing and now is known to occur within 24 mainstem or tributary populations within each of the historic major river systems the Mobile River Basin: Alabama River, Cahaba River, Coosa River, Tallapoosa River, and Tombigbee River. New records from the Buttahatchee River (Lamar County, Alabama) (range extension); Bear and Bogue Chitto Creek (Pickens County, Alabama); Cahaba River and Shultz Creek (Bibb County, Alabama); Uphappee Creek (Macon County, Alabama); Coosa River below Logan Martin (Calhoun/St. Clair County, Alabama) and Jordan (Elmore County, Alabama) dams; Yellowleaf Creek (Shelby County, Alabama); and Little Canoe Creek (Etowah/St. Clair County, Alabama) have been documented. The southern clubshell had previously been thought extirpated from the Cahaba River drainage, but now is known to occur within the Cahaba River and its tributary Shultz Creek. Localized reaches within eight of these populations (Conasauga River, Coosa River (Weiss Bypass), Big Canoe Creek, Cahaba River, Bogue Chitto Creek, Bull Mountain Creek, Buttahatchee River, and Sipsey River) exhibit viability with moderate to high densities (0.4-17.7 individuals/m^2) and multiple age classes. Although one population, Chewacla Creek (Macon County, Alabama), does seems to have suffered significant declines since listing, most populations exhibit a stable or increasing trend. The overall increases in distribution, range, geography, and population demographics; increases the ability of the southern clubshell to adapt to change and withstand stochastic or catastrophic events.

Threats under Factors a and e (above) have been reduced by flow improvements have been made by Alabama Power Company within the Weiss Bypass on the Coosa River and by restored connectivity by the recent removal of dams within the Cahaba River (Marvel Slab Dam), Big Canoe Creek (Goodwin's Mill Dam) (Coosa tributary), and Sucarnoochee River (Livingston Dam) (Tombigbee River tributary). This flow restoration should benefit the population of southern clubshell within the Weiss Bypass and improve water quality and connectivity upstream and downstream of these dam removals. Water quality has also improved recently within the Cahaba River from wastewater treatment upgrades (Thom *et al.* 2013, P. Johnson pers. comm. 2018).

Dark Pigtoe: Declining

The dark pigtoe has seen declines to the species since the time of listing. The most robust population remains to be the Sipsey Fork (Winston/Lawrence Counties, Alabama), where it continues to show viability with recent recruitment and being composed of multiple age classes (Moran 2015). However, significant declines were documented within Bankhead National Forest in the Sipsey Fork and its tributaries (Flannagin Creek and Rush Creek) following the severe drought in 2000 (Haag and Warren 2008). Densities of dark pigtoe dropped from 0.12 to 0 individuals/m^2 in Flannagin Creek, 0.08 to 0 individuals/m^2 in Rush Creek, and 0.48 to 0.18 individuals/m^2 in Sipsey Fork. The dark pigtoe also went from being one of the most abundant mussel species (4^{th} most abundant out of 15 total species) during sampling from 1991 to 1996 (26 individuals), to only one individual being found (out of 61 sampling sites) during the 2008 survey effort (McGregor and Wynn 2008). The species has been recently rediscovered (2014) in the Locust Fork (Blount County, Alabama), and brood stock was collected from this site for a host fish trial in 2015, but minimum transformational success produced only 10 juveniles (Johnson 2018).

Southern Pigtoe: Declining

All populations of southern pigtoe appear to be small and localized. The most robust population of southern pigtoe is Shoal Creek (Cleburne County, Alabama) located in an isolated 10 km reach in Talladega National Forest between Sweetwater and Highrock Lakes (MRBMRC 2010). Warren *et al.* (2004) had previously estimated the Shoal Creek population size to be 800 individuals in 2003, but this population seems to have declined in recent years due to recent exceptional drought conditions in 2007-08 and 2017 (United States Drought Monitor 2019 (https://droughtmonitor.unl.edu), J. Moran and P. Johnson pers. comm. 2019). Biologists were unable to estimate densities during a 2011 survey due to the lack of animals found during quantitative sampling; however, qualitative searches did indicate low relative abundance (collecting only two individuals) (Krause *et al.* 2012). New tributary occurrences have been documented in Armuchee Creek (Floyd County, Georgia), Yellowleaf Creek (Shelby County, Alabama), and Hatchet Creek (Coosa County, Alabama) since

listing (Gangloff 2005; Buntin 2015; Johnson 2018; USFWS Alabama Field Office database). While attempts to culture this mussel were made in 2010 and 2015, these attempts were only of limited success, producing only 49 juveniles.

Ovate Clubshell: Stable

The ovate clubshell is currently stable and not believed to have lost any known populations since the time of listing. The most robust population occurs in the Sipsey River (Tuscaloosa/Greene/Pickens Counties, Alabama) (MRBMRC 2010), Atkinson (pers. comm. 2018) reported that recent densities from the Sipsey River (13 sites) range between 0-0.2 individuals/m^2. Additionally, tributary populations have been discovered in several Tombigbee River tributaries, including East Fork Tombigbee River and Bull Mountain Creek (Itawamba County, Mississippi), Trussels Creek (Greene County, Alabama), and Wilson Creek (Lamar County, Alabama) (Buntin *et al.* 2015); the Cahaba River tributary, Oakmulgee Creek (Dallas County, Alabama); and several Alabama River tributaries, McCalls and Sturdivant Creek (Wilcox County, Alabama) and Tallatchee Creek (Monroe County, Alabama).

Triangular Kidneyshell: Stable

The triangular kidneyshell is currently stable and not believed to have lost any known populations since the time of listing. The most robust population is the Cahaba River (Jefferson/Bibb/Shelby Counties, Alabama), where densities have been found up to 0.25 individuals/m^2 (P. Johnson pers. comm. 2018). The Sipsey Fork population was believed healthy until the 2000 drought, when the predrought densities were documented at 0.88 individuals/m^2, but postdrought were measured at 0.18 individuals/m^2 (Haag and Warren 2008). The triangular kidneyshell was cultured in 2014 using Cahaba River brood stock and identified several darters as good hosts, but no stockings have yet taken place (Johnson 2018).

III. RESULTS

A. Recommended Classification resulting from the 5-Year Review:

a. No change is needed:
Finelined pocketbook
Orangenacre mucket
Alabama moccasinshell
Coosa moccasinshell
Ovate clubshell
Dark pigtoe
Southern pigtoe
Triangular kidneyshell

b. Downlist to threatened:

Southern clubshell

Although many populations of the southern clubshell remain isolated by dams, connectivity has been recently improved with several dam removals (Table 1) from across the Mobile River Basin. Additionally, water improvement have taken place within the Cahaba River and flow restoration has taken place downstream of Weiss Dam in the Weiss Bypass (Coosa River). The reduction of these threats in addition to several new populations that have been documented since listing, and considering that eight populations appear to be robust and well distributed throughout the historic range, any individual event is unlikely to seriously impact all population simultaneously. This lends itself to the ability by the southern clubshell to adapt to change and withstand stochastic or catastrophic events, and the improvement its status makes it unlikely for the southern clubshell to become extinct within the foreseeable future. Therefore, the best scientific and commercial data available indicate that southern clubshell is no longer an endangered species. Southern clubshell does remain extirpated from a significant portion of its historical range and surviving populations remain isolated by large dams. Surviving drainage populations are isolated and remain vulnerable to changes in water quality, land use runoff, toxic spills, as well as floods and droughts. Therefore threatened status is currently appropriate for the species.

B. **Recovery Priority Number**

a. **No change is needed:**
Finelined pocketbook - 8
Orangenacre mucket - 8
Alabama moccasinshell - 8
Coosa moccasinshell - 5
Southern clubshell - 8
Dark pigtoe - 5
Southern pigtoe - 5
Ovate clubshell - 5
Triangular kidneyshell - 8

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1) Develop measurable recovery criteria for these mussel species.
2) Develop and implement a plan to quantify and monitor surviving populations.
3) Continue to refine and implement the Mobile River Basin Mollusk Propagation Plan.
4) Continue to work with States to reintroduce hatchery reared mussels into restored habitats, as appropriate.
5) Several changes were noted in this review to taxonomic classification or changes in nomenclature. These changes are detailed by Williams *et al.* (2017). A need exists

to publish and recognize the changes that have occurred since listing action in the Federal Register.

6) Conduct additional genetic analyses to determine the species status for rayed kidneyshell. If findings confirm species status for both kidneyshell mussels, their protective status should be reassessed under the Endangered Species Act as separate species.
7) Develop and implement a plan to describe and monitor habitat conditions where the mussels survive.
8) Conduct additional toxicological and biological tolerance levels (DO, pH, temperature, conductivity, etc.) to better assess water quality standards for these imperiled mollusks.
9) Protect water quality within drainages known to support habitat for these mussels through cooperative agreements (e.g., Partners for Fish and Wildlife), conservation land acquisitions (e.g., Cahaba River NWR acquisition boundary, TNC reserves or easements, Forever Wildlife Land Trust), and best management practices (e.g., forestry conservation practices), targeting priority parcels identified by conservation partners in each SHU.
10) Work with landowners of priority parcels to identify, fund, and implement management actions to improve water quality.
11) Increase public awareness through outreach materials, festivals, outings, and other methods.

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Peer-Reviewers

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

Mr. Jason M. Wisniewski, Mussel Biologist
Tennessee Wildlife Resources Agency, Nashville, TN

Mr. Matthew D. Wagner, State Ichthyologist/Curator of Fishes
Mississippi Department of Wildlife, Fisheries, and Parks:
Mississippi Museum of Natural Science, Jackson, MS

Provided new/updated information

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

Mr. Jason M. Wisniewski, Mussel Biologist
Tennessee Wildlife Resources Agency, Nashville, TN

Dr. Carla Atkinson, Assistant Professor
Department of Biological Sciences, University of Alabama, Tuscaloosa, AL

Dr. Nathan A. Johnson, Research Biologist
Wetland and Aquatic Research Center, U.S. Geological Survey, Gainesville, FL

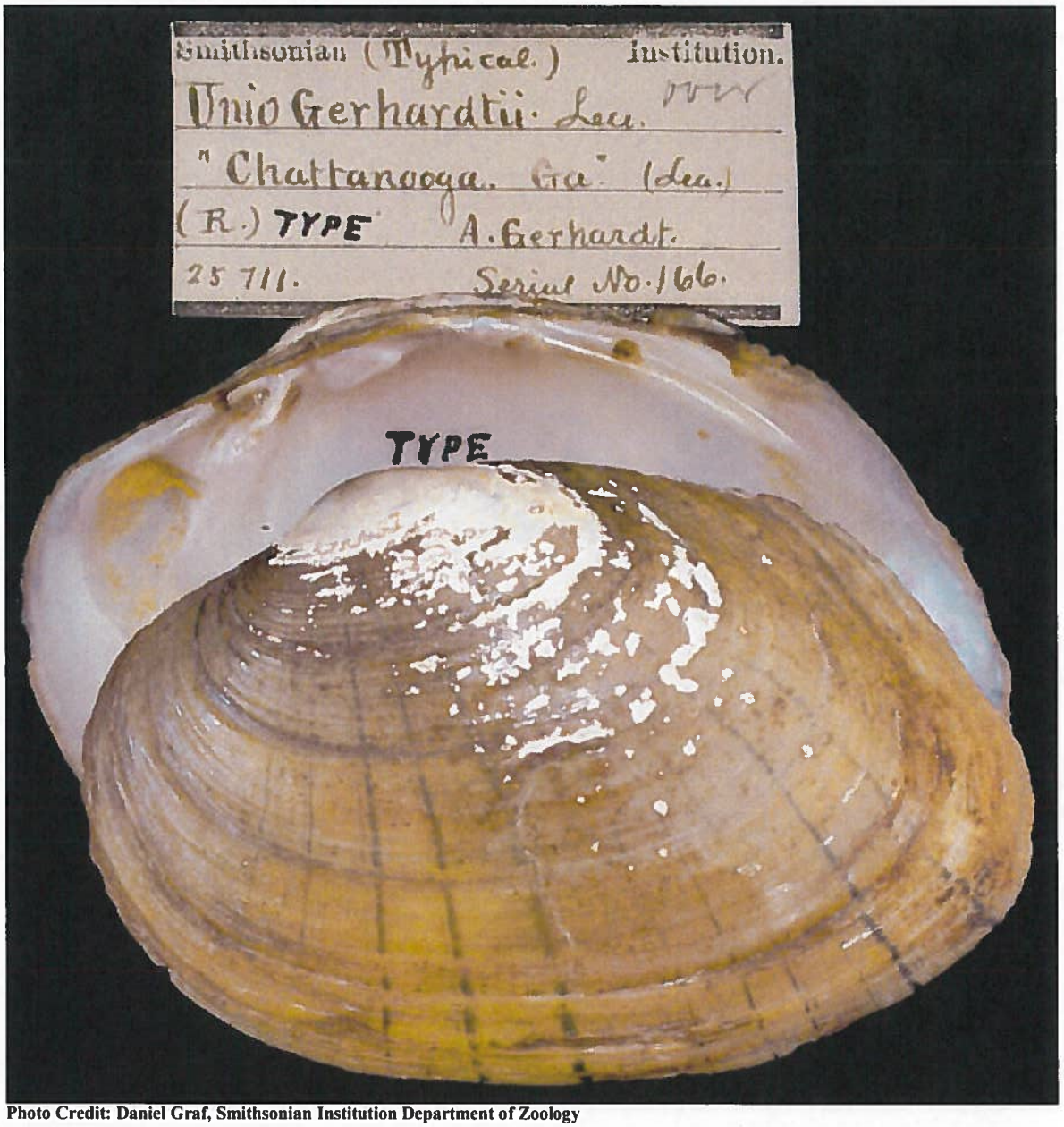

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 1. Finelined pocketbook [synonymy: *Unio gerhardtii* Lea, 1862]; Type locality: Chattanooga, [Chattooga River], Georgia, Alexander Gerhardt, Holotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 25711).

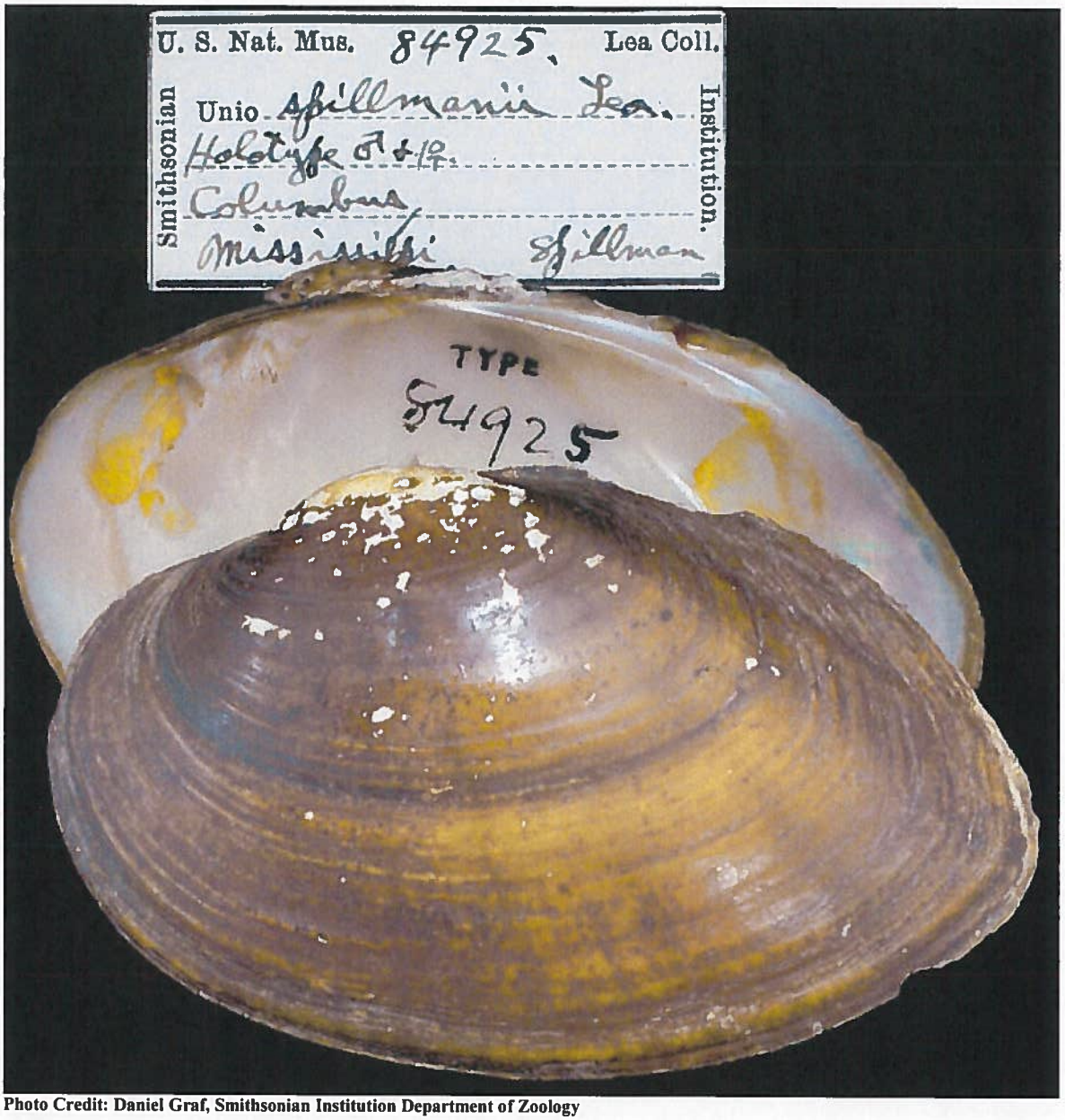

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 2. Orangenacre mucket [synonymy: *Unio spillmanii* Lea, 1861]; Type locality: Luxpalila [Luxapallila] Creek, near Columbus [Lowndes County,] Mississippi, W. Spillman, M.D., Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84925).

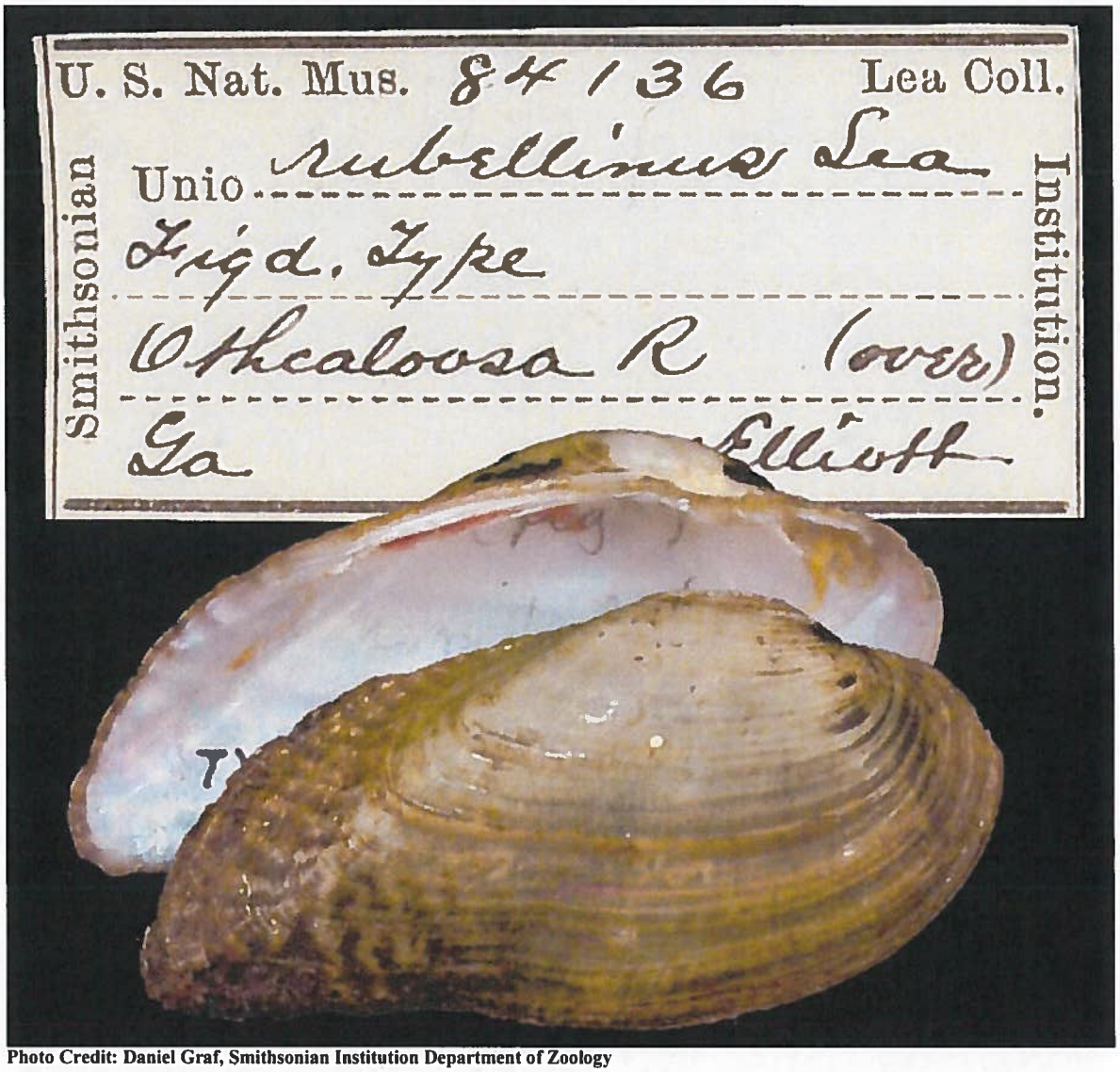

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 3. Alabama moccasinshell [synonymy: *Unio rubellinus* Lea, 1857]; Type locality: Othcalooga Creek, Gordon County, Georgia, Bishop Elliott, Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84136).

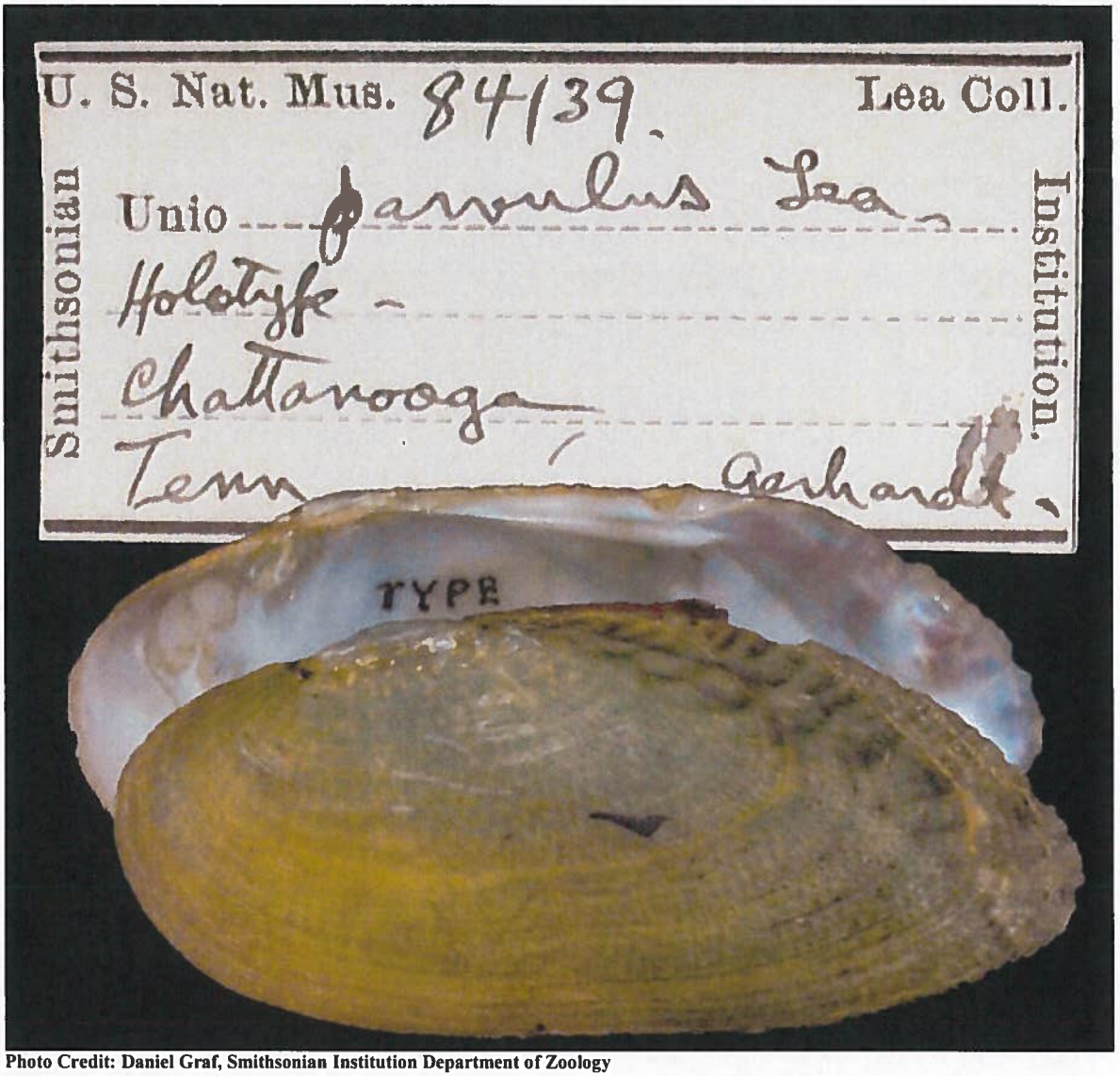

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 4. Coosa moccasinshell [synonymy: *Unio parvulus* Lea, 1860]; Type locality: Coosa River, Alabama, E.R. Showalter, M.D., Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84139). However, this lectotype designation is invalid, as the figured specimen is from Chattooga River, Georgia, and not from the stated type locality "Coosa River, Alabama" (Williams *et al.* 2008).

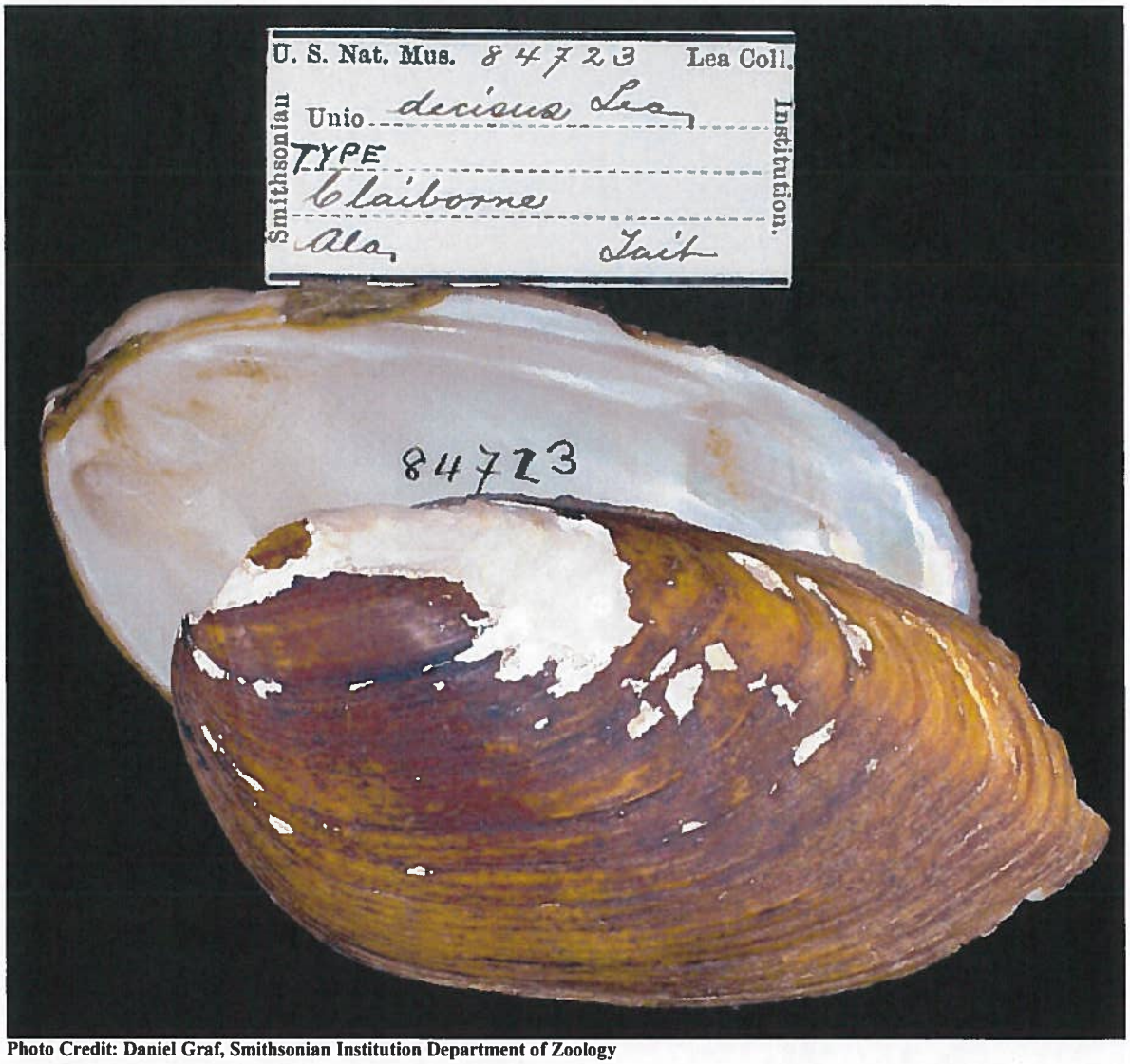

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 5. Southern clubshell [synonymy: *Unio decisus* Lea, 1831]; Type locality: Alabama River [Alabama], Judge Tait, Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84723).

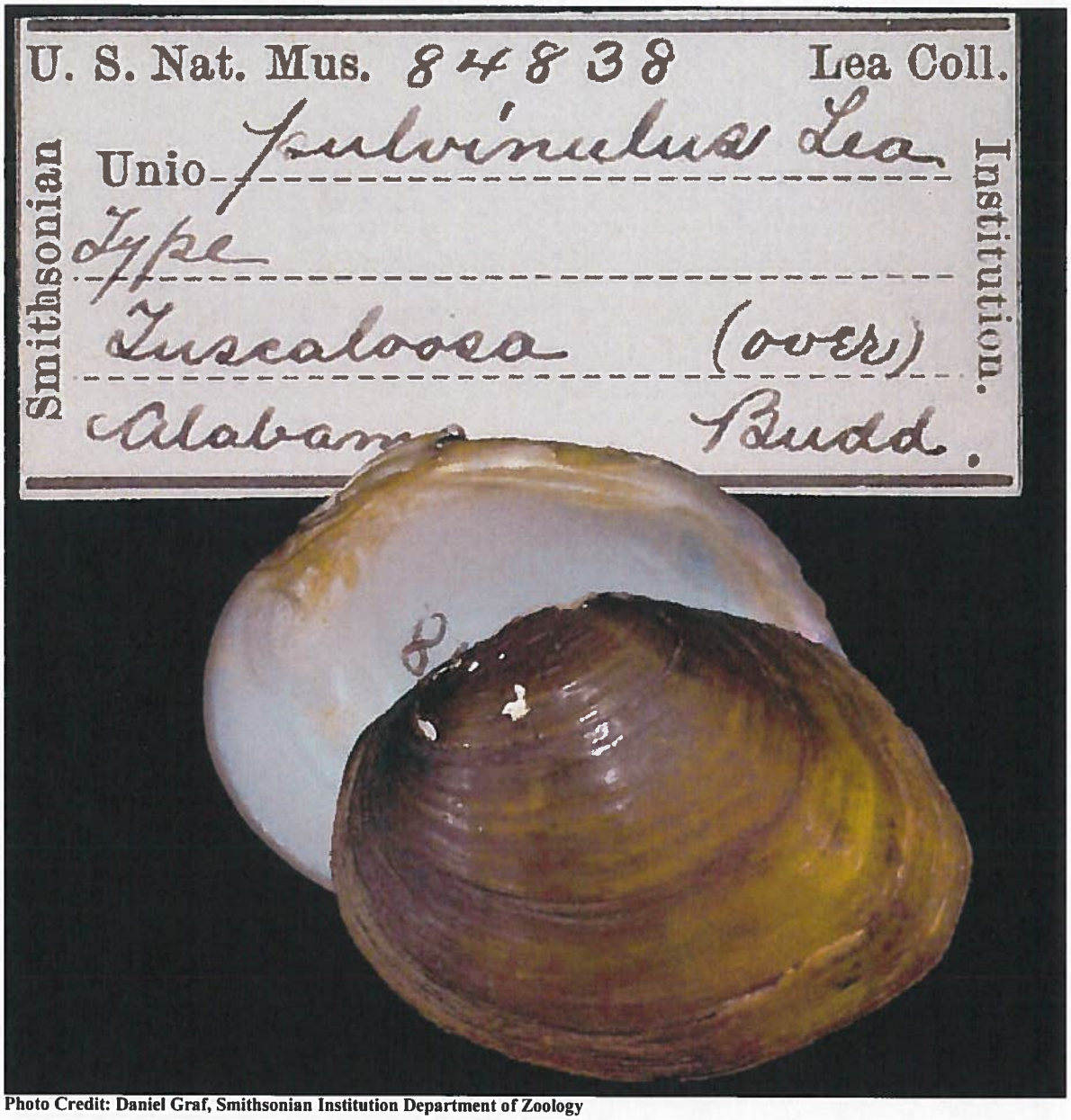

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 6. Dark pigtoe [synonymy: *Unio pulvinulus* Lea, 1845]; Type locality: [Black Warrior River,] Tuscaloosa, [Tuscaloosa County,] Alabama, B.W. Budd, M.D., Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84838).

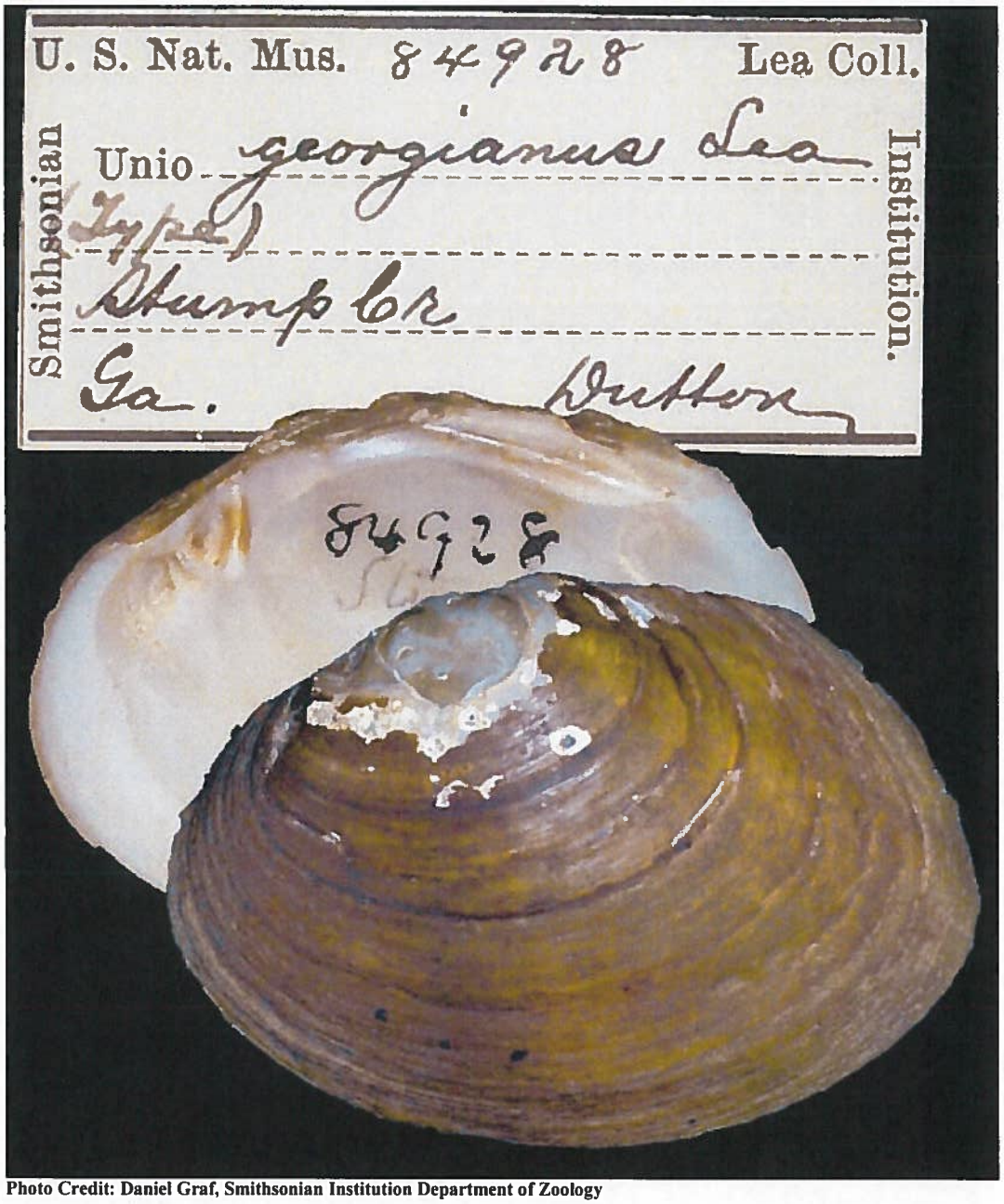

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 7. Southern pigtoe [synonymy: *Unio georgianus* Lea, 1841]; Type locality: Stump [Stamp] Creek, [Bartow County,] Georgia, T.R. Dutton, Holotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84928).

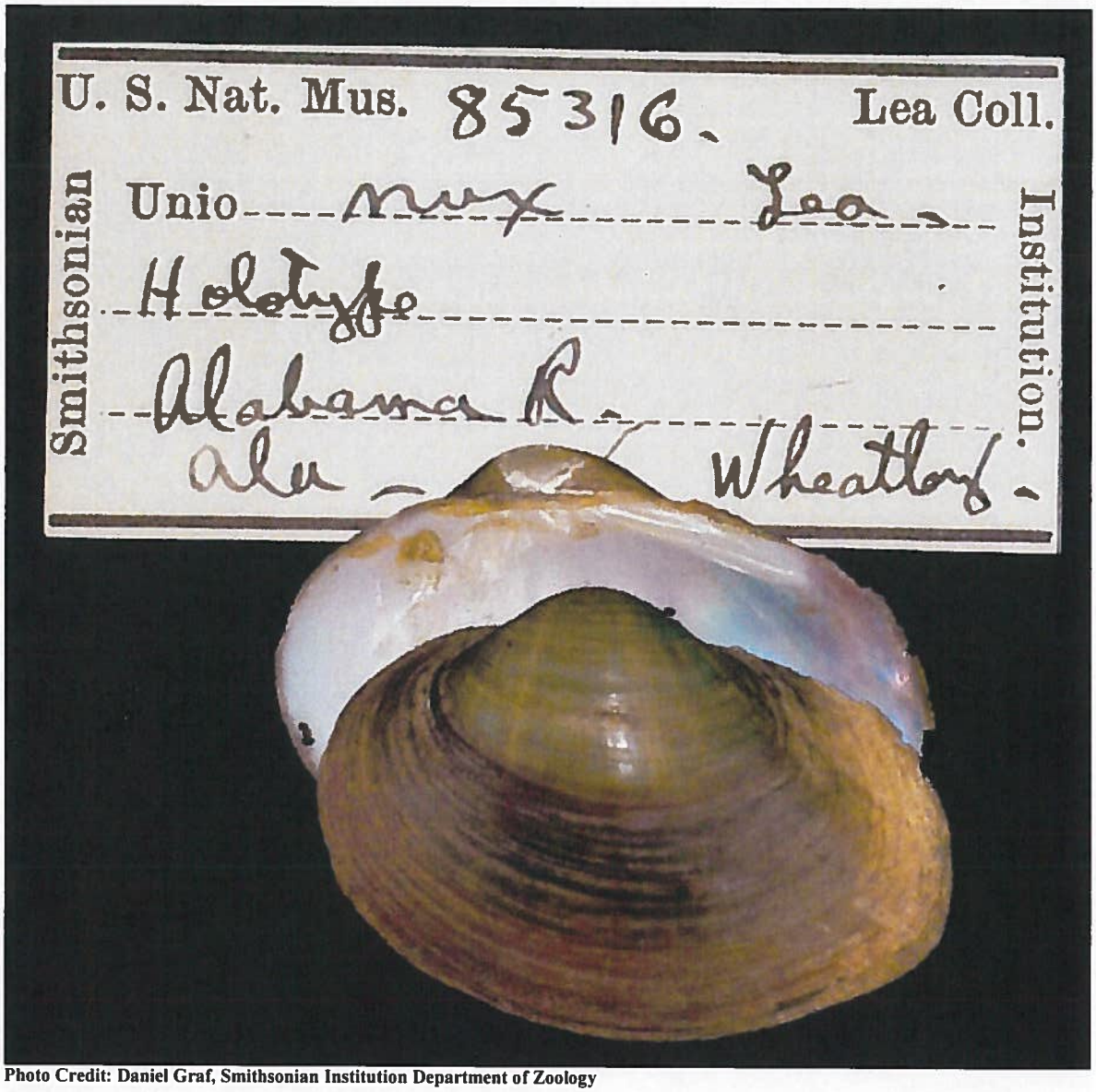

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 8. Ovate clubshell [synonymy: *Unio nux* Lea, 1852]; Type locality: Alabama River, [Alabama,], C.M. Wheatley, Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 85316).

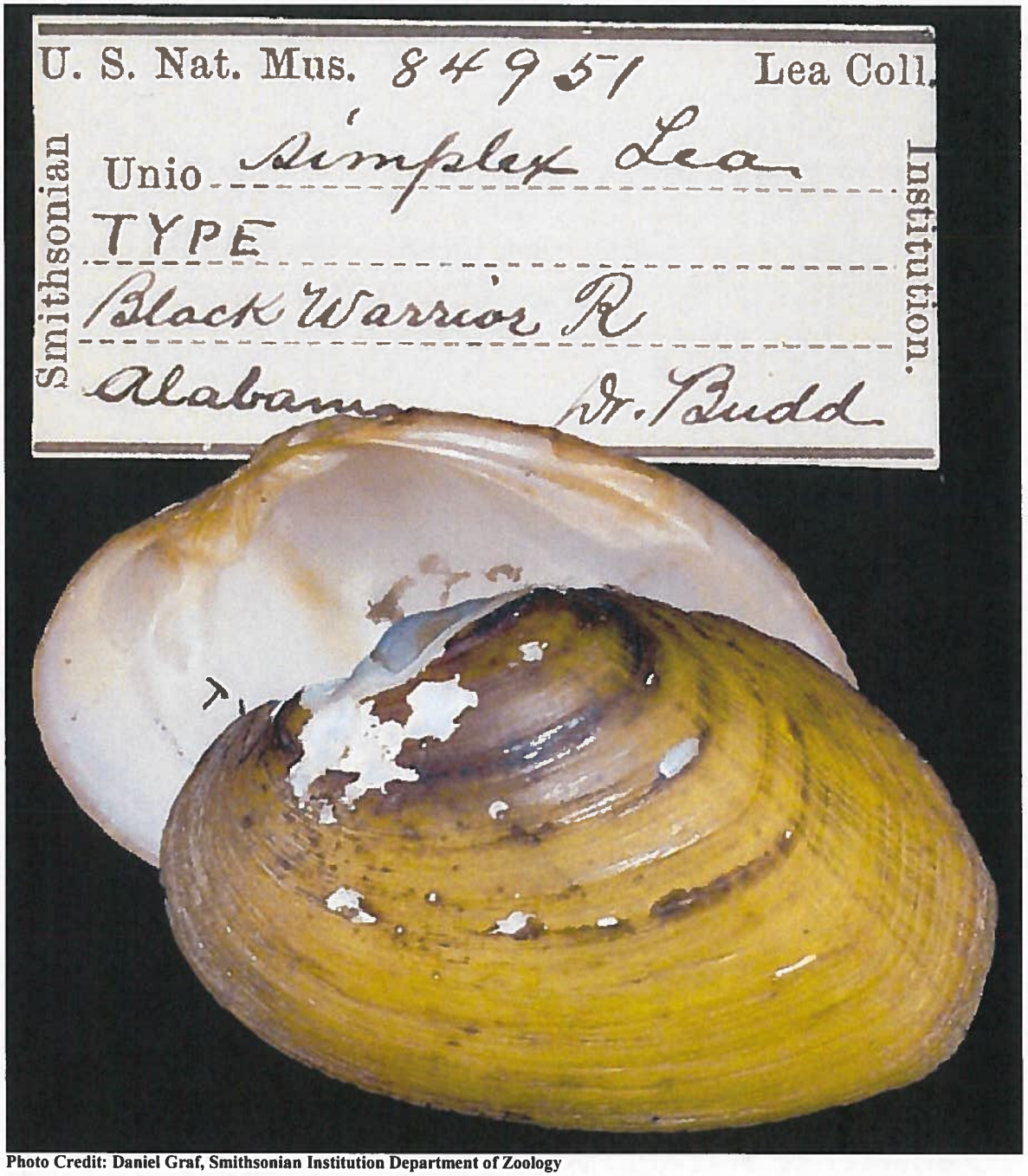

Photo Credit: Daniel Graf, Smithsonian Institution Department of Zoology

Figure 9. Triangular kidneyshell [synonymy: *Unio simplex* Lea, 1845]; Type locality: Black Warrior River, Alabama, B.W. Budd, M.D., Lectotype. Specimen is located in the Department of Invertebrate Zoology Collections, Smithsonian National Museum of Natural History (USNM 84951).

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Fine-lined pocketbook
Orange-nacre mucket
Alabama moccasinshell

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist
_X_ No change needed

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

Review Conducted By: Anthony Ford, Alabama Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Alabama Ecological Services Field Office, Daphne, AL

Approve: WILLIAM PEARSON Digitally signed by WILLIAM PEARSON Date: 2019.09.12 14:32:59 -05'00' Date: _____

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Coosa moccasinshell
Ovate clubshell
Dark pigtoe
Southern pigtoe
Triangular kidneyshell

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

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

Review Conducted By: Anthony Ford, Alabama Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Alabama Ecological Services Field Office, Daphne, AL

Approve: WILLIAM PEARSON Digitally signed by WILLIAM PEARSON Date: 2019.09.12 14:33:47 -05'00' Date: _____

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Southern clubshell

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable: 8.

Review Conducted By: Anthony Ford, Alabama Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Alabama Ecological Services Field Office, Daphne, AL

Approve: WILLIAM PEARSON Digitally signed by WILLIAM PEARSON Date: 2019.09.12 14:34:23 -05'00' Date: _____

REGIONAL OFFICE APPROVAL:

Lead Regional Director, U.S. Fish and Wildlife Service, South Atlantic-Gulf & Mississippi-Basin, Atlanta, GA

Approve: Acting Franklin Jones Date: 9/23/2019

APPENDIX A: Summary of peer review for the 5-year review of the finelined pocketbook, orangenacre mucket, Alabama moccasinshell, Coosa moccasinshell, southern clubshell, dark pigtoe, southern pigtoe, ovate clubshell, and triangular kidneyshell.

A. Peer Review Method: see below

B. Peer Review Charge:

Requests were made to each peer reviewer of the 5-year review via email request (August 22, 2019). 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.

Dr. Paul 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. Specifically, Dr. Johnson is one of the world's foremost snail and mussel experts. Dr. Johnson has extensive local expertise with Mobile River Basin mussel fauna.

Mr. Jason Wisniewski is a mussel biologist with the Tennessee Wildlife Resources Agency where he works at the Cumberland River Aquatic Center focusing on fish and mussel propagation and culture systems. He also previously worked (2004-2019) for the Georgia Department of Natural Resources as a mussel biologist, where he managed Georgia's aquatic wildlife conservation program. Mr. Wisniewski has worked extensively with freshwater mussels in the Mobile River Basin.

Mr. Matthew Wagner is a conservation resource biologist with the Mississippi Museum of Natural Science, and serves as both state ichthyologist and curator of fishes. Mr. Wagner has sampled multiple has extensive expertise and sampling experience within the Mobile River Basin.

C. Summary of Peer Review Comments/Report

Dr. Paul Johnson: Dr. Johnson provided new and updated information on multiple populations of these nine mussels, including propagation work, host trials, reintroductions, and post monitoring of hatchery introduced mussels. Dr. Johnson also provided multiple personal communications to clarify ongoing or recent updates to genetic and systematic or taxonomic classifications (i.e., dark pigtoe and triangular kidneyshell). Dr. Johnson did recommend an additional future action to research and understand toxicological and biological tolerance levels to better address water quality standards.

Mr. Jason Wisniewski: Mr. Wisniewski provided new information on two previously undocumented populations of finelined pocketbook of the upper Coosa River Basin of

Georgia, and provided additional survey information for the southern clubshell within the Conasauga River, Murray County GA. Mr. Wisniewski suggested that the additional information for finelined pocketbook in Georgia may justify the species' status being considered improved, additionally Mr. Wisniewski agreed with the review's assessment and recommendation for downlisting the southern clubshell.

Mr. Matthew Wagner: found no substantial comments or edits, and are generally supportive of the conclusion of the review.

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

D. Response to Peer Review

Dr. Paul Johnson: We updated the report to include the new information provided by Dr. Johnson regarding known populations, propagation work, host trials, and reintroductions of these mussel species. We also included several new personal communication citations as it regards this information and clarification on genetics and systematics. We also agree with Dr. Johnson's recommendation to include a recommended future action to research and better understand toxicological and biological tolerances in order to better address water quality standards of these listed mussels.

Mr. Jason Wisniewski: We updated the report to include the provided information on the two new populations of the finelined pocketbook from the upper Coosa River Basin in Georgia, and the additional survey information for the southern clubshell within the Conasauga River in Georgia. We also considered and agree with Mr. Wisniewski that these additional populations for the finelined pocketbook would result in an improved status for the species. So we adjusted our assessment of our status from stable to improving (Section I.C).

Mr. Matthew Wagner: No changes were suggested or incorporated.