Round Ebonyshell, *Reginaia rotulata*
Southern Kidneyshell, *Ptychobranchus jonesi*
Choctaw Bean, *Obovaria choctawensis*
Tapered Pigtoe, *Fusconaia burkei*
Narrow Pigtoe, *Fusconaia escambia*
Southern Sandshell, *Hamiota australis*
Fuzzy Pigtoe, *Pleurobema strodeanum*

Status Review:
Summary and Evaluation

Photo location and credit: 1. Pea River, Alabama (U.S. Fish and Wildlife Service), 2. Choctawhatchee River, Florida (Florida Fish and Wildlife Conservation Commission), 3. Escambia River, Florida (U.S. Fish and Wildlife Service), 4. Pea River, Alabama (M. Gangloff), 5. Yellow River, Florida (J. Dickey), 6. Point A Lake, Alabama (U.S. Fish and Wildlife Service), 7. Camp Creek, Alabama (J. Moran, U.S. Forest Service).

August 2022

U.S. Fish and Wildlife Service
Southeast Region
Florida Ecological Services Field Office
Panama City, Florida

STATUS REVIEW

Round Ebonyshell (*Reginaia rotulata*), Southern Kidneyshell (*Ptychobranchus jonesi*), Choctaw Bean (*Obovaria choctawensis*), Tapered Pigtoe (*Fusconaia burkei*), Narrow Pigtoe (*Fusconaia escambia*), Southern Sandshell (*Hamiota australis*), and Fuzzy Pigtoe (*Pleurobema strodeanum*)

GENERAL INFORMATION

Current Classification:

Endangered: Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean.
Threatened: Narrow Pigtoe, Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe.

Lead Field Office: Florida Ecological Services Field Office (FLESFO), Panama City Office; Sandra Pursifull (author), *sandra_pursifull@fws.gov*, (850) 769-0552.

Reviewers:
Lead Field Office: Florida Ecological Services Field Office, Annie Dziergowski and Michelle Krauser.
Lead Regional Office: Atlanta Regional Office, Carrie Straight, (404) 679-7226.
Cooperating Field Office: Alabama Ecological Services Field Office, Brittany Barker-Jones.

Date of original listing: October 10, 2012 (77 FR 61664).

Critical Habitat final rule: October 10, 2012 (77 FR 61687).

Methodology used to complete the review:
In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a status review is to assess each threatened species or endangered species to determine whether its status has changed and if it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants (50 CFR 424.11). The U.S. Fish and Wildlife Service (Service) evaluated the biology, habitat, and threats of the Round Ebonyshell, Southern Kidneyshell, Choctaw Bean, Narrow Pigtoe, Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe to inform this status review.

We announced initiation of this review in the Federal Register on April 11, 2019 (84 FR 14669) with a 60-day public comment period and received one comment providing information and references on the relationship between forest management and aquatic species, specifically on the contributions of forestry best management practices to the conservation of aquatic organisms. The primary sources of information used in this analysis were peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts. This review was completed by the Service's, Florida Ecological Services Field Office, Panama City Office, Florida. All literature and documents used for this review are on file at the Panama City Office. All recommendations resulting from this review are the result of thoroughly reviewing the best available information on these species.

FR Notice citation announcing the species is under active review:
84 FR 14669 (April 11, 2019).

Species' Recovery Priority Number at start of review:
RPN 5. Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean are species with a high degree of threat and a low recovery potential.
RPN 11. Narrow Pigtoe, Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe are species with a moderate degree of threat and a low recovery potential.

Review history:
A Recovery Outline was developed for the species where the species' recovery priority numbers were set (Service 2012b).
This is the first 5-year status review for all seven species.

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature

The entities listed as Round Ebonyshell, Southern Kidneyshell, Choctaw Bean, Narrow Pigtoe, Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe remain valid. Since being listed in 2012, genetic studies lead to the reassignment of Round Ebonyshell and Choctaw Bean to different genera (detailed below). In February 2022, the Service published a rule to reflect the scientifically accepted taxonomy and nomenclature of these two species (87 FR 8960). The seven mussels' current taxonomy and nomenclature of are consistent with Williams et al. 2017 *A Revised List of the Freshwater Mussels (Mollusca: Bivalvia: Unionida) of the United States and Canada mussels*, and Graf and Cummings 2021 *A 'big data' approach to global freshwater mussel diversity (Bivalvia: Unionoida), with an updated checklist of genera and species*).

Recovery Criteria

Recovery Plan or Outline

A Recovery Outline was finalized November 13, 2012 (Service 2012b). At the time of this review, recovery plan for these species has not been finalized.

Biology and Habitat

Introductory information and methods

These mussel species only occur in the Escambia, Yellow, and Choctawhatchee (EYC) river basins of south Alabama and northwest Florida (Fig. 1). The basins lie entirely within the Coastal Plain physiographic province and flow directly into the northern Gulf of Mexico. The three basins contain 11 endemic mussel species, including the seven listed mussels that are the focus of this review (Haag 2012). The Escambia basin's mainstem (known as the Escambia River in Florida and the Conecuh River in Alabama) is impounded at approximately river mile 140 and 145 by Point A Dam and Gantt Dam, respectively (Fig. 2). The dams effectively isolate the Patsaliga Creek drainage (which flows into Point A Lake) and the upper Conecuh River drainage (which flows into Gantt Lake reservoir).

Since being listed in 2012, reproductive studies have provided new information regarding fish host use and the early life history of the Southern Kidneyshell and Narrow Pigtoe. In addition, various studies over the past decade have significantly expanded our general understanding of freshwater mussel life history, including traits, such as growth, longevity, age at maturity, and fecundity, vary among freshwater mussel species (Haag and Rypel 2011, Haag 2013, Haag and Stoeckel 2021). These characteristics are fundamental to understanding mussel life-history strategies and have important conservation and management implications (Haag 2012). For example, long-lived, slow-growing species are adapted to living in stable environments and recover slowly from disturbance (Haag 2012, Hornbach et al. 2019). Haag (2012) used known mussel traits to categorize species into three life-history strategies (opportunistic, periodic, and equilibrium). The classification system has been widely adopted among mussel biologists (Randklev et al. 2019, Hornbach et al. 2019) and was validated and expanded by Moore et al. (2021). Information gaps continue to exist for all seven species, however, based on mussel life history strategies, we do know that the Round Ebonyshell, Tapered Pigtoe, Narrow Pigtoe, and Fuzzy Pigtoe are grouped with species that typically exhibit low to moderate growth rates, long life spans (>25 years), and late maturity (>3 years); the Southern Kidneyshell, Choctaw Bean, and Southern Sandshell are grouped with species that typically exhibit moderate to high growth rates, moderate life spans (8-30 years) and low to moderate age at maturity (1-3 years); and all species likely exhibit low to moderate fecundity (Haag 2012).

In 2014, the Service funded biologists with Florida Fish and Wildlife Conservation Commission (FWC) to examine freshwater mussel holdings in seven museums. The biologists verified and corrected species identifications and recorded associated data (e.g., the number of specimens, locality data, date of collection, etc.). In total, 7,347 lots were reviewed, totaling approximately 6,000 individual animals (FWC 2015 unpubl. report). The most common correction (45% of all records) was outdated taxonomy. Misidentification was common, with 20% of reviewed lots being misidentified or containing individuals from species that were not included on the label. We attempted to incorporate these taxonomic corrections into our mussel database, and these edits likely resulted in some minor changes in occupancy since the species were listed in 2012.

This review examined occupancy by hydrologic unit code (HUC) 8 subbasins, which provide natural hydrologic boundaries (Table 1; Appendix B; Fig. 2). Subbasin names are italicized in the text. We lack genetic data to determine the population structure for any of these mussels. Therefore, the term 'population' is used in a geographic sense to indicate a group of individuals occurring within a particular reach (stream system, subbasin, basin, etc.), which may over or under represent the true number of populations for each species. Individuals within an area may exist as an isolated population due to host fish dispersal ability, habitat condition, or a barrier. Current records (also referred to as 'present' or 'recent') are comprised of survey data collected from March 2000 to June 2021. This time frame was used because these mussels are believed to be relatively long-lived, most likely having maximum life spans exceeding 15 years. In addition, enough surveys have occurred during this time period to better assess trends. Locations sampled during this period are shown in Figure 2.

The general biology and life history information is detailed in the species listing rule (Service 2012a, 77 FR 61664). The information provided below about biology and life history addresses each species separately and provides new information since the listing rule. Because of the similarity of resource needs and threats amongst most of our native mussels and the overlapping range of these species, the discussion of threats addresses all species combined, unless noted.

Table 1. Escambia, Yellow, and Choctawhatchee hydrologic unit code 8 subbasins.

Basin	HUC 8	Subbasin	State	Area km^2
Escambia	03140301	*Upper Conecuh*	AL	2,129
Escambia	03140302	*Patsaliga*	AL	1,554
Escambia	03140303	*Sepulga*	AL	2,718
Escambia	03140304	*Lower Conecuh*	AL, FL	2,626
Escambia	03140305	*Escambia*	AL, FL	1,967
Yellow	03140103	*Yellow*	AL, FL	3,560
Choctawhatchee	03140202	*Pea*	AL, FL	4,028
Choctawhatchee	03140201	*Upper Choctawhatchee*	AL	3,997
Choctawhatchee	03140203	*Lower Choctawhatchee*	AL, FL	4,037

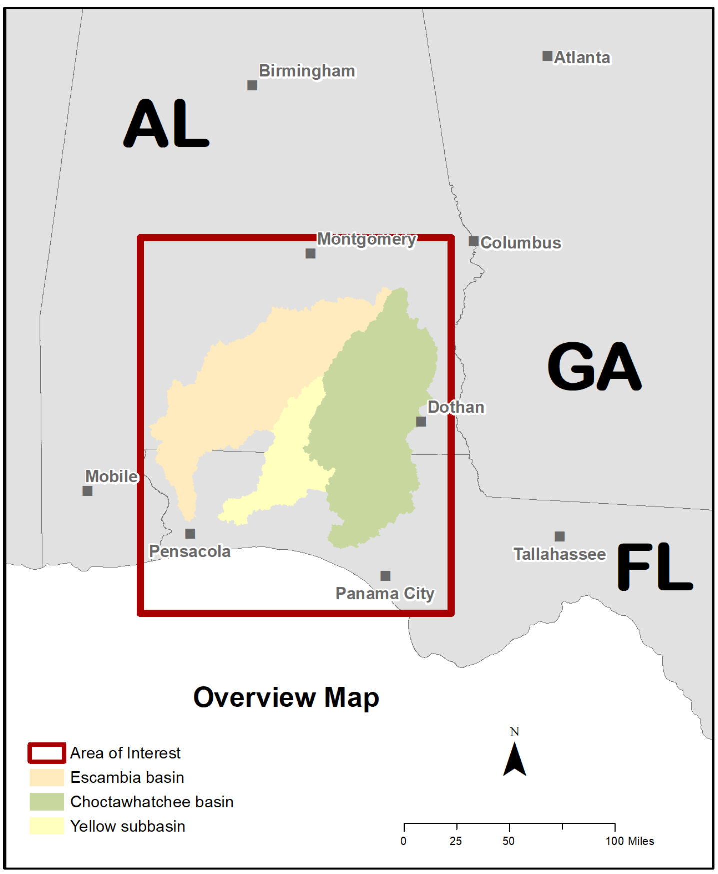

Figure 1. Overview map of the Escambia, Yellow, and Choctawhatchee River basins in Alabama and Florida.

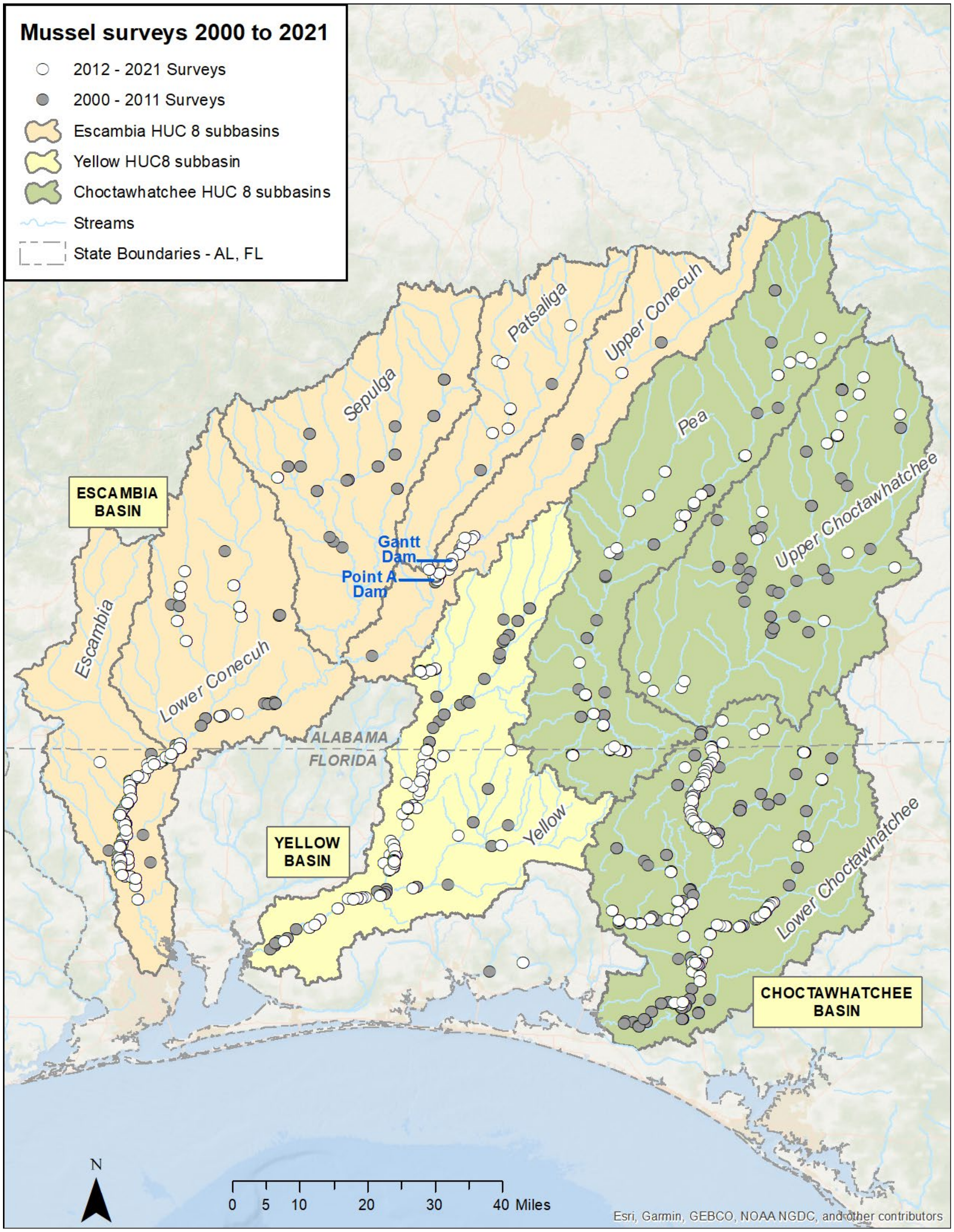

Figure 2. Locations of recent (2000–2021) mussel surveys in the Escambia, Yellow, and Choctawhatchee River basins. HUC 8 subbasins are outlined.

<u>Round Ebonyshell (*Reginaia rotulata*)</u>

Summary of new information of species' biology and life history:
Almost nothing specifically is known about Round Ebonyshell reproduction. However, we have assumed that Round Ebonyshell reproduction and much of its life history is likely similar to the Ebonyshell (*Reginaia ebenus*), a closely related mussel species widespread in the Mississippi Basin. Gravid Round Ebonyshell females have never been observed, however, the species is most likely a short-term brooder and probably releases glochidia in the spring and summer (Williams et al. 2014). Although the specific host fish species used by Round Ebonyshell is currently unknown, the mussel is likely a host specialist and probably uses migratory Clupeids (shads), similar to *R. ebenus*. The Skipjack Herring (*Alosa chrysochloris*) was found to be a suitable host for *R. ebenus* in laboratory trials (Hart 2018). Two species of migratory shad, Skipjack Herring and Alabama Shad (*Alosa alabamae*), occur in the Escambia River basin (Boschung 2004), and one or both of these fish species likely serve as the glochidial host of Round Ebonyshell. Both fish migrate upriver to spawn in March and April. The Alabama Shad is a marine species and returns to the Gulf shortly after spawning, while the Skipjack Herring is a freshwater species but occasionally enters saltwater (Boschung 2004).

Abundance, population trends, demography:
Round Ebonyshell records are known from the Escambia River basin in Alabama and Florida (Fig. 3). Historical records (prior to 2000) are limited to 20 collections consisting of six live individuals and shell material of 24 individuals. Live collections are rare because it is challenging to sample deep, mainstem habitats where the species occurs. The use of SCUBA gear has increased the detection of live individuals and resulted in recent observations of 17 live mussels. However, the scarcity of historical records makes it difficult to examine abundance trends. Round Ebonyshell current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

The Round Ebonyshell's status in Alabama is uncertain due to limited surveying in the Conecuh River since 2000, and additionally, some remote reaches of the river have never been surveyed. Current observations include nine live individuals and three shells collected at four locations. The Round Ebonyshell may have been extirpated from some areas, including the reach around the Alabama-Florida state line (near Pollard, Alabama). It has not been detected in this reach since three shells were found in 1998. Severe channel instability has deteriorated stable habitat in this reach. The Round Ebonyshell appears extant throughout its Florida range but is extremely rare. Despite a considerable amount of survey effort in the Escambia River, FL since 2000, only eight live individuals and three shells were documented at four locations. Targeted surveys found the species in extremely low densities relative to other native mussel species detected. Using survey methods suitable for detecting Round Ebonyshell, surveyors found two live individuals, which comprised 0.09% of the collective sample (FWC unpubl. data collected October 13–14, 2016).

Genetics:
An examination of molecular data and re-examination of shell morphology and anatomy of the Ambleminae subfamily found the Round Ebonyshell belonged in a separate genus, resulting in

the new genus, *Reginaia* (Campbell and Lydeard 2012a). We are unaware of any new genetic information relative to the status of the species.

Taxonomic classification or changes in nomenclature:
Since listing, the Round Ebonyshell was reassigned to the genus *Reginaia* (from *Fusconaia*). The genus includes two other species, *Reginaia ebenus* and *Reginaia apalachicola*. *Reginaia ebenus* is widespread in Gulf Coast river systems, including the Mississippi basin. *Reginaia apalachicola* is known only from prehistoric archeological sites in the Apalachicola basin and is considered extinct (Williams and Fradkin 1999, Campbell and Lydeard 2012a, b). The genus was formerly corrected for the species listed under protections of the Act (50 CFR 17.11) in the Federal Register to be consistent with this updated taxonomy (i.e., changed to *Reginaia rotulata*) on February 17, 2022 (87 FR 8960). The current nomenclature is consistent with Williams et al. (2017) and Graf and Cummings (2021).

Distribution and trends in spatial distribution:
The Round Ebonyshell has only been documented in a 150 km (93 mi) reach of the Escambia-Conecuh River. However, the full extent of its range is difficult to determine due to limited historical data (20 collection records), some with only vague locality data, and difficulty in sampling for the species. In addition, no Round Ebonyshell collections are known from the Conecuh River, AL prior to construction of the Point A and Gantt dams in the 1920s.

There is no indication that the species' distribution has changed substantially since being listed. Recent surveys have documented its persistence in the Florida portion of the mainstem. However, it may be locally extirpated in the reach around the state line, where it has not been detected since 1998. Limited survey data indicates the species is extant in the Conecuh River, however, too few surveys have been conducted in this reach to accurately assess its status in this portion of its historical range. Historical and current Round Ebonyshell occurrences are shown in Figure 3.

Habitat or ecosystem conditions:
The Round Ebonyshell generally inhabits deeper areas with stable habitat. Most live specimens were collected using SCUBA gear; when recorded, survey depths ranged from about 2–6 meters (6.5–20 feet). Habitat descriptions in field survey notes included the presence of large woody material. Embedded logs may help stabilize substrates and act as a flow refuge during flooding. Channel instability is a problem in the Escambia-Conecuh River, particularly around the state line, where it has deteriorated mussel habitat (discussed under Factor A). Possible exposure to contaminants persisting in mainstem sediments is also a concern, including high concentrations of DDT (dichloro-diphenyl-trichloroethane) and dioxin-like PCBs (polychlorinated biphenyls; discussed under Factor A) and saltwater intrusion (discussed under Factor E).

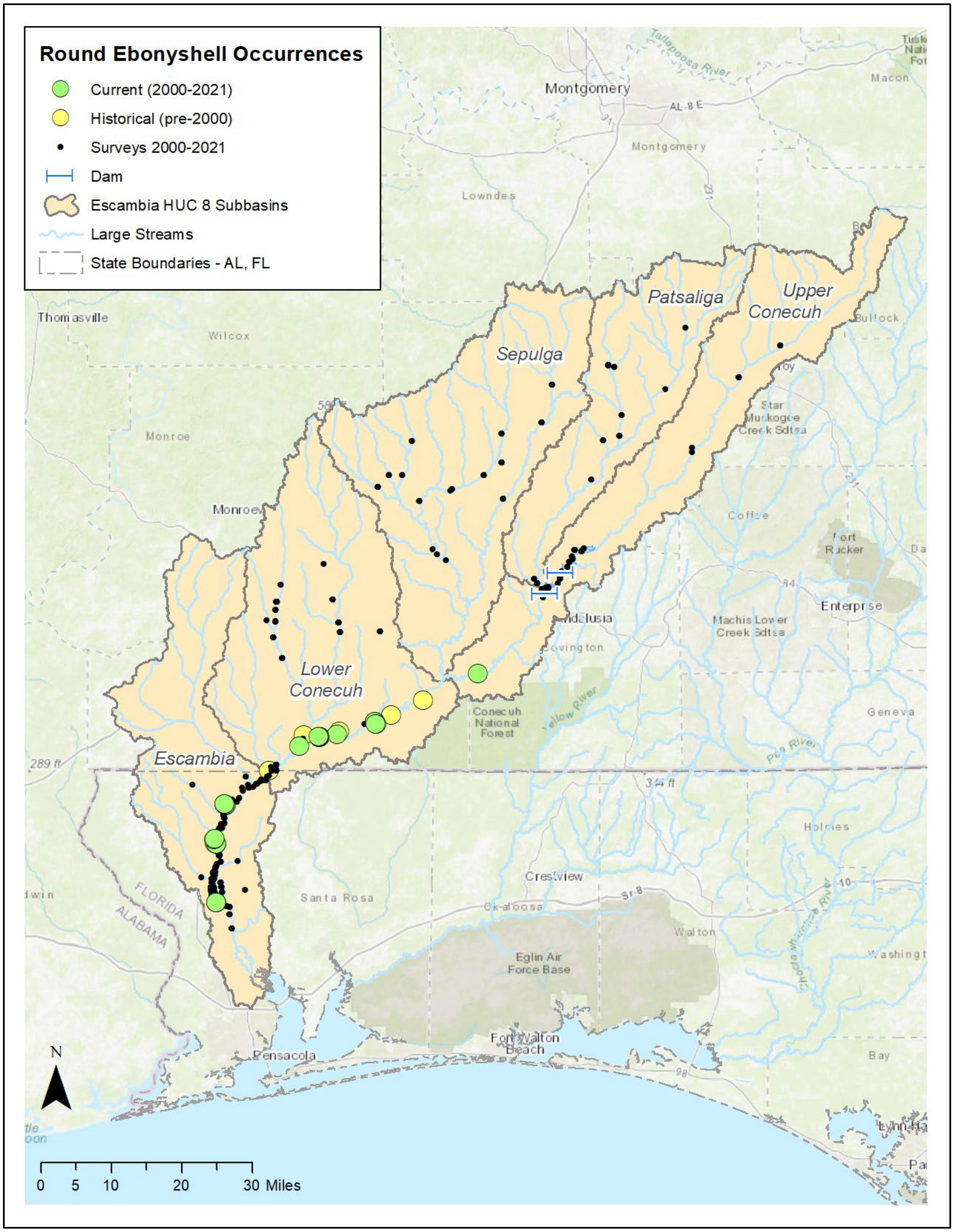

Figure 3. Round Ebonyshell historical and current occurrences and locations surveyed during the current period. Note: the upper-most occurrence record on the Conecuh River is a weathered shell collected in 2002 and is considered historical.

Southern Kidneyshell (*Ptychobranchus jonesi*)

Summary of new information of species' biology and life history:
The Southern Kidneyshell is an incredibly cryptic mussel species and is easily confused with other species (Gangloff and Hartfield 2009). Its similarity to other mussels is noteworthy, likely meaning that some historical and recent surveys have not documented its entire extent. Careful examination by regional experts is necessary to ensure Southern Kidneyshells are accurately identified, and genetic analyses may be necessary to positively identify questionable individuals (McLeod et al. 2017).

A study of Southern Kidneyshell early life history has provided new information regarding its reproductive biology. Two females collected from the Pea River in January 2015 released conglutinates (packets of larvae) daily over four months, from early February to early June (McLeod et al. 2017). The extremely adhesive conglutinates attach immediately to any surface. The conglutinates resembled simullid (black fly) larvae and fish eggs and were released with both forms loosely attached 26% of the time; more frequently, the egg (41%) and larva (33%) forms were released as separate segments (McLeod et al. 2017). The total calculated fecundity was 196,183 glochidia for the larger (56.1 mm) mussel and 53,425 for the smaller (37.4 mm) mussel (McLeod et al. 2017).

Southern Kidneyshell glochidia transformed on three darter species in inoculation-bath and conglutinate-feeding host trials: Blackbanded Darters (*Percina nigrofasciata*), Brown Darters (*Etheostoma edwini*), and Swamp Darters (*Etheostoma fusiforme*) (McLeod et al. 2017). Blackbanded Darters were the primary hosts in both trials. The encystment period lasted from 21 to 39 days. Twenty-five other fish species from 11 families were also tested, but none successfully transformed larvae, indicating the Southern Kidneyshell is a host specialist and dependent on darters for reproduction (McLeod et al. 2017). Blackbanded Darters are one of the most abundant darter species in Coastal Plain streams (Kuehne and Barbour 1983, Robins et al. 2018). However, reduced gene flow in darter-using mussel species suggests that parasitized darters rarely migrate long distances between isolated mussel populations (Jones et al. 2015). Thus, the Southern Kidneyshell may be unable to disperse long distances or recolonize areas from which it has been extirpated.

Abundance, population trends, demography:
Southern Kidneyshell records are known from the Escambia, Yellow, and Choctawhatchee River basins (Fig. 4). At the time of listing, the species was considered extant in only the Choctawhatchee basin. Since 2012, a population was found in Burnt Corn Creek (*Lower Conecuh*), providing the first record of Southern Kidneyshell in the Escambia River basin since 1972. Currently, the species occurs in one stream system in the Escambia River basin and four widely separated stream systems in the Choctawhatchee River basin, which may represent disjunct populations. The Southern Kidneyshell appears to be nearly extirpated in the Escambia River basin and declining in the Choctawhatchee basin. Southern Kidneyshell current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

Escambia River basin
A previously unknown population was detected in an 18-km (11 mi) reach of Burnt Corn Creek (*Lower Conecuh*) in Alabama. From 2012 to 2015, four live individuals and one fresh dead shell

were collected at three locations. Habitat in this reach of Burnt Corn Creek was described as stable and high-quality (Gangloff and Hamstead 2013). This remnant population appears to be extremely small, and its trend is currently unknown.

Choctawhatchee River basin
The *Pea* subbasin harbors the largest known population, with 101 individuals detected at seven Pea River locations since 2000. However, most individuals (*n* = 85) were documented at one site near Alabama Highway 167, and some were likely collected multiple times during targeted surveys from 2012 to 2015. Recruitment was evident at the Hwy 167 site in 2012, with 28 sub-adults observed, ranging in length from 27–37 millimeters (1.1–1.5 inches) (Gangloff and Hamstead 2013). In the *Upper Choctawhatchee*, a small population persists in the West Fork Choctawhatchee River (Alabama), where nine live individuals have been detected since 2000. This is a significant decrease in abundance compared to the 1960s when 98 individuals were collected at this location during one sampling event. One live individual (2003) and one shell (2007) were detected in the Choctawhatchee River (near the US Hwy 84 crossing in Alabama). Present occupancy in the *Lower Choctawhatchee* is based on one shell collected in Holmes Creek (Florida) in 2009. Recent surveys in Holmes Creek have failed to detect any additional specimens. The species may persist in such low densities in Holmes Creek that it is undetectable.

Genetics:
Molecular analysis confirmed Southern Kidneyshell belongs in the genus *Ptychobranchus* (Roe 2013).

Taxonomic classification or changes in nomenclature:
No new information is available.

Distribution and trends in spatial distribution:
Historically, the Southern Kidneyshell occurred in the Escambia and Yellow River basins in Alabama and the Choctawhatchee River basin in Alabama and Florida. Recent surveys confirm that the species is extirpated in the Yellow River basin.

Since its listing, a population found in an 18-km (11 mi) reach of Burnt Corn Creek (*Lower Conecuh*) represents the only extant population in the Escambia River basin. In the past, the species was relatively widespread throughout the upper Escambia River basin. However, it was last detected in the *Upper Conecuh*, *Patsiliga*, and *Sepulga* subbasins in the 1910s. Status surveys are needed to determine if the species is still extant in these reaches. There is no indication that its distribution in the Choctawhatchee basin has changed substantially since listing. It remains extirpated from many reaches in its former Choctawhatchee basin range. Historical and current Southern Kidneyshell occurrences are shown in Figure 4.

Habitat or ecosystem conditions:
The Southern Kidneyshell may be particularly sensitive to siltation. Its sticky conglutinates require clean, hard surfaces like rocks to adhere to and be seen by host fish (McLeod et al. 2017). At locations that still support the species, clear, high-quality streams with stable substrates appear to be important habitat conditions.

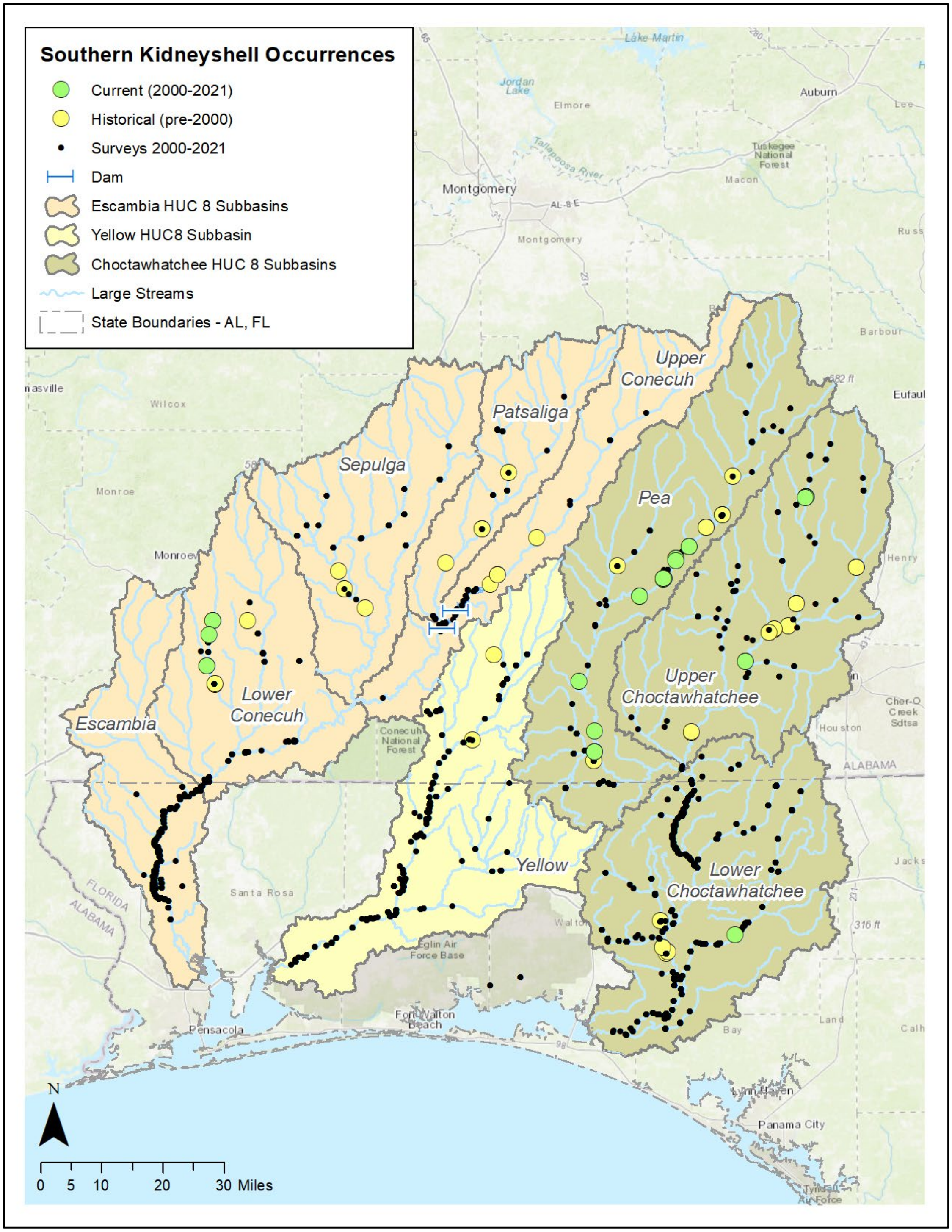

Figure 4. Southern Kidneyshell historical and current occurrences and locations surveyed during the current period.

<u>Choctaw Bean (*Obovaria choctawensis*)</u>

Summary of new information of species' biology and life history:
Field examination of 43 females (9 gravid) indicates the Choctaw Bean is a long-term brooder and gravid from late summer or autumn through the spring (FWC unpubl. data collected 2013–2021). Fish hosts have not been identified; however, the Choctaw Bean may be a host specialist like other species of *Obovaria* (Williams et al. 2014). In the adjacent Mobile River basin, *O. unicolor* and *O. arkansasensis* use darters and shiners as hosts (Haag and Warren 2003).

Abundance, population trends, demography:
Choctaw Bean records are known from the Escambia, Yellow, and Choctawhatchee River basins in Alabama and Florida (Fig. 5). The species occurs throughout the three basins but is uncommon and appears to have been extirpated from multiple historical sites. At locations that still support the species, an average of five individuals were observed per sampling event. Overall, Choctaw Bean populations in all basins are small and declining. Choctaw Bean current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

<u>Escambia River basin</u>
A total of five live individuals and one shell have been detected in the *Upper and Lower Conecuh*, *Sepulga*, and *Patsiliga* subbasins since 2000. Dams isolate each of the populations in *Patsiliga* and *Upper Conecuh*, and the species is likely nearly extirpated in these reaches. Surveys are needed to determine its current status in the Alabama portion of its range. Recent sampling in the *Escambia* subbasin detected 196 live individuals in the Escambia River and Pine Barren Creek in Florida. Its abundance in the Escambia River appears lower now than in historical surveys.

<u>Yellow River basin</u>
The species was last observed in Five Runs Creek in 1996 and may be extirpated in that stream system. It occurs in 5 scattered locations on the Yellow River, where a total of 12 individuals have been detected.

<u>Choctawhatchee River basin</u>
A total of 74 live individuals were detected in the *Pea* and *Upper Choctawhatchee* subbasins. Most individuals (40) came from one location on the West Fork Choctawhatchee River (AL Hwy 10 crossing) near Blue Springs State Park, a site known for its diverse mussel assemblage. Presently, the species occurs in mostly low abundance and is likely extirpated in localized areas in the two subbasins. Recent sampling within the *Lower Choctawhatchee* subbasin detected 108 live individuals. Its abundance in the Choctawhatchee River in Florida appears lower now than in historical surveys. For example, collections by H. D. Athearn in 1958 and 1961 commonly included 10 or more Choctaw Beans per site in the Florida mainstem. Whereas recent surveys by teams using snorkeling gear found an average of two individuals per site. Apparently, Choctaw Bean populations within the *Lower Choctawhatchee* subbasin are small and appear to be declining.

Genetics:
No new information is available.

Taxonomic classification or changes in nomenclature:
The Choctaw Bean was reassigned to the genus *Obovaria* (from *Villosa*) based on marsupial color, gravid female morphology, and mitochondrial DNA (Williams et al. 2011, Williams et al. 2014). The genus was formerly corrected for the species listed under protections of the Act (50 CFR 17.11) in the Federal Register to be consistent with this updated taxonomy (i.e., changed to *Obovaria choctawensis*) on February 17, 2022 (87 FR 8960). The present nomenclature is consistent with Williams et al. (2017) and Graf and Cummings (2021).

Distribution and trends in spatial distribution:
Historically, the Choctaw Bean was widely distributed throughout the EYC basins. There is no indication that the species' distribution has changed substantially since the listing rule was published. It is largely extant in the lower portions of the three basins but extirpated in many historically occupied locations in the upper portions. The species is nearly extirpated in the middle and upper reaches of the Escambia basin in Alabama, where it is known only from three isolated populations. Additionally, the species no longer occupies several historical locations in Five Runs Creek and the upper Yellow River in the upper Yellow basin. The Choctaw Bean is extant in most portions of its historical range in the Choctawhatchee basin but is likely locally extirpated in several areas, including in reaches of the Pea River and West Fork Choctawhatchee River systems and the Choctawhatchee River. Historical and current Choctaw Bean occurrences are shown in Figure 5.

Habitat or ecosystem conditions:
The Choctaw Bean inhabits large creeks and rivers where it is typically found in silty sand or sandy clay substrates (Williams et al. 2014). Based on conditions at collection locations, the species requires high-quality streams with stable channels.

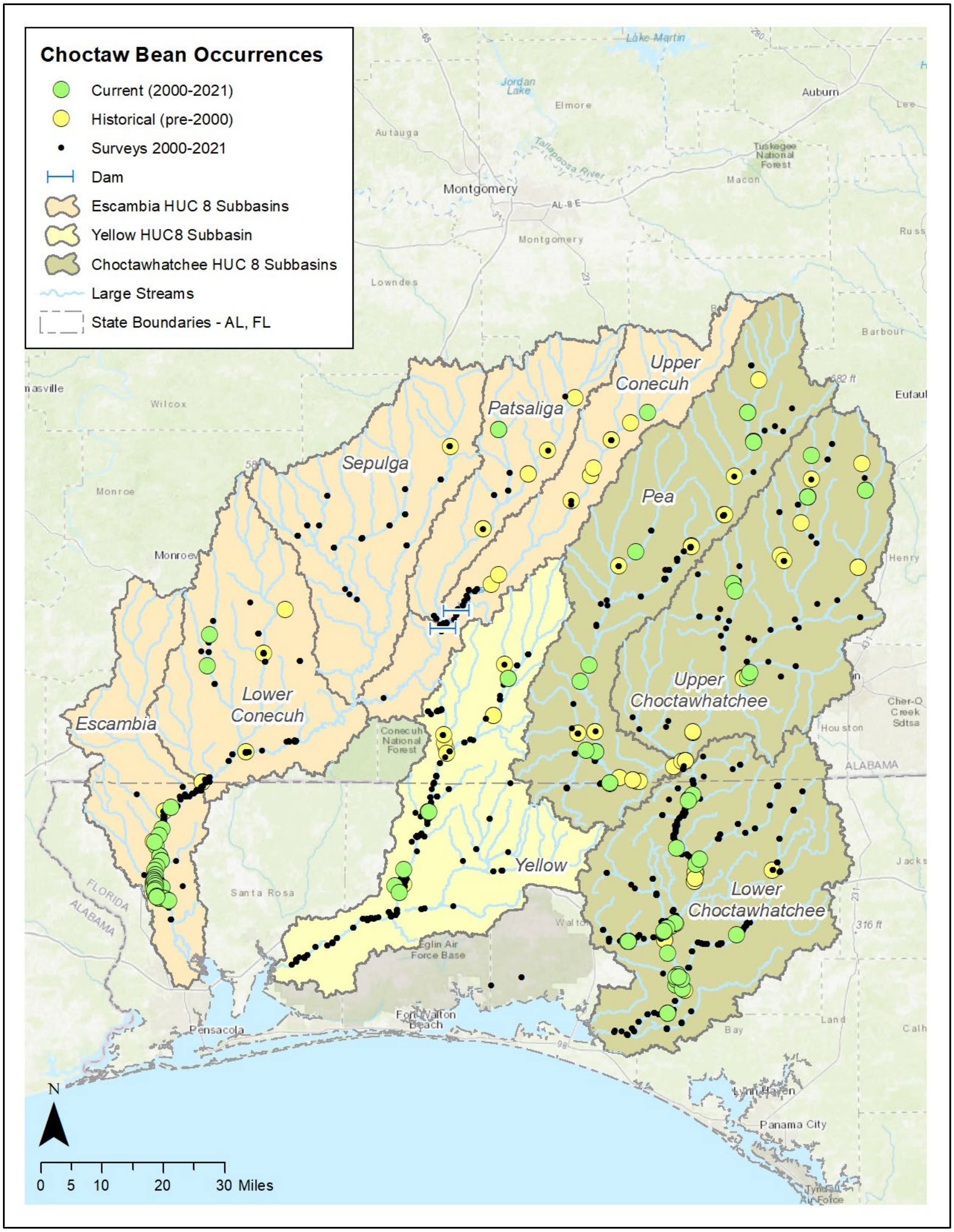

Figure 5. Choctaw Bean historical and current occurrences and locations surveyed during the current period.

Tapered Pigtoe (*Fusconaia burkei*)

Summary of new information of species' biology and life history:
No new information is available.

Abundance, population trends, demography:
Tapered Pigtoe records are known from the Choctawhatchee River basin in Alabama and Florida (Fig. 6). Overall, the species exists in low abundance at most locations and appears extirpated in several historical reaches. New information indicates the species is relatively abundant in some high-quality stream systems, including Eightmile Creek (AL) and Bruce Creek (FL). Tapered Pigtoe current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

In the *Pea* subbasin, 355 live individuals have been observed since 2000. Most of these individuals (n = 285) were collected during a long-term monitoring study in Eightmile Creek, a tributary to the lower Pea River. The species is less common in the subbasin's upper reaches, where 25 live individuals were observed. Recent surveys in the *Upper Choctawhatchee* subbasin detected 19 individuals at 4 locations. The species is likely extirpated in many historical *Upper Choctawhatchee* subbasin stream systems, and the remaining populations are small and possibly isolated. The Tapered Pigtoe is widespread and appears to be maintaining populations within the *Lower Choctawhatchee* subbasin, where recent sampling documented at least 705 live individuals. Observations made during a long-term monitoring study in Bruce Creek (FL) found a relatively large and reproducing population (FWS unpublished data, collected from January 2015 to September 2016).

Genetics:
Recent genetic investigations confirmed that Tapered Pigtoe and Narrow Pigtoe (*Fusconaia escambia*) are closely related but distinct species (Pfeiffer et al. 2016, Pieri et al. 2018, Smith et al. 2020). The morphology and geography of these species also provide evidence of speciation (Johnson 2017).

Taxonomic classification or changes in nomenclature:
No new information is available.

Distribution and trends in spatial distribution:
Historically, the Tapered Pigtoe was widely distributed throughout the Choctawhatchee River basin. There is no indication that the species' distribution has changed substantially since it was listed. It remains extirpated in localized areas of the *Upper Choctawhatchee* subbasin, including the Little Choctawhatchee River system. Historical and current Tapered Pigtoe occurrences are shown in Figure 6.

Habitat or ecosystem conditions:
Studies on microhabitat use in tributaries suggest the Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe often occur near logs and limbs and in areas with deep, fast-flowing water and consolidated sediments that remain stable during high flows (Niraula et al. 2015a, 2015b;

Niraula et al. 2016). Thus, important habitat characteristics for the Tapered Pigtoe include stream channels with stable substrates, natural flow regimes, and intact riparian areas.

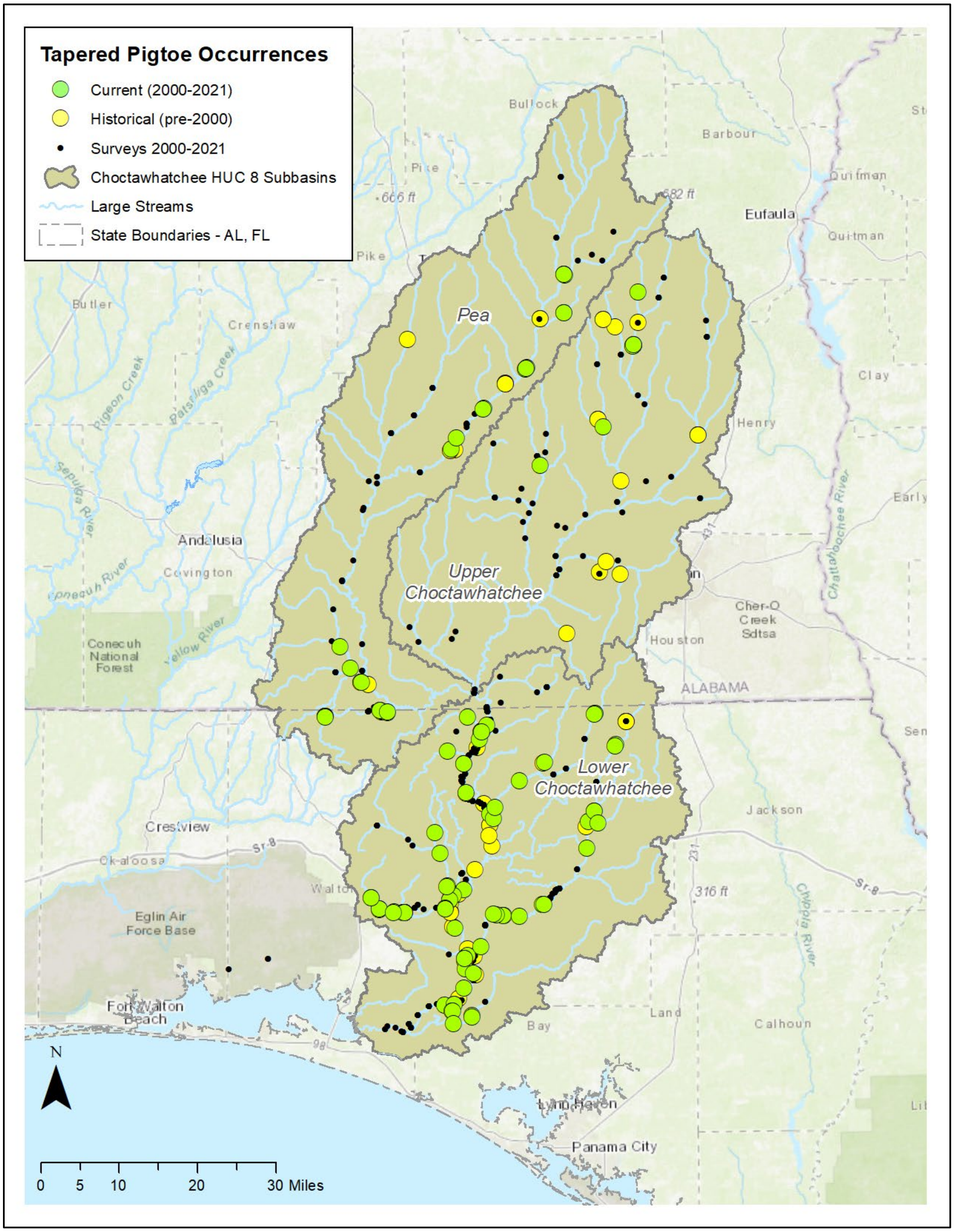

Figure 6. Tapered Pigtoe historical and current occurrences and locations surveyed during the current period.

<u>Narrow Pigtoe (*Fusconaia escambia*)</u>

Summary of new information of species' biology and life history:
Studies by FWC of Narrow Pigtoe early life history have provided new information. Field examination of 550 individuals from the Escambia River in Florida found 103 gravid females from early March to late October, with the peak months of gravidity in May to July (Holcomb et al. 2020). Laboratory host trials identified nine fish species from five genera as hosts for Narrow Pigtoe larvae, with Blacktail Shiner (*Cyprinella venusta*) and Weed Shiner (*Notropis texanus*) consistently producing the greatest number of viable juvenile mussels (Holcomb et al. 2020).

Abundance, population trends, demography:
Narrow Pigtoe records are known from the Escambia River basin in Alabama and Florida and the Yellow River basin in Florida (Fig. 7). Overall, the species maintains low abundance at most locations and appears extirpated from multiple historical locations. Narrow Pigtoe current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

<u>Escambia River Basin</u>
In the *Upper Conecuh* subbasin, approximately 4,115 individuals have been observed since 2000. New information is available regarding Narrow Pigtoe populations in Point A and Gantt lakes because of salvage efforts during full drawdowns of the reservoirs in 2017 and 2019. The reservoirs support suitable Narrow Pigtoe habitat in some submerged areas, and reproducing populations occur in both reservoirs. PowerSouth Energy Cooperative and resource agencies coordinated large-scale salvage events to move mussels from dewatered areas to the unaffected reservoir. In September 2017, 241 stranded individuals were collected in Point A Lake and relocated to suitable habitat in Gantt Lake. In the larger Gantt Lake reservoir, significant survey effort (approximately 2,000 survey hours over 5 days) resulted in the relocation of 3,817 individuals to Point A in September 2019. The maintenance drawdowns last for several weeks and many Narrow Pigtoe (especially small individuals) likely go undetected and perish due to extended emersion or predation. Full drawdowns occur about every 10 years and previously occurred in 2005 and 2006, demonstrating that the species can withstand these periodic disturbance events and maintain localized populations in the reservoirs. Although relatively abundant and reproducing, the reservoir populations are isolated and spatially limited. Outside of the reservoirs, the species occurs in one mainstem location upstream of Gantt Lake, however, too few surveys have been conducted in this reach to accurately assess its status in this portion of its historical range.

In the *Patsiliga* and *Sepulga* subbasins, a total of three live individuals have been observed since 2000. The *Patsiliga* population is isolated by the dams. Too few surveys have been conducted in these subbasins to fully assess its status in this portion of its range. Available survey data indicates it persists in very low abundance and is declining in these subbasins. The species appears to be maintaining populations in the *Lower Conecuh* subbasin, where 93 live individuals were observed since 2000. In the *Escambia* subbasin, considerable recent sampling effort detected 920 live Narrow Pigtoe individuals in the Escambia River and Pine Barren Creek. The species is locally extirpated around the state line but is maintaining populations elsewhere in the Escambia River.

Yellow River basin

All observations are from the Yellow River in Florida, where 49 individuals have been observed since 2000. Only three historical Narrow Pigtoe observations exist for the basin, making it difficult to assess trends. Based on available data, it may be extirpated in the upper-most extent of its range, near the State Road 2 crossing.

Genetics:

No new information is available.

Taxonomic classification or changes in nomenclature:

Genetic investigations confirmed that Narrow Pigtoe and Tapered Narrow (*Fusconaia burkei*) are closely related but distinct species (Pfeiffer et al. 2016, Pieri et al. 2018, Smith et al. 2020). The morphology and geography of these species also provide evidence of speciation (Johnson 2017).

Distribution and trends in spatial distribution:

Although the Narrow Pigtoe is largely extant throughout its historical range and has populated the two reservoirs, it appears extirpated in some localized areas, especially in the upper reaches of its range. An examination of spatial and temporal changes in Narrow Pigtoe distribution suggested that the population is stable in Florida, but too few surveys have been conducted in Alabama subbasins to fully assess its status throughout its range (Holcomb et al. 2020). Historical and current Narrow Pigtoe occurrences are shown in Figure 7.

Habitat or ecosystem conditions:

The Narrow Pigtoe is found in higher abundance in slow-flowing areas in the lower Escambia and Yellow rivers (Holcomb et al. 2020).

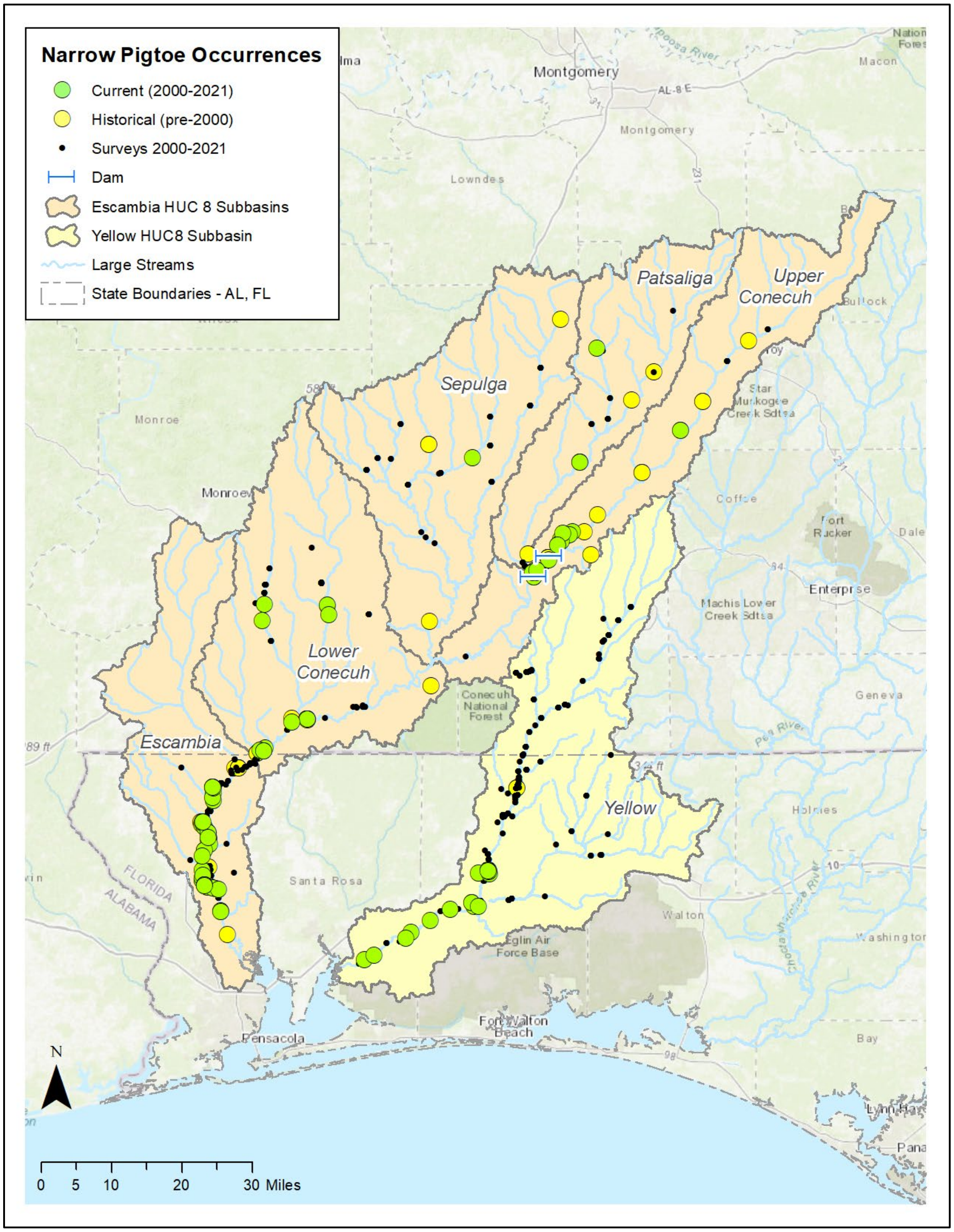

Figure 7. Narrow Pigtoe historical and current occurrences and locations surveyed during the current period.

<u>Southern Sandshell (*Hamiota australis*)</u>

Summary of new information of species' biology and life history:
No new information is available.

Abundance, population trends, demography:
Southern Sandshell records are known from the Escambia River basin in Alabama and the Yellow and Choctawhatchee River basins in Alabama and Florida (Fig. 8). Overall, the species is maintaining populations in the Yellow River basin and in some high-quality tributaries in the Choctawhatchee River basin. However, it is likely declining elsewhere in its historical range. The species is occasionally found in lightly disturbed habitats, but only occurs in high abundance in high-quality stream systems. Southern Sandshell current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

<u>Escambia River Basin</u>
A small population exists in the *Lower Conecuh* subbasin, where 20 live individuals have been observed since 2000. It has not been detected recently within the *Sepulga*, *Patsaliga*, and *Upper Conecuh* subbasins; however, too few surveys have been conducted in these reaches to fully assess its status in this portion of its range. Overall, the species appears to be declining in the Escambia River basin.

<u>Yellow River Basin</u>
Presently, the species is maintaining populations in the Yellow River basin, but it is relatively uncommon. A total of 135 live individuals were observed in recent surveys. One live individual was detected in the Five Runs Creek stream system in Alabama, indicating a small population exists within the tributary system.

<u>Choctawhatchee River Basin</u>
A total of 690 live individuals were detected in recent surveys; most (n = 450) were observed in the *Lower Choctawhatchee* subbasin in Florida. The species is abundant in a few high-quality tributaries, including Bruce Creek (FL), Eightmile Creek (AL), and upper Pea River (AL), but is relatively uncommon elsewhere in its range. Overall, the Southern Sandshell remains widespread in the basin but is likely extirpated in some historical locations.

Genetics:
No new information is available.

Taxonomic classification or changes in nomenclature:
No new information is available.

Distribution and trends in spatial distribution:
The Southern Sandshell was historically known from the Escambia River basin in Alabama, and the Yellow and Choctawhatchee River basins in Alabama and Florida. The species was recently detected for the first time in the Five Runs Creek system in Alabama. Surveys are needed to assess its current distribution in the upper Escambia River basin. Based on available data, the

range of the Southern Sandshell has not changed substantially since its listing in 2012. Historical and current Southern Sandshell occurrences are shown in Figure 8.

Habitat or ecosystem conditions:
The Southern Sandshell seems to tolerate lightly disturbed habitats but is only found in high abundance in streams with stable substrates and good water quality. Studies on microhabitat use in tributaries suggest the Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe often occur near logs and limbs and in areas with deep, fast-flowing water and consolidated sediments that remain stable during high flows (Niraula et al. 2015a, 2015b; Niraula et al. 2016). Thus, important habitat characteristics for the Southern Sandshell include stream channels with stable substrates, natural flow regimes, and intact riparian areas.

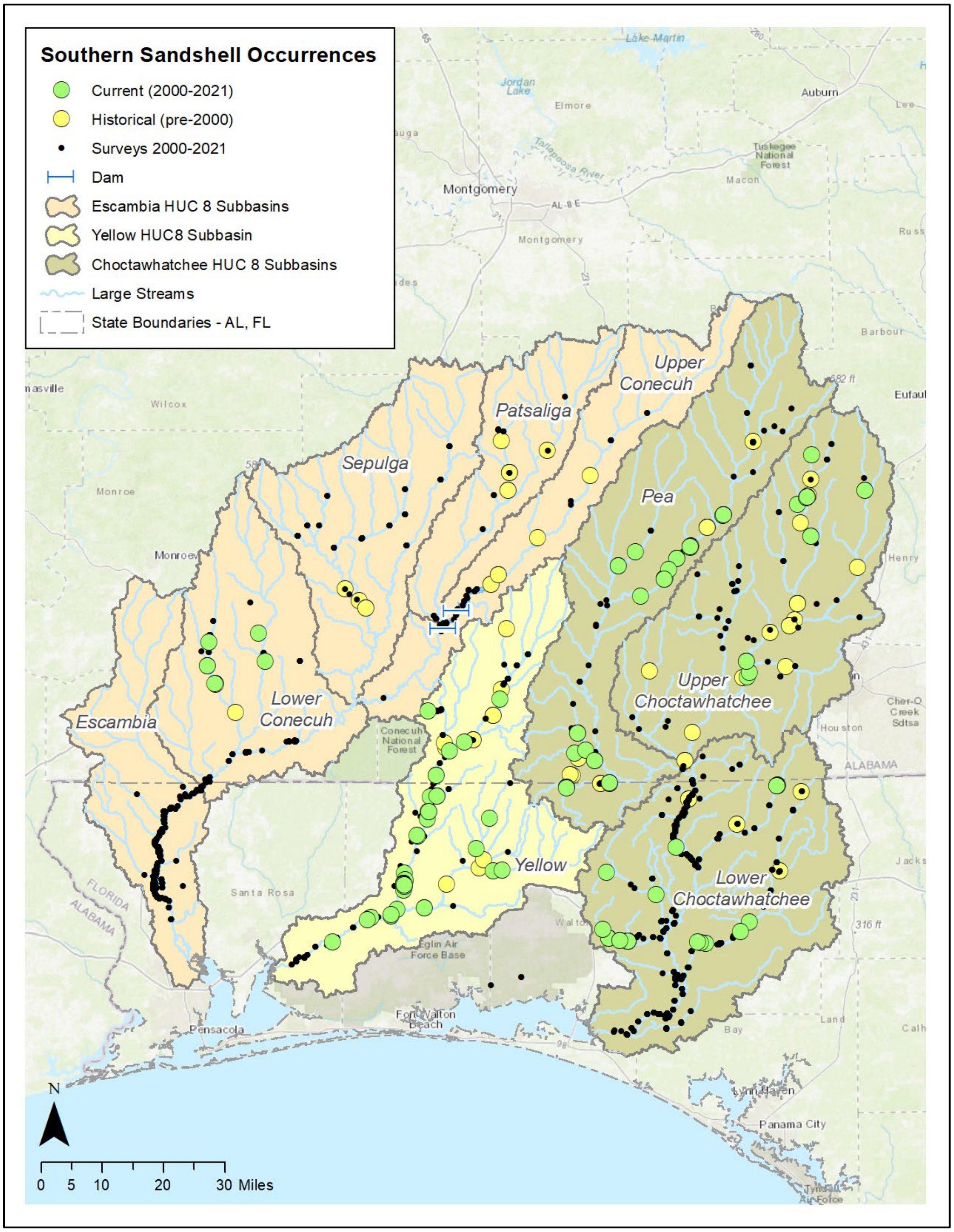

Figure 8. Southern Sandshell historical and current occurrences and locations surveyed during the current period.

<u>Fuzzy Pigtoe (*Pleurobema strodeanum*)</u>

Summary of new information of species' biology and life history:
No new information is available.

Abundance, population trends, demography:
Fuzzy Pigtoe records are known from the Escambia, Yellow, and Choctawhatchee River basins in Alabama and Florida (Fig. 9). Based on available data, the species is likely declining overall in the Escambia River basin. It is exceedingly rare in the Yellow River basin, and the viability of this population appears tenuous. In the Choctawhatchee River basin, relatively abundant Fuzzy Pigtoe populations occur within a few high-quality reaches, but populations are declining elsewhere within the basin. Fuzzy Pigtoe current (2000–2021) occurrences are discussed below and summarized by subbasin in Appendix A.

<u>Escambia River Basin</u>
A total of 194 live individuals were detected in the basin since 2000. The majority (*n*=147) were observed in the *Escambia* subbasin, and it appears to be maintaining populations in the lower mainstem. Too few surveys have been conducted in the upper portions of its range to fully assess it status in the *Sepulga*, *Patsaliga*, and *Upper Conecuh* subbasins; however, based on available data it appears to be declining in those stream systems.

<u>Yellow River Basin</u>
Since 2000, only three live individuals have been detected in the basin. Two individuals were found in the Five Runs Creek stream system in Alabama, representing new records for that system. Despite considerable sampling effort within its mainstem historical range, only one live individual was detected in recent years.

<u>Choctawhatchee River Basin</u>
A total of 1,346 live individuals were detected in the basin since 2000. The majority (*n* = 935) of which were observed within the *Pea* subbasin, where relatively abundant populations occur within a few high-quality reaches, including Eightmile Creek, upper Pea River, West Fork Choctawhatchee River, and lower Choctawhatchee River. Overall, the species appears to be maintaining populations in the basin, but it is locally extirpated at some historical locations.

Genetics:
A molecular study of phylogenetic relationships of *Fusconaia* and *Pleurobema* indicates that Fuzzy Pigtoe from the Escambia River, Florida, and the Choctawhatchee River, Florida, may be separate species (Inoue et al. 2018). Geographic isolation may have led to significant genetic differentiation within the species. However, further investigation, including larger samples and greater spatial coverage, is required to determine the taxonomic identity of these species (Inoue et al. 2018).

Taxonomic classification or changes in nomenclature:
No new information is available.

Distribution and trends in spatial distribution:
The Fuzzy Pigtoe was historically known from the Escambia, Yellow, and Choctawhatchee River basins in Alabama and Florida. Its range in the Escambia River basin appears to be declining; however, surveys are needed to assess its current distribution in the Alabama portions of the basin. In the Yellow River basin, a new population was found in the Five Runs Creek system (AL). Presently, it is known from two locations in the Yellow River basin and occupies a small portion of its historical range. The species occupies most of its historical range in the Choctawhatchee River basin but may be locally extirpated in some reaches. Based on available data, its distribution has not changed substantially since it was listed in 2012. Historical and current Fuzzy Pigtoe occurrences are shown in Figure 9.

Habitat or ecosystem conditions:
Studies on microhabitat use in tributaries suggest the Tapered Pigtoe, Southern Sandshell, and Fuzzy Pigtoe often occur near logs and limbs and in areas with deep, fast-flowing water and consolidated sediments that remain stable during high flows (Niraula et al. 2015a, 2015b; Niraula et al. 2016). Thus, important habitat characteristics for the Fuzzy Pigtoe include stream channels with stable substrates, natural flow regimes, and intact riparian areas.

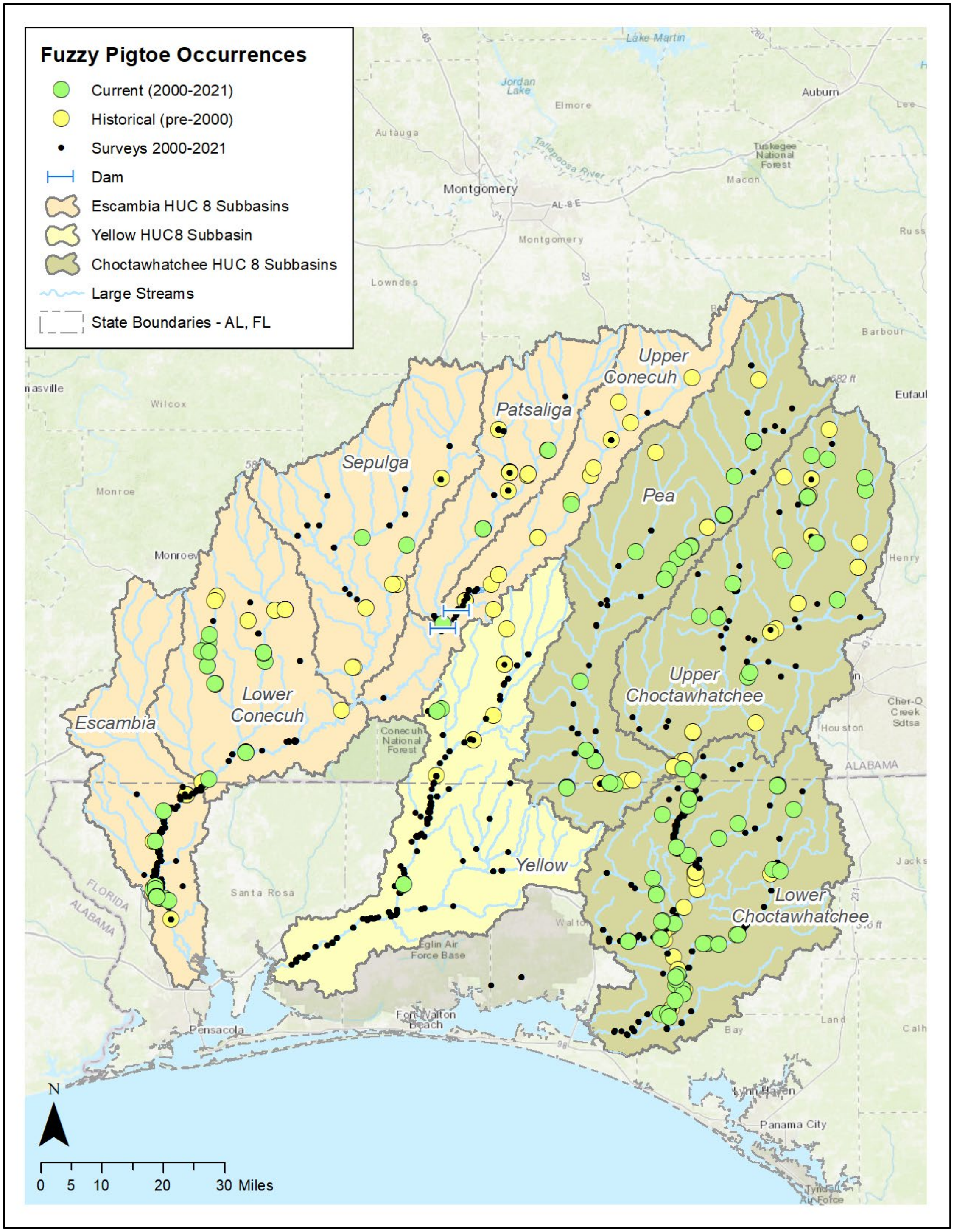

Figure 9. Fuzzy Pigtoe historical (pre-2000) and current (2000-2021) occurrences, and locations surveyed during the current period.

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

The purpose of a 5-year review is to recommend whether a listed taxon continues to warrant protection under the Act and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of listing under the Act. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis under Factor D (Inadequacy of Existing Regulatory Mechanisms) focuses on the availability of alternative (i.e., non-Act) mechanisms to address the continuing and foreseeable threats.

Since their listing in 2012, numerous studies have furthered our understanding of stressors responsible for freshwater mussel declines in general, and new information of specific threats to these species is available. Below we provide a brief discussion of relevant new information, and summary information for context. Detailed discussions of these threats can be found in the final listing rule (Service 2012a, 77 FR 61664).

Factor A. Present or threatened destruction, modification, or curtailment of its habitat or range

Habitat degradation and loss is on-going and is a significant threat to all populations of these mussels. Many EYC basin streams continue to experience high silt, sediment, nutrient, and pollutant loads, habitat instability, and altered flow regimes.

Water Quality Impairment

Studies indicate that the primary cause of water quality impairment in the Alabama portions of the Yellow, Pea, and Choctawhatchee rivers originates from nonpoint sources and includes suspended sediments, nutrients, bacteria, and metals (Murgulet and Cook 2010, Ponta and Jones 2018). Similar impairments have been identified in the Florida portions of the basins (NWFWMD 2017a, b). Although coliform bacteria are not necessarily harmful to mussels, the assays are useful indicators of septic tank leaching, inadequate sewage treatment or spills, and stormwater runoff from livestock and poultry operations (USEPA 2006), which can be harmful to mussels, their hosts, and their habitat. Researchers have attributed these problems primarily to past and current land-use practices within the watersheds, particularly row crop agriculture and urban and suburban development (Murgulet and Cook 2010, Ponta and Jones 2018, NWFWMD 2017a, b). For example, a water quality assessment in the Little Choctawhatchee River watershed attributed elevated nutrient concentrations to municipal wastewater and the high portion of urban and agricultural lands (>60%) in the watershed (Miller and Stewart 2013).

The Service used the 2019 Natural Land Cover Database (Dewitz 2021) to examine land cover in the EYC watersheds (the 15 land cover categories were generalized into 6 categories). Agricultural land cover accounted for 16% of land uses across all basins, with higher rates occurring in the *Upper Choctawhatchee* (27%), *Escambia* (21%), and *Pea* (20%) subbasins. Development comprised 6% of total land cover, with the large urban areas located around Dothan, Alabama, and Crestview, Florida. Agricultural and urban land uses are associated with mussel declines, presumably due to high loadings of silt, sediment, and chemicals (including nitrogen and pesticides), flashier flow regimes, and elevated stream temperatures caused by vegetation loss (Poole and Downing 2004, Strayer and Malcom 2012, Hornbach et al. 2019). Development has also resulted in an increased number of sewage treatment plants in drainages that support these mussels and an increase in the amount of sewage discharged from existing plants. Continued changes in land use and increased demands on wastewater and stormwater management systems due to population growth is projected for the EYC region (NWFWMD 2017a, b). All of these changes have the potential to impact each of these listed mussels and their habitats, and some details of those impacts are referenced below.

Contaminants. The final listing rule contains details regarding the effects of contaminants (Service 2012a). New research confirms that freshwater mussel early life stages are sensitive to the chemicals found in treated sewage effluent and agricultural runoff. Toxins, such as chlorine, ammonia, certain pesticides, surfactants used in glyphosate-based herbicides and common household products, heavy metals, and salt ions can disrupt growth, feeding, and reproduction in freshwater mussels, and prolonged exposure to such toxins can be lethal (Pandolfo et al. 2012, Strayer and Malcom 2012, Gibson 2015, Gibson et al. 2016, Wang et al. 2016, Archambault et al. 2017, Ciparis et al. 2017, Gibson et al. 2018, Salerno 2020, Bringolf et al. 2022).

A new study found concerning levels of the organochlorine pesticide DDT in lower Escambia River sediments within mussel critical habitat. The DDT found in the study is characteristic of recent releases. Potential sources include undocumented landfills and illegal use of the banned pesticide in areas upstream of the sampling locations (Liebens and Mohrherr 2015). Studies have demonstrated negative endocrine and reproductive effects in freshwater bivalves exposed to organochlorine pesticides (Kernaghan et al 2004, Lehmann et al. 2007).

Nutrients. Excessive nitrogen and phosphorus inputs may lead to harmful algal blooms and low dissolved oxygen (DO) levels, and mussels may be directly affected by the toxic effects of nitrogen (Hernandez et al. 2016). In its unionized form, ammonia is highly toxic to freshwater mussels (Newton and Bartsch 2007, Wang et al. 2007, Salerno 2020) and has been linked to recruitment failure when present in sediments (Strayer and Malcom 2012). Nitrogen-based fertilizers and wastewater discharges are sources of ammonia in streams.

Temperature and dissolved oxygen. Mounting evidence indicates that water temperature and dissolved oxygen (DO) are important during the early life stages of freshwater mussels, which are more sensitive to deviations from normal ranges. Stream temperature is largely influenced by air temperature and flow; DO concentrations can vary due to several factors, including water temperature, water velocity, and nutrient levels. Since 1970, average annual air temperatures in the Southeast region have risen by about 2°F, with the greatest warming occurring during the summer (Carter et al. 2018). During prolonged summer drought, mussels may be exposed to low DO concentrations and elevated water temperatures for extended periods (Haag and Warren 2008). Moreover, water temperature also plays an indirect role in the overall water quality because oxygen solubility and ammonia toxicity are temperature dependent.

Specific water temperature and dissolved oxygen parameters for these species are unknown; however, we expect them all to behave similarly with increases in mortality as temperatures increase above a temperature threshold and DO concentrations below a threshold level. Studies of other freshwater mussel species show water temperatures of not more than 32 °C (91 °F) represent important thresholds for freshwater mussel early life stages (Sparks and Strayer 1998, Pandolfo et al. 2010, Khan et al. 2019). Temperatures above 31 °C (88.7 °F) were fatal to the larval Alabama Pearlshell (Fobian et al. 2018), an endangered mussel whose range includes the Escambia River basin. Research on freshwater mussels in the lower Flint River basin found that DO concentrations below 5.0 mg/L correlated to significant increases in adult mussel mortality, especially for certain species considered sensitive to disturbance (Gagnon et al. 2004). Along with other impacts, such as riparian vegetation loss and urban stormwater inputs, presumably summer water temperatures and dissolved oxygen levels periodically exceed the tolerance range of these mussels. Moreover, in some mussel-fish relationships, the associated host fish species is less thermally tolerant than the mussel (Pandolfo et al. 2012).

Suspended sediment. A recent literature review concluded that suspended sediment concentrations above certain thresholds interfere with key aspects of mussel biology (Goldsmith et al. 2020). For example, high levels of suspended inorganic and organic particles have been shown to reduce mussel fertilization success in females by disrupting sperm capture, and by affecting their ability to meet energetic demands (Gascho Landis et al. 2013, Gascho Landis and Stoeckel 2015). High levels of suspended solids have also been shown to reduce mussel feeding and respiratory efficiency (Dennis 1984, Aldridge et al. 1987) and alter behavior (Ellis 1936). However, these types of effects are not well understood. The potential for physiological stress due to high particle levels exists for mussels in the EYC basins. For example, Bruce Creek mussels (Choctawhatchee River basin) were found to contain more sediment, detritus, and mucous in their mantel cavities shortly after a high-flow event compared to examinations absent a high-low event (S. Pursifull, pers. obs. from January 2015 to September 2016). Because of the similar habitats and feeding mechanisms these impacts to varying levels could be expected in all mussels experiencing similar conditions in the Choctawhatchee and other river basins.

Altered flow regimes

Changes to natural flow regimes have been attributed to human activities, such as land-use change, ground and surface water pumping, impounding, loss of riparian vegetation, and global climate change. These activities can alter hydrologic processes, including surface runoff, streamflow, evapotranspiration, and groundwater recharge. Watersheds with high portions of deforestation, impervious surfaces, or loss of riparian vegetation are subject to higher surface runoff rates, causing streams to receive large volumes of water during heavy rainfall events. Stream channels become highly unstable as they respond to increased flows and may experience extensive bank erosion, channel deepening, channel widening and shallowing, unconsolidated sediments, and other geomorphic changes. Scouring flows can wash mussels, particularly juveniles, into unsuitable areas (Peterson et al. 2011) or cause smothering (Goldsmith et al. 2020). Studies have indicated that high shear stress is associated with low mussel richness and abundance (Layzer and Madison 1995, Allen and Vaughn 2010, Goldsmith et al. 2020). Mussels are most likely to occur in areas of the stream bottom that remain stable during high-flow events and in wetted, thermally buffered areas during periods of low flow (Strayer 2008). Flashy tributaries carrying and depositing pulses of contaminated sediments from agricultural and urban areas may harm mainstem mussel populations (Holcomb et al 2020).

Prolonged summer drought can cause drastic flow reductions, especially in smaller tributaries, which may cease to flow. Rain deficiencies during 1998–2002 caused a severe drought and record low stream flows. The most severe drought years in northwest Florida were 2000 and

2002, when only 35 and 37 percent of average annual streamflow occurred, respectively (Verdi et al. 2006). The lowest instantaneous streamflow on record was recorded in 2000 at gages on the Escambia River (near Century), Yellow River (at Milligan), and Choctawhatchee River (near Bruce) (Verdi et al. 2006). Increased water temperatures and decreased dissolved oxygen levels are important secondary effects of flow reduction and cessation during summer drought (Haag and Warren 2008). The adverse effects of drought, such as emersion, reduced dissolved oxygen levels, and increased water temperatures, on mussel populations in southeastern streams are well documented (Gagnon et al. 2004, Golladay et al. 2004, Haag and Warren 2008, Gough et al. 2012, Shea et al. 2013).

While floods and droughts are a natural part of the hydrologic processes in these river systems, these events may compound the effects of other stressors, and exacerbate the decline of mussel populations. Moreover, these events are increasing in frequency and severity as the effects of climate change worsen (discussed under Factor E, below). To manage drought stresses, an Natural Resources Conservation Service (NRCS) project presently in the planning phase proposes to expand cropland irrigation by 16,800 acres in the Alabama portions of the Choctawhatchee River basin (USDA-NRCS 2021). The potential cumulative effects of increased ground and surface water withdrawal within the upper watershed could lower the regional water table, especially under drought conditions, and decrease the amount of groundwater entering streams. Decreases in stream flows in the upper basin would likely extend downstream into the lower Choctawhatchee River and Bay. Without a long-term environmental sustainability plan for the watershed, the expansion of irrigation could significantly impact aquatic species and habitat throughout the basin.

Channel and floodplain disturbance

Activities that physically disturb the stream channel or riparian areas within the range of these mussels include floodplain mining of gravel and mineral resources, bridge and pipeline construction, channel dredging and de-snagging, deadhead logging, and ATV use. These activities are still acting on the species at similar levels as discussed in the 2012 listing rule, and that information remains valid.

Channel impoundment

Impacts related to the operation and maintenance of Point A and Gantt dams, such as periodic drawdowns, are ongoing. The dams were constructed in 1923 for hydroelectric power generation and collectively impound approximately 19 km (11.8 mi.) of the Conecuh River. Choctaw Bean, Southern Sandshell, and Fuzzy Pigtoe have disappeared from the impounded reaches of the Conecuh River and lower Patsiliga Creek. Narrow Pigtoe is established in both reservoirs and appears tolerant of the full drawdowns that occur about every ten years (see discussion under Narrow Pigtoe above). Hydroelectric dams are associated with downstream declines of freshwater mussels due to altered flow, sediment, temperature, dissolved oxygen regimes, and channel geomorphology (Haag and Williams 2014). Very little sampling has occurred in the Conecuh River downstream of the impoundments, making it difficult to assess the status of listed mussels in this reach.

In the 2012 listing rule, we discussed impacts related to the Elba Dam on the Pea River (Choctawhatchee River basin) including significant down-cutting of the streambed downstream of the structure. In 2020, a large section of the aging dam was completely breached during high flows (apparently associated with precipitation/flooding as a result of Hurricane Sally), and the dam's owner is in the process of surrendering its Federal Energy and Regulatory Commission (FERC) license (Metcalf 2022 pers. com.). Although the Pea River is again free-flowing, the dam significantly altered the channel, and it could take decades for habitat to stabilize in this reach.

Given the projected human population growth and the need for municipal water infrastructure, additional impoundments within the EYC basins are likely in the future. The Choctawhatchee, Pea, and Yellow Rivers Watershed Management Authority initiated the permitting processes for a reservoir on the Little Choctawhatchee River, a tributary to the Choctawhatchee in Alabama. While the permit application has been suspended, history shows that similar projects are likely to arise (Miller and Stewart 2013).

Oil and gas extraction

Oil and natural gas extraction wells are present in the Escambia River basin. The majority are in Alabama, where at least 700 active and non-active well sites are in drainages that contain mussel critical habitat (ADCNR 2015, Service In prep.). Although oil and gas extraction pads are typically constructed away from streams, extensive road networks are required to construct and maintain the wells (ADCNR 2015). These access roads frequently cross or occur near streams, contributing sediment to nearby waterways. In addition, the well operations are subject to periodic spills, either directly at the well site or with the transport of the oil.

Conservation measures

A partnership between the Geological Survey of Alabama, the Service, and Alabama Department of Conservation and Natural Resources has prioritized watersheds and river segments in Alabama and northwest Florida for managing, protecting, restoring, and recovering populations of rare fishes, mussels, snails, and crayfishes (Wynn et al. 2018). Within the EYC basins, 18 designated reaches include many of the remaining high-quality streams and reflect the variety of habitats historically and currently occupied by these species. The Strategic Habitat and River Reach Units facilitate and coordinate watershed management and restoration efforts and prioritize funding to address habitat and water quality issues.

The mussels may indirectly benefit from Federal, State, local, and private programs that acquire or manage lands within the watersheds, particularly along stream riparian corridors. Larger tracts within the three basins include:

- The Northwest Florida Water Management District (NWFWMD) owns, manages, or co-manages a significant portion of the basins' riparian lands. The NWFWMD owns and manages over 53,000 acres along the Florida portions of the Escambia and Yellow Rivers and over 62,000 acres along the Choctawhatchee River. The tracts are managed to preserve and restore riparian and floodplain habitats.
- Large tracts of Eglin AFB in Florida are managed for habitat conservation and the protection of endangered species under the Integrated Natural Resources Management Plan.

Management actions on the Eglin property can substantially influence water and habitat quality in the lower Yellow River.

- The Conecuh National Forest encompasses over 84,000 acres within the Yellow and Escambia River watersheds in Alabama and is managed to restore and maintain the longleaf pine ecosystem. If necessary, management actions will be implemented to conserve and recover threatened, endangered, sensitive, and locally rare species.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes

In the 2012 listing rule, overutilization was not considered a threat to any of the seven mussels. They are not commercially valuable species, although rare mussels have the potential to be sought after by collectors. We do not expect overutilization to become a threat in the future. However, over-collecting for scientific or educational purposes could impact localized populations if unregulated individuals perform this activity.

Factor C. Disease or predation

Disease and predation were not considered threats to any of the seven mussels at the time of listing. Since the 1970s, episodic mass mortality events of freshwater mussels have been documented around the world (Richard et al. 2020). The mass die-offs appear to have only affected a single species in the communities where they have occurred, prompting speculation that viral infections could be the driving force behind these events (Richard et al. 2020). Since 2016, massive mortality events in Clinch River (Tennessee) populations of *Actinonaias pectorosa* (Pheasantshell) have caused a precipitous decline in this once common mussel species (Richard et al. 2020). Analysis of the affected mussels has shown a strong correlation between a novel densovirus and morbidity. However, continued studies are needed to link this virus or other viral infections to mortality events (Richard et al. 2020). Disease appears to be a threat to mussel communities in the Southeastern United States and could potentially become a threat to these mussels in the future.

Factor D. Inadequacy of existing regulatory mechanisms

The Clean Water Act is the primary federal law in the United States governing water pollution. One of its primary roles is to regulate the point source discharge of pollutants into surface waters. These regulations have helped reduce the adverse effects of point source discharges since the 1970s, yet they are difficult to implement and regulate. Some basin streams continue to be degraded by permitted wastewater discharges. The Little Choctawhatchee River is a documented example of a stream system in which municipal wastewater has adversely affected mussel populations (Miller and Stewart 2013).

Current State and Federal regulations that establish limits on pollutants discharged into waterbodies are assumed to be protective of freshwater mollusks; however, these species may be more susceptible to some pollutants than the test organisms typically used to establish criteria protective of aquatic life. For example, in 2013 the U.S. Environmental Protection Agency revised its recommended water quality criteria for ammonia after new toxicity studies indicated that the previous criteria were not protective of sensitive freshwater mollusks (Augspurger et al. 2003, 2007; Newton et al. 2003; Newton and Bartsch 2007; Mummert et al. 2003). While new criteria are being developed, freshwater mollusks are underrepresented in toxicity databases that are used to determine water quality criteria (Wang et al. 2016). In some instances, a pollutant of concern may not yet have water quality criteria (e.g., potassium and sodium dodecyl sulfate, a common household surfactant) (Gibson et al. 2016, 2018).

Nonpoint inputs such as silt, nutrients, and other contaminants may not be sufficiently regulated. Agriculture, suburban, and urban land-uses continue to expand in many watersheds in the existing ranges of these species. Further, these land-use changes alter runoff patterns and flow with unknown consequences to the remaining populations. Few regulatory mechanisms exist to address land-use changes that may indirectly affect stream habitat remote from the disturbance.

Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the United States, including wetlands. Any activities in waters of the United States are regulated under this program, such as water resource projects, infrastructure development, and mining projects. While a single project is unlikely to jeopardize the continued existence of any one species, the collective impact of multiple development projects on finite habitat is often not assessed on a permit-by-permit case.

Factor E. Other natural or manmade factors affecting their continued existence:

Climate change – temperature and precipitation

Climate change has already had adverse impacts on terrestrial, freshwater, and coastal ecosystems globally, and observed increases in temperature extremes, heavy precipitation, drought, and fire have been attributed to climate change (Intergovernmental Panel on Climate Change [IPCC] 2022). In the coming decades, human-induced climate change will push natural and human systems beyond their ability to adapt (IPCC 2022).

Climate models forecast more extreme climate and precipitation events in the southeastern U.S. (Carter et al. 2018, LaFontaine et al. 2019). By 2050, summer maximum air temperature within the EYC watersheds is projected to increase by 2.6–3.1°F above historical (1981–2010) levels (Fig. 9 and 10; Alder and Hostetler 2013). For thermally sensitive mussel species, climate change-induced increases of 3.6–5.4°F may exceed their ability to adapt (Payton et al. 2016).

Changes to annual and seasonal streamflow in northern Gulf Coast rivers due to a warmer and wetter climate are predicted (Neupane et al. 2018). An examination of future land-use and climate change in the *Upper Choctawhatchee* subbasin shows an 11% increase in precipitation by midcentury (Makhtoumi et al. 2020). Combined with an increase in impervious surfaces, the analysis projects significantly more surface runoff (Makhtoumi et al. 2020), leading to more frequent and intense flooding.

All indications are that precipitation extremes are occurring in the EYC watersheds. An examination of long-term streamflow in the Choctawhatchee and Escambia rivers suggests that the rivers have been experiencing significant climate-driven declines in streamflow since 2000 (Vines et al. 2021). The study used U.S. Geological Survey (USGS) gauge data and tree ring chronologies to construct a nearly 800-year record. The reconstructions showed that declining streamflow and drought over the past two decades have resulted in one of the lowest recorded flow periods in the Choctawhatchee and Escambia Rivers (Vines et al. 2021). Conversely, heavy rains and tropical cyclones have caused severe flooding within the basins that damaged many stream crossings and resulted in federal disaster declarations within all or portions of the EYC basins in 2013, 2014, 2017, 2018, and 2020. The impacts of drought and flooding on mussels and stream habitats are discussed under Factor A.

Temperature increases and more extreme hydrologic conditions pose a significant threat to these mussels. As climate change intensifies within the EYC region, the problems discussed under Factor A, such as altered stream flow, habitat instability, and degraded water quality, will likely worsen.

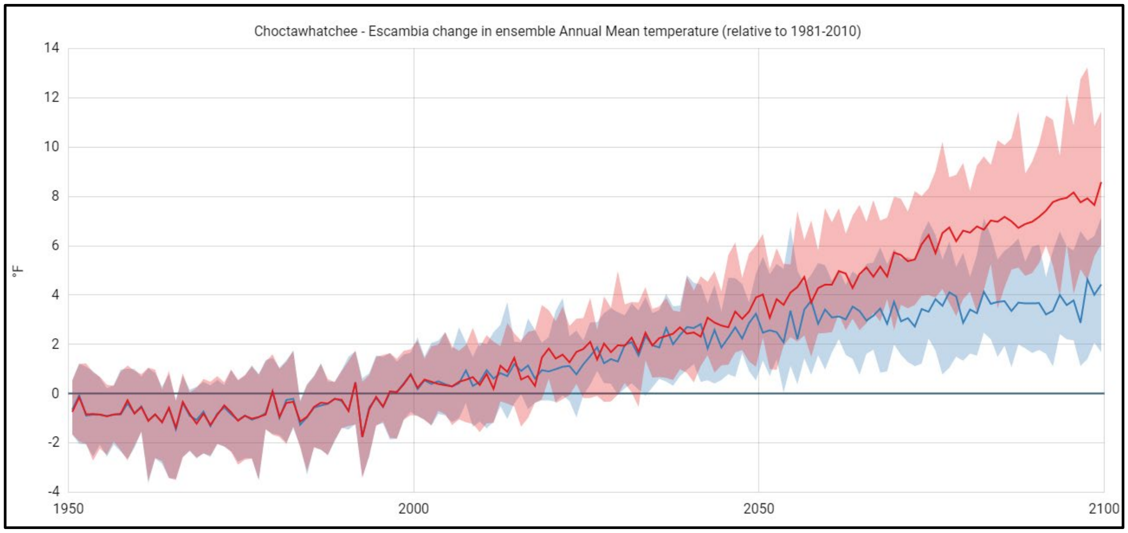

Figure 9. Choctawhatchee – Escambia (0314) subregion future minus historical change in annual mean temperature (°F) for RCP4.5 (blue) and RCP8.5 (red). The historical period ends in 2005 and the future periods begin in 2006. The median of 20 CMIP5 models is indicated by the solid lines and the ensemble 10th to 90th percentile range is indicated by the respective shaded envelopes (Alder and Hostetler 2013).

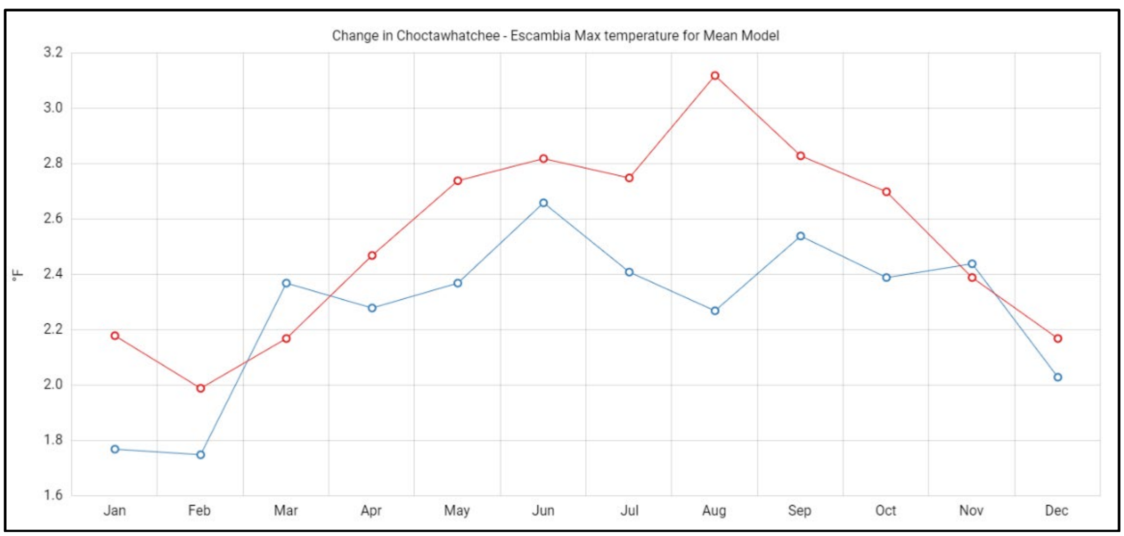

Figure 10. Choctawhatchee – Escambia (0314) subregion change in monthly maximum temperature (°F) for the 2025-2049 time period compared to the historical (1981-2010) period

for RCP4.5 (blue) and RCP8.5 (red), using the median of 20 CMIP5 models. Mean temperature increase for summer is 2.45 (°F) (Alder and Hostetler 2013).

Climate change – sea level rise

As sea levels rise, mussel populations in the lower mainstems are vulnerable to saltwater encroachment during extreme high tide and storm surge events. Mid-range sea level rise scenarios for the northern Gulf of Mexico from Pensacola to Panama City, Florida, predict sea levels will rise by 1.1 ft by 2050 and 2.25 ft by 2080 (National Oceanic and Atmospheric Administration [NOAA] website, accessed 3 Mar 2022). However, these sea water elevations will be reached well before then with short-term events such as storm surges. In addition, mussel habitats dependent on flowing water will become unsuitable as the tidal influence zone shifts upstream.

Nonnative species

Recent studies suggest that invasive *Corbicula fluminea* (Asian Clam) may be an "important but overlooked factor in widespread native mussel declines" (Haag et al. 2021). The introduced clam was first documented in the Escambia River in 1960 (Schneider 1967) and is widespread throughout the EYC basins. In high densities, *Corbicula* can remove substantial amounts of seston (suspended particles) from the water column, reducing food sources and negatively impacting mussel growth (Ferreira-Rodríguez et al. 2018, Haag et al. 2021). The sudden decline of certain mussel species in other Gulf coast drainages coincided with the appearance of *Corbicula* (Heard 1975). However, the onset of significant perturbations around the same period makes it difficult to determine if *Corbicula* contributed to the declines (Pursifull et al. 2021).

Barriers to host fish movement and reach isolation

Activities that affect the distribution and abundance of native fishes directly affect mussel distribution and abundance. Point A and Gantt dams block fish migration routes on the Escambia-Conecuh River. This may have implications for the Round Ebonyshell which likely uses only migratory shad as its larval host. It is unknown whether the dams have affected skipjack herring, but dams are considered the primary reason for the decline of Alabama Shad (National Marine Fisheries Service [NMFS] 2017). In addition, impoundments in the Flint River basin in Georgia were shown to isolate and contribute to the extirpation of mussel populations upstream of dams (Shea et al. 2013). The isolated populations of Choctaw Bean, Southern Sandshell, and Fuzzy Pigtoe upstream of Point A and Gantt dams are more vulnerable to extirpation due to losses resulting from stochastic events such as droughts, floods, and pollutants.

In the 2012 listing rule, we discussed the Elba Dam on the Pea River (Choctawhatchee River basin) as a barrier to upstream fish migration. The aging dam was completely breached in 2020 and the river is again free-flowing (see discussion under Factor A). The dam's demise will provide Gulf Sturgeon and Alabama Shad access to historical habitat and allow free movement of mussel host fish species.

Small population size / Linear populations

The Round Ebonyshell has a narrow distribution with an extremely small and declining population size. The Southern Kidneyshell and Choctaw Bean have experienced declines in distribution and abundance, especially in the peripheral areas of their range, and their populations are small and fragmented. Their small and declining populations, especially those that are in single, linear reaches of water could contribute significantly to the risk of extinction since smaller populations have less of a buffer against threats than larger populations and having a linear nature increases susceptibility of individuals to threats. The influence of stochastic variation on demographic (reproductive and mortality) rates is much higher for small populations than large ones. Stochastic variation in demographic rates causes small populations to fluctuate randomly in size. In general, the smaller the population, the greater the probability that fluctuations will lead to extinction. Mussel species with low abundance levels are particularly susceptible to habitat deterioration, catastrophic events, introduced species, and demographic or environmental stochasticity (Soulé 1980, Primack 2008, Haag 2012). The minimum viable population size needed to withstand stochastic events is unknown for mussels. However, species with complex life histories, like freshwater mussels, likely require a population of considerable size to persist long-term (Haag 2012).

Synthesis

The Round Ebonyshell, Southern Kidneyshell, Choctaw Bean, Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe are freshwater mussels endemic to the Escambia, Yellow, and Choctawhatchee river basins in south Alabama and northwest Florida. Each species has experienced varying degrees of declines in range and/or abundance since being listed.

- The Round Ebonyshell's distribution has not changed significantly since the species' listing but its numbers may have declined. It is an exceedingly rare species and its range remains extremely small. It inhabits only the middle and lower reaches of the Escambia-Conecuh River and is extirpated in some localized areas. The species' limited range and small population makes it vulnerable to catastrophic and stochastic events. In addition, storm surge and sea level rise may be of greater consequence to the species because of its limited distribution in the lower mainstem.

- Although the Southern Kidneyshell's known distribution has changed slightly since the species' listing, its range remains small and its numbers are very low. The species occurs in one stream system in the Escambia River basin, where its distribution is drastically reduced and it appears to be nearly extirpated in the basin. It occurs in four widely separated stream systems in the Choctawhatchee River basin, which may represent isolated populations. One population (in the Pea River) appears viable and shows ample recent recruitment, but all other populations are small and likely declining. The species is sensitive to disturbance and remaining populations occur only in reaches with intact riparian areas, stable habitat and relatively good water quality. Because of its reliance on darters, recolonization into remote streams is less likely.

- The Choctaw Bean's distribution is unchanged since the species' listing but its numbers may have declined and it is uncommon throughout its range. Although it appears to be maintaining population levels in the lower portions of the three basins, the species is extirpated from multiple historical sites in the upper basins, especially in the upper Escambia River basin, where it appears nearly extirpated.

- The Tapered Pigtoe’s distribution has not changed significantly since the species’ listing. It is endemic to the Choctawhatchee River basin, where it exists in low abundance at most locations. The species is likely extirpated in several historical reaches. New information indicates it is relatively abundant in a few high-quality streams systems, however, these populations are not sufficient to compensate for declines observed elsewhere in its range.

- The Narrow Pigtoe’s distribution has not changed significantly since its listing, but its numbers may have declined. It is endemic to the Escambia and Yellow River basins, where it exists in low abundance at most locations. The species is likely extirpated in multiple historical locations. Relatively abundant and reproducing populations occur in Point A Lake and Gantt Lake reservoirs, however, the populations are isolated, spatially limited, and subject to periodic reservoir drawdowns.

- The Southern Sandshell’s distribution and numbers have not changed significantly since its listing. Overall, the species is maintaining populations in the Yellow River basin and in some high-quality tributaries in the Choctawhatchee River basin. However, it is likely declining elsewhere in its historical range. The species is occasionally found in mildly disturbed habitats, but only occurs in high abundance in high-quality stream systems.

- The Fuzzy Pigtoe’s distribution and numbers have not changed significantly since its listing. It occurs in very low abundance in the Yellow River basin, where it appears to be nearly extirpated. The species largely occurs throughout its historical range in the Escambia and Choctawhatchee basins but is extirpated in localized areas. Relatively large populations persist in a few Choctawhatchee stream systems; however, these populations are not sufficient to compensate for declines observed elsewhere in its range.

The threats of incompatible land uses and management practices, pollution, ground and surface water pumping, channel impoundment and modification continue throughout the range of each species. In addition since the rule, climate change-associated impacts, like extreme precipitation events and rising temperatures, have increased throughout their ranges, and are expected to increase in the future. Along with human population growth, most these threats are expected to increase in the coming decades. Other relevant on-going threats include competition from introduced *Corbicula* and decreased host fish abundance. Collectively, these threats are impacting the species’ future viability, and there is a real possibility of further range contraction and abundance decline. For the three endangered mussels, the magnitude of these threats is greater due to small population sizes. While a few high-quality streams harbor relatively abundant populations of some of these species, these do not compensate for declining populations and lost habitat elsewhere in their range.

Riverine habitats are not easily protected from stormwater runoff and point source pollution continues to degrade some stream systems. Current water quality criteria may not fully protect these species, which are more sensitive some pollutants than the test organisms typically used to establish criteria. Although conservation lands border portions of inhabited streams, adequate protection of these mussel populations is extremely challenging given the geographic extent of their riverine systems.

Because of ongoing threats and the current condition of the species, the Round Ebonyshell, Southern Kidneyshell, and Choctaw Bean continue to meet the definition of an endangered species under the Act, and the Tapered Pigtoe, Narrow Pigtoe, Southern Sandshell, and Fuzzy Pigtoe continue to meet the definition of a threatened species under the Act.

RECOMMENDED FUTURE ACTIVITIES

These seven species do not have a final recovery plan. While completing this status review, we have identified the following potential recovery activities, which are included below.

Recovery Activities

a. Encourage the protection and establishment of wide riparian buffer zones along all streams containing or draining into the historical ranges of these species. Buffers of at least 300 feet in width and consisting of native forest are considered the most protective and effective. A greater width may be necessary to effectively buffer storm water runoff from urban and suburban lands, cultivated fields, and timber harvest operations.

b. Restore and increase in-stream habitat and stream connectivity through conservation actions, including but not limited to removing artificial fish migration barriers, bank stabilization, riparian buffer maintenance or augmentation, improving water quality downstream of impoundments, and adherence to BMPs.

c. Work with state and federal agencies and private organizations to promote land and water stewardship awareness (e.g., Soil and Water Conservation Districts, Natural Resource Conservation Service (NRCS), State Forestry Commissions, private industry groups, environmental groups, etc.).

d. Develop programs and outreach materials to increase public awareness of these species and explain the benefits of protecting stream ecosystems.

Monitoring and Research Activities

a. Conduct status survey for Round Ebonyshell in the Conecuh River and document habitat conditions.

b. Conduct surveys in under sampled portions of their ranges to examine the species' status and habitat conditions.

c. Conduct quantitative assessments of mussel assemblages to examine relative abundance, catch per unit effort, and population demographics.

d. Conduct long-term monitoring studies to obtain demographic data, including population estimates, population growth rates, recruitment levels, and age-specific survival.

e. Use eDNA as a detection tool to provide up-to-date distributional information, especially for rare or cryptic species like Southern Kidneyshell. Use assays to confirm presence in historical reaches and detect previously unknown populations.

f. Conduct long-term monitoring studies of stream thermal regimes, especially during summer low flow conditions.

g. Prepare a comprehensive threats assessment that identifies and maps existing and potential threats within the watersheds and identifies activities or practices that may affect the seven mussels or their habitats. Use the assessment to develop SSAs and recovery plans for the species.

h. Model future precipitation, temperature, and flow scenarios in the basins to examine the impacts of climate change and consumptive uses. Use the assessment to develop SSAs and recovery plans for the species.

i. Model future sea level and flow scenarios to analyze the effects of saltwater encroachment in the lower mainstems during high tide and storm surge events. Use the assessment to develop SSAs and recovery plans for the species.

j. Research important life-history traits, such as host fish use, growth, longevity, age at maturity, and fecundity, and incorporate the results into management and protection actions. All partners should be aware of research efforts and results to facilitate the immediate application of results.

k. Determine temperature and contaminant sensitivity for each life-stage, and develop recommendations for EPA and state water quality criteria to protect and enhance habitat.

l. Conduct genetic analysis to determine adaptive capacity, evaluate species boundaries, and establish genetic management plans.

m. Study the life history and identify the host fish of the Southern Sandshell, Choctaw Bean, and Round Ebonyshell.

RESULTS / SIGNATURES

U.S. Fish and Wildlife Service
Status Review of
Round Ebonyshell (*Reginaia rotulata*), Southern Kidneyshell (*Ptychobranchus jonesi*), Choctaw Bean (*Obovaria choctawensis*), Tapered Pigtoe (*Fusconaia burkei*), Narrow Pigtoe (*Fusconaia escambia*), Southern Sandshell (*Hamiota australis*), and Fuzzy Pigtoe (*Pleurobema strodeanum*)

Status Recommendation:

On the basis of this review, we recommend the following status for each of the seven species. A 5-year review presents a recommendation of the species status. Any change to the status requires a separate rulemaking process that includes public review and comment, as defined in the Act.

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist:
 ____ *The species is extinct*
 ____ *The species does not meet the definition of an endangered or threatened species*
 ____ *The listed entity does not meet the statutory definition of a species*
_X_ No change needed for all species.
 The following species remain listed as endangered - round ebonyshell, southern kidneyshell, Choctaw bean.
 The following species remain listed as threatened -tapered pigtoe, narrow pigtoe, southern sandshell, fuzzy pigtoe.

FIELD OFFICE APPROVAL:

Division Manager, Florida Ecological Services Field Office, Fish and Wildlife Service

Approve LOURDES MENA Digitally signed by LOURDES MENA Date: 2022.09.13 08:58:55 -04'00' Adobe Acrobat version: 2022.002.20191

REGIONAL OFFICE APPROVAL:

Acting for:
Assistant Regional Director – Ecological Services, Fish and Wildlife Service

Approve AARON VALENTA Digitally signed by AARON VALENTA Date: 2022.09.13 13:56:44 -04'00'

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APPENDIX A: Summary of current (2000-2021) occurrence by subbasin. Subbasins gray highlight contain historical occurrences only.

A. Round Ebonyshell (*Reginaia rotulata*)

[1] **Basin / *Subbasin***	[2] **Last observation**	[3] **Evidence of Recruitment**	[4] **# of live observed**	[5] **Population trend**	**Notes**
Escambia / *Upper Conecuh*	2002		0	[Historical]	Occupancy is based on 1 weathered shell collected in 2002 and considered historical.
Escambia / *Lower Conecuh*	2006		9	Unknown	In addition, 1 weathered shell observed in 2018.
Escambia / *Escambia*	2017		8	Declining	

B. Southern Kidneyshell (*Ptychobranchus jonesi*)

[1] **Basin / *Subbasin***	[2] **Last observation**	[3] **Evidence of Recruitment**	[4] **# of live observed**	[5] **Population trend**	**Notes**
Escambia / *Upper Conecuh*	1916			[Historical]	Possibly extirpated; surveys are needed. Upper Conecuh River is isolated by dams.
Escambia / *Patsaliga*	1915			[Historical]	Likely extirpated. Subbasin is isolated by dams.
Escambia / *Sepulga*	1912			[Historical]	Possibly extirpated; surveys are needed.
Escambia / *Lower Conecuh*	2015		4	Unknown	Population discovered in 2012.
Yellow / *Yellow*	1963			[Historical]	Extirpated in the basin.
Choctawhatchee / *Pea*	2015	Yes	101	No change	Some individuals were likely observed multiple times.
Choctawhatchee / *Upper Choc*	2007		9	Declining	
Choctawhatchee / *Lower Choc*	2009		0	Declining	Occupancy is based on 1 shell.

C. Choctaw Bean (*Obovaria choctawensis*)

[1] Basin / *Subbasin*	[2] Last observation	[3] Evidence of recruitment	[4] # of live observed	[5] Population trend	Notes
Escambia / *Upper Conecuh*	2001		1	Declining	
Escambia / *Patsaliga*	2012		0	Declining	Occupancy is based on 1 shell.
Escambia / *Sepulga*	1986			[Historical]	Species appears historically uncommon in the subbasin.
Escambia / *Lower Conecuh*	2012		4	Declining	
Escambia / *Escambia*	2020		144	Declining	
Yellow / *Yellow*	2018		12	Declining	
Choctawhatchee / *Pea*	2014		22	Declining	
Choctawhatchee / *Upper Choc*	2016		43	Declining	
Choctawhatchee / *Lower Choc*	2020		108	Declining	

D. Tapered Pigtoe (*Fusconaia burkei*)

[1] Basin / *Subbasin*	[2] Last observation	[3] Evidence of recruitment	[4] # of live observed	[5] Population trend	Notes
Choctawhatchee / *Pea*	2017		355	Declining	Most individuals (N=285) found during a long-term study in Eightmile Creek.
Choctawhatchee / *Upper Choc*	2016		19	Declining	Known only from an isolated population in the West Fork Choctawhatchee River system.
Choctawhatchee / *Lower Choc*	2020	Yes	705	No change	

E. Narrow Pigtoe (*Fusconaia escambia*)

[1] **Basin / *Subbasin***	[2] **Last observation**	[3] **Evidence of recruitment**	[4] **# of live observed**	[5] **Population trend**	**Notes**
Escambia / *Upper Conecuh*	2019	Yes	4,115	Declining	Almost all observations resulted from intensive salvage efforts while reservoirs were drawdown.
Escambia / *Patsaliga*	2012		2	Declining	
Escambia / *Sepulga*	2011		1	Declining	
Escambia / *Lower Conecuh*	2015		93	No change	
Escambia / *Escambia*	2019		920	Declining	Relatively abundant in the lower Escambia River but extirpated around the state line.
Yellow / *Yellow*	2019		49	Declining	

F. Southern Sandshell (*Hamiota australis*)

[1] **Basin / *Subbasin***	[2] **Last observation**	[3] **Evidence of recruitment**	[4] **# of live observed**	[5] **Population trend**	**Notes**
Escambia / *Upper Conecuh*	1996			[Historical]	
Escambia / *Patsaliga*	1995			[Historical]	
Escambia / *Sepulga*	1915			[Historical]	
Escambia / *Lower Conecuh*	2013		20	No change	
Yellow / *Yellow*	2021		135	No change	
Choctawhatchee / *Pea*	2018		180	No change	
Choctawhatchee / *Upper Choc*	2012		60	Declining	
Choctawhatchee / *Lower Choc*	2020	Yes	450	No change	

G. Fuzzy Pigtoe (*Pleurobema strodeanum*)

[1] **Basin / *Subbasin***	[2] **Last observation**	[3] **Evidence of recruitment**	[4] **# live observed**	[5] **Population trend**	**Notes**
Escambia / *Upper Conecuh*	2016		6	Declining	
Escambia / *Patsaliga*	2004		3	Declining	
Escambia / *Sepulga*	2011		1	Declining	Nearly extirpated in subbasin.
Escambia / *Lower Conecuh*	2013		37	No change	
Escambia / *Escambia*	2020		147	No change	
Yellow / *Yellow*	2020		3	Declining	
Choctawhatchee / *Pea*	2018	Yes	935	Increasing	Species may be increasing in a few reaches with stable habitat and good water quality.
Choctawhatchee / *Upper Choc*	2017		231	No change	
Choctawhatchee / *Lower Choc*	2020		180	No change	

[1] **Basin / Subbasin:** Basin (HUC 6) in bold / subbasin (HUC 8) in italics.
[2] **Last observation:** Year a live or fresh dead specimen was last observed.
[3] **Evidence of recruitment:** Sub-adult (≤ 3 years) individuals were observed during current period (2000-2021).
[4] **# live observed:** Provided to give an indication of abundance, however, survey effort and methods must be taken in account. NR=not recorded.
[5] **Current population trend:** Trends are a comparison of “historical” and “current” abundance and distribution. Trends were determined by professional opinion and other gathered information, and do not necessarily represent statistically significant analyses.
Increasing: Evidence that the numbers of individuals have been on an increasing trend over the past 20 years or more.
No change: Evidence that the numbers of individuals have remained relatively stable over the past 20 years.
Declining: Evidence that the numbers of individuals have been on a decreasing trend over the past 20 years or more.
Unknown: Insufficient evidence to estimate trend.