

Pink Mucket
(*Lampsilis abrupta*)

Status Review:
Summary and Evaluation



Recaptured Propagated Pink Mucket (*Lampsilis abrupta*) from the Osage River, Missouri
Photo Credit: Bryan Simmons, U.S. Fish and Wildlife Service

U.S. Fish and Wildlife Service
Missouri Ecological Services Field Office
Columbia, Missouri
August 6, 2024

STATUS REVIEW

Pink Mucket (*Lampsilis abrupta*)

GENERAL INFORMATION

Species: Pink Mucket (*Lampsilis abrupta*); as currently listed in 50 CFR 17.11 [Link](#)

Reviewers:

Lead Field Office: Josh Hundley, Missouri Ecological Services Field Office, (573) 540-3829

Lead Regional Office: Laura Ragan, Region 3 Regional Office, (612) 713-5157

Cooperating Field Office(s): Chris Davidson, Arkansas Ecological Services Field Office, (501) 513-4481; Erin Sasser, Alabama Ecological Services Field Office, (251) 298-4226; Sara Schmuecker, Illinois-Iowa Ecological Services Field Office, (309) 757-5800, ext. 203; Matthew Mangan, Southern Illinois Ecological Services Sub-Office, (618) 998-5945; William Tucker and Sarah Harrison, Indiana Ecological Services Field Office, (812) 334-4261; Taylor Fagin, Kentucky Ecological Services Field Office, (502) 330-6616; Monica Sikes, Louisiana Ecological Services Field Office, (337) 291-3118; Angela Boyer, Ohio Ecological Services Field Office, (614) 416-8993 ext. 122; Anthony Ford, Tennessee Ecological Services Field Office, (931) 319-7747; Jordan Richard, Virginia Ecological Services Field Office, (757) 570-3697; West Virginia Ecological Services Field Office, (304) 866-3858.

Cooperating Regional Office(s): Carrie Straight, Region 4 Regional Office, (404) 679-7226; Sarah Furtak, Region 5 Regional Office, (413) 326-4687

Date of listing publication: June 14, 1976

FR citation(s): 41 FR 24064-24069

Classification: Endangered

Methodology used to complete the review:

To prepare this status review, the U.S. Fish and Wildlife Service (USFWS) solicited pertinent information from the public through a 60-day comment period on Federal Register notice 89 FR 804–806 on January 5, 2024. Pertinent information to determine the current status was obtained from the Recovery Plan (USFWS 1985; hereafter not cited but referred as “Recovery Plan”), recent reports of freshwater mussel surveys, and submissions by USFWS Field Offices and state natural resource agencies within the range of the species. This 5-year review was completed by Josh Hundley, Fish and Wildlife Biologist with the Missouri 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 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 USFWS evaluated aspects of the Pink Mucket biology and population demographics to inform this status review. This review summarizes species information obtained or developed since the previous status evaluations (USFWS 2019).

FR Notice citation announcing the species is under active review: January 5, 2024, 89 FR 804-806.

Review History: The Pink Mucket was included in a cursory review of all species listed before 1991 (56 FR 56882; November 6, 1991), followed by a 5-year summary and evaluation review by the North Carolina Ecological Services Field Office, Asheville, North Carolina in 2019 (USFWS 2019), which proposed no change to the listing classification of endangered.

REVIEW ANALYSIS

Recovery Criteria:

Recovery Plan or Outline: Recovery Plan [for the] Pink Mucket Pearly Mussel *Lampsilis orbiculata* [=abrupta]

Recovery criteria for delisting were developed in the 1985 Recovery Plan (USFWS 1985, p. 22). The Pink Mucket may be considered for delisting when the following three criteria have been achieved:

Criterion 1 – When two additional viable populations of L. orbiculata [=abrupta] are found in any two rivers except the Tennessee, Cumberland, and Meramec Rivers. Both of these rivers will contain viable populations that are distributed such that a single event would be unlikely to eliminate L. orbiculata [=abrupta] from the river system. Survey data must show at least five viable populations with each population having a minimum of two year-classes between 4 and 10 years of age as evidence of reproduction.

This criterion has not been met, but Pink Mucket has been found in almost twice as many streams since the Recovery Plan completion. Additional management efforts have assisted with propagation, re-introduction, and augmentation of many populations. Many populations have an unknown status, but approximately 40% of the populations are considered stable with some recruitment. However, no populations are considered to be improving. While more populations are known since its listing, Pink Mucket is still rare in most streams and without enough individuals to establish two year-classes between 4 and 10 years of age.

Criterion 2 - Additional mussel sanctuaries are established or expanded in river systems which contain known concentrations of L. orbiculata [=abrupta].

This criterion has been met as stated in the previous 5-year review.

Criterion 3 - An education program is established for the public with major emphasis towards commercial mussel fishermen.

This criterion has been met as stated in the previous 5-year review.

Criterion 4 - 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.

This criterion is partially met. While some changes have been made to help protect mussel habitat, the overarching threats of habitat degradation/fragmentation, water quality, landscape changes, climate change, and invasive species continue to negatively impact Pink Mucket populations throughout most of its range. Reservoirs and the operation of large dams, commercial navigation and channel maintenance, agriculture, sedimentation, and mining (aggregate, coal, and mineral) appear to be some of the biggest threats. Although most dam operations adversely affect Pink Mucket populations, there are means for improving dam discharges at hydropeaking facilities to improve tailwater conditions as seen on the Osage River and some TVA managed reservoirs.

Updated Information Relevant to the Current Species' Status

A Species Status Assessment (SSA) has not been conducted for Pink Mucket. The USFWS develops SSAs utilizing a framework that considers species needs relevant to its current and plausible future condition to inform decisions under the ESA (USFWS 2016, entire). These assessments are comprehensive and use the conservation biology principles of resiliency, redundancy, and representation (collectively referred to as the “3Rs”) to characterize species' viability. Viability is the species' ability to persist in the wild over a trajectory of time. Viability is considered as a non-static measure and influenced by known, perceived, and possible unknown environmental individual-level, population-level, and species-level parameters. The 3Rs collectively attempt to measure the health of the species across populations and as a whole.

To sustain populations over time, a species must have the capacity to withstand:

- (1) environmental and demographic stochasticity and disturbances (Resiliency),
- (2) catastrophes (Redundancy), and
- (3) novel changes in its biological and physical environment (Representation).

We present the following information in context of these principles to relate and synthesize inferences toward the Pink Mucket's general status and potential need for status level changes.

Biology and Habitat:

Range and distribution:

At the time of listing Pink Mucket was known to occur in four streams: Green (KY), Kanawha (WV), Tennessee (AL, TN), and Muskingum (OH) rivers. An additional 12 extant stream populations were discovered by the time the Recovery Plan was written including: Ohio (IL, KY, OH, WV), Cumberland (KY, TN), Clinch (TN, VA), Paint Rock (AL), Osage (MO), Gasconade (MO), Meramec (MO), Big (MO), Black (AR, MO), Current (AR), Little Black (MO), and Spring (AR) rivers (USFWS 1985), but the Muskingum River population was considered extirpated, bringing the total number of extant populations to 15. By 2019, the USFWS noted an increase in survey efforts increased the extant stream populations to 29 (USFWS 2019). There have not been any notable changes to the Pink Mucket range and distribution since then and the 29 stream populations are still considered extant (Figure 1). Along with those 29 populations, Pink Mucket has been re-introduced into three streams within the historical range (Duck River (TN), Elk River (AL, TN), and Nolichucky River (TN)). Figure 1 shows the updated range map with river segments that are currently extant, possibly extirpated, and augmented with propagated Pink Mucket. Please note, the current range illustrated within some rivers might be an over-estimation. With lacking data, populations in some river segments were assumed and/or extended to the river confluence if the species in the receiving river is also considered extant.

Population demographics:

An annotated summary of each of the 29 stream populations considered extant was provided in the 2019 5-year review (USFWS 2019, pp. 13 - 35). Pink Mucket is still considered extant in those 29 streams, and Table 1 provides a summary of those populations. Populations are considered to be large if they have more than 100 individuals since 2000 that are generally distributed over 40km of contiguous stream length, with evidence of recruitment. The USFWS has no updated population demographic information on the following 25 streams: Sac (MO), Bourbeuse (MO), Big (MO), St. Francis (MO), Black (AR, MO), Current (AR), Eleven Point (AR), Spring (AR), White (AR), Little Missouri (AR), Elk (WV), Barren (KY), Clinch (TN),

VA), Holston (TN), French Broad (TN), Paint Rock (AL) rivers, Bayou Bartholomew (AR, LA), and Bear Creek (AL). Based on data since 2000, the Sac, Bourbeuse, St. Francis, Current, Eleven Point rivers, and Bear Creek populations are represented by five or fewer live and/or fresh dead (FD) individuals. The following streams have updated population demographic data since 2019, as described below.

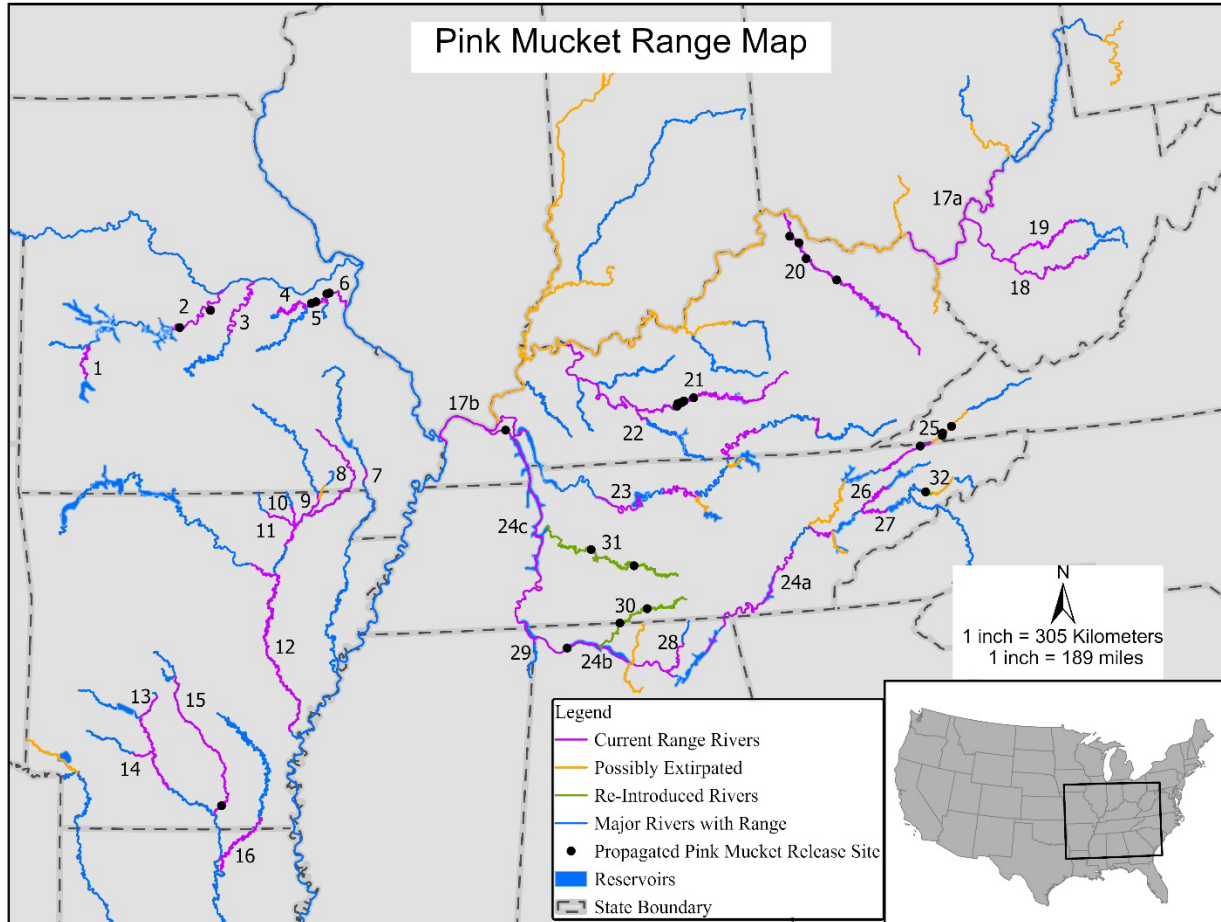


Figure 1. Pink Mucket range map. The numbers are associated with Table 1 for stream identification.

Osage River, MO (Map Number 2): In 2014, a long-term mussel monitoring project was established in the lower 80 miles (129 kilometers (km)) of the Osage River below Bagnell Dam. This monitoring is intended to assess mussel community demographics at 18 mussel beds on a regular sampling rotation through 2047. From 2014 to 2023, 31 Pink Mucket have been reported from 11 sites within approximately 60 miles (97 km) (Roberts et al. 2021, p. 19; USFWS 2022, pp. 1 - 2; USFWS 2023b, pp. 1 - 2; USFWS 2024, pp. 1 - 2). These Pink Mucket ranged from 72 mm to 124 mm in length and were estimated as 9 years old to greater than 20 years old. Nineteen males and 12 females, including three that were gravid, were observed. Additionally, 141 propagated Pink Mucket were observed since 2020 at two sites (A. Roberts, pers. comm. 2024). During 2012-2013 about 14,400 subadults were propagated, tagged, and systematically released within two of the long-term monitoring sites in the lower river (RM 27 and RM 72) (Simmons and Roberts 2014). The most recent monitoring of RM 27 and RM 72 occurred in 2020 and yielded 42 and 63 tagged Pink Mucket, respectively (Simmons et al. 2021, pp. 1 - 2). The 42

Pink Mucket collected at RM 27 were comprised of 14 females and 28 males with an average length of 80 mm. The 63 Pink Mucket collected at RM 72 were comprised of 35 females and 28 males with an average length of 81 mm. More than 25 Pink Mucket were observed luring at RM 72 prior to sampling. This sampling reported approximately 50% survival and noted visual evidence of luring females (Simmons et al. 2021, p. 4).

Gasconade River, MO (Map Number 3): There have not been any recent comprehensive surveys of the Gasconade River, but one fresh-dead (FD) Pink Mucket shell was incidentally collected at one site in 2022 (MDC Database, S. McMurray, pers. comm. 2024).

Meramec River, MO (Map Number 6): There have not been any recent comprehensive surveys of the Meramec River, and the previous 5-year review reported records through 2003. From 2004 to 2019, six live or FD Pink Mucket were collected at four sites, including one gravid female (MDC Database, S. McMurray, pers. comm. 2024).

Saline River, AR (Map Number 11): In 2022, five live Pink Mucket were reported from two sites (C. Davidson, pers. comm., 2024).

Ouachita River, AR (Map Number 13): In 2023, eight live Pink Mucket were reported from three sites. They ranged in age from six to ten years old and 63 mm to 97 mm in length (EcoAnalysts, Inc. 2023, p. 23).

Ohio River, OH, WV (Map Number 17a): There have not been any recent comprehensive surveys of the Ohio River, but two Pink Mucket were collected at two sites within the Greenup Pool in 2019 and 2022 during mussel surveys for proposed projects (EnviroScience 2019, p. 5; Edge Engineering and Science 2022, p. 3). USFWS (2023a, p. 52) also notes 1,624 Pink Mucket were collected in Robert C. Byrd, Racine, Belleville, Willow Island, Hannibal, Pike Island, and New Cumberland pools in West Virginia from 2002 to 2021.

Kanawha River, WV (Map Number 18): There have not been any recent comprehensive surveys of the Kanawha River, but one live tagged individual and several dead shells were reported at Kanawha Falls in 2022 (K. Eliason, pers. comm. 2024).

Licking River, KY (Map Number 20): In 2019, 792 propagated Pink Mucket were released at four sites in the Licking River. Quantitative sampling at one site in 2019 reported a Pink Mucket density of 0.029/m². Qualitative sampling in 2019 reported five live Pink Mucket from three sites and an additional site listing Pink Mucket as “common” (McGregor and Jacobs 2020, pp. 22, 30, 37).

Green River, KY (Map Number 21): From 2017 to 2019, 2,350 propagated Pink Mucket were released at five sites in the Green River. Augmented Pink Mucket were detected at a density of 0.20/m² at one site on the Green River in 2019 and at 0.26/m² in 2021, indicating successful augmentation and sufficient sampling effort (McGregor and Jacobs 2020, pp. 28, 36; Jacobs et al. 2023, p. 28). Qualitative sampling in 2019 reported one live Pink Mucket at one site and an additional site listing Pink Mucket as “common” (McGregor and Jacobs 2020, p. 22).

Cumberland River, KY, TN (Map Number 23): There have not been any recent comprehensive surveys of the Cumberland River, but the previous 5-year review only reported records through 2008. Hubbs (2012, pp. 36-39) reported 92 live Pink Mucket from two sites in 2011-2012. Of those 92, 37 males ranging from 83mm to 111 mm and 47 females ranging from 77 mm to 110 mm were collected. All 84 of those Pink Mucket were greater than 20 years old.

Tennessee River, AL, TN (Map Number 24b): In 2018, 50 propagated Pink Mucket were released at one site in the Tennessee River (McGregor and Jacobs 2020, p. 37). More recently, the presence of Pink Mucket was reconfirmed at a previously surveyed area in the Tennessee River downstream of the Wilson Dam. Three individuals (two individuals were measured as 103 mm and 114 mm) were found at this location during a USFWS dive team workshop in June of 2024 (J. Garner, pers. comm. 2024).

Tennessee River, KY, TN (Map Number 24c): There was data collected in 2012 and 2015 that were not reported in the previous 5-year review. Surveys in 2011-2012 and 2014-2015 found 360 live Pink Mucket at four sites (Hubbs 2012, pp. 29-31; Hubbs 2015, pp. 19-20). One-hundred-forty-two Pink Mucket were collected at four sites, including 72 males ranging from 71mm to 117mm in length and from 5 years old to 25 years old, and 46 females ranging from 61 mm to 100 mm in length and 4 years old to 18 years old (Hubbs (2012, pp. 33-34). Hubbs (2015, pp. 22-25) reported 229 Pink Mucket at three sites comprised of 119 males ranging from 75 mm to 121 mm in length and from 5 years old to 20 years old, and 110 females ranging from 62 mm to 103 mm in length and 5 years old to 20 years old were collected. Since 2019, 63 live Pink Mucket have been reported from broodstock collections. In Kentucky, 13, 15, 18, 16, and one live Pink Mucket were observed in 2019, 2021, 2022, 2023, and 2024 respectively (D. Hua, pers. comm. 2024).

Elk River, AL, TN (Map Number 30): In 2013, 200 propagated Pink Mucket were released at one site in the Elk River (TN) within the Tennessee River drainage. In 2017, an additional 133 propagated Pink Mucket were released at another site in the Elk River (TN) (AWCC 2023, p. 55). In 2024, five male and five female Pink Mucket from the 2017 reintroduction were collected at one site and were reported as looking healthy (A. Ford, pers. comm. 2024). This river is a tributary to the Tennessee River and is within the historical range of Pink Mucket, but there have not been any previous records. This population is considered a re-introduced population that is sourced from the Tennessee River population. The re-introduction of Pink Mucket into the Elk River was recommended by the CRMRC (2010, p. 77) and listed as a priority activity in the 2019 5-year review. Recruitment and population status is unknown.

Duck River, TN (Map Number 31): In 2013, 419 propagated Pink Mucket were released at two sites in the Duck River (TN). An additional 100 propagated Pink Mucket were released at one of those sites in 2015 (Hubbs 2020, p. 34), and another 50 propagated Pink Mucket released at the other site in 2021. An additional 50 propagated Pink Mucket were released at a third site in 2021 (Hua 2022, p. 7). Three live Pink Mucket were observed at one site in 2023 and an additional live Pink Mucket was observed in 2024. Additionally, two Pink Mucket were recaptured at one site in 2022, but recruitment and population status is unknown for the Duck River (Hubbs 2020, p. 19; Hua 2023, p. 11). The augmentation of Pink Mucket in the Duck River was recommended by the CRMRC (2010) and listed as a priority activity in the 2019 5-year review.

Nolichucky River, TN (Map Number 32): In 2013, 130 propagated Pink Mucket were released at one site in the Nolichucky River (TN), with an additional 100 propagated Pink Mucket released 2015 and again in 2016 at the same site. Two live Pink Mucket were observed at the site in 2017 during broodstock collection, but recruitment and population status is unknown for the Nolichucky River (Hubbs 2020, p. 55). The augmentation of Pink Mucket in the Nolichucky River was recommended by the CRMRC (2010, p. 77) and listed as a priority activity in the 2019 5-year review.

Table 1. Summary of population demographic data for Pink Mucket. *Population size does not account for propagated individuals released into the stream.

Map Number	Stream (State)	Last L/FD Observation	Recruiting	Population Size*	Population Trend
1	Sac (MO)	2001	No	2 Live	Unknown
2	Osage (MO)	2023	Yes	Medium - Augmented 2010-2012	Stable
3	Gasconade (MO)	2022	Unknown	Small	Declining
4	Bourbeuse (MO)	2002	No	1 Live	Unknown
5	Big (MO)	2002	No	Small	Declining
6	Meramec (MO)	2019	Unknown	Medium	Declining
7	St. Francis (MO)	2002	No	1 Live	Unknown
8	Black (MO/AR)	2003	Yes	Medium	Stable
9	Current (AR)	1983	No	1 Live	Unknown
10	Eleven Point (AR)	2003	Unknown	2 FD	Unknown
11	Spring (AR)	2005	Unknown	Small	Declining
12	White (AR)	2000	Unknown	Medium	Unknown
13	Ouachita (AR)	2023	Yes	Medium	Stable
14	Little Missouri (AR)	2004	Unknown	Small	Unknown
15	Saline (AR)	2022	Yes	Large	Stable
16	Bayou Bartholomew (AR, LA)	1992	Unknown	Small	Unknown
17	Ohio (OH, WV, IL, KY)	2022	Unknown	Medium	Declining
17a	<i>Upper Ohio (OH, WV)</i>	2022	Unknown	Medium	Declining
17b	<i>Lower Ohio (IL, KY)</i>	2001	Unknown	Unknown	Declining
18	Kanawha (WV)	2022	Unknown	Small	Stable
19	Elk (WV)	2018	Unknown	Small	Unknown
20	Licking (KY)	2019	Unknown	Medium - Augmented in 2019	Unknown
21	Green (KY)	2021	Unknown	Medium - Periodic augmentations	Unknown
22	Barren (KY)	2008	Unknown	Small	Unknown
23	Cumberland (KY, TN)	2012	Yes	Large	Stable
24	Tennessee (KY, AL, TN)	2024	Yes	Large	Stable
24a	<i>Holston/French Broad to Sequatchie rivers (TN)</i>	2014	Yes	Medium	Stable

Map Number	Stream (State)	Last L/FD Observation	Recruiting	Population Size*	Population Trend
24b	<i>Sequatchie R. to Pickwick Dam (AL, TN)</i>	2024	Yes	Medium	Stable
24c	<i>Pickwick Dam to Ohio R. (KY, TN)</i>	2024	Yes	Large	Stable
25	Clinch (TN, VA)	2016	Unknown	Small – Augmented since 2010	Unknown
26	Holston (TN)	2002	No	Small	Unknown
27	French Broad (TN)	2002	Unknown	Small	Unknown
28	Paint Rock (AL)	2008	Unknown	Small	Unknown
29	Bear (AL)	1999	Unknown	1 Live	Unknown
30	Elk (AL, TN)	2017	Unknown	Re-introduced population	Unknown
31	Duck (TN)	2024	Unknown	Re-introduced population	Unknown
32	Nolichucky (TN)	2019	Unknown	Re-introduced population	Unknown

Genetics:

There are no changes or updates regarding genetics since USFWS (2019).

Taxonomic and nomenclature:

There are no changes in taxonomic classification or nomenclature since USFWS (2019).

Habitat:

In 2022, Barren River Lock and Dam #1, at approximately mile 15, was removed reconnecting approximately 55 miles (89 km) of stream. Nearby, Green River Lock and Dam #5 (scheduled 2024) and Green River Lock and Dam #6 (2017) were removed, restoring free-flowing conditions to 73 miles (117 km) of the Green River. The removal of Harm's Mill Dam on the Elk River (TN) is also in development and the proposal states the removal would result in 134 free flowing miles (215.65 km).

Threats Analysis (threats, conservation measures, and regulatory mechanisms):

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

The threats currently affecting Pink Mucket have remained the same. Habitat degradation/fragmentation, decreased water quality, population isolation and impoundments, climate change, and invasive species are the current threats to Pink Mucket populations and habitat. Specifically, extant populations are primarily affected by navigational activities, reservoir releases, mining practices, inadequately treated wastewater discharges, and factors associated with small disjunct populations. The risk from these threats will likely fluctuate over time.

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

We have no new information regarding overutilization for Pink Mucket since the last 5-year review. The commercial mussel harvest industry is nearly non-existent. Thus, overutilization is not currently considered to be a threat to Pink Mucket.

Factor C. Disease or predation:

The Recovery Plan did not specifically discuss disease or predation as limiting factors for Pink Mucket. We have no new information on disease that would indicate it as a limiting factor.

Factor D. Inadequacy of existing regulatory mechanisms:

The inadequacy of existing regulatory mechanisms was not specifically considered a limiting factor in the Recovery Plan. However, impacts from navigational activities, reservoir releases, aggregate mining, point source discharges (namely ammonia and pesticides), and pharmaceuticals and sediment entering the streams may not be regulated sufficiently, may not provide adequate protection, or have inconsistent enforcement.

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

Threats from other natural or manmade factors affecting the continued existence of Pink Mucket are unchanged from the previous 5-year review. Chemical spills are a concern due to the association of highways, railroads, pipelines, and navigational channels with Pink Mucket streams. With the reduced population parameters across much of the range, demographic stochasticity is also a concern. Environmental stochastic events are more liable to be catastrophic for populations that are linearly distributed, while demographic stochastic events are more liable

to be catastrophic for small populations – both scenarios can potentially be highly detrimental to the majority of Pink Mucket populations. Population fragmentation and isolation are also a concern for Pink Mucket throughout much of its range because of the sporadic distribution and low population sizes. General degradation continues to decrease habitat patch size and act insidiously in the decline of several isolated and small Pink Mucket populations. Once isolated, the absence of an available source population makes recolonization impossible without human intervention. Affects from climate change, including increased water temperature and changes in precipitation will affect Pink Mucket. Future increases in the frequency and severity of both extreme drought and extreme rainfall are expected to transform many ecosystems (Carter et al. 2018, p. 786). Physiological tolerances (e.g., temperature, dissolved oxygen) of most mussel species are largely unknown but changes that cross critical thresholds could disrupt life stages or host availability. The ability to physiologically adapt to changes likely varies among mussel species. Laboratory experiments determined that dewatered conditions (a surrogate for drought) significantly reduced burrowing in Pink Mucket, and that increasing temperature diminished both burrowing and byssal thread production in the species (Archambault et al. 2013, pp. 236-242; 2014, pp. 606-608). Drought conditions and warming stream waters may therefore have sub-lethal effects on the wellbeing of Pink Mucket populations.

Conservation Measures

The recent removal of Barren River Lock and Dam 1 (KY) and Green River (KY) Lock and Dam 6, along with the planned removal of Lock and Dam 5 and the planned removal of Harm's Mill Dam on the Elk River (TN) may improve aquatic habitat and connectivity for Pink Mucket. Augmentation of Pink Mucket from cultured propagation efforts has occurred at several sites in the Clinch River in Tennessee and Virginia, one site in the Nolichucky River in Tennessee, one site in the Tennessee River in Alabama, one site in the Green River in Kentucky, one site in the Licking River in Kentucky, one site in the Saline River in Arkansas, four sites in the Meramec River in Missouri, and two sites in the Osage River in Missouri. Additionally, re-introduction of Pink Mucket from cultured propagation efforts has occurred at two sites on the Duck River in Tennessee and two sites on the Elk River in Tennessee. Success of these efforts have been documented in the Osage River with approximately 50% survival and visual evidence of luring females (Simmons et al. 2021, p. 4). Success of the other efforts has not yet been documented. Pink Mucket have not been propagated in approximately 10 years, but a genetic study is currently being developed to assess the population genetics in the Osage River related to the propagated animals. This study should help inform future propagation efforts. A restoration plan was written to establish a collaborative approach to conserving and restoring priority freshwater mussel species throughout the Osage Basin (Simmons 2022, entire). The primary goal of the plan is to implement conservation and restoration activities to maintain extant populations, reduce the risk of population extirpations, and promote species recovery. A primary strategy for areas with improved or otherwise suitable habitat is to use artificial propagation to restore mussel populations to self-sustaining levels.

In 2007, Bagnell Dam, a hydropower facility creating the Lake of the Ozarks in Missouri received a renewed 40-year operating license issued by the Federal Energy Regulatory Commission (FERC). The new license included many enhancements that benefit mussels and other aquatic resources in the lower Osage River (LOR). These changes have greatly improved the dissolved oxygen levels and flow regime in the river. Additionally, the Lower Osage River Protection and Enhancement Program (LORPEP) was established, which funds the

implementation of adaptive management actions to help protect and mitigate impacts to aquatic resources in the LOR. The main elements of this program include instream aquatic habitat improvements, mussel propagation, and monitoring.

Recommendations for future activities

The recommendations listed in USFWS (2019) still apply and list the highest priority actions needed to inform the recovery of Pink Mucket.

Synthesis

The Pink Mucket is a freshwater mussel known from 32 extant streams in Alabama, Arkansas, Illinois, Kentucky, Louisiana, Missouri, Ohio, Tennessee, Virginia, and West Virginia. There has been no change in the species' range and the status has remained relatively constant since the previous 5-year review. Since the previous 5-year review in 2019, no comprehensive surveys have been completed, but Pink Mucket were reported from 11 (34%) of the extant streams. Many populations have an unknown status, but approximately 25% of the populations are considered stable with some recruitment. While more populations are known since its listing, Pink Mucket is still rare in most streams and without enough individuals to establish two year-classes between four and ten years of age.

Pink Mucket has also been successfully propagated since the early 2000s and at least ten streams have augmented or re-introduced Pink Mucket populations. Propagation efforts have resulted in at least 18,700 Pink Mucket being released at 15 sites within seven streams (Osage, Licking, Green, Tennessee, Elk, Duck, and Nolichucky rivers). Releases of propagated Pink Mucket have also occurred in the Meramec, Saline, and Clinch rivers.

The threats of habitat degradation/fragmentation, decreased water quality (including pharmaceuticals and personal care products), population isolation and impoundments, sedimentation, invasive species, and climate change continue throughout much of the species' range. Extant populations are primarily affected by navigational activities, reservoir releases, mining practices, inadequately treated wastewater discharges, and factors associated with small disjunct populations (e.g., stochasticity, low genetic diversity, habitat fragmentation and population isolation). Although there are ongoing attempts to alleviate some threats, there appear to be no populations without current substantive threats and many of these threats are without obvious or readily available solutions.

Because of the ongoing threats and the current condition of the species, Pink Mucket continues to meet the definition of an endangered species.

RESULTS / SIGNATURES

**U.S. FISH AND WILDLIFE SERVICE
STATUS REVIEW of *Lampsilis abrupta***

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
- No change needed

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date _____

REFERENCES

- Archambault, J.M., W.G. Cope, and T.J. Kwak. 2013. Burrowing, byssus, and biomarkers: behavioral and physiological indicators of sublethal thermal stress in freshwater mussels (Unionidae). *Marine and Freshwater Behaviour and Physiology* 46(4):229-250.
- Archambault, J.M., W.G. Cope, and T.J. Kwak. 2014. Survival and behaviour of juvenile unionid mussels exposed to thermal stress and dewatering in the presence of a sediment temperature gradient. *Freshwater Biology* 59:601-613.
- [AWCC] Aquatic Wildlife Conservation Center. 2023. Species profiles for federally endangered mussel cultured and stocked by the Aquatic Wildlife Conservation Center, January 2023. Aquatic Wildlife Conservation Center, Virginia Department of Wildlife Resources. Marion, Virginia. 101pp.
- Carter, L., A. Terando, K. Dow, K. Hiers, K.E. Kunkel, A. Lascurain, D. Marcy, M. Osland, and P. Schramm. 2018: Souteast. Pp. 743-808 *in*: Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart eds. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II - U.S. Global Change Research Program, Washington, DC, USA. <https://doi.org/10.7930/NCA4.2018.CH19>
- [CRMRC] Cumberlandian Region Mollusk Restoration Committee. 2010. Plan for the population restoration and conservation of freshwater mollusks of the Cumberlandian Region. Unpublished report, Asheville, North Carolina. 18pp+App.
- Edge Engineering and Science, LLC. 2022. Nucor Steel West Virginia – Apple Grove Steel Mill Freshwater Mussel Survey Report, Mason County, West Virginia, 2022-W-0628, LRH-2022-55-OHR. Ohio River – Greenup Pool. August 29, 2022. Prepared for Civil and Environmental Consultants, Inc. 28pp+App.
- EcoAnalysts, Inc. 2023. Unionid Survey at Four Proposed Dredge Locations, Ouachita River, Camden, Arkansas, 2023. Technical Report, Project No. 23-007. Prepared for U.S. Army Corps of Engineers. 25pp+App.
- EnviroScience. 2019. Mussel Survey on the Ohio River near rive mile 315 for Ceredo Barge Fleet maintenance dredging, Wayne County, West Virginia. Revised April 14, 2020. Prepared for Marathon Petroleum Corporation. 34pp.
- Hua, D. 2022. Annual Progress Report: Propagation and restoration of aquatic animals. Cumberland River Aquatic Center, Tennessee Wildlife Resource Agency. Submitted to U.S. Fish and Wildlife Service. 16pp.
- Hua, D. 2023. Annual Progress Report: Propagation and restoration of aquatic animals. Cumberland River Aquatic Center, Tennessee Wildlife Resource Agency. Submitted to U.S. Fish and Wildlife Service. 19pp.
- Hubbs, D. 2012. 2011-12 Orangefooted Pimpleback and Catspaw Survey - Tennessee and Cumberland Rivers, for Kentucky Waterways Grant Project 7367. Tennessee Wildlife Resources Agency, Environmental Services Division, Nashville, Tennessee. 52pp.

- Hubbs, D. 2015. 2014-15 Orangefooted Pimpleback and Catspaw Survey - Tennessee and Cumberland Rivers, for Kentucky Waterways Grant Project 7367. Tennessee Wildlife Resources Agency, Environmental Services Division, Nashville, Tennessee. 32pp.
- Hubbs, D. 2020. 2019 Annual Mussel Recovery Activity Report for Project 7775. Tennessee Wildlife Resources Agency, Environmental Services Division, Nashville, Tennessee. 83pp.
- Jacobs, J.M., M.A. McGregor, A.C. Shepard, T.J. Bailey, M.A. King, and T. Williams. 2023. Community changes in a freshwater mussel bed from 2005 to 2021 in the Green River, Kentucky. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, Kentucky. 40pp.
- McGregor, M.A., and J. Jacobs. 2020. 2020 Final Report-years 2017-2020 – Aquatic Restoration Initiative Grant No: T-68. Kentucky Department of Fish and Wildlife Resources, Center for Mollusk Conservation, Frankfort, Kentucky.
- Roberts, A.D., J.T. Hundley, and B.R. Simmons. 2021. Long-term Monitoring of Freshwater Mussels in the Lower Osage River, Missouri: A summary of the first five years of sampling: 2014 to 2018, April 2021, Lower Osage River Protection and Enhancement Program Project 15-1. Appendix III in U.S. Fish and Wildlife Service. 2021. Lower Osage River Protection and Enhancement Program, 2020 Annual Report submitted to Ameren Missouri, 5pp+App. U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services.
- Simmons, B.R. 2022. The Osage River Basin Freshwater Mussel Conservation and Restoration Plan. Version 1.0 5pp+App. U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services.
- Simmons, B.R. and A.D. Roberts. 2014. Progress Report: 2013 Propagation Efforts for Freshwater Mussels, January 2014, Project 08-5 of the Lower Osage Protection and Enhancement Program, 10pp., Appendix III in U.S. Fish and Wildlife Service. 2014. Lower Osage River Protection and Enhancement Program, 2013 Annual Report submitted to Ameren Missouri, 9pp+App. U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services.
- Simmons, B.R. A.D. Roberts, and J.T. Hundley. 2021. Monitoring of Pink Mucket (*Lampsilis abrupta*) Released in the Lower Osage River. 2020 Progress Report for the Lower Osage River Protection and Enhancement Program (LORPEP) Project 08-5. 8pp., Appendix II in U.S. Fish and Wildlife Service. 2021. Lower Osage River Protection and Enhancement Program, 2020 Annual Report submitted to Ameren Missouri, 5pp+App. U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services.
- [USFWS] U.S. Fish and Wildlife Service. 1985. Recovery Plan [for the] Pink Mucket Pearly Mussel *Lampsilis orbiculata* [=abrupta]. Atlanta, Georgia. 47pp.
- [USFWS] U.S. Fish and Wildlife Service. 2016. USFWS Species Status Assessment Framework: an integrated analytical framework for conservation. Version 3.4 dated August 2016.
- [USFWS] U.S. Fish and Wildlife Service. 2019. Pink Mucket (*Lampsilis abrupta*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Asheville, North Carolina. April 2018.

- [USFWS] U.S. Fish and Wildlife Service. 2022. Freshwater Mussel Monitoring in the Lower Osage River. 2021 Progress Memo for the Lower Osage River Protection and Enhancement Program Project 15-1. 3pp., Appendix II in U.S. Fish and Wildlife Service. 2022. Lower Osage River Protection and Enhancement Program, 2021 Annual Report submitted to Ameren Missouri, 5pp+App. U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services.
- [USFWS] U.S. Fish and Wildlife Service. 2023a. Biological opinion for the Nucor Steel Apple Grove Steel Mill Project, Mason County, West Virginia. West Virginia Ecological Services Field Office, Elkins, WV. April 11, 2023.
- [USFWS] U.S. Fish and Wildlife Service. 2023b. Freshwater Mussel Monitoring in the Lower Osage River. 2022 Progress Memo for the Lower Osage River Protection and Enhancement Program Project 15-1. 3pp., Appendix III in U.S. Fish and Wildlife Service. 2023. Lower Osage River Protection and Enhancement Program, 2022 Annual Report submitted to Ameren Missouri, 5pp+App. U.S. Fish and Wildlife Service, Columbia Missouri Ecological Services.
- [USFWS] U.S. Fish and Wildlife Service. 2024. Freshwater Mussel Monitoring in the Lower Osage River. 2023 Progress Memo for the Lower Osage River Protection and Enhancement Program Project 15-1. 3pp., Appendix II in U.S. Fish and Wildlife Service. 2024. Lower Osage River Protection and Enhancement Program, 2023 Annual Report submitted to Ameren Missouri, 53pp+App. U.S. Fish and Wildlife Service, Missouri Ecological Services Field Office.