Orangefoot Pimpleback (Pearlymussel)

(Plethobasus cooperianus)

Status Review:

Summary and Evaluation

Collection of the Illinois State Museum, photographed by Karen Little

U.S. Fish and Wildlife Service
Southeast Region
Kentucky Ecological Services Field Office
Frankfort, Kentucky

December 2022

STATUS REVIEW

Orangefoot Pimpleback (pearlymussel) (*Plethobasus cooperianus*)

GENERAL INFORMATION

Current Classification: Endangered

Lead Field Office: Kentucky Ecological Services Field Office, Taylor Fagin (502) 330-6616

Review Authors: Taylor Fagin, Kentucky Ecological Services Field Office; Shelby Bauer and Mary Lou Hoffacker, University of Georgia; and Miracle Stanford, Georgia Gwinnett College

Reviewers:

Lead Regional Office: Atlanta Regional Office, Carrie Straight (404) 679-7226.

Cooperating Field Office(s):

Tennessee Ecological Services Field Office, Andy Ford (931) 319-7747

Date of original listing: June 14, 1976 (41 FR 24062)

Experimental population designation: Establishment of Non-essential Experimental Population Status for 15 Freshwater Mussels, 1 Freshwater Snail, and 5 Fishes in the Lower French Broad River and in the Lower Holston River, Tennessee: September 13, 2007 (72 FR 52434)

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. The U.S. Fish and Wildlife Service (Service) and other authors evaluated the biology, habitat, and threats of the orangefoot pimpleback to inform this status review.

The Service published an announcement in the Federal Register requesting information on this species on May 13, 2022 (87 FR 29364), and a 60-day comment period was opened and we received one public comment. The National Council for Air and Stream Improvement (NCASI) provided information regarding the use and effectiveness of forestry best management practices and their importance in protecting aquatic species and stream habitats in the United States. We have noted best management practices in the review. The primary sources of information used in this analysis were the 2018 5-Year Review, the 1984 recovery plan, peer-reviewed reports, agency reports, unpublished survey data and reports, and personal communications with recognized experts.

FR Notice citation announcing the species is under active review:
May 13, 2022 (87 FR 29364)

Species' Recovery Priority Number at start of 5-year review (48 FR 43098):
The orangefoot pimpleback has a recovery priority number of 5, indicating a high degree of threat, a low recovery potential, and species level taxonomy.

Review History:

- Final Recovery Plan - September 30, 1984 (Service 1984)
- Five Year Review: November 6, 1991. In this review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors as they pertained to each species' recovery. No changes were proposed for the status of the orangefoot pimpleback in this review.
- Five Year Review – 2018 (Service 2018). No change in status was recommended for the orangefoot pimpleback.

REVIEW ANALYSIS

Listed Entity

Taxonomy and nomenclature: The orangefoot pimpleback is still considered a valid species and accepted taxonomy remains consistent with the Integrated Taxonomic Information System (2022), the Freshwater Mollusk Conservation Society bivalve list (2021), and Williams *et al.* 2017.

Distinct Population Segment (DPS)
The DPS policy is not applicable to the orangefoot pimpleback because it is not a vertebrate species.

Recovery Criteria

Recovery Plan or Outline:
Recovery Plan for the Orange-footed Pearly Mussel (*Plethobasus cooperianus*), August 30, 1984.

Recovery plans are not regulatory documents and intended to provide guidance to the Service, States, and other partners on methods of minimizing threats to listed species and on criteria that may be used to determine when recovery is achieved. If the recovery criteria defined in the plan are still valid, meeting recovery criteria can indicate that the species no longer requires protections under the Act. However, when recommending whether a listed species should be delisted, the Service must apply the factors in section 4(a) of the Act (84 FR 45020).

Delisting Criteria
The recovery plan states that the orangefoot pimpleback will be considered for removal from Endangered Species Act protection when the likelihood of the species becoming threatened in the foreseeable future has been eliminated due to achieving the following criteria:

1. A viable population of *P. cooperianus* exists in the Tennessee, Cumberland, and Ohio Rivers. These populations are dispersed throughout each river so that it is unlikely that any one event would cause the total loss of either population.
2. Through reestablishment and/or by discoveries of new populations, viable populations exist in two additional rivers. Each of these rivers will contain a viable population that is distributed such that a single event would be unlikely to eliminate *P. cooperianus* from the river system. For reestablished populations, surveys must show that three year-classes including one year-class 10 years old or older have been naturally produced within the river system.
3. The species and its habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.
4. Noticeable improvements in siltation problems and substrate quality have occurred.

These delisting criteria have not been met.

Biology and Habitat Summary

The orangefoot pimpleback is thought to be a typical, long-lived unionid mussel historically distributed throughout the Ohio, Cumberland, and Tennessee River drainages. When the recovery plan was completed, the species was known to occur in the Tennessee, Cumberland, and lower Ohio rivers (Service 1984). The species is currently considered extirpated in the lower Ohio River in southern Illinois (upstream of the Tennessee River confluence) and the Tennessee River in Alabama. It inhabits silt-free sand or gravel in clean, fast flowing stretches of large rivers. Additional details of the species' life history and habitat needs can be found in the Recovery Plan and the most recent 5-year review (Service 2018).

Due to the rarity of the species, little is known about the abundance, population trends, or the demographics of the orangefoot pimpleback. The species is difficult to detect because, like other freshwater mussels, it can burrow into bottom substrates and spend long periods buried below the surface, making it challenging to obtain information about this species' abundance and distribution. This species also has a low rate of detection during targeted surveys. For example, in a 2008 survey at Tennessee River Mile 160.7, only 1 orangefoot pimpleback was collected out of 11,090 native mussels (17 species) (Service 2018).

The size of each population currently cannot be estimated. This species is located in deeper habitats compared to other mussels, making it difficult to detect and making surveys more expensive. Extant populations and potentially occupied reaches of orangefoot pimpleback are located within the following stream systems:

Ohio River – a 34-mile reach downstream of the mouth of the Tennessee River.

Tennessee River – a mainstem reach of approximately 45 miles in Tennessee downstream of Pickwick Landing Dam and largely upstream of Kentucky Lake. This population is considered to be isolated from the population downstream of Kentucky Lock and Dam because of Kentucky Dam, a likely barrier to fish host dispersal.

Tennessee River – 22-mile riverine reach downstream of Kentucky Lock and Dam. The species in this section of the Tennessee River is considered part of the Ohio River population because of its proximity to the Ohio River and a lack of recognized barriers between the two reaches (Service 2018)

Tennessee River- 35-mile reach downstream of Chickamauga Lock and Dam and upstream of Nickajack Lake. This population was last documented by a single individual in 2004 (Lewis 2004).

Cumberland River – The orangefoot pimpleback was last documented (1 individual) in the Cumberland River during a 2011-2012 survey (34 sites) by the Tennessee Wildlife Resources Agency (Hubbs 2017).

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; Factor E: other natural or manmade factors affecting its continued existence. All of the threats described in the most recent (2018) 5-year review still affect the species and have not changed in intensity. A detailed summary of the relationship between threats and species concerns is described in the recovery plan and previous 5-year reviews (Service 1984 and 2018, respectively). A summary of this assessment is detailed below.

Threats to this unionid mussel stem from a range-wide history of dredging, damming, and adjacent land development that have fragmented and degraded this species' habitat (Factor A). The Service expects the range-wide and population-level effects of this regional history to persist into the future without restoration or management interventions. The introduction of inorganic sediments into the ecosystem from land use changes and increased sedimentation of waterways leads to increases in stream turbidity, reduces light penetration, smothers benthic substrates, and affects mussels physically through shell abrasion. All of these negative effects can irritate, clog, or damage the gills or feeding structure of the orangefoot pimpleback, which can also inhibit the species' ability to feed.

Overutilization (Factor B) is not currently considered a threat to the species. This species has a number of potential predators (Factor C), including muskrats, raccoons, otters, molluscivorous fishes, and some invertebrates, which could reduce abundance of local populations; however, predation by these species is a natural part of the species' life history and has been occurring for thousands of years. Since the 1970s, episodic mass mortality events of freshwater mussels have been documented around the world (Richard et al. 2020). Since 2016, massive mortality events in the Clinch River (Tennessee) have caused a precipitous decline in a once common mussel species (Richard *et al*. 2020). Disease (Factor C) appears to be a threat to mussel communities in the Southeastern United States and could potentially become a threat to the orangefoot pimpleback in the future.

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. Since passage in the 1970s, these regulations have helped reduce the adverse effects of point source discharges, yet they are difficult to implement and regulate. Some basin streams continue to be degraded by permitted wastewater discharges. 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 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). Additionally, nonpoint source pollutants such as silt, nutrients, and other contaminants are likely not to be sufficiently regulated. These concerns suggest that existing regulatory mechanisms are not adequate to eliminate threats to the orangefoot pimpleback (Factor D); however, appropriate best management practices that are properly implemented can be effective in protecting water quality and instream habitats, which can moderate these threats in some instances.

Climate models forecast more extreme climate and precipitation events in the southeastern U.S. (Carter et al. 2018, LaFontaine et al. 2019). The impacts on the species from climate change is unclear at this time, but could result in changes in water quality, quantity, and timing that could impact the mussels themselves or their host species. Generally, temperatures within the species' range have been increasing but at less than the national average with an increase of 0.5°F since 1900 (Runkle et al. 2022). Additionally, thirty-three major disasters have been declared in Tennessee alone in the last two decades from extreme weather events (Runkle et al. 2022). Extreme weather events involving flooding have the potential to increase sedimentation and organic inputs, negatively impacting mussel habitats.

The nonnative zebra mussel (*Dreissena polymorpha*) may represent a major threat to the orangefoot pimpleback. The population of this invasive species has increased over the last four decades. Zebra mussels were introduced in the Tennessee River system in the early 1990's and continue to pose a significant threat to the orangefoot pimpleback mussel (Service, 2018). Zebra mussel densities have increased and could eliminate or reduce the number of new locations where the species could be established, which complicates any possible recovery actions (Service, 2018). There is a potential that climate change (discussed above) could affect the distribution and habitat suitability of zebra mussels (Petsch et al. 2021).

Recent studies suggest that invasive *Corbicula fluminea* (Asian clam) may be an "important but overlooked factor in widespread native mussel declines" (Haag and Stoeckel 2021). In high densities, *Corbicula* can remove substantial amounts of seston (suspended particles) from the water column, reducing food sources and negatively affecting mussel growth (Ferreira-Rodríguez et al. 2018, Haag and Stoeckel 2021). However, it is unclear if this species has had an adverse effect on the orangefoot pimpleback.

Generally, the limited number of remaining orangefoot pimpleback mussels and limited apparent recruitment has put this species at risk of extirpation. The existing populations are in linear reaches of water which could contribute significantly to the risk of extinction. Smaller populations have less of a buffer against threats than larger populations, and the organgefoot pimpleback's linear distribution increases its susceptibility to single catastrophic events that can eliminate whole populations. Barriers (*i.e.*, dams) also restrict movement of host fishes, preventing any recolonization and impacting genetic exchange and maintenance of genetic diversity. 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, 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 over long periods of time (Haag 2012).

Synthesis

The orangefoot pimpleback is a mussel native to large rivers in sand and gravel substrates. The Service is aware of three remaining populations or potentially occupied reaches: the Tennessee River, Ohio River, and Cumberland River. These populations are unlikely to experience genetic exchange or survive a catastrophic event. The species is extremely rare compared to other native mussels, even where it is found. This may put the species at risk from limiting genetic exchange and a subsequent decrease in fitness, and it may also impact recruitment because of limitations in proximity of reproductive adults. The species is still at risk of water quality impacts, dredging, damming, and adjacent land development that have fragmented and degraded the species' habitat. In addition, invasive species and climate change also may affect the species. Existing regulatory mechanisms are not adequate to eliminate these threats; therefore, we recommend the orange-foot pimpleback remain listed as endangered.

RECOMMENDED FUTURE ACTIVITIES

A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1984). In the course of this status review, potential recovery activities were identified and are included below.

Recovery Activities

Because of the limited number of orangefoot pimpleback individuals, current recovery activities should continue to focus on methodologies and planning for potential reintroductions. Between 2013-2022, a total of 55 orangefoot pimpleback individuals have been placed within a grid formation in the Tennessee River and are to be used as a source stock for propagation efforts. Given the low abundance of the species throughout its range, the close proximity of males and females within the grid allow for natural fertilization. In 2016, Dr. Monte McGregor, a malacologist with the Kentucky Department of Fish and Wildlife Resources (KDFWR), successfully used in-vitro metamorphosis to transform 5,000 larvae into juveniles. However, subsequent culturing and rearing were not successful. In 2022, a check for gravid orangefoot pimplebacks in the grid was conducted resulting in the retrieval of 32 individuals. Upon investigation by KDFWR personnel, six female orangefoot pimplebacks were found to be gravid and subsequently transported to a holding station located on Lake Cumberland, Kentucky. Dr. McGregor and other KDFWR personnel will use these individuals for propagation activities in upcoming years.

Monitoring / Research Activities

- Conduct research on how zebra mussels are possibly outcompeting the orangefoot pimpleback populations for food and other resources.
- Conduct research on how orangefoot pimpleback responds to warming water temperatures caused by climate change.
- Conduct annual surveys to determine if conservation efforts are working.
- Collaborate with partners to fill research gaps related to the species biology and life history to support understanding of species resiliency, representation, and redundancy, including:
    - Age and growth analyses to estimate the longevity of the species.
    - Identification of the fish host for the species
    - Development of methods for propagation and culture of juveniles.
    - Identification of additional threats and stressors within each river ecosystem where orangefoot pimpleback population occurs.
    - Improve understanding of the potential effects of climate change on the species.

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RESULTS/SIGNATURES

U.S. FISH AND WILDLIFE SERVICE
Status Review of Orangefoot Pimpleback

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 *(Indicate reasons for delisting per 50 CFR 424.11)*:
____ *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:

Field Supervisor, Kentucky Ecological Services Field Office, Fish and Wildlife Service

VIRGIL ANDREWS Digitally signed by VIRGIL ANDREWS
Date: 2023.01.30 16:09:22 -05'00'

Approve _____

** Since 2014, Southeast Region Field Supervisors have been delegated authority to approve 5-year reviews that do not recommend a status change.*