

**Shinyrayed Pocketbook (*Lampsilis subangulata* (now known as
Hamiota subangulata)
Gulf Moccasinshell (*Medionidus penicillatus*)**

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



Shinyrayed Pocketbook Photo Credit: USFWS



Gulf Moccasinshell Photo Credit: USFWS

**U.S. Fish and Wildlife Service
Southeast Region
Georgia Ecological Services Office
Athens, Georgia**

5-YEAR REVIEW

Shinyrayed Pocketbook (*Lampsilis subangulata* (now known as *Hamiota subangulata*) Gulf Moccasinshell (*Medionidus penicillatus*)

I. GENERAL INFORMATION

A. Methodology used to complete the review: In conducting this 5-year review, we relied on the best available information pertaining to historical and current distributions, life history, genetics, habitats, and potential threats to these species. We announced this review and requested information in a published *Federal Register* (FR) notice with a 60-day comment period in August 2018 (83 FR 38320). There were no comments received during the 60-day public comment period. Information sources used for this review include the final rule listing these species under the Endangered Species Act (68 FR 56647), the rule designating critical habitat (72 FR 64286), the Recovery Plan (U.S. Fish and Wildlife Service (USFWS or Service) 2003); the amendment to the original recovery plan (USFWS 2019), the previous 5-Year Review (USFWS 2007); peer-reviewed scientific publications; unpublished reports; ongoing field survey results and information from qualified Service and State biologists. Information gathered and evaluated was used to update information presented in the 2007 5-year review, as appropriate. The species' recovery lead biologist in the Georgia Ecological Services Field Office compiled all of the best available information and data and completed the review. All literature and documents used for this review are on file at that Field Office. [Note: in relation to the shinyrayed pocketbook's species nomenclature, see section 1. C. d for how we will address the name change that we have yet to address.]

B. Reviewers

Lead Region: Southeast Region, Kelly Bibb, 404-679-7132

Lead Field Office: Sandy Abbott, Georgia Ecological Services Office, 706-544-7518

Cooperating Field Office: Sandra Pursiful, Panama City Ecological Services Field Office, 850-769-0552

C. Background

- 1. Federal Register Notice citation announcing initiation of this review:** 83 FR 38320 (August 6, 2018)
- 2. Species status:** The status of the shinyrayed pocketbook has improved due to finding additional populations since their listing in 1998 (USFWS 2007). Shinyrayed pocketbook however appears to be stable since 2007 as local populations that have declined has been offset with the discovery of additional populations. The Gulf moccasinshell appears to be declining based on recent surveys which are showing decreases in collection numbers.

3. Recovery achieved: 1 for both mussels (1 = 0-25% species recovery objectives achieved).

4. Listing history

Original Listing

FR notice: 63 FR 12664

Date listed: March 16, 1998

Entity listed: Species

Classification:

Shinyrayed pocketbook: Endangered

Gulf moccasinshell: Endangered

5. Associated rulemakings: Critical habitat was designated on November 15, 2007 (72 FR 64286).

6. Review History:

Recovery Plan: 2003

Each year, the Service reviews and updates listed species information for inclusion in the required Recovery Report to Congress. Through 2013, we performed a recovery data call that included status recommendations, like “stable” for these species.

Five-year Review: 2007. No change of status was recommended for either species based on the best information available. The status was reported as improving for shinyrayed pocketbook, due to recent surveys indicating range extensions, and unknown for Gulf moccasinshell, due to no recent information available.

7. Species’ Recovery Priority Number at start of review (48 FR 43098): 5 (both species) This number indicates a:

Degree of Threat: High

Recovery Potential: Low

Taxonomy: Species

8. Recovery Plan

Name of plan: Recovery Plan for Endangered Fat Threeridge (*Amblema neislerii*), Shinyrayed Pocketbook (*Lampsilis subangulata*), Gulf Moccasinshell (*Medionidus penicillatus*), Ochlockonee Moccasinshell (*Medionidus simpsonianus*), and Oval Pigtoe (*Pleurobema pyriforme*); and Threatened Chipola Slabshell (*Elliptio chipolaensis*), and Purple Bankclimber (*Elliptoideus sloatianus*).

Date issued: September 19, 2003

Amendment to the original 2003 Recovery Plan for the Gulf Moccasinshell (*Medionidus penicillatus*), Oval Pigtoe (*Pleurobema pyriforme*), Purple Bankclimber

(*Elliptoideus sloatianus*), and Shinyrayed Pocketbook (*Hamiota subangulata*); Recovery Criteria Revision.

Date issued: September 26, 2019

II. REVIEW ANALYSIS

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

Not applicable. The Endangered Species Act (ESA) defines species as including any subspecies of fish or wildlife or plants 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 these two species are invertebrates and therefore not covered by the DPS policy, we will not discuss it further.

B. Recovery Criteria

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

2. Adequacy of recovery criteria.

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

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

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

The Amendment to the Original Recovery Plan (USFWS 2019) includes delisting criteria for this species, which was not previously provided by the Recovery Plan (USFWS 2003). The original criteria established a number of subpopulations per sub-basin and large river basin, and occupied river miles needed to determine species status for reclassification to threatened. Specific increases in subpopulations and river miles needed to delist this species was unknown.

In the revised criteria, populations are delineated by sub-basins; however, they may contain one or more subpopulations/sites (USFWS 2019). Sub-basins are considered areas of relatively un-fragmented habitat that the Service regards as separate watersheds for the listed mussels for management purposes, because host fishes are potentially able to move between all occupied sites within those sub-basins (USFWS 2003). Subpopulations/sites were loosely defined as stream reaches that would typically yield multiple live specimens with approximately 4-6 person hours sampling effort generally separated by reaches of unsuitable habitat

(USFWS 2003). New survey and modeling methods developed since 2007 provide a more comprehensive perspective on habitat use, detection, distribution, and abundance. The revised criteria will ensure the resiliency, redundancy, and representation for this species based on the viability of each sub-basin population as well as mussel distribution across and within river systems (USFWS 2019). This approach is more transparent and easier to replicate than determining numbers of sites per sub-basin needed for recovery.

The shinyrayed pocketbook and Gulf moccasinshell will be considered for delisting when:

1. Populations exhibit a stable or increasing trend, by natural recruitment, and multiple age classes.

1a) At least eight (8) populations of shinyrayed pocketbook exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes.

This criterion has not been met. Spring Creek and Chiploa sub-basin populations contain larger numbers of the shinyrayed pocketbook with multiple occurrences, and evidence of recruitment (GADNR, unpub. data, 2011-2017; S. Geda pers. comm. 2019). The Lower Chattahoochee sub-basin population is restricted to Sawhatchee and Sheffield Mill Creeks where the species occurs in small numbers, though there is some evidence of recruitment (GADNR, unpub. data, 2005-2018). Populations within other sub-basins (Upper, Middle and Lower Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Middle Chattahoochee and Econfina) are localized, with only a few individuals, and with no to little evidence of recruitment. Comprehensive age-class structure data is not available to understand population demography in each sub-basin. The previous 5-year review did not provide information on population trends, recruitment, or age class structure. Section II.C.1.b includes the most up to date information on the status of this species in each sub-basin.

1a) At least seven (7) populations of Gulf moccasinshell exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes.

This criterion has not been met. The Lower Chattahoochee sub-basin population is restricted to Sawhatchee and Sheffield Mill Creeks and is currently the only location Gulf moccasinshells can be found in larger numbers with multiple occurrences and evidence of recruitment (GADNR, unpub. data, 2005-2018). The Middle Flint Sub-basin population in Chokey Creek has recently documented an increase in individuals with evidence of recruitment but from only one location (GADNR, unpub. data, 2008-2019). Populations within the remaining sub-basins (Upper Flint,

Kinchafoonee-Muckalee, Ichawaynochaway, Econfina, and Chipola) are mostly of single individuals and localized where they are found. Comprehensive age-class structure data is not available to understand population demography in each sub-basin. The previous 5-year review did not provide information on population trends, recruitment, or age-class structure. Section II.C.1.b includes the most up to date information on the status of this species in each sub-basin.

2. The spatial distribution of populations (as described in Criteria 1) are sufficient to protect against extinction from catastrophic events and maintain adaptive potential.

2a) At least one (1) population of shinyrayed pocketbook in each of the Econfina Creek, Chipola, Chattahoochee, Flint, and Ochlockonee Rivers, and two (2) populations being located within the major tributary sub-basins of the Flint River.

This criterion has not been met. The overall trend within the historical range is a reduction in the number of sites with possible extirpation in the Ochlockonee River. The shinyrayed pocketbook was last collected live in 2002 with no occurrences during extensive surveys from 2006 to 2016 (S. Pursifull et al., in review to publish). As of this review, only three sub-basins (the Chipola, Spring Creek and Lower Chattahoochee) contain shinyrayed pocketbook populations with multiple occurrences and evidence of recruitment. Sawhatchee Creek and Sheffield Mill Creek are considered one population and are the only known sites within the whole Lower Chattahoochee sub-basin. Spring Creek is a major tributary of the Flint River and this population represents one of two major tributary populations that are needed for species representation and redundancy. The Spring Creek sub-basin is susceptible to extended periods of drying resulting in mussel mortality.

This species is present in Econfina Creek, Middle Chattahoochee, and all major tributary sub-basins in the Flint River. However, most populations are of few individuals with little evidence of recruitment and multiple age classes as required in Criterion 1. Section II.C.1.b includes the most up to date information on the status of this species in each sub-basin.

2a) At least one (1) population of Gulf moccasinshell in each of the Econfina Creek, Chipola, Chattahoochee, and Flint River systems, and two populations being located within the major tributary sub-basins of the Flint River.

This criterion has not been met. The overall trend within the historical range is a reduction in the number of sites with possible extirpation in

Spring Creek. Extensive surveys of the Spring Creek sub-basin have been conducted since 2000 (USFWS, unpub. data 2000 and 2008; GADNR, unpub. data 2005-2006 and 2010-2017); no live individuals or dead shells were found during these surveys. However, all occurrences, with the exception of Sawhatchee Creek and Sheffield Mill Creek (Lower Chattahoochee sub-basin) and Chokey Creek (Middle Flint sub-basin), are of few individuals with no evidence of recruitment, which does not meet Criterion 1 for populations. This species is highly susceptible to extinction from catastrophic events with only two known reproducing populations located in Georgia in Sawhatchee and Chokey creeks.

The species is also present in Econfinia, Chipola, Upper Flint, Kinchafoonee-Muckalee and Ichawaynochaway sub-basins. These populations do not exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes as required in Criterion 1. Section II.C.1.b includes the most up to date information on the status of this species in each sub-basin.

3. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future.

This criterion has not been met. Threats continue for both species from habitat alteration and loss from a variety of land use activities, including water withdrawal, dams, channelization, gravel mining, pollution, sedimentation, and deadhead logging. The effects of climate change are uncertain within the range of the shinyrayed pocketbook and Gulf moccasinshell, but are considered a threat to the viability of this species.[Please refer to section C.2. for details on the five listing factors as they relate to these species.]

C. Updated Information and Current Species Status

1. Biology and Habitat

a. New information on the species' biology and life history:

Recent host fish trials by Fritts and Bringolf (2014) tested between 19-27 fish species for the shinyrayed pocketbook and Gulf moccasinshell with the following results:

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Three potential species demonstrated successful transformation in laboratory conditions for the shinyrayed pocketbook; shoal bass (*Micropterus cataractae*), redeye bass (*Micropterus coosae*) and largemouth bass (*Micropterus salmoides*) metamorphosis (mussel larvae to juvenile mussels)(success was greater than (>) 78 percent (%) on all three.

Gulf Moccasinshell

Four potential darter species demonstrated successful transformation in laboratory conditions for the Gulf moccasinshell; turquoise darter (*Etheostoma inscriptum*), gulf darter (*Etheostoma swaini*), halloween darter (*Percina crypta*), and blackbanded darter (*Percina nigrofasciata*). Metamorphosis success varied but was the highest on turquoise darter (40%) and blackbanded darter (39%).

b. Abundance, population trends, demographic features or trends:

Trend data is generally lacking for both species with the exception of three GADNR long-term monitoring sites in Sawhatchee Creek (Lower Chatahoochee sub-basin) (GADNR, unpub. data, 2005-2018), Chokey Creek (Middle Flint Sub-basin) (GADNR, unpub. data., 2008-2018) and Spring Creek (Spring Sub-basin) (GADNR, unpub. data, 2011-2018). Most surveys usually detect small and localized populations with low densities, with the exception of Spring Creek (Spring Creek Sub-basin) (GADNR, unpub. data, 2011-2018), Sawhatchee Creek (Lower Chattahoochee Sub-basin) (GADNR, unpub. data, 2005-2018), and Chipola River (Chipola Sub-basin) (FWC, unpub. data, 2014-2015 and 2017-2018; USFWS, 2008, 2011, 2013-2013-2019; Cardno ENTRIX 2011) for the shinyrayed pocketbook and Sawhatchee Creek (Lower Chattahoochee Sub-basin) (GADNR, unpub. data, 2005-2018) and Chokey Creek (Middle Flint Sub-basin) (GADNR, unpub. data., 2008-2018) for the Gulf moccasinshell. Traditional sampling techniques that do not account for the detection of a species may not reflect accurate assessments of presence or abundance (Wisniewski *et al* 2013). Detection can vary with species, stream size, shell length, sampler experience, and other variables. Most of the data available for these species is from qualitative or semi-quantitative sampling efforts that did not include estimates of detection.

Status for the shinyrayed pocketbook and Gulf moccasinshell is summarized by sub-basins in the 2003 recovery plan (USFWS 2003). The Middle and Lower Flint sub-basins were further divided into major tributary watersheds at the time new recovery criteria were established for both mussel species on September 26, 2019 (80 FR 30764). The Middle Flint Sub-basin subdivided the Kinchafoonee-Muckalee into a separate sub-basin and the Lower Flint Sub-basin subdivided Ichawaynochaway and Spring into separate sub-basins. The subdivision of these major tributaries is consistent with U.S. Geological Survey 8-digit hydrologic cataloging units. These sub-basins are considered areas of relatively un-fragmented habitat that we identify as separate watersheds for the listed mussels for management purposes, because host fish are potentially able to move between all occupied sites within those sub-basins.

The status of both species since the 2007 5-year review is updated below:

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Upper Flint Sub-basin, Georgia

An extensive survey of the northern part of this sub-basin was conducted in 2013-14 by the Georgia Department of Natural Resources resulting in no findings of shinyrayed pocketbooks. The only population recorded from the Upper Flint since 2008 was two individuals from Turkey Creek in 2013 (GADNR, unpub. data, 2013). Other tributary localities that were surveyed but where shinyrayed pocketbook was not found include Red Oak, Hogcrawl, and Limestone Creeks (GADNR, unpublished data 2011, 2013, 2014, 2017). However, shinyrayed pocketbook may still occur in these localities at such low numbers that detection is difficult.

Middle Flint Sub-basin, Georgia

Chokee Creek contains a long-term mark-recapture study site established by GADNR 50-m downstream of New York Road in Lee County, Georgia. Yearly surveys have been conducted in a 100-meter (m) stretch from 2008-2019 (GADNR, unpub. data, 2008-2019). To date, 24 individual shinyrayed pocketbooks have been tagged and recorded from this site with an average length of 64-mm with no evidence of recruitment. (GADNR, unpub. data, 2008-2019). GADNR also recorded shinyrayed pocketbooks from Mercer Millpond Creek in 2010 (GADNR, unpub. data, 2010).

Kinchafoonee-Muckalee Sub-basins, Georgia

Service personnel conducted timed searches at 10 locations in the upper mainstem of Kinchafoonee Creek in 2015 finding one individual shinyrayed pocketbook downstream of the bridge at Highway 280 (USFWS, unpub. data, 2015). There have been no documented occurrences of shinyrayed pocketbooks recorded in Muckalee Creek since 2007 (GADNR, unpub. data), however, limited survey work has been conducted since 2008. Status of the species in the Kinchafoonee-Muckalee sub-basin is unclear; all known sites have not been surveyed since the last 5-year review.

Lower Flint Sub-basin, Georgia

Lower Flint sub-basin had 5 new sub-populations recorded from the Flint mainstem. A total of 23 individuals were found in Baker (2009-2011) and Mitchell (2009 and 2011) counties (GADNR, unpub. data 2009-2011). There was also one individual recorded in 2017 further downstream on the Flint River mainstem in Decatur County (GADNR, unpub. data). Shinyrayed pocketbooks have not been recorded from the Lower Flint mainstem since the mid-1950s (Brim-Box and Williams 2000). One individual was recorded from

a tributary in this sub-basin, Coolewahee Creek, in 2009 near its confluence with the Flint River. (GADNR, unpub. data 2009).

Ichawaynochaway Sub-basin, Georgia

Four individual shinyrayed pocketbooks were documented from 2 locations from 2011 to 2019 in Ichawaynochaway Creek (Ecological Solutions 2011 and 2012; CCR 2019). Surveys in 2010, 2011 and 2014 from 3 locations in Chickasawhatchee Creek yielded 18 individuals (GADNR, unpub. data, 2010, 2011, and 2014).

Spring Creek Sub-basin, Georgia

Spring Creek sub-basin harbors the largest number of shinyrayed pocketbooks known to occur in Georgia. Individuals are still recorded through-out Spring Creek. One individual was documented in 2010 and 45 individuals were documented in 2011 in the lower reaches of Spring Creek in Decatur County near Seminole Lake, up to Harmony Church Road (J. Wisniewski, pers. com. 2018). Service and GADNR personnel established a long-term mark-recapture monitoring site in support of a water augmentation pilot project approximately a quarter-mile upstream of the Highway 27 Bridge in Colquitt, Miller County, Georgia. The study site is 90-m in length and has been surveyed from 2011-2017. To date, 262 shinyrayed pocketbooks have been recorded and tagged with an average length of 59-mm and evidence of recruitment. In 2018, Hurricane Michael damaged portions of Spring Creek's forested riparian zone, with many trees left lying across the creek channel. Potential effects could include lateral scour that would increase sediment load and change in flow regimes. The population in Spring Creek has remained relatively stable since the last 5-year review, however long-term effects from Hurricane Michael remain unknown and stretches of creek continue to dry up periodically from excessive ground water withdrawals for agricultural use within this sub-basin (an action was added to section IV to address effects of Hurricane Michael).

Upper Chattahoochee Sub-basin, Alabama and Georgia

Upper Chattahoochee sub-basin contain only historical populations of shinyrayed pocketbooks. It has most likely been extirpated from this sub-basin due to several mainstem impoundments and urbanization.

Middle Chattahoochee Sub-basin, Alabama and Georgia

The Middle Chattahoochee sub-basin has one new population of shinyrayed pocketbooks documented from Watermelon Creek in Russell County, Alabama. Watermelon Creek is a tributary of Hatchechubbee Creek that flows in the Chattahoochee River. Service personnel recorded 2 individual shinyrayed pocketbooks in 2019 on private property (Dudley Farms) in the

town of Pittsview, Alabama (USFWS, unpub. data 2019). There are no historic records of shinyrayed pocketbooks from Watermelon Creek and therefore represents a new population in the Middle Chattahoochee Sub-basin.

Uchee Creek contains the only other record of shinyrayed pocketbooks in the Middle Chattahoochee sub-basin. Carson Stringfellow (2010) found one individual in Uchee Creek just upstream of Carson Drive and seven individuals were documented during a survey at Highway 169 by Alabama State biologist in 2015 (J. Garner, pers. comm. 2018).

Lower Chattahoochee Sub-basin, Alabama and Georgia

In the Lower Chattahoochee sub-basin, shinyrayed pocketbooks are limited to the Sawhatchee Creek system, Early County, Georgia. They are usually found in small numbers (1-3) with consistently documented occurrences throughout its mainstem and Sheffield's Mill Creek tributary. The Service and GADNR have conducted yearly surveys from 2005-2018 in a 150-m stretch of Sawhatchee Creek (at Dowry Road) in support of a long term mark-recapture study. To date, 83 shinyrayed pocketbooks have been tagged from this site with an average length of 69-mm and evidence of recruitment (GADNR, unpub. data 2005-2018).

Upper Ochlockonee Sub-basin, Florida and Georgia

It is considered likely extirpated in the upper Ochlockonee River sub-basin as the species was last collected live in 2002 with no occurrences during extensive surveys from 2006 to 2016 (S. Pursifull et al., in review for publication).

Chipola Sub-basin, Alabama and Florida

Chipola River sub-basin has significantly increased in the number and locations found since 2008. Since 2015, 147 individuals were found from 39 sites, including Cowarts Creek, with evidence of recruitment (S. Geda pers. comm. 2019). Most surveys usually find 1 to 2 individuals, however, 39 shinyrayed pocketbooks were documented just downstream of State Road 20 in 2013 (USFWS, unpub. data 2013).

Econfina Sub-basin, Florida

Shinyrayed pocketbooks were documented from one location for the first time in Econfina Creek in 2006 (USFWS 2007). The historic distribution of shinyrayed pocketbook did not extend to Econfina Creek until this discovery. They have continued to be documented in Econfina with 6 individuals found from 3 locations in 2009 and 8 individuals from 1 location in 2015 (USFWS, unpub. data 2015).

Apalachicola Sub-basin, Florida

Apalachicola sub-basin contain only historical records of shinyrayed pocketbooks from Mosquito Creek, a tributary of the Apalachicola River, near Chattahoochee, Florida. It was last documented from Mosquito Creek in 1963. There are no known historical records from the main channel of the Apalachicola River (Brim-Box and Williams 2000). It has most likely been extirpated from this sub-basin.

Gulf Moccasinshell

Upper Flint Sub-basin, Georgia

The Upper Flint Sub-basin has only 1 individual Gulf moccasinshell recorded since 2008 from Whitewater Creek in 2014 (GADNR, unpub. data, 2014). Gulf moccasinshells may still occur in these localities at such low numbers that detection is difficult.

Middle Flint Sub-basin, Georgia

Chokee Creek contains a long-term mark-recapture study site established by GADNR 50-m downstream of New York Road in Lee County, Georgia. Yearly surveys have been conducted in a 100-m stretch from 2008-2018. To date, 102 individual Gulf moccasinshells have been tagged and recorded from this site with average length of 31-mm and evidence of recruitment (GADNR, unpub. data 2008-2018).

Kinchafoonee-Muckalee Sub-basin, Georgia

Service personnel conducted timed searches at 10 locations in the upper mainstem of Kinchafoonee Creek in 2015 but did not encounter any Gulf moccasinshells (USFWS, unpub. data 2015). Muckalee Creek has only one record of a Gulf moccasinshell, a dead shell, in 1992 (USGS unpub. data 1992). Status of the species in the Kinchafoonee-Muckalee sub-basin is unclear; all known sites have not been surveyed since the last 5-year review.

Lower Flint Sub-basin, Georgia

The Lower Flint Sub-basin has had no new populations documented since 2008. The last record of a Gulf moccasinshell from this sub-basin was of a dead shell in 1991 (USGS unpub. data 1991).

Ichawaynochaway Sub-basin, Georgia

The Ichawaynochaway sub-basin has had only 1 individual recorded since 2008 from Chickasawhatchee Creek in 2014 (GADNR, unpub. data 2014). Gulf moccasinshells may still occur in these localities at such low numbers that detection is difficult.

Spring Creek Sub-basin, Georgia

The USFWS and GADNR have conducted extensive surveys of the Spring Creek sub-basin since 2000 (USFWS, unpub. data 2000 and 2008; GADNR, unpub. data 2005-2006 and 2010-2017); no live individuals or dead shells were found during these surveys and it is likely extirpated.

Upper and Middle Chattahoochee Sub-basins, Alabama and Georgia

The Gulf moccasinshell is likely extirpated from the Upper and Middle Chattahoochee sub-basins; there have been no records of occurrence since the 1970's (Brim Box and Williams 2000).

Lower Chattahoochee Sub-basin, Alabama and Georgia

In this sub-basin, the Gulf moccasinshell is limited to the Sawhatchee Creek system, Early County, Georgia. This is the largest known assemblage of this species in Georgia. They are located throughout this system and show evidence of recruitment. USFWS and GADNR personnel have tagged 412 Gulf moccasinshells with an average length of 38-mm from yearly surveys (2005-2018) in a 150-meter stretch of Sawhatchee Creek (GADNR, unpub. data, 2005-2018).

Chipola Sub-basin, Alabama and Florida

Five individuals were documented from 3 location in Dry Creek (USFWS, unpub. data 2009 and 2014; USGS, unpub. data 2012) that was last recorded in 1988. A total of 9 individuals were recorded from 2 locations in Baker Creek (USGS, unpub. data, 2012; FWC, unpub. data, 2018) that was last recorded in 1994. Five individuals were also recorded in Spring Creek (USFWS, unpub. data, 2012) and 1 individual was collected from the Chipola proper (Cardno ENTRIX 2013).

Econfina Sub-basin, Florida

The population within Econfina Creek has remained stable since 2008. Six individuals were documented from three locations in 2009 and 2 individuals from one location in 2015 (USFWS, unpub. data 2009 and 2015).

Apalachicola Sub-basin, Florida

Apalachicola sub-basin contain only historical records of Gulf moccasinshell from the Apalachicola River, near Chattahoochee, Florida. It was last recorded from this location in 1954 (Brim-Box and Williams 2000). It has most likely been extirpated from this sub-basin.

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

No data available for either species.

d. Taxonomic classification or changes in nomenclature:

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The previous 5-year review (Service 2007) noted that the shinyrayed pocketbook was placed into a new freshwater mussel genus, *Hamiota*, by Roe and Hartfield (2005). The new genus has been recognized with a recent taxonomic publication (Williams *et.al.* 2017). The Service expects to complete a formal name change under 50 CFR 17.11 in the near future.

Gulf Moccasinshell

No changes to taxonomic classification or nomenclature have occurred for Gulf moccasinshell since listing. Nomenclature is consistent and follows that in Williams *et.al.* (2017).

e. Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range):

The shinyrayed pocketbook historically occurred in 11 sub-basins (USFWS 2003) and currently occupies Chipola, Middle Chattahoochee, Lower Chattahoochee, Upper Flint, Middle Flint, Lower Flint, Kinchafoonee, Ichawaynochaway, and Spring sub-basins. It now also occurs in the Econfina sub-basin, which was not initially included in its historical range. Since the last 5-year review, survey data illustrates mussel distribution varied by sub-basin with decreases (Upper Flint), a few increases (Chipola, Middle Chattahoochee and Lower and Middle Flint sub-basins) and potential stability in others (Spring, Lower Chattahoochee and Ichawaynochaway). Populations in the Lower Chattahoochee, Spring, and Chipola sub-basins, that have evidence of recruitment or are limited in distribution, remain susceptible to catastrophic events. Loss of any of these populations may reduce species redundancy and representation. The species has been extirpated from over half of its historical range (USFWS 2007) including possible extirpation in the Upper Ochlockonee River (S. Pursifull *et al.*, in review for publication). Overall, this species distribution has remained stable since the last 5-year review in 2007.

The Gulf moccasinshell historically occurred in 11 sub-basins (USFWS 2003) and currently occupies Econfina, Chipola, Lower Chattahoochee, Ichawaynochaway, Middle Flint and Upper Flint sub-basins. Since the last 5-year review, within sub-basin distribution has mainly decreased with the exception of Sawhatchee Creek (Lower Chattahoochee sub-basin) and Chokey Creek (Middle Flint sub-basin). These two sites where higher densities of Gulf moccasinshells can be found with evidence of recruitment are susceptible to catastrophic events. Loss of any of these populations may reduce species redundancy and representation. Overall, the species has continued to decline in numbers and distribution within its historical range with probable extirpation in Upper and Middle Chattahoochee and Spring sub-basins.

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

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

The decline in range and abundance of the shinyrayed pocketbook and Gulf moccasinshell is due mostly to changes in their riverine habitats resulting from dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals (USFWS, 2003 and USFWS, 2007). These impacts have decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. Many of the threats that lead to the listing of these species continue today.

Water quantity continues to be a problem in the lower Flint, upper Chipola, and upper Ochlockonee River systems during droughts, worsened by agricultural water withdrawals. Significant droughts have continued to occur (2007-2008 and 2010-2011) with associated mussel mortality (USFWS unpub. data). Large sections of the Spring sub-basin has dried up for extended periods with excessive mussel mortality since 2000 (Wisniewski *et al.* 2015; USFWS unpub. data). Shea *et al.* (2013) found that mussel assemblages in the lower Flint River basin have declined in species richness since the 2000 drought. Dry portions of streams also represent further habitat fragmentation resulting from water withdrawals.

Water quality continues to be a present threat to some degree throughout the range of both species. The most recent assessments by State agencies under Section 305(b) of the Clean Water Act found water quality impaired or potentially impaired in some portions of the ACF and Ochlockonee River systems (e.g., Flint River, Spring Creek, Coolewahee Creek, Ochlockonee River, Cowarts Creek, and Chipola River) (ADEM 2018, FDEP 2019, GEPD 2019)

Sedimentation can lead to water quality impairments, habitat alteration, and changes in natural flow regimes. Current activities that cause channel degradation by reducing riparian buffers and increasing runoff are common in all sub-basins and include livestock grazing, road and bridge construction, unpaved roads, clear-cut logging, and off-road vehicle use. Sedimentation has direct biological impacts on mussels (eg., suffocation, reduced feeding, reduced growth rates), can negatively affect substrate composition, and can alter channel geometry and stability (USFWS 2003).

The construction and operation of dams, water withdrawals, and water diversions may alter features of the flow regime important to mussels and their host fishes. This threat is present to some degree throughout the entire range of both mussels, but is greatest in the Flint and Ochlockonee, which are downstream of the major mainstem dams or in areas of relatively high municipal, industrial, or agricultural water use. Dams have continued to be constructed in the upper Flint River and the upper Ochlockonee sub-basins. Lake McIntosh was constructed in the upper Flint River sub-basin on Line Creek in 2007 and Tired Creek reservoir was constructed on Tired Creek, Upper Ochlockonee River sub-basin, in 2014.

A recent court decision in Georgia (Aqua Log Inc. v. State of Georgia, 2015) now allows citizens to remove deadhead logs, old-growth timber, from the streambed of Georgia waterways without requiring any type of state permit. Unembedded logs may be removed by use of winch, cable, and crane only. There are known caches of deadhead logs throughout the rivers and larger streams within these species range. The Florida Department of Environmental Protection manages deadhead logging through a permitting process that includes several conditions to avoid impacts to mussels and other aquatic life. It is unknown at this time if this will have a significant impact to these mussels or their habitat.

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

Overutilization is not considered a threat to the shinyrayed pocketbook or Gulf moccasinshell at this time.

c. Disease or predation:

Although natural predation may not be considered a threat, it may be a problem during low-water years. Predation on mussels has been observed during drought years in a number of creeks. Garner *et al.* (2009) observed fresh-dead mussels in Big Creek with obvious signs of predation, likely by otters. However, these impacts are considered minimal and do not impact mussels during normal or wet years. Introduced flathead and blue catfish species were identified as a threat in the last 5-year review and continue to be

a threat.

d. Inadequacy of existing regulatory mechanisms:

The shinyrayed pocketbook and Gulf moccasinshell are protected under Georgia's Endangered Wildlife Act (EWA), Alabama's Invertebrate Species Regulation (Alabama Administrative Code 220-2-98), and Florida's Wildlife Rule (68A-21.00s of the Florida Administrative Code). These protections prevent harm or killing of the species; however, the Georgia EWA does not prevent habitat changes that lead to population loss. The rule specifically states that construction of any nature shall not be impeded. Florida prohibitions include protection from harm, which includes significant habitat modification, and harassment. In Florida, local governments have authority to regulate land use practices for the protection and conservation of natural resources, including wildlife and wildlife habitats (Shaefer et al. 2012).

Georgia and Florida are applying regulatory mechanisms to protect water resources in the Flint and Ochlockonee region that is heavily influenced by groundwater pumping for agricultural purposes, including state permitting programs for water withdrawals. In addition, Georgia's Flint River Drought Protection Act provides for agricultural irrigation suspension in times of drought, and sets requirements for agricultural irrigation efficiency to be met by 2020 (Georgia Water Planning Council 2017). Minimum flows and levels (MFLs) for specific surface and ground waters are required by Florida Statute to be established by each water management district; however, there are no MFL assessments scheduled for any waters in the Ochlockonee River basin (Northwest Florida Water Management District 2017). Despite these regulations, streams of the Flint and Ochlockonee River basins continue to be impacted by consumptive water use.

The objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA) (33 U.S.C. 1251 *et seq.*), is to restore and maintain the chemical, physical, and biological integrity of the nation's waters by preventing point and nonpoint pollution sources. States are responsible for setting and implementing water quality standards that align with the requirements of the CWA. Overall, implementation of the CWA could benefit the shinyrayed pocketbook and Gulf moccasinshell through the point and nonpoint programs.

Nonpoint source (NPS) pollution comes from many diffuse sources, unlike pollution from industrial and sewage treatment plants. As the runoff moves, it transports natural and human-made pollutants (nonpoint source). States report that nonpoint source pollution is the leading remaining cause of water quality problems. Sources of NPS pollution within the watersheds occupied by both mussel species include timber clear-cutting, clearing of riparian vegetation, urbanization, road construction, and other practices that allow bare earth to

enter streams. Currently, the CWA may not adequately protect both mussel species habitat from NPS pollution. There is no information concerning the implementation of the CWA regarding NPS pollution specific to protection of both mussel species. However, insufficient implementation could threaten the shinyrayed pocketbook and Gulf moccasinshell.

A new water quality criteria for ammonia was published in 2013 by the Environmental Protection Agency (EPA) that included acute and chronic toxicity testing for 13 freshwater mussels. This led to an improved understanding of ammonia toxicity and lower ammonia criteria for freshwater mussels (EPA 2013). The states adopted these criteria in 2016-17 however, the degree of enforcement is unknown. It is also unknown whether implementation of this new criteria will have positive effects on the most vulnerable juvenile stage for these species.

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

Sub-basins have continued to experience habitat alterations that contribute to water quality and quantity impairments and may preclude the movement of host fish species between occupied sites. At least two new dams have been built since 2007; in the headwaters of the Flint River, Lake McIntosh was created within Line Creek in 2012. Upper Tired Creek, a tributary to Ochlockonee River was dammed in 2014.

Water quantity continues to be a problem in the lower Flint, upper Chipola, and upper Ochlockonee River systems during droughts, worsened by agricultural water withdrawals. Significant droughts have continued to occur (2007-2008 and 2010-2011) with associated mussel mortality (USFWS unpub. data). Large sections of the Spring sub-basin have dried up for extended periods with excessive mussel mortality since 2000 (Wisniewski *et al.* 2015; USFWS unpub. data). Shea *et al.* (2013) found that mussel assemblages in the lower Flint River basin have declined in species richness since the 2000 drought. Larger streams experienced less mussel mortality, signifying the importance of conserving these populations for refugia, in addition to smaller streams that are more vulnerable to drought (Shea *et al.* 2013). Drought can impede the movement of mussels and host fish in re-colonizing the impacted areas, further fragmenting the population.

Spring Creek, Chipola, and Sawhatchee Creek were all impacted from Hurricane Michael in October of 2018. The hurricane left numerous downed trees in its path with many laying across and within the stream channels. A number of downed trees have been cut and removed from Chipola and Spring Creek, but many remain. GADNR also reported that a “hypoxic” (low oxygen) event occurred right after the storm in Spring Creek due to the heavy rains that caused a large fish die-off. The long-term effects of this particular event and Hurricane Michael are unknown at this time.

In its Fifth Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (IPCC 2014). Numerous long-term climate changes have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (IPCC 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change; however, while continued change is certain, the magnitude and rate of change is unknown in many cases.

Thomas *et al.* (2004) report that frequency, duration, and intensity of droughts are likely to increase in the Southeast as a result of global climate change. 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). While the effects of drought and floods on mussels are documented (Golladay *et al.* 2004; Shea *et al.* 2013; USFWS 2003, 2007), thermal tolerances of the shinyrayed pocketbook and Gulf moccasinshell are uncertain. According to Kaushal *et al.* (2010), stream temperatures in the Southeast have increased roughly 0.2–0.4°C (0.4–0.7°F) per decade over the past 30 years, and as air temperature is a strong predictor of water temperature, stream temperatures are expected to continue to rise.

There is uncertainty about the specific effects of climate change (and their magnitude) on the shinyrayed pocketbook and Gulf moccasinshell; however, climate change is almost certain to affect aquatic habitats throughout the range of both mussel species. Increasing temperatures and the associated increase in frequency, intensity, and duration of extreme heat events will lead to more droughts (Carter *et al.* 2014), such as the one that occurred throughout the range of both species in 2007. Also, species with limited ranges, fragmented distributions, and small population size are thought to be especially vulnerable to the effects of climate change (Byers and Norris 2011). Thus, we consider climate change to be a threat to the shinyrayed pocketbook and Gulf moccasinshell.

D. Synthesis

The Service does not recommend a change to the listing classification or priority ranking of the shinyrayed pocketbook or Gulf moccasinshell. The population recovery criteria have not been met and all threats have not been managed to the extent that the species will remain viable into the foreseeable future. The Econfina, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokee Creek), Spring, and Chipola populations (i.e., sub-basins) have remained stable and/or have evidence of

recruitment for the shinyrayed pocketbook. The remaining sub-basins (e.g., Upper Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Middle Chattahoochee) have minimal numbers of individuals and have no evidence of recruitment. In addition, the shinyrayed pocketbook is possibly extirpated from the Upper Ochlockonee sub-basin. The Econfina, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokee Creek), and Chipola populations (i.e., sub-basins) have remained stable and/or have evidence of recruitment for the Gulf moccasinshell. The remaining sub-basins (e.g., Upper and Lower Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Middle Chattahoochee) have minimal numbers of individuals and have no evidence of recruitment. In addition, the Gulf moccasinshell is possibly extirpated from the Spring Creek sub-basin. Most sub-basins consist of localized, fragmented sites with generally small numbers of individuals. Most stable populations are restricted to short stream reaches and remain vulnerable to random natural or human-induced events such as droughts or spills. Overall, both species and their habitat continue to be impacted by excessive sediment, channel instability, reduced water quality, developmental activities, water withdrawal, drought, impoundments, and invasive species. The degree of threat to the persistence of both endangered species remains high, and the potential for recovery remains low. At this time, the shinyrayed pocketbook and Gulf moccasinshell continues to meet the definition of an endangered species under the Act.

III. RESULTS

A. Recommended Classification

 X No change is needed

B. New Recovery Priority Number No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Define “viable population” through implementation of Recovery Tasks 1.3.6 and 1.3.7.
2. Reduce/prevent threats to existing populations and their habitats through habitat restoration programs and partnerships with various stakeholders.
3. Continue to work with State and Federal partners to incorporate conservation approaches into flow requirements and water allocation strategies.
4. Assess the short and long-term effects of Hurricane Michael on the mussel populations in Spring and Econfina creeks.
5. Develop and implement a program to monitor population levels and habitat conditions of existing populations.

6. Identify and survey poorly explored suitable habitat in currently and historically occupied sub-basins where the species may be present in low numbers or where re-introduction may be feasible.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of
Shinyrayed Pocketbook (*Lampsilis subangulata* (now known as *Hamiota subangulata*)
Gulf Moccasinshell (*Medionidus penicillatus*)

Current Classification: Shinyrayed Pocketbook - Endangered
Gulf Moccasinshell - Endangered

Recommendation resulting from the 5-Year Review:

- Downlist to Threatened**
- Uplist to Endangered**
- Delist**
- No change is needed**

A

Review Conducted By: Sandy Abbott, U.S. Fish and Wildlife Service, Georgia Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve: Donald W. [Signature] Date: 17 September 2020

Appendix A. Summary of peer review for the 5-year review of Shinyrayed Pocketbook (*Lampsilis subangulata* (now known as *Hamiota subangulata*) and Gulf Moccasinshell (*Medionidus penicillatus*)

A. Peer Review Method: Because of the strong integration of state and University species experts in updating information, and developing the revised 5-year review, this step was considered unnecessary since no status change has been proposed.

B. Peer Review Charge:

C. Summary of Peer Review Comments/Report:

D. Response to Peer Review: