Oval Pigtoe
(*Pleurobema pyriforme*)

5-Year Review:
Summary and Evaluation

Oval Pigtoe (*Pleurobema pyriforme*), Econfina Creek, Florida
Photo Credit: USFWS.

U.S. Fish and Wildlife Service
South Atlantic-Gulf Region
Panama City Ecological Services Field Office
Panama City, Florida

5-YEAR REVIEW
Oval Pigtoe (*Pleurobema pyriforme*)

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 contemporary distributions, life histories, genetics, habitats, and threats of this species. We announced initiation of this review and requested information in a published *Federal Register* (FR) notice with a 60-day comment period in August 2018 (83 FR 38320). We received no public comments during the 60-day open comment period. We used a variety of information resources, including: the final rule listing this species under the Endangered Species Act (ESA) (63 FR 12664); 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original recovery plan (USFWS 2019); the previous 5-Year Review (USFWS 2007); peer reviewed scientific publications; unpublished field observations by Federal, State, and other experienced biologists; unpublished studies and survey reports; and notes and communications from other qualified individuals. All literature and documents used for this review are on file at the Panama City Ecological Services Field Office. A draft of the 5-year review was peer reviewed by cooperating field offices and three experts familiar with the species (see Appendix A for a summary of the peer review). Comments were evaluated and incorporated into this final document as appropriate.

B. Reviewers

Lead Region: South Atlantic-Gulf Region, Aaron Valenta (404) 679-4144

Lead Field Office: Panama City Ecological Services Field Office, Gayle Martin, (850) 769-0552 ext. 48513

Cooperating Field Offices: Georgia Ecological Services Field Office, Sandy Abbott, (706) 544-6419

C. Background:

1. **Federal Register Notice citation announcing initiation of this review:** August 6, 2018; 83 FR 38320.

2. **Species status:** Declining. Survey data indicates an overall decline in species distribution and abundance (Georgia Department of Natural Resources (GADNR), unpublished data 2008-2018; USFWS, unpublished data 2008-2019; Peterson et al. 2011; U.S. Geological Survey (USGS), unpublished data 2012; Cardno ENTRIX 2013; Wisniewski et al. 2013; Florida Fish and Wildlife Conservation Commission (FWC), unpublished data 2015-2019;; Wisniewksi 2015; Wisniewski et al. 2015; Pursifull et al. *in press*.).

3. **Recovery achieved:** 1 (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: 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 to benefit the required Recovery Report to Congress. Through 2013, we performed a recovery data call that included status recommendations, such as "Declining" for this species. We continue to show this species' status recommendation in 5-year reviews. The most recent evaluation of this species for inclusion in the Recovery Report to Congress was completed in 2019.

   Five-year review: 2007. In this review, no change in status was recommended based on the best information available since the recovery plan. The status was reported as declining; populations declined in abundance. The species continued to be impacted by threats including excessive sediment, reduced water quality, development related activities, invasive species and small population size.

7. **Species' Recovery Priority Number at start of review (48 FR 43098):** 5

   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 (*Hamiota 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 Recovery Plan for the Gulf Moccasinshell (*Medionidus penicillatus*), Oval Pigtoe (*Pleurobema pyriforme*), Purple Bankclimber (*Elliptoideus sloatianus*), and Shinyrayed Pocketbook (*Hamiota subangulata*).

   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 the oval pigtoe is an invertebrate and is 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. An amendment to the 2003 recovery plan which revised the criteria was finalized in September 2019.

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?** 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, not previously provided by the Recovery Plan (USFWS 2003). The original criteria established the number of subpopulations per sub-basin and per large river basin, and length of occupied river miles needed to determine species status for reclassification to threatened. Specific increases in subpopulations and river miles needed to delist this species were unknown.

   The revised criteria include a number of resilient populations distributed within the historical range to ensure that species' redundancy and representation are such that the species is recovered, and no longer in need of protection under the Endangered Species Act (USFWS 2019). Populations are delineated by river sub-basins and may contain one or more previously defined subpopulations. 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). Figure 1 illustrates the sub-basin boundaries. The Recovery Plan defined subpopulations (i.e., sites) 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, i.e., mussels in relatively close proximity that represent a potentially reproducing group (USFWS 2003). One of the recommendations in the previous review was to revise recovery criteria and use quantitative methods to monitor population size within each sub-basin (USFWS

2007). The 2003 subpopulation criteria based on sites was thought to be vague and less meaningful than actual density or population estimates (USFWS 2007). A more comprehensive perspective on habitat use, detection, distribution, and abundance may be possible with new survey and modeling methods developed since the Recovery Plan was written. The 2019 revised recovery criteria alleviate the ambiguity of the subpopulation criteria by evaluating the resiliency of the population at the sub-basin level (USFWS 2019).

The oval pigtoe will be considered for delisting when:

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

1a) At least nine populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes.

This Criterion has not been met. The Econfina, Lower Chattahoochee (Sawhatchee and Sheffield Mill Creeks), Middle Flint (Chokee Creek), Spring, and Chipola populations have remained stable (i.e., persisted) and/or have evidence of recruitment (GADNR, unpublished data 2008-2019; USFWS, unpublished data 2008-2019; Peterson et al. 2011; USGS, unpublished data 2012; Cardno ENTRIX 2013; Wisniewski et al. 2013; FWC, unpublished data 2015-2019; Wisniewski et al. 2015). Recruitment was documented in the Middle Flint, Lower Chattahoochee, and Spring Creek (GADNR, unpublished data 2008-2018; J. Wisniewski pers. comm. 2020). The remaining occupied sub-basins (e.g., Upper Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Santa Fe, and Lower Suwannee) have minimal numbers of individuals and have no 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.

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

2a) At least one population in each of the Econfina Creek, Chipola, Chattahoochee, Flint, Ochlockonee, Santa Fe, and Suwannee 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 the Ochlockonee River. The species was last collected live in the Ochlockonee River in 2005 with no oval pigtoe found during extensive surveys from 2006 to 2017 (Pursifull et al. *in press*). Of the five stable or naturally recruiting populations mentioned in Criterion 1a, three occupy short reaches and/or are the only localities within their

sub-basin. The Sawhatchee Creek and Sheffield Mill sites are considered one population and are the only known sites within the whole Chattahoochee River system. Chokee Creek (100 m or 0.06 mi) and Spring Creek (90 m or 0.055 mi) are the only occupied reaches in the Middle Flint and Spring Creek sub-basins. 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, and this reach of Spring Creek specifically, are susceptible to extended periods of drying resulting in mussel mortality.

The species is present in the Santa Fe and Suwannee River systems and in the major tributary sub-basins of the Flint River. 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. Activities that result in habitat alteration, water quality impairments, changes in flow regimes, and increased isolation (Factors A, D, and E) remain threats to the viability of this species. The effects of climate change are uncertain within the range of the oval pigtoe, but are considered a threat to the viability of this species. Please refer to section II.C.2 for further details on the five listing factors as they relate to this species.

C. Updated Information and Current Species Status

1. Biology and Habitat

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

Fritts and Bringolf (2014) documented the successful transformation (>27%) of oval pigtoe glochidia (i.e., larval mussels) on six minnow species (Cyprinidae): blacktail shiner (*Cyprinella venusta*), bluehead chub (*Nocomis leptocephalus*), longjaw minnow (*Notropis amplamala*), yellowfin shiner (*N. lutipinnis*), fathead minnow (*Pimephales promelas*), and creek chub (*Semotilus atromaculatus*). *Cyprinella venusta* and *Semotilus atromaculatus* had the highest transformation success at 58.3% and 52.7% respectively. They found that glochidia were released as fragile pink conglutinates (i.e., aggregates) consistent with previous descriptions for Pleurobema (e.g., Hove and Neves 1994; Haag and Warren 1997).

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

Demographic trends of a population, which include a measure of age-class structure and numbers of newly recruited juveniles, is difficult to determine without consistent size data, known age-length curves, and sampling techniques

for capturing juveniles. In addition, 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 abiotic or biotic variables. Most of the data available for this species is from qualitative or semi-quantitative sampling efforts that did not include estimates of detection.

Oval pigtoe status is summarized for each sub-basin population. Sub-basin boundaries are described in the recovery plan (USFWS 2003), and shown in Figure 1. To evaluate population status, the Middle and Lower Flint sub-basins were further divided into the major tributary watersheds (Kinchafoonee-Muckalee, Ichawaynochaway, and Spring Creek) consistent with USGS 8-digit hydrologic cataloging units (http://water.usgs.gov/GIS/huc.html). Information on species status is provided for the period since the last 5-year review (2008-2019).

Econfina Sub-basin, Florida

The oval pigtoe population in Econfina Creek has persisted with generally good site distribution with varying site abundance. Oval pigtoe were found at seven sites with most of the collections under five individuals (USFWS, unpublished data 2009, 2010, 2014, 2015). Three sites had 56, 60, and 100 individuals each (USFWS, unpublished data 2009-2010). Length data from one of the abundant sites upstream of the Highway 388 bridge averaged 45.4 mm (1.8 in) and ranged from 36 to 50.7 mm (1.4 to 2 in) (n=30) (USFWS, unpublished data 2009). These are likely adult mussels, as the oval pigtoe is a small to medium-sized mussel only reaching lengths of 60 mm (2.4 in) (Williams et al. 2014).

Middle Chattahoochee Sub-basin, Alabama and Georgia

The Alabama Department of Conservation and Natural Resources surveyed a reach of Uchee Creek in 2015, where oval pigtoe historically occurred. Seven mussel species were found, including the federally endangered shinyrayed pocketbook, but not the oval pigtoe (Buntin et al. 2015).

Lower Chattahoochee Sub-basin, Alabama and Georgia

The Sawhatchee Creek and Sheffield Mill Creek population persists as the only occupied reaches within the Lower Chattahoochee sub-basin and represents the largest number of oval pigtoe in Georgia. The Sawhatchee Creek location has been the basis for stream flow, demographic, and detection studies where over 700 individuals were tagged from 2005-2018 (GADNR, unpublished data 2005-2018; Peterson et al. 2011; Wisniewski et al. 2013). At this location in 2019, 126 oval pigtoe between 19 and 53 mm (0.75 and 2.1 in) were collected; 90 of which were recaptures from previous years (GADNR, unpublished data 2019).

In Sawhatchee Creek, Peterson et al. (2011) concluded that high flows in the summer and spring were negatively related to mussel survival. However, low flow mortality was not validated as in previous findings likely because the stream did not experience low flows during the study period. Risk of mortality from high

flows was theorized to be associated with seasonal behavior such as brooding, which would make the species more vulnerable to scouring flows, but effects might vary with stream size and geomorphology. Model results indicate that flow components related to recruitment had a greater effect on the population growth rate than survival; and, a median seasonal discharge of 1.8 m^3/s would result in a stable population using average observed survival rates. Possible mechanisms for better recruitment with higher flows were improved water quality (e.g. dissolved oxygen) or access for host fish species. Model simulations (based on long-term flow data from Spring Creek calibrated to the Sawhatchee gage) using historic (1940-1969) and current (1980-2008) water use scenarios indicated extinction risk was higher under current hydrologic regimes.

Wisniewski et al. (2013) modeled survival and recapture probabilities in Sawhatchee Creek. Oval pigtoe recapture probability averaged 0.33 and annual apparent survival was 0.81 for all species. Recapture probabilities for oval pigtoe increased with increased shell length, and lengths ranged from 26 mm (1.0 in) to 55 mm (2.2 in). The low estimated recapture probability of smaller individuals was suggested to be a result of both missing individuals and low overall abundance.

Upper Flint Sub-basin, Georgia

GADNR conducted an extensive survey of the northern part of the Upper Flint sub-basin in 2013-2014 resulting in only one recently recruited individual. This Flint River main stem site is only one of two known main stem occurrences since 1990 (Wisniewski 2015). The locality was near the Montezuma Bluff Wildlife Management Area where one oval pigtoe was collected in 2007. The species may be extirpated from previously known locations in Line Creek above and below Lake McIntosh; a 650-acre reservoir completed in 2012 near Peachtree City, Georgia. Other tributary localities that were surveyed but where oval pigtoe was not found include Red Oak, Hogcrawl, and Limestone Creeks (GADNR, unpublished data 2011, 2013, 2014, 2017). However, oval pigtoe may still occur in these localities at such low numbers that detection is difficult. The status of the oval pigtoe in Swift Creek, a direct tributary to Lake Blackshear where it was previously collected in 2005, is unclear. This sub-population would be isolated from the remainder of the Flint River as the lake would act as a barrier to host fish.

Middle Flint and Kinchafoonee-Muckalee Sub-basins, Georgia

There is evidence of recruitment within the last 10 years in Chokee Creek, the only currently known site within the Middle Flint sub-basin, verified by GADNR recapture surveys. Sixty-eight oval pigtoe were tagged at this location (GADNR, unpublished data 2008-2018). At this location in 2019, 26 oval pigtoe between 19 and 49 mm were collected; five were recaptures from previous years (GADNR, unpublished data 2019). Survey information is not available for the Jones Creek locality.

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. Oval pigtoe were found at two previously known sites on Kinchafoonee Creek (Webster County) but not at another (Lee/Terrell Counties). In 2009, a new location was documented with one live individual in Bear Creek (GADNR, unpublished data 2009).

Lower Flint, Ichawaynochaway, and Spring Sub-basins, Georgia

No oval pigtoe were found in surveys of the Lower Flint sub-basin (GADNR, unpublished data 2008-2017). The last recorded occurrence was in Coolewahee Creek in 1992 (Brim Box and Williams 2000).

In the Ichawaynochaway sub-basin, survey information is only available for one locality, Chickasawhatchee Creek (Baker County), where one individual was collected (GADNR, unpublished data 2011). A GADNR long term mark and recapture data set for a locality upstream of West Lee Street/County Road 141 on Ichawaynochaway Creek is available from 2008-2019 though no oval pigtoe have ever been found at this location (GADNR, unpublished data 2008-2019.

Spring Creek has the largest number of oval pigtoe in the Flint River system where USFWS and GADNR biologists collected over 300 individuals since 2011 within a 90-meter reach upstream of the Highway 27 Bridge in Colquitt, Georgia (GADNR, unpublished data 2011-2018). In August 2010, oval pigtoe and shinyrayed pocketbook mortality occurred within this reach due to severe drought and groundwater withdrawals (Wisniewski et al. 2015). USFWS and GADNR relocated mussels, including 41 oval pigtoe, from this reach to a historical locality downstream of U.S. Route 84 during the drought of 2011 (GADNR, unpublished data 2011). A project was initiated to supplement streamflow during drought periods using ground wells, and to study the effects on mussel survival and burrowing at the Colquitt site (Wisniewski et al. 2015). Oval pigtoe apparent survival was 0.98 when the stream was augmented and survival rates decreased at lower stream stages for all species, but remained relatively high overall. Water temperature and dissolved oxygen concentrations were improved; however, augmentation rates were not sufficient to establish a significant change in survival among treatments (Wisniewski et al. 2015).

The Spring Creek site was surveyed in August 2019 by GADNR where habitat changes from Hurricane Michael impacts were noted (see Section II.C.1.f). Oval pigtoe were recaptured at the site but in lower numbers than found in 2017 (75 versus 152) (GADNR, unpublished data 2019). 152 P. pyriforme in 2017 vs 75 P. pyriforme in 2019. These figures are presented without the removal of recaptured individuals and should be used as a rough qualitative comparison only. full analysis of this data is still pending.

Chipola Sub-basin, Florida

The oval pigtoe population remains stable within the sub-basin. Within this review period there were 71 occurrence records from 46 sites distributed throughout the sub-basin, including two large collections of over 100 individuals from one site in 2018 (USFWS, unpublished data 2008, 2009, 2011-2014, 2017-2019; USGS, unpublished data 2012; Cardno ENTRIX 2013; FWC, unpublished data 2015, 2017-2019). Approximately 820 individual oval pigtoe were collected from main stem and tributary sites averaging 11.5 per collection effort. In 2014, numerous unexplained dead oval pigtoe and shinyrayed pocketbook were observed at the Highway 73 Bridge on Dry Creek by USFWS biologists. Oval pigtoe lengths collected as part of a genetics study from Dry Creek averaged 43.8 mm (1.7 in) and ranged from 34.5 mm (1.4 in) to 53.4 mm (2.1) (n=30) (USFWS, unpublished data 2009). In 2017, FWC documented a potentially new site with one small (34 mm or 1.3 in) live individual 2.7 river km (1.7 river mi) below the Chipola River Cutoff, which connects the Apalachicola River to the Chipola River. This section of the river is influenced by the hydrology of the Apalachicola River and oval pigtoe has not been historically documented in this reach; however, one previously unreported collection was made near the cut in 2006 (Columbus State University, unpublished data 2006).

Upper Ochlockonee Sub-basin, Georgia and Florida

Oval pigtoe were last collected from the Ochlockonee River in 2005. The species has not been found during extensive surveys of the sub-basin between 2006 and 2017 (Pursifull et al. *in press*). This basin has experienced water quality impairments and drought conditions (Pursifull et al. *in press*). Substantial habitat alteration was noted in the previous 5-year review and persists. Both of these threats may have contributed to the decline of this species in this sub-basin.

Lower Ochlockonee Sub-basin, Florida

Historical occurrences in the Ochlockonee River system were limited to areas above the Jackson Bluff Dam, which forms Lake Talquin. Holcomb et al. (2015) surveyed the Lower Ochlockonee sub-basin extensively and did not locate any oval pigtoe, but believe that there is potential for it to occur in overlooked habitats.

Santa Fe Sub-basin, Florida

Williams et al. (2014) noted that the oval pigtoe is increasingly rare in the Santa Fe River drainage. Only three localities were documented since the last 5-year review; two sites in the Santa Fe River in 2011 (Williams et al. 2014) and one site in the New River in 2015 (FWC, unpublished data 2015). Only one or two live mussels were collected at each site.

Lower Suwannee Sub-basin, Florida

One oval pigtoe each was collected from two Suwannee River main stem sites near Branford, FL by FWC in 2016 and 2017. One shell was collected at another location (FWC, unpublished data 2014); other specimens from this river are only

known from museum records. While these sites may represent range extensions in historical habitat, additional surveys are necessary to verify that live individuals persist.

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

USFWS initiated an effort to collect genetic material for the oval pigtoe in 2009. The intent was to be able to compare populations and genetic diversity within and among critical habitat units, rank populations by status, and facilitate recovery actions. The full breadth of the study was not realized; however, Moyer and Williams (2010) did isolate microsatellite loci (i.e., genetic markers) to assist in future population genetics studies. In addition, Inoue et al. (2018) generated genetic sequences for samples from Sawhatchee Creek for a study of Pleurobimini subfamily molecular genetics. Campbell et al. (2005) and Campbell and Lydeard (2012) examined sequences generated from oval pigtoe specimens from the Chipola River for phylogenetic studies. These genetic markers are publicly available and may be useful for future analysis of species representation and redundancy.

d. Taxonomic classification or changes in nomenclature:

The previous review stated that taxonomic status of the oval pigtoe was unclear, as discussed in the recovery plan and critical habitat rule. Oval pigtoe taxonomy has been resolved; Pleurobema species within the Apalachicola-Chattahoochee-Flint (ACF), Ochlockonee, and Suwanee River systems are recognized as *Pleurobema pyriforme* (Williams et al. 2014; J. Williams, pers. comm. 2019). Williams et al. (2011) synonymized *Pleurobema reclusum*, thought to be a distinct species from the Suwannee system, with *P. pyriforme*. The genetic analysis by Campbell et al. (2005), Campbell and Lydeard (2012), and Inoue et al. (2018) support the current species taxonomy.

e. Spatial distribution, trends in spatial distribution, or historical range:

The oval pigtoe historically occurred in 14 sub-basins (USFWS 2003) and currently occupies 10 sub-basins in Georgia, Alabama, and Florida: the Upper Flint, Middle Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Spring Creek, Lower Chattahoochee, Chipola, Santa Fe, Lower Suwannee, and Econfina Creek (Figure 1). During this review period, survey data illustrates within sub-basin mussel distribution varied by sub-basin with localized extirpations (e.g., Upper Flint and Upper Ochlockonee), potential stability (e.g., Chipola, Econfina Creek, Lower Chattahoochee, Middle Flint, and Spring Creek), and possible expansion (e.g., Lower Suwanee). The Lower Chattahoochee, Middle Flint, and Spring Creek populations are isolated and limited in distribution, and thus are susceptible to human or naturally caused catastrophic events and environmental variability. Loss of any of these populations may reduce species redundancy and representation. Overall, the species has continued to decline in distribution within its historical range.

f. Habitat or ecosystem conditions:

Wisniewski (2015) found one oval pigtoe in a coarse sand flat edgewater habitat in the upper Flint River main stem consistent with its described habitat (in USFWS 2003, page 43, small to medium-sized creeks to small rivers where it inhabits silty sand to sand and gravel substrates, usually in slow to moderate current). Oval pigtoe were absent from surveys in the Line Creek watershed, a tributary to the Flint River, and habitat was considered poor in surveyed tributaries of the Flint River between Hogcrawl and Red Oak Creeks (Wisniewski 2015). Wisniewski (2015) suggests that urbanization in the Flint River headwaters and destabilization of the stream channel (J. Wisniewski, pers. comm. 2020) are significant threats to this species in the Upper Flint sub-basin.

In the Chipola watershed, there is an ongoing habitat threats assessment to identify areas of channel instability for developing restoration priorities (USFWS 2011). Specific threats identified in the Service's Chipola River Watershed Threats Assessment (USFWS 2014) are being addressed by multiple partnership efforts. Projects within the watershed are designed to promote the restoration of spring, riparian and stream systems, and emphasize the conservation of native aquatic communities.

In October 2018, Hurricane Michael caused widespread tree damage in the region that may have effects (e.g., change in flow regimes, sediment loads) on occupied reaches in Spring and Econfina Creeks (S. Abbott, pers. comm. 2019 and S. Pursifull, pers. comm. 2019, respectively) and Chipola River (S. Geda, pers. comm 2020). The augmentation pumps at the Colquitt site on Spring Creek were rendered inoperable by hurricane damage. Low oxygen conditions in Spring Creek also led to a fish kill after the hurricane (S. Abbott, pers. comm. 2019). GADNR surveyed the site in August 2019 and observed large quantities of large woody debris and downed trees which reduced canopy cover and increased light penetration (M. Rowe, pers. comm. 2020). Considerable scouring under logs and around standing trees occurred from the large woody debris in the stream channel (M. Rowe, pers. comm. 2020). A full analysis of mussel data is pending but anecdotally, total mussel numbers were reduced over previous recent years (965 total non-Elliptio mussels in 2019 versus 1938 total non-Elliptio mussels in 2017) (GADNR, unpublished data 2017, 2019). Habitat alteration (e.g., low to no flow, isolation, and reduced water quality) caused by drought conditions and water withdrawals continue in the Spring Creek sub-basin. The Florida Forest Service documented significant tree fall in the Chipola River drainage, which could also result in habitat changes for the oval pigtoe and other freshwater mussels (S. Geda, pers. comm. 2020).

The Upper Ochlockonee sub-basin has also experienced exceptional drought periods since listing with smaller tributaries going completely dry (Pursifull et al. *in press*). Water quality is an issue including sediment and chemical loads from runoff of agricultural and developed lands (Pursifull et al. *in press*). Thresholds for nitrogen and dissolved oxygen were exceeded in the upper reaches of the Ochlockonee River for multiple years (Leon County 2018). Localized sites on the

main stem have experienced degradation with substrate instability and more widespread channel instability has been documented in the tributaries of the upper basin (USFWS 2007, Pursifull et al. *in press*).

Reduced flows are also a concern in the Suwanee and Santa Fe River systems (Holcomb et al. 2015; Johnson et al. 2016). A normally perennial, occupied reach of the Santa Fe has dried several times since 2000 (Johnson et al. 2016).

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 oval pigtoe was due to activities that decreased water quality, changed natural flow regimes, increased isolation, and directly altered riverine habitat. These effects were the result of dams, dredging, mining, channelization, pollution, sedimentation, and water withdrawals (USFWS 2003; 71 FR 32746).

Most of the water quality threats reviewed in the listing and critical habitat rules remain applicable today (refer to 63 FR 12664 and 72 FR 64286). Since listing, there have been improvements in water quality conditions within the species range. However, in the most recent assessments by State agencies under Section 305(b) of the Clean Water Act (CWA), water quality is impaired or potentially impaired in some portions of the ACF, Suwannee, and Ochlockonee River systems (e.g., Flint River, Spring Creek, Cooleewahee 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 (e.g., suffocation, reduced feeding, reduced growth rates), can negatively affect substrate composition, and can alter channel geometry and stability (USFWS 2003).

The operation of dams, water withdrawals, and water diversions may alter features of the flow regime important to the species and its host fish. All of these threats are present to some degree throughout the range of the oval pigtoe but are greatest in the Flint, Ochlockonee, and Suwannee River systems, which are downstream of major main stem dams or are in areas of relatively high municipal, industrial, or agricultural water use. Historically the construction of dams and the associated habitat loss from impoundments altered habitat and increased isolation. Within this review period, new dams were built on Line Creek, a headwater stream in the upper Flint River, and upper Tired Creek, a tributary to the Ochlockonee River. The reservoir on Line Creek was created between two

previously occupied oval pigtoe sites. While there have been no documented occurrences of oval pigtoe in Tired Creek, the creation of this dam may impact water quality and quantity of flows to the Ochlockonee River, thus potentially affecting downstream sites.

Deadhead logging, the salvage of old-growth timber from stream bottoms, is now allowed in Georgia per a recent court decision (Aqua Log Inc. v. State of Georgia, 2015). These activities may result in localized damage to mussels by re-suspending fine sediments and disrupting stable substrates. 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. There is no permit required in Georgia on navigable waters, logs can be dislodged by hand or cable only, machinery is not allowed (W. Hubbard, pers. comm. 2019). Occupied rivers in both Georgia and Florida are subject to this operation.

A phosphate mine has been proposed in Bradford County, Florida near the New River upstream of current oval pigtoe sites. Public hearings on the permit have not been scheduled as of February 2020. Mining operations could have significant impacts to the land use and land cover within the watershed, including new road crossings that contribute to erosion and channel instability. Any proposed mining operation could greatly reduce connections between the mined area and surrounding floodplains, which would reduce the amount of sediment trapping in the floodplain, and severely alter nutrient dynamics in the system. Potential retention lakes could reduce the amount of surface water flow to the New River, contributing to concerns regarding the lack of groundwater recharge and stream drying. The Service will work with all partners to ensure conservation measures are considered for this species should the mine be approved.

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

Overutilization is not considered a threat to the oval pigtoe at this time.

c. Disease or predation:

Previously, observations of predation on stranded mussels during droughts were reported, but this is not considered a threat during normal and wet years (USFWS 2007). Through direct predation of mussels and indirect predation on fish hosts, non-native fish affect mussel population recruitment and survival. 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 oval pigtoe is 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, Ochlockonee, and Suwannee River basins continue to be impacted by consumptive water use.

The Clean Water Act (33 U.S.C. 1251 et seq.) was established to prevent pollution from point and nonpoint sources. States are responsible for implementing standards that meet or exceed those established by the Environmental Protection Agency (EPA). The final rule (63 FR 12664) determining that this species is endangered stated that existing authorities, such as the CWA, might not have been fully utilized in the protection of aquatic systems. Under Section 305(b) of the CWA, States provide designated uses for streams. Designated use categories include: fish and aquatic life, livestock watering and wildlife, irrigation, navigation, domestic water supply, and industrial water supply, among others. Criteria to support the designated uses are also established and include numeric criteria for water quality parameters (e.g., ammonia, heavy metals, dissolved oxygen) and narrative criteria for biological parameters (e.g. benthic macroinvertebrates). Streams that do not meet designated uses for certain criteria are placed on a Section 303(d) list of impaired waters (currently impaired streams were discussed under Factor A). An anti-degradation policy establishes that all designated uses be maintained and guides the State as to which activities can or cannot be permitted in specific streams and stream reaches. Recovery Task 1.1 is to revise the numerical criteria for pollutants if they are not protective of mussels (e.g., ammonia).

In 2013, the EPA updated the freshwater ammonia life ambient water quality criteria (78 FR 52192). The new criteria included ammonia threshold testing on 13 freshwater mussel species (USEPA 2013). The Florida Department of Environmental Protection adopted the chronic criteria for ammonia as both the acute and chronic values for streams in 2016. This further improves the ammonia standard for conservation of freshwater mussels in the state of Florida (USEPA

2016). The Georgia Environmental Protection Division did not adopt the numeric ammonia criteria, but implemented it through the narrative toxicity criteria, the wasteload allocation process, and instream monitoring.

All three states are applying regulatory mechanisms under the CWA to both point and nonpoint source problems identified throughout the range of the oval pigtoe; however, water quality threats continue to persist. Not all water quality criteria take into account sensitive aquatic species, and other factors can contribute to reduced standards primarily from nonpoint sources. Runoff from adjacent lands can introduce harmful contaminants into streams especially those without adequate riparian buffers (e.g., sedimentation, pesticides, accidental spills, errant point-source discharges). Activities that contribute to nonpoint source pollution in oval pigtoe watersheds include timber-clear cutting, urbanization, road construction, and agricultural practices. Recovery task 1.3.4 involves determining contaminant sensitivity for each life history stage, including the effects of multiple toxin mixtures commonly encountered within the watersheds. The Service will also continue to work with regulatory agencies to improve criteria for freshwater mussel species.

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

The presence and potential introduction of non-indigenous species, potential insufficient densities of host fish in streams supporting the oval pigtoe, lack of subpopulation connectivity (leading to inbreeding depression and other genetic considerations), drought, and climate change are considered threats to this species.

As mentioned above non-native flathead and blue catfish can negatively affect mussel populations through predation on host fish. Zebra mussels and black carp were identified as a threat in the recovery plan and remain a concern if introduced into the range of the oval pigtoe (USFWS 2003). Alabama, Georgia, and Florida either prohibit the possession of live black carp or require a permit for their import, possession and/or distribution of individuals that are either sterile, non-sterile (e.g., diploid, triploid), or both. Zebra mussels are also a prohibited species in Florida. The invasive Asian clam (*Corbicula fluminea*) is found in high densities in the ACF Basin and are believe to be a threat to native mussel species. The negative effects could include food competition, ingestion of sperm, glochidia, or juveniles, habitat disturbance, and water quality degradation associated with mass die-offs (Haag 2019).

Relatively stable, non-imperiled populations of host fish within each sub-basin are needed to maintain natural recruitment. Fish host populations are adversely affected by a variety of the same habitat alterations that have contributed to the decline of the mussel fauna (Richter et al. 1997; Warren et al. 2000). The status of known oval pigtoe fish hosts, which include common minnow species, is unknown in each sub-basin but none are considered imperiled or listed under the Endangered Species Act.

Drought conditions are a threat to the oval pigtoe resulting in directly mortality, reduced water quality, decreased reproductive success, and isolation especially in the upper Ochlockonee, Santa Fe, upper Chipola, and lower Flint River systems. Significant droughts have occurred in 2000-2001, 2007-2008 and 2010-2011 (Seager et al. 2009; Gordon et al. 2012) with associated mussel mortality. In the Spring sub-basin of the lower Flint River system (i.e., the area that falls within the Coastal Plain physiographic province), extended periods of drying in the last 15 years have resulted in mussel mortality throughout widespread reaches (Wisniewski et al. 2015). Shea et al. (2013) found that mussel assemblages in the lower Flint River basin have declined in species richness since the 2000 drought. Despite being of the same severity, the 2007-2008 drought had less impact on the mussel assemblage than the 2007-2008 drought; possibly a result of having less time for recovery of populations from previous droughts (Shea et al. 2013). 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). Smaller streams are highly sensitive to groundwater withdrawal and can go dry during droughts (Golladay et al. 2004; Rugel et al. 2011). Ichawaynochaway and Spring sub-basins have the highest burden of ground and surface water withdrawals in Georgia (Rugel et al. 2011). During dry months, irrigation pumping in the Flint River basin can also affect water availability in the neighboring Ochlockonee basin (Gordon et al. 2012). The Santa Fe and Suwannee Rivers have experienced flow declines of approximately 30 percent (81 FR 69417). An occupied reach of the Santa Fe River near Worthington Springs, Florida has gone dry multiple times since 2000 (Johnson et. al. 2016). Both drought and impoundments can impede the movement of mussels and host fish in re-colonizing the impacted areas, further fragmenting the population.

Increasing temperatures and changes in precipitation patterns that result in more frequent and prolonged droughts and abnormally wet and dry summers are potential effects of climate change within the Southeast (Ingram et al. 2013). Under certain climate scenarios, the ACF is likely to experience more severe than historical stresses including deeper reservoir drawdowns, greater water supply deficits, less firm energy generation, and more frequent and severe violations of environmental flow requirements (Ingram et al. 2013).

As mentioned in the Ingram et al. (2013) report on Climate of the Southeast United States, impacts of climate change on freshwater systems can potentially include:

- Warmer water temperatures that are expected to put organisms closer to the threshold temperature for their thermal tolerance and exacerbate low dissolved oxygen conditions.
- In parts of the Southeast, droughts that are more frequent coupled with increasing water demands from greater evapotranspiration and growing human consumption may result in more frequent stream drying, even in

systems historically considered perennial, which may in turn increase the frequency of local species extirpations.

- Non-native, invasive species will increase due to less frequent and shorter durations of cold temperatures caused by climate change.
- Where long-term trends of increasing temperatures and extremes in rainfall occur, these are likely to alter distributions and abundance of freshwater algae, zooplankton, benthic invertebrates, and fish as well as ecosystem processes.

The effects of drought and floods on mussels are documented (Golladay et al. 2004; Shea et al. 2013; USFWS 2003; USFWS 2007); however, thermal tolerances of the oval pigtoe have not been studied. Direct effects of increased water temperatures on mussel mortality may be a potential significant threat with a predicted rise in air temperatures due to climate change (Ganser et al. 2013; Hastie et al. 2003; Pandolfo et al. 2010).

There is uncertainty about the specific effects of climate change (and their magnitude) on the oval pigtoe; however, climate change is almost certain to affect aquatic habitats throughout the range of the species. The small and fragmented populations make the oval pigtoe more vulnerable to threats associated with climate change. Thus, we consider climate change to be a threat to the oval pigtoe.

D. Synthesis

The Service does not recommend a change to the listing classification or priority ranking of the oval pigtoe. 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. The remaining sub-basins (e.g., Upper Flint, Kinchafoonee-Muckalee, Ichawaynochaway, Santa Fe, and Lower Suwannee) have minimal numbers of individuals and have no evidence of recruitment. In addition, the oval pigtoe is possibly extirpated from the Upper Ochlockonee sub-basin. Most sub-basins consist of localized, fragmented sites with generally small numbers of individuals. Three of the stable populations are restricted to short stream reaches and remain vulnerable to random natural or human-induced events such as droughts or spills. Overall, the species and its 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 this endangered species remains high, and the potential for recovery remains low. At this time, the oval pigtoe continues to meet the definition of an endangered species under the Act.

III. RESULTS

A. Recommended Classification:

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

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Assess the effects of Hurricane Michael damage on the affected sub-basins, especially the small stream populations in Econfina and Spring Creeks.

2. Reduce/prevent threats to existing populations and their habitats through habitat restoration programs and partnerships with various stakeholders.

3. Develop and adopt environmental flow criteria needed to maintain populations.

4. Complete genetic analysis to determine adaptive capacity.

5. Complete a detailed threats analysis for this species.

6. Incorporate detection analysis, occupancy modeling, and collection of size class data into monitoring efforts where possible.

7. Continue to work with State and Federal partners to incorporate conservation approaches into flow requirements and water allocation strategies.

8. 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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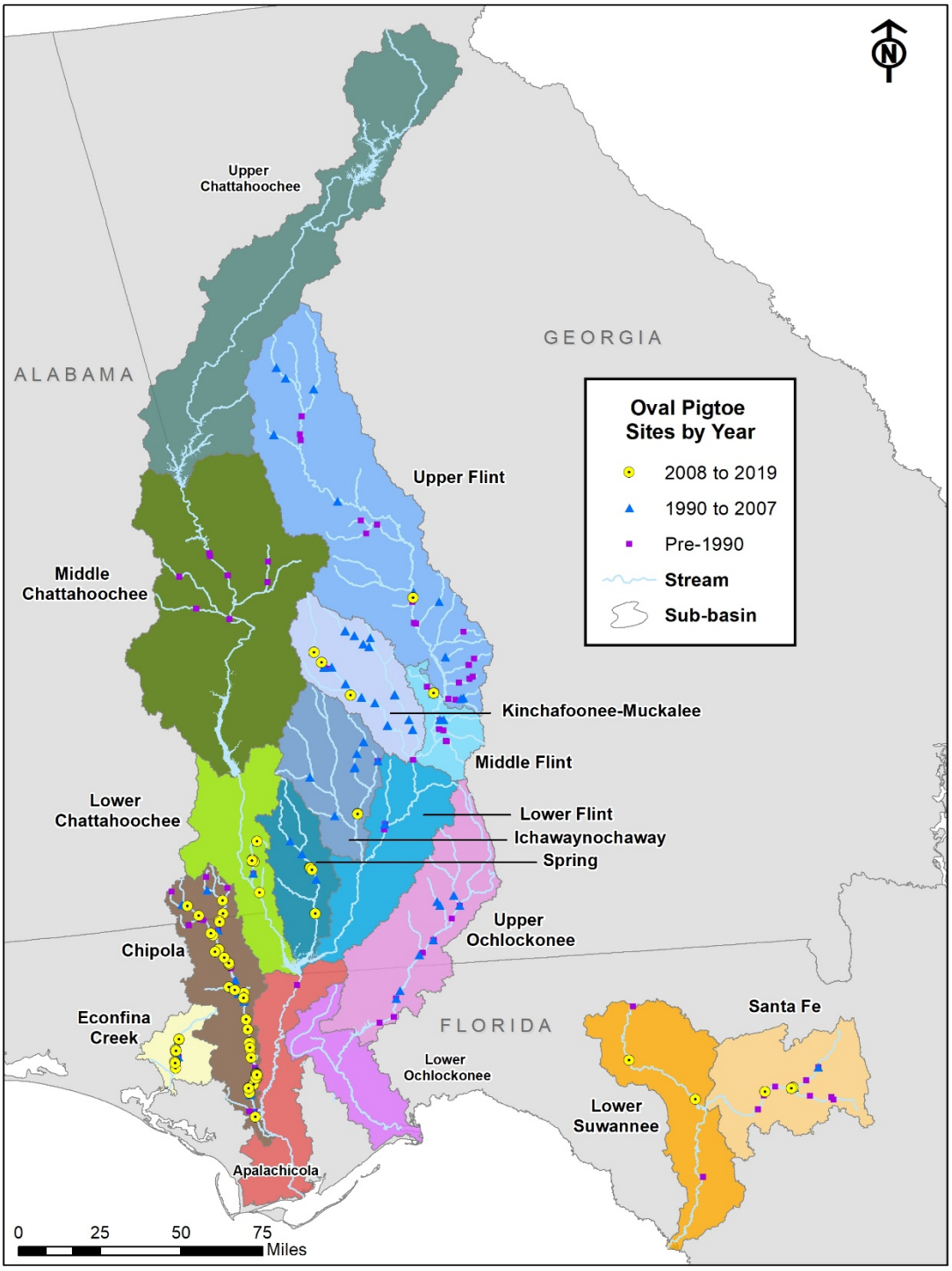

Figure 1. Occupied sites representing historical (pre-1990), listing to previous 5-year review and critical habitat designation (1990-2007), and current review (2008-2019) time periods (as reported in USFWS 2003, USFWS 2007, 72 FR 64286, and Section II.C.1.b.) Only locations with known localities or coordinates are represented.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Oval Pigtoe (*Pleurobema pyriforme*)

Current Classification:

Oval pigtoe: 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: Gayle Martin, Panama City Ecological Services Field Office

FIELD OFFICE APPROVAL:

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

Approved: SEAN BLOMQUIST Digitally signed by SEAN BLOMQUIST Date: 2020.05.01 13:03:24 -05'00' Date: _____

Appendix A. Summary of peer review for the 5-year review of Oval Pigtoe (*Pleurobema pyriforme*)

A. Peer Review Method: Requests were made to each peer reviewer of the 5-year review via email (March 2020). 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 provide information the validity of the data used and any new information available.

Peer Reviewers:
Mr. Jason Wisniewksi 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 Apalachicola Basin.

Ms. Susan Geda is the Freshwater Mussel Program Coordinator for the Florida Fish and Wildlife Conservation Commission at Garcon Point Aquatic Research Center. She has extensive experience with freshwater mussel research and monitoring including mussels in the Apalachicola Basin.

Mr. Matthew Rowe is the current mussel biologist for the state of Georgia with the Georgia Department of Natural Resources. He previously completed freshwater mussel research and monitoring as a biologist with the Florida Fish and Wildlife Conservation Commission.

B. Peer Review Charge: see above

C. Summary of Peer Review Comments:

Mr. Jason Wisniewski: Mr. Wisniewski provided believed the document to be complete and well supported by the data. He provided insight on the status of certain populations, additional information on a locality within Swift Creek, and suggested references for supporting threats analysis.

Ms. Susan Geda: Ms. Geda provided some clarification language on localities in the Suwannee River, provided references on size data for other Pleurobema species and P. pyriforme genetics, suggested that Chipola River should also be surveyed for impacts from Hurricane Michael, and discussed the potential effects from a proposed mine near the New River, Florida.

Mr. Matthew Rowe: Mr. Rowe provided new survey data for 2019 on mark-recapture sites, information on the effects of Hurricane Michael on Spring Creek, and a reference for P. pyriforme genetics. He believed the document to be accurate and up to date.

D. Response to Peer Review:

Mr. Jason Wisniewski: We updated the review to include the provided information on the un-documented locality in the Swift Creek in Georgia, the description of the Sawhatchee and Sheffield Mill Creek population, added the clarification language to certain citations by the author, and added any additional suggested references to the threats analysis.

Ms. Susan Geda: We updated the review to include the provided information on P. pyriforme genetics, conditions of the Chipola River, and the potential mining impacts.

Mr. Matthew Rowe: We updated the review to include the new survey data for the mark-recapture sites, the conditions of Spring Creek, and included the reference on P. pyriforme genetics.