Rayed Bean
(*Villosa fabalis*)

Status Review:
Summary and Evaluation

Photo Credit: G. Thomas Watters, Ohio State University

U.S. Fish and Wildlife Service
Ohio Ecological Services Field Office
Columbus, Ohio
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STATUS REVIEW
Rayed bean (*Villosa fabalis*)

GENERAL INFORMATION

Species: Rayed bean

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Date of listing publication: February 14, 2012

FR citation(s): 77 FR 8632

Classification: Endangered

Critical habitat/4(d) rule/Experimental population designation/Similarity of appearance listing: None

Methodology used to complete the review: Public notice was given in the *Federal Register* (88 FR 2368) requesting new scientific or commercial data and information that may have a bearing on the rayed bean (*Villosa fabalis*) classification of endangered status. Pertinent data were obtained from the final listing rule (77 FR 8632), the species status assessment (SSA, USFWS 2022a), 2018 5-year review (USFWS 2018), recent reports of freshwater mussel surveys, and data submitted by U.S. Fish and Wildlife Service (Service) Field Offices and state and provincial natural resource agencies within the range of the species. This status review was completed by Angela Boyer, Fish and Wildlife Biologist with the Ohio Ecological Services Field Office.

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 evaluated the biology and status of the rayed bean to inform this status review.

A Service team developed the SSA (USFWS 2022a). The SSA represents our evaluation of the best available scientific information, including the resource needs and the current and future condition of the species. We developed two future scenarios of environmental and management conditions to discuss the viability of the species in the future. Independent peer reviewers and partner representatives reviewed the SSA before we used it as the scientific basis to support our status review.

FR Notice citation announcing the species is under active review: January 13, 2023, FR 88, No. 9

Species' Recovery Priority Number at start of 5-year review (48 FR 43098): 5. The "5" indicates a high degree of threat, low recovery potential, and a taxonomic classification as a species.

Review History: The first species 5-year review was completed in 2018 resulting in no recommended change in the species' listing status. An SSA was completed in 2022 to assist in the development of this 5-year review and an upcoming recovery plan and critical habitat designation.

REVIEW ANALYSIS

Recovery Criteria

Recovery Plan or Outline: A draft recovery plan is currently being developed.

Updated Information Relevant to the Current Species' Status

An SSA was completed for the rayed bean in May 2022 (USFWS 2022a). New information has been obtained since the completion of the SSA that documents one previously unknown extant population and two reintroduced populations into the species' historical range. Additionally, new data documents a range expansion in two populations.

Biology and Habitat: There is no new information on the species biology and habitat since the completion of the 2022 SSA.

Range and distribution:

The rayed bean was historically distributed in at least 115 streams, lakes, and some human-made canals in the Great Lakes (~26%), Ohio (~64%), and Tennessee River (~10%) systems in 10 states: Illinois, Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia; and Ontario, Canada. At the time of the previous 5-year review in 2018, the species was known to be extant in 34 streams and 1 lake in 7 states: Indiana, Michigan, New York, Ohio, Pennsylvania, Tennessee, and West Virginia; and Ontario, Canada.

Currently the rayed bean occurs in seven states, as well as the Canadian province of Ontario (Figure 1). For the 2022 SSA, we described and analyzed the distribution of the rayed bean in

terms of watersheds occupied, delineated by the U.S. Geological Survey (USGS) based on surface hydrological features. These hydrological areas are identified as hydrological units at various geographic scales (referred to as HUC). In the 2022 SSA, we used the HUC2 scale to delineate three representation units for the rayed bean: Great Lakes, Ohio, and Tennessee Basins. The species currently ranges across all three representation units.

In the SSA, we used the HUC8 at the subbasin scale to define a population of the rayed bean and conduct our current condition analysis. Defining a population at the HUC8 scale resulted in 19 extant populations range wide. New data obtained since the completion of the SSA documents that the species currently has 22 extant HUC8 populations, which includes a total of 37 occupied streams.

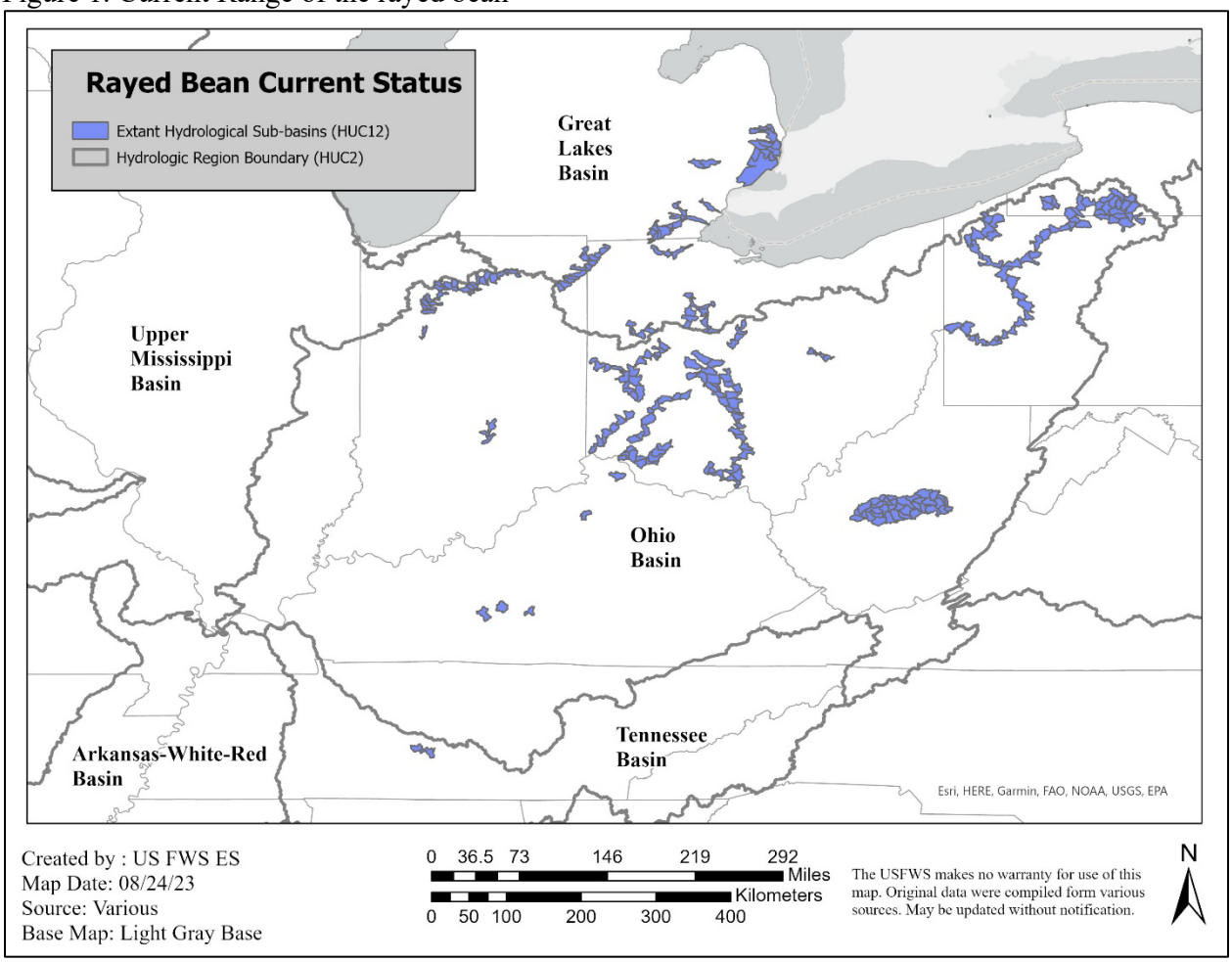
While the rayed bean SSA defined the populations of the species using HUC8 units for the purpose of analysis, the species current OneRange[1] has been developed at a more refined level, using HUC12 units rather than HUC8 units (Figure 1)

Four Ohio streams where the species was thought to be extant in the 2018 5-year review are now considered to be extirpated: the Walhonding River, Scioto Brush Creek, Little Miami River, and East Fork Little Miami River. The last time the rayed bean was documented in the Walhonding River was during a 1991-1993 survey effort that found one live individual and one fresh dead specimen (Hoggarth 1994). Numerous mussel surveys have occurred in the Walhonding River in the past three decades and there is no evidence that the species is still extant in the stream. The rayed bean was last documented in Scioto Brush Creek during a 1987 survey when two fresh dead specimens were found (Watters 1988). In 2021, a survey targeting the rayed bean was conducted and no evidence was found to indicate the species still occurs in the stream (ES 2023). The last records for the rayed bean in the Little Miami River and East Fork Little Miami River are from a system wide mussel survey conducted in 1990-1991 (Hoggarth 1992). During that survey, two fresh dead rayed bean were found in the Little Miami River and one live rayed bean, and three fresh dead specimens were found in the East Fork Little Miami River. There have been numerous mussel surveys in the Little Miami River and the East Fork Little Miami River in the past three decades, including another system wide survey in 2019-2020 (Hoggarth 2020). No evidence was found to indicate that the species is extant in the Little Miami River or East Fork Little Miami River.

Following the completion of the SSA, two live and one fresh dead rayed bean were found in 2022 in the Auglaize HUC8 unit in the Auglaize River in Ohio (Lawhon & Associates 2022). Prior to this discovery, the rayed bean was thought to be extirpated from the Auglaize HUC8 unit with the last record occurring in 1964. In 2022, one fresh dead rayed bean each was found in the Olentangy River and Little Darby Creek in Ohio, and one fresh dead rayed bean was found in Honeoyo Creek in Pennsylvania (Hoggarth 2022; Gable 2023, pers. comm.; Anderson 2022, pers. comm.). Prior to the 2022 observations, the rayed bean was thought to be extirpated from

[1] OneRange is the geographic area where we know or suspect that a species currently occurs modeled at a resolution unit for aquatic species using the line segment catchment polygons associated with the National Hydrography Dataset (NHD)-plus dataset from the United States Geological Survey.

Figure 1. Current Range of the rayed bean



the Olentangy River and Little Darby Creek in the Upper Scioto HUC8 unit in Ohio and Honeoyo Creek in the Upper Allegheny HUC8 unit in Pennsylvania.

In addition to the newly discovered Auglaize population and the expansion of the species' range in the Upper Scioto and Upper Allegheny HUC8 units, there are also two populations that were reintroduced into Kentucky in the Licking HUC8 unit in the Licking River and Upper Green HUC8 unit in the Green River.

Taxonomic and nomenclature: The rayed bean was federally listed under the scientific name *Villosa fabalis*. In 2018, a review of the genus *Villosa* resulted in the reclassification of the genus for rayed bean as *Paetulunio* (Watters 2018; FMCS 2021). At this time, the Service has not published a formal rulemaking adopting the new nomenclature as *Paetulunio fabalis* for the rayed bean and the species remains listed as *Villosa fabalis*.

Additional information:

Five-Factor Analysis

Factor A. Present or threatened destruction, modification or curtailment of its habitat or range: Current or potential future threats to rayed bean habitat include contaminants, inadequate hydrological regime, landscape alteration, lack of connectivity, and invasive species. These are the primary risk factors influencing the resources upon which the rayed bean relies, either directly or indirectly (USFWS 2022a).

Several projects have adversely affected some rayed bean populations since the last 5-year review. Two bridge projects that affected rayed bean occurred in the Allegheny River (NY) and one in Oswayo Creek (NY) (USFWS 2023; USFWS 2021). Take from these projects was from direct mortality, harassment during salvage and relocation, and temporary impacts to suitable habitat. Two other projects are currently planned for locations where rayed bean occur: a bridge project in the Auglaize River (OH) and a sanitary sewer pipe crossing in the Great Miami River (OH) (Lawhon & Associates 2022; BioSurvey Group 2022). Impacts on rayed bean are expected to be similar to the New York bridge projects.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes: Overutilization is not considered to be a threat to the rayed bean.

Factor C. Disease or predation:
We have no new information regarding disease or predation for the rayed bean since the last 5-year review and disease and predation are not considered to be significant threats to the species.

Factor D. Inadequacy of existing regulatory mechanisms:
Inconsistent enforcement of current Federal and state laws to prevent sediment entering waterways causes risk to the rayed bean. Best management practices for sediment and erosion control are often recommended or required by local ordinances for construction projects; however, compliance, monitoring, and enforcement of these recommendations are often poorly implemented. Furthermore, prior to listing, there were no requirements within the scope of Federal environmental laws to specifically consider the rayed bean during Federal activities, or to ensure that Federal projects would not jeopardize their continued existence.

Since the previous 5-year review, there have been at least three projects with the potential to impact rayed bean populations. Instream effects could not be avoided for those projects due to the nature of them requiring instream work. Through consultation with the local Service Field Offices, a portion of the effected rayed bean were relocated out of harm's way. One of these projects salvaged and relocated nearly 8,000 live rayed bean in the Allegheny River in New York (Anderson 2019, pers. comm.). This information indicates that were the species not listed, these projects would have had greater effects on the species, further demonstrating the inadequacy of existing non-ESA regulatory mechanisms.

Factor E. Other natural or manmade factors affecting its continued existence:
Invasive species are one of the primary risk factors influencing the species (USFWS 2022a). Various exotic species are well established within the range of the rayed bean. Exotic species,

including the zebra mussel (*Dreissena polymorpha*), Asian clam (*Corbicula fluminea*), round goby (*Neogobius melanostomus*), and black carp (*Mylopharyngodon piceus*), negatively impact the rayed bean, or its host fish, or both, through mechanisms such as habitat modification, competition, and predation.

We also consider climate change to pose a risk to the rayed bean. While stochastic events such as flooding, drought, and spills may occur randomly throughout the species' range, climate change directly or indirectly exacerbates these stressors in duration and severity, posing a greater threat of population declines.

We are not aware of any new threats from other natural or manmade factors since the last 5-year review.

Conservation Measures: In 2020, rayed bean were reintroduced into two streams where the species historically occurred. Rayed bean were collected in 2020 during a mussel salvage in the Allegheny River in Olean, New York in advance of a remediation project to remove spilled petroleum material in sediment (McGregor 2022, pers. comm.; EnviroScience 2022). A total of 5,646 adult rayed bean were transferred to the Kentucky Department of Fish and Wildlife and then released into to the Green River and Licking River in 2020.

Synthesis

The rayed bean is a federally listed endangered species that, at the time of the last 5-year review in 2018, was known from 34 streams and 1 lake in Indiana, Michigan, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Ontario, Canada. Four Ohio streams where the species was thought to be extant during the previous 5-Year Review are now considered to be extirpated: the Walhonding River, Scioto Brush Creek, Little Miami River, and East Fork Little Miami River. The last occurrence record of the rayed bean in each of these streams is from 30 or more years ago and recent surveys have failed to find any evidence that the species is still extant in them. In Ohio in 2022, live rayed bean were found in the Auglaize River and fresh dead rayed bean were found in the Olentangy River and Little Darby Creek (Lawhon & Associates 2022; Hoggarth 2022; Gable 2023, pers. comm). Prior to these 2022 records, the rayed bean was thought to be extirpated in these three Ohio streams. A fresh dead rayed bean was also found in in Pennsylvania in 2022 in Honeoyo Creek, a stream where the species had never before been documented (Anderson 2022, pers. comm.). In 2020, the rayed bean was reintroduced into Kentucky in the Licking and Green Rivers using adults collected from the Allegheny River in Pennsylvania (McGregor 2022, pers. comm.). Currently, the rayed bean is known to be extant in 37 streams and 1 lake in Indiana, Kentucky, Michigan, New York, Ohio, Pennsylvania, Tennessee, West Virginia, and Ontario, Canada.

The biology of the rayed bean is similar to other bivalve mollusks belonging to the family Unionidae. They are sexually dimorphic, though the age of sexual maturity is unknown. The only verified rayed bean host fish are the Tippecanoe and spotted darters. Effective holding and propagation of the species has not yet occurred.

There has been no change in the species' historical range, but the spatial distribution has increased with the reintroduction of the species into the Licking and Green Rivers in Kentucky.

Furthermore, the survey work performed for the petroleum spill remediation project on the Allegheny River provided a density estimate for the rayed bean of over 18,000 individuals in the project action area. This estimate indicates that the Upper Allegheny HUC8 population may be larger than previously known or it may be increasing in size (Doran 2023, pers. comm.).

The status of the rayed bean has remained relatively constant since both listing and the previous 5-year review (they have been extirpated from 4 steams and have been found or reintroduced into 7 additional streams). Additionally, threats persist for the remaining rayed bean populations, including habitat degradation and climate change effects. Many of the remaining populations are small and restricted to short river reaches making them vulnerable to stochastic events such as spills and drought. The life history of the species is poorly known, and captive propagation has not been initiated, thereby preventing efforts to improve the species status using augmentation and reintroduction.

After reviewing the best available scientific information, we conclude that the rayed bean remains an endangered species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Act at the time of listing remains an accurate reflection of the species' status.

RESULTS

U.S. FISH AND WILDLIFE SERVICE
STATUS REVIEW OF THE RAYED BEAN

Current Classification: Endangered

Status Recommendation resulting from Status Review:

____ 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

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

Approve SCOTT HICKS Digitally signed by SCOTT HICKS Date: 2023.11.28 13:11:13 -05'00' Date _____

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