Suwannee Moccasinshell
(*Medionidus walkeri*)

Status Review:
Summary and Evaluation

Suwannee Moccasinshell from the Santa Fe River, FL.
Credit: M.M. Gangloff, Appalachian State University.

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

September 2022

STATUS REVIEW
Suwannee Moccasinshell (*Medionidus walkeri*)

GENERAL INFORMATION

Current Classification: Threatened

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.

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Cooperating Field Office: Georgia Ecological Services Office, Sandy Abbott.

Date of original listing: October 6, 2016 (81 FR 69417).

Critical Habitat rule: August 2, 2021 (86 FR 34979).

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 Suwannee Moccasinshell to inform this status review.

We announced initiation of this review in the Federal Register on July 14, 2021 (86 FR 37178) with a 60-day comment period. Two public comments were received. One comment provided 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. Another comment expressed concern for the species and the general threats of climate change and pollution to plants and animals; no specific data or information was supplied with the comment.

The primary sources of information used in this analysis were the 2015 proposed listing rule (80 FR 60335), 2016 final listing rule (81 FR 69417), 2021 critical habitat rule (86 FR 34979), 2016 Recovery Outline, peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communication with recognized experts. This review was completed by Sandra Pursifull, Ecologist with the FLESFO, Panama City Office. 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 the Suwannee Moccasinshell.

FR Notice citation announcing the species is under active review:
July 14, 2021 (86 FR 37178)

Species' Recovery Priority Number at start of 5-year review (48 FR 43098):
Recovery Priority Number: 11

Review History:
A Recovery Outline was developed for the species where the species' recovery priority numbers were set (Service 2016b).

This is the first 5-year status review for this species.

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature
The entity listed as Suwannee Moccasinshell remains valid and we are not aware of any changes to its taxonomy. Its current taxonomy and nomenclature is consistent with and follows 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
At the time of this review, recovery criteria for this species have not been finalized.

Biology and Habitat Summary

A detailed review of the species' biology and habitat information can be found in the final listing rule (Service 2016a).

The Suwannee Moccasinshell (*Medionidus walkeri*) is a small freshwater mussel endemic to the Suwannee River basin in southeast Georgia and north-central Florida (Fig. 1). Its historical range is restricted to the mainstem of the Suwannee River and its two largest tributaries—the Santa Fe River subbasin and the lower portion of the Withlacoochee River (Johnson et al. 2016). The Suwannee River basin has unique hydrology in that it transitions from a tributary fed system to a karst, spring-fed system downstream of the Cody Scarp in Florida, where 90% of the flow of the lower Suwannee River is from spring and groundwater sources (Grubbs and Crandall 2007). The Santa Fe River runs underground for about 5 kilometers (3.1 miles) but is intermittently connected during high flow events. The species historically occurred in the upper Santa Fe subbasin (upstream of the subterranean section), but presently is known only known in the lower Santa Fe mainstem.

The Suwannee Moccasinshell is associated with substrates of muddy sand or sand with some gravel where it typically occurs near bank margins with a moderate slope, and in areas with

moderate flow and slightly depositional conditions (Williams et al. 2014, Service 2015). A recent study provided important information on its habitat requirements and the influence of survey effort on detection of the mussel. Using survey data collected during 2013–2016 at 220 locations, researchers found that detection of the species is strongly and positively correlated to survey effort, and that sites with cumulative spring discharge greater than 28 cubic meters per second were the most likely to support Suwannee Moccasinshell populations (Holcomb et al. 2018). Occupancy declined in the lower-most reaches of the Suwannee mainstem despite high spring discharge, likely from increased tidal influences and changes in physical and chemical habitat conditions. The findings suggest that springs are a critical resource for the Suwannee Moccasinshell and its darter hosts (e.g., *Etheostoma* and *Percina* species; Johnson et al. 2016), as they might buffer tannic surface waters and maintain adequate flow and temperature during periods of drought (Holcomb et al. 2018; J.D. Williams 2022, pers. comm.).

Distribution and abundance summary

We lack genetic data to determine the population structure for the Suwannee Moccasinshell. All remaining individuals occur within a contiguous stream system between which genetic exchange could occur, and because of that we currently consider the species to consist of one population.

A review of current (2005–2021) and historical (pre–2005) collection records show the species has declined in the periphery of its range, and it is extirpated in the Withlacoochee River, upper Santa Fe subbasin (upstream of the subterranean section), and lower Suwannee River (generally downstream of Fanning Springs) (Fig. 1). Its range has not changed since being listed in 2016. Detection of the species has likely increased in recent years as a result of greater survey effort, the use of snorkeling equipment, and a better understanding of its habitat requirement rather than any perceived increase in abundance or distribution (J.D. Williams, pers. comm. 2022). Even with increased detections, targeted surveys by the Florida Fish and Wildlife Conservation Commission (FWC) during 2015–2020 show its numbers are very low. The agency conducted 75 surveys throughout its historical range; a total of 85 person hours resulted in the detection of 16 live individuals at 9 locations in two subbasins in the Suwannee River watershed (FWC unpubl. data provided 9/13/2021). Suwannee Moccasinshell current occurrences are discussed below by HUC 8 subbasin and summarized in Table 1.

Santa Fe subbasin – The species currently occurs in a 36-kilometer (22-mile) reach of the lower Santa Fe River channel, where two live individuals and seven shells have been observed since 2005. Since being listed, surveyors conducted 32 unique sampling events throughout its range during 2016–2020 but did not detect the species. The Suwannee Moccasinshell was last observed upstream of the subterranean section in 1996 and is either below detectable levels or extirpated in this reach (Johnson et al. 2016). Its numbers are declining in the Santa Fe River, where it was lasted detected in 2015 and the species appears nearly extirpated in the subbasin. Its decline is attributed to decreases in stream flow and changes in water quality, especially increased nitrogen loads and algae growth (Service 2021).

Lower Suwannee subbasin – The species currently occurs in a 124-kilometer (77-mile) reach of the middle Suwannee River, where 88 live individuals and 11 shells have been detected since 2005. Observations of multiple age classes and gravid females indicate the species is recruiting (FWC unpubl. data provided 9/13/2021). One relic shell found in 2015 extended its known range

in the lower mainstem downstream by about 11.5-kilometers (7-mile); however, the species appears extirpated in the lower-most reach of the Suwannee River, generally downstream of Fanning Springs. Its extirpation in this reach is attributed to changes to water chemistry and habitat conditions as a result of flow declines and salt water encroachment (discussed in the threats summary below).

Table 1. Summary of current (2005-2021) Suwannee Moccasinshell occurrences by HUC 8 subbasin. No change indicates relatively stable numbers since 2005 and declining indicates decreasing numbers since 2005

Subbasin	Last live observation	Evidence of recruitment[1]	Live individuals (shells)	Estimated Trend	Notes
Withlacoochee 03110203	1969	No	0	[Historical]	No current collections.
Lower Suwannee 03110205	2021	Yes	88 (11)	No change	Extirpated in the lower-most reach of Suwannee mainstem.
Santa Fe 03110206	2015	No	2 (7)	Declining	Species appears nearly extirpated in the subbasin.

[1] **Evidence of recruitment**: Sub-adult (≤ 3 years) individuals were observed during current (2005–2021) period.
[2] **Estimated trend:** Trends are a comparison of "historical" and "current" abundance. Trends were determined by professional opinion and other gathered information, and do not necessarily represent statistically significant analyses.

Threats (Five-Factor Analysis) Summary

The status of a species is determined from an assessment of factors specified in section 4 (a)(1) of the Act, including: Factor A: the present or threatened destruction, modification, or curtailment of its habitat or range; Factor B: overutilization for commercial, recreational, scientific, or educational purposes; Factor C: disease or predation; Factor D: the inadequacy of existing regulatory mechanisms; and Factor E: other natural or manmade factors affecting its continued existence.

The Suwannee Moccasinshell was listed due to factors including habitat destruction and pollution (Factor A), inadequate regulation of point source discharges (Factor D), introduction of invasive species (Factor E), climate change (Factor E), and small population size and reduced distribution (Factor E). These factors all continue to pose a threat to the species. A detailed evaluation of the factors affecting the Suwannee Moccasinshell can be found in the 2016 listing rule (Service 2016a) and 2021 critical habitat designation (Service 2021). A summary of current threats is also detailed below.

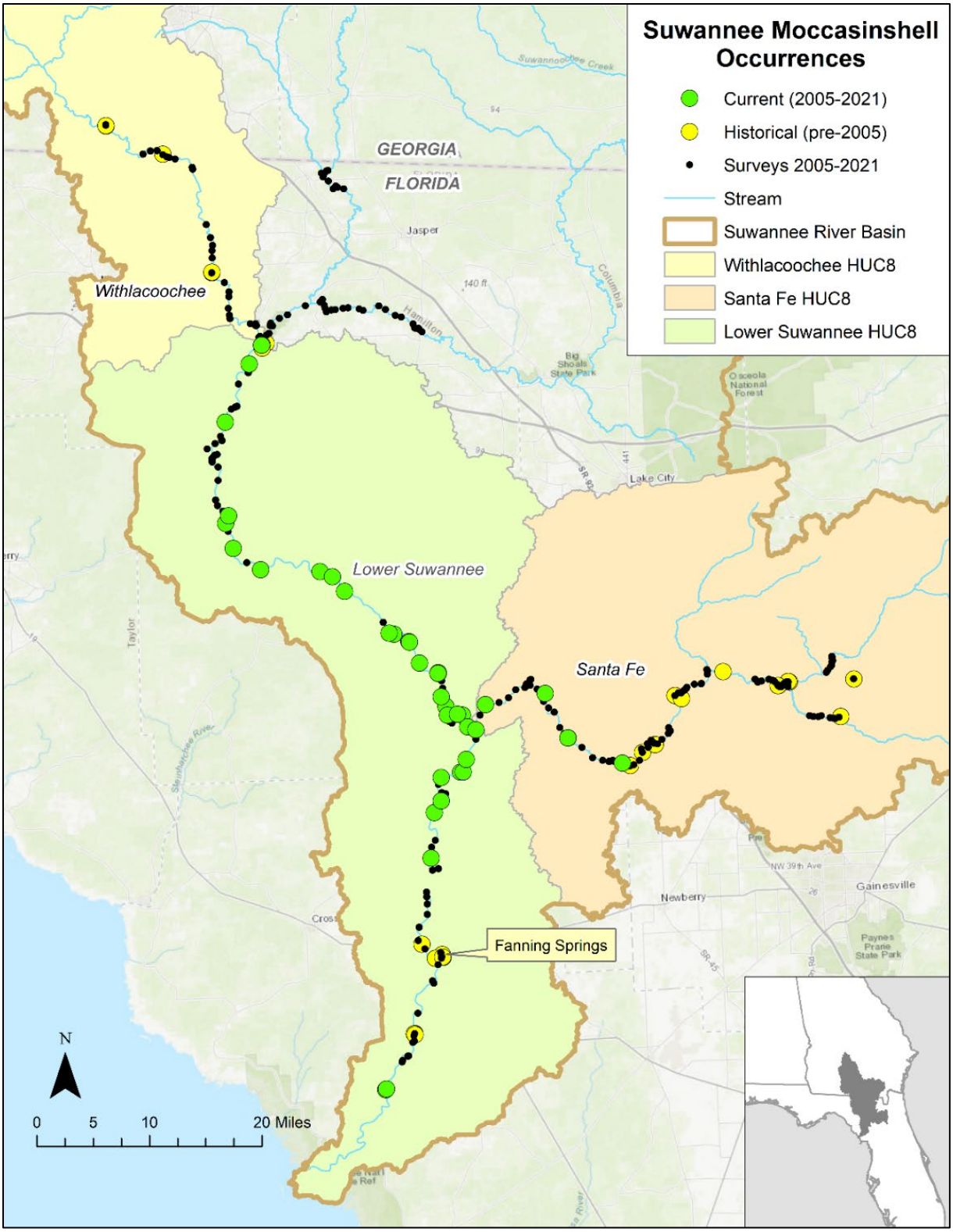

Figure 1. Suwannee Moccasinshell current (2005–2021) and historical (pre–2005) occurrences and all locations sampled during the current period. Note: the lower-most occurrence in the Suwannee River is one relic shell collected in 2015 and considered a historical occurrence.

The primary threat to the species continues to be the degradation of its stream habitats caused by pollutants in runoff from agricultural lands and in wastewater discharged from industrial and municipal sources and mining operations, decreased flows due to groundwater extraction and drought, habitat instability and disturbance, and excessive sedimentation (**Factor A**). Recent information shows that groundwater and surface water withdrawals for domestic, industrial, and agricultural uses and nitrates from fertilizers have increased in recent years and are presently major drivers limiting the species' viability (Thom et al. 2015, Florida Springs Institute [FSI] 2021). Groundwater discharge via springs is critical to maintaining flows and water quality needed by the species and its fish hosts, especially during drought (Holcomb et al. 2018; J.D. Williams 2022, pers. comm.). Decreases in stream flow, nutrient enrichment, and excessive algae growth are recognized problems within the Suwannee and Santa Fe Rivers in Florida that have been attributed primarily to intense agricultural land uses including row crops, silviculture, and livestock and to urban land uses (SRWMD 2017, FSI 2021). These threats are more severe in the Santa Fe River, where spring flows have declined on average by 20 percent compared to the earliest base flow records, and nitrate-nitrogen concentrations have increased by an average of 2,600 percent over the past 70 years of record (FSI 2021). Water use for agriculture is projected to increase by approximately 40 percent by 2040 in the Suwannee basin (SRWMD 2017). Therefore, threats associated with habitat degradation and loss remain ongoing and occur throughout the species' range but are more severe in the Santa Fe River. We expect these threats to continue in the future.

We have no evidence that overutilization for commercial, recreational, scientific, or educational purposes (**Factor B**) or disease and predation (**Factor C**) are currently threats to the Suwannee Moccasinshell.

Inadequate regulation of point source discharges (**Factor D**) continues as a threat to the Suwannee Moccasinshell (Service 2016a). We have identified the inadequate regulation of pollutant loads and minimum flow levels as new threats to the species. New information indicates that decreases in stream flow and nitrogen enrichment are harming aquatic communities in the basin despite regulatory limits on maximum nutrient (NO3) loads and minimum flow levels (MFLs) imposed by the State of Florida (FSI 2021). Documented flow regimes for the Santa Fe River have consistently remained below the reduced flows allowed by the 2007 and 2015 MFLs and harmful limits on nitrates are exceeded, and even if met, the current criteria may be not adequate to protect sensitive aquatic species (FSI 2021). Moreover, the State of Florida continues to issue new water use permits authorizing groundwater extractions from springs supplying flows to the Santa Fe River (FSI 2021). Therefore, the species is not adequately protected by existing regulatory mechanisms throughout its range.

Recent projections on climate change associated impacts (**Factor E**) within the southeastern United States suggest hotter and drier conditions with a greater frequency of extreme precipitation events (Carter et al. 2018, LaFontaine et al. 2019). Within the Suwannee River basin, average July air temperature is projected to increase approximately 4.1 °F (2.3 °C) by 2050 and 5.8 °F (3.2 °C) by 2075 above historical (1981–2010) levels (Alder and Hostetler 2013, accessed 10 Aug 2022). Such increases potentially exceed the thermal tolerance range of sensitive aquatic species like the Suwanee Moccasinshell and its darter hosts (Pandolfo et al. 2012, Payton et al. 2016). Changes to annual and seasonal streamflow in watersheds of the Gulf Coast due to a warmer and wetter climate are also predicted (Neupane et al. 2018). Hydrologic

changes within the Suwannee basin include decreases in mean annual streamflow (13% decrease) and substantially lower summer stream flows (up to 25% decrease) by 2080 (Neupane et al. 2018). The freshwater riverine wetlands in the lower Suwannee River are vulnerable to saltwater intrusion during periods of decreased discharge and in conjunction with sea level rise (Guerra-Chanis et al. 2022). The rate of sea level rise has accelerated over the last few decades. Mid-range scenarios for the eastern Gulf of Mexico near Cedar Key, Florida, predict sea levels will rise 1.4 feet by 2060 (National Oceanic and Atmospheric Administration [NOAA] 2022). However, these sea water elevations will be reached well before then during extreme high tide and storm surge events. The possibility of increases in temperature and severe droughts and flooding pose significant threats throughout its range and saltwater intrusion to individuals remaining in the lower Suwannee River.

Other manmade or natural threats (**Factor E**) to the Suwannee Moccasinshell include competition from introduced *Corbicula fluminea* (Asian clam), which 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). Because of the species' small and declining population size, range, and the linear nature of the populations increase the species' vulnerability to certain threats (e.g. habitat deterioration, major spills, introduced species) (Soulé 1980, Primack 2008, Haag 2012). Therefore, natural and manmade threats remain severe and on-going throughout the species' range. We expect these threats to continue in the future.

Synthesis

The Suwannee Moccasinshell is a small freshwater mussel presently found only in the Suwannee River and in a short reach of the lower Santa Fe River in Florida. Since being listed as threatened in 2016, the species' distribution remains limited to approximately 160-kilometers (99-miles) of stream channel where fewer than ten live individuals have been observed. The decline of individuals in the lower Santa Fe River continues to be concerning for the species. The threats of reduced flows, pollution, channel instability, direct habitat disturbance, and competition from invasive *Corbicula* continue throughout its range. Groundwater and surface water withdrawals and nitrate levels have increased in recent years, and reduced flows and nutrient pollution are presently major drivers limiting the species' viability. Saltwater intrusion is an imminent threat to individuals remaining in the lower-most reach of the Suwannee mainstem. According to future modeling, temperature and extreme weather events are expected to increase. Collectively, these threats are impacting the species' future viability, and there is a real possibility of further range contraction and reduction in numbers. Because of ongoing threats and the current condition of the species, the Suwannee Moccasinshell continues to meet the definition of a threatened species.

RECOMMENDED FUTURE ACTIVITIES

This species does 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) Use regulatory means and advocacy to initiate actions that protect aquatic resources in the Suwanee River basin, including but not limited to:

- minimizing ground and surface water withdrawals or other actions that alter stream hydrology;
- improving ground water recharge or preventing action that would decrease groundwater recharge, such as large changes in land use;
- reducing the use of fertilizers and pesticides, especially in spring recharge areas and near stream channels;
- improving treatment of wastewater discharged from permitted facilities and the operation of those facilities;
- implementing practices that protect or restore riparian buffer areas along stream corridors, avoid physical alternations to the stream channel and floodplain, and ensure continued connection between the two;
- prohibiting the removal of pre-cut submerged timber (deadhead logs); and
- establishing and enforcing restrictions on boat speed and length, especially in the lower Santa Fe River.

b) Develop captive propagation and reintroduction plan for the Suwannee River basin in cooperation with State partners.

c) Initiate actions to restore stream connectivity and increase in-stream habitat. Actions include, but are not limited to, an assessment of all road crossings and replacing those that present a barrier to transit by aquatic organisms, bank stabilization, and riparian buffer maintenance or augmentation.

d) Develop programs and outreach materials to increase public awareness of the species and explain the benefits of protecting stream ecosystems, including through the use of conservation easements.

Monitoring and Research Activities

e) Determine life history, reproductive biology, fecundity, sizes and viabilities of extant populations, and microhabitat requirements, as well as sensitivity to silt, excessive nutrients, and pollutants. All partners should be aware of research efforts and results to facilitate the immediate application of results.

f) Conduct genetic analysis to determine adaptive capacity, evaluate species boundaries, and population genetic structure, and establish genetic management plans.

g) Determine flow requirements for each life-stage.

h) Use eDNA as a detection tool to provide up-to-date distributional information. Use assays to confirm presence in historical reaches and detect previously unknown populations.

i) Conduct status surveys in the Withlacoochee River in Florida and Georgia and lower Santa Fe River in Florida and document habitat conditions.

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

k) Conduct long-term monitoring studies to obtain demographic data, including population estimates, population growth rates, recruitment levels, age-specific survival, and monitor changes through time.

l) Examine the population status of host fishes (e.g., *Percina* spp. and *Etheostoma* spp.) and identify factors potentially inhibiting host-mussel interactions.

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

n) Establish and maintain long-term salinity monitoring stations in the lower Suwannee River to better evaluate seasonal changes and impacts related to storm events, droughts, flooding, sea-level rise, and freshwater withdrawals.

o) Model future precipitation, temperature, and flow scenarios in the Suwannee River basin to examine the impacts of climate change and consumptive uses.

p) Model predicted climate related impacts of concern, including saltwater intrusion into freshwater wetlands in the lower Suwannee River system as a result of multiple factors including sea-level rise, altered hydrologic regimes, and increased water withdrawals.

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APPROVAL / SIGNATURES

U.S. Fish and Wildlife Service
Status Review of Suwannee Moccasinshell (*Medionidus walkeri*)

Status Recommendation:

On the basis of this review, we recommend the following status for this 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

FIELD OFFICE APPROVAL

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

Approve LOURDES MENA Digitally signed by LOURDES MENA Date: 2022.09.14 07:02:07 -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: 2022.09.14 10:56:03 -04'00'