Purple Cat's Paw Pearlymussel
(*Epioblasma obliquata obliquata*)

5-Year Review:
Summary and Evaluation

Juvenile Purple Cat's Paw Pearlymussels, Photo by Keith Lott, USFWS

U.S. Fish and Wildlife Service, Interior Region 3
Ecological Services Field Office
Columbus, Ohio

5-YEAR REVIEW

Purple Cat's Paw Pearlymussel/*Epioblasma obliquata obliquata*

1.0 GENERAL INFORMATION

1.1 Reviewers

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

Lead Field Office: Ohio Ecological Services Field Office, Angela Boyer, (614) 416-8993, ext. 22

Cooperating Field Offices:
Kentucky Ecological Services Field Office, Jennifer Garland, (502) 695-0468, ext. 115
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Cooperating Regional Offices:
North Atlantic-Appalachian Interior Region 1, Martin Miller, (413) 253-8615
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1.2 Methodology used to complete the review:

The purpose of this 5-year review is to review new information since the last review of the species' status (April 21, 2015) and consider whether any of this information indicates that a change in the listing status of the species may be warranted. Public notice was given in the *Federal Register* (84 FR 17420) requesting new scientific or commercial data and information that may have a bearing on the purple cat's paw pearlymussel (*Epioblasma obliquata obliquata*) classification of endangered status. Pertinent data were obtained from the Recovery Plan, from recent reports of freshwater mussel surveys of Killbuck Creek, and from recent propagation, augmentation, and reintroduction efforts in Kentucky, Ohio, Tennessee, and West Virginia. This 5-year review was completed by Angela Boyer, Fish and Wildlife Biologist with the Ohio Ecological Services Field Office. Peer review of this document was determined to be unnecessary because there is a lack of new information about this species and this 5-year review resulted in a recommendation to leave the status unchanged.

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review:

84 FR 17420-17421 (April 25, 2019) – Endangered and Threatened Wildlife and Plants; Initiation of a 5-Year Status Reviews of Six Listed Animal and Plant Species.

1.3.2 Listing history

Original Listing
FR notice: 55 FR 28209
Date listed: July 10, 1990
Entity listed: Purple Cat's Paw Pearlymussel (*Epioblasma obliquata obliquata*); Subspecies
Classification: Endangered

1.3.3 Associated rulemakings: A final rule was published for the establishment of a non-essential experimental population for the purple cat's paw pearlymussel in the Tennessee River below Wilson Dam in Alabama on June 14, 2001 (66 FR 32250). The ''When Listed'' numbers in the table of species information was inadvertently omitted in this final rule. A correction to this final rule, amending the table of species information to include the "When Listed" numbers, was published on August 21, 2001 (66 FR 43808).

1.3.4 Review History: Purple cat's paw pearlymussel was included in a cursory review initiated November 6, 1991 (56 FR 56882) for all endangered and threatened species listed before 1991. Five year reviews were initiated on March 18, 2009 (74 FR 11600) and July 8, 2014 (79 FR 38560) and completed on September 24, 2010 and April 21, 2015. These reviews resulted in no change in the listing classification of endangered.

1.3.5 Species' Recovery Priority Number at start of 5-year review: 6. The "6" indicates a high degree of threat and low recovery potential for a subspecies or DPS (vertebrate).

1.3.6 Recovery Plan

Name of plan: Purple Cat's Paw Pearlymussel Recovery Plan
Date issued: March 10, 1992
Dates of previous revisions, if applicable: none

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? *No.*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? *Yes.*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? *Yes.*

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

All of the relevant listing factors are addressed in the recovery criteria and there is no new information to consider regarding existing or new threats.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The purple cat's paw pearlymussel may be considered for reclassification to threatened status when the following criteria are met:

Criterion 1. Through protection of existing populations and successful establishment of reintroduced populations or the discovery of additional populations, a total of at least four Ohio River system tributaries contain viable populations. These populations will be distributed within the Ohio River system as follows: two populations in the upper Ohio River basin in Ohio, Indiana, or Illinois; one population in Kentucky; and one population in Tennessee.

In 1992 when the recovery plan was issued, the purple cat's paw was only known to be extant in two river reaches – the middle Cumberland River in Tennessee and the Green River in Kentucky. However, no living or freshdead purple cat's paw pearlymussels have been collected in these two rivers in over 30 years. The species is likely extirpated from the Cumberland River. The species was also likely extirpated from the Green River. However, as discussed below, an effort to reestablish a purple cat's paw population in the Green River was initiated in 2017. In 1994, a small population of the purple cat's paw was discovered in Killbuck Creek in Coshocton County, Ohio.

Killbuck Creek was closed in 2004 to all mussel sampling and collecting except for that required in conjunction with life history research approved by the Ohio Department of Natural Resources (R. Ollis, Ohio Department of Natural Resources, Division of Wildlife, in litt. 2010).

In 2005, the U.S. Fish and Wildlife Service's Ohio Ecological Services Field Office (OHFO) received a Preventing Extinction grant to conduct surveys in Killbuck Creek to locate and obtain live male and female purple cat's paw for a captive propagation program. The survey effort conducted with that funding only found live males. OHFO received additional Preventing Extinction grants in 2007 and 2009 to continue the survey efforts.

Survey efforts in Killbuck Creek from 2009 through 2011 yielded only two live males in 2009. Both males had been found before as they were already tagged in previous years. During 2011

sampling, one freshdead female was also found. It was estimated to be around three years of age. This find indicated recruitment in the stream only a few years prior.

In 2012, Ohio experienced a drought which reduced flows in Killbuck Creek which provided excellent sampling conditions for purple cat's paw by increasing visibility in the creek. Areas where purple cat's paw had been previously found were searched extensively. A new location in the stream was also found and sampled due to the low flows and turbidity resulting from drought conditions. The 2012 survey efforts yielded a total of 11 live females and 16 live males, the first living females of the species found since 1996.

The mussels were placed into cages in Killbuck Creek where they were held until the following spring. In late March 2013, the females were removed from the cages and checked for gravidity. Six females were found to be gravid. Mussel conservation facilities, in Ohio, Kentucky, and West Virginia, received two females each in order to initiate propagation of the species. Of the 3 facilities, White Sulphur Springs National Fish Hatchery in West Virginia was the only facility that had successful transformation of purple cat's paw larvae, resulting in 13 juveniles. Those juveniles were later transported to the Center for Mollusk Conservation in Kentucky due to staffing changes at the West Virginia facility.

One additional live female was found in Killbuck Creek in the fall of 2013 and placed into the holding cage with the 2012 non-gravid females for holding. Propagation efforts were repeated in April 2014 at the Ohio and Kentucky mussel facilities. The Kentucky facility successfully propagated purple cat's paw and had 17 surviving juveniles. Combined with the 13 juveniles from the 2013 efforts, the total living juveniles in captivity was increased to 30.

The Killbuck Creek survey effort continued in 2014 and six additional live adult female purple cat's paw were found. Those individuals were held in a cage in Killbuck Creek along with the other two females to continue the propagation effort in the spring of 2015. In November 2014, caged females were checked for gravidity. In order to expand the propagation efforts, larvae were extracted from one female and transported to the Kentucky facility for in-vitro propagation. In 2015, 51 juveniles were being reared at the Kentucky facility from all propagation efforts. Additional propagation efforts at the Kentucky facility since 2015 have produced several thousand additional juveniles.

Since the completion of the last 5-year review in 2015, an additional 25 females and 29 males have been collected in Killbuck Creek during sampling efforts in 2015 – 2017. Collected purple cat's paws were kept in Killbuck Creek in cages each winter to allow larvae in gravid females to mature. The mussels were retrieved from the cages in the spring and transported each year to the Kentucky mussel facility for propagation.

Purple cat's paw propagation at the Kentucky facility has been conducted each year since 2013 with larvae from the Killbuck Creek females. Adult males are also being kept at the Kentucky facility to allow fertilization of the females in captivity for future propagation efforts. In August 2017, approximately 2,700 juveniles (ages 1 – 2) were large enough for tagging and stocking for reintroduction efforts.

In 2017, five streams in the species' historic range were chosen for pilot studies to determine their suitability for purple cat's paw reintroductions. Eight sites were chosen to receive 50 juveniles each including 1 site in the Walhonding River (OH), 1 site in the Ohio River (WV), 2 sites in the Green River (KY), 2 sites in the Licking River (KY), and 2 sites in the Duck River (TN). The sites were chosen based on the habitat quality and diverse mussel communities with multiple age classes which include other federally listed mussel species, including other *Epioblasma* species at most locations. The juveniles were all marked with numbered tags and glitter (affixed to shells with glue) and a few individuals at each location were PIT tagged to facilitate relocating individuals for monitoring. The length of the juveniles ranged from 13 – 18 mm.

All pilot study sites except the Kentucky sites were monitored in September and October 2018 for survival and growth of the juveniles. The Kentucky sites were not monitored because high stream flow conditions made sampling unsafe (McGregor 2019, pers. comm.). At all sites monitored, PIT tagged individuals were found live and most had nearly doubled in size with lengths ranging from 23 – 30 mm. The mussels were found to have either not moved from the release sites or have moved only a few meters downstream (Boyer pers. obs.; Clayton 2018, pers. comm.; Hua 2018, pers. comm.).

All monitored pilot sites were determined to be suitable to receive additional juveniles based on the survival and growth of the juveniles released in 2017. Approximately 2000 juveniles were available for additional augmentations in 2018. Approximately 250 juveniles were released at each site in September – October 2018, with the exception of the Kentucky sites and the Ohio River due to elevated flow conditions (high water). All individuals were tagged (shellfish tags and glitter) and a subset of each batch were also PIT tagged. The Killbuck Creek population was also augmented with 50 juveniles in September 2018.

In fall 2019, a total of 1,268 juvenile cat's paw were stocked into four streams (Ohio River, Licking River, Green River, and Duck River). All of the 2019 releases occurred at previous release sites except for one new release site on the Licking River. No additional juveniles were released into the Walhonding River or Killbuck Creek in 2019 due to high water conditions. Monitoring of the previously released purple cat's paw documented both continued survival and growth.

Captive propagation at the Kentucky facility is ongoing and is utilizing previously collected females that have become gravid while in holding at the facility. Juveniles produced from these efforts will continue to be used for augmentations and reintroductions in the species current and historical range.

This criterion addresses listing factor A, which is the present or threatened destruction, modification, or curtailment of habitat or range. Some progress has been made to address the threats under listing factor A, including a dam removal completed on the Green River in Kentucky in with a second dam removal project being planned for that stream. Another dam removal project is scheduled for the fall of 2020 on the Walhonding River in Ohio. Currently there is one small reproducing population of cat's paw in Killbuck Creek and five newly reintroduced populations (Walhonding River (OH), Ohio River (WV), Green River (KY),

Licking River (KY), and Duck River (TN) which currently only harbor juveniles or young adults. Neither reproduction nor recruitment has been documented in any of these five reintroduced populations. Criterion 1 has not been met because reproduction and recruitment in the reintroduced populations has not yet been documented, though the recent reintroduction efforts are focused on addressing this criterion.

Criterion 2. Two naturally reproduced year classes exist within each of the four populations. Both year classes must have been produced within 10 years, and one year class within 5 years, of the downlisting date. Within 1 year of the downlisting date, gravid females of the subspecies and its fish host must be present in each river.

There is currently one reproducing population (Killbuck Creek) and five reintroduced populations (Walhonding River, Ohio River, Green River, Licking River, and Duck River). Long-term viability of the Killbuck Creek is questionable due to the low density, though some recent recruitment has occurred and the population was augmented with captively propagated juveniles in 2018. The five reintroduced populations contain only young individuals. While some of these may have reached sexual maturity, evidence of reproduction has not yet been documented. Due to the small size and restricted range of the Killbuck Creek population and the current non-reproductive status of the five reintroduced populations, Criterion 2 has not been met.

Criterion 3. Biological and ecological studies have been completed, and the recovery measures developed and implemented from these studies are beginning to be successful, as evidenced by an increase in population density and/or an increase in the population size and the length of the river reach inhabited within each of the populations.

Captive propagation of purple cat's paw was initiated in 2013 utilizing known and potential fish hosts. In 2013, White Sulphur Springs National Fish Hatchery was successful at transforming 13 larval purple cat's paw into juveniles using mottled sculpin (*Cottus bairdii*) as the intermediary host. Propagation using other fish species was not successful for juvenile transformation.

Starting in 2014, in vitro techniques were used, in addition to mottled sculpin, for purple cat's paw propagation. Once the in vitro was used for several years and the methods perfected, it was found to be the most efficient propagation method for the purple cat's paw because it produced significantly larger numbers of juveniles than were being produced by inoculating fish. In 2016, approximately 3,000 juveniles were produced from in vitro propagation. In 2017, 400 of these juveniles were released at 8 sites (50 per site) for a pilot reintroduction project. The release sites were all within the historic range of the purple cat's paw and were currently supporting a large, diverse mussel assemblage including at least one other federally listed mussel.

A subset of the juveniles released in 2017 had passive integrated transponder (PIT) tags attached to them to aid in future monitoring efforts. In 2018, the pilot project sites were monitored for survival and growth. PIT tagged juveniles at all sites were found to have survived and most juveniles had nearly doubled in size. All of the sites were determined to be suitable to support purple cat's paw and receive additional juveniles. In 2018 and 2019, several hundred juveniles

were stocked at each of the reintroduction sites. Augmentation of these sites will continue for several more years with the goal of reestablishing viable populations.

Efforts are underway to meet the recovery goals of the species. However, at this time Criterion 3 has not been met because reproduction and recruitment has not yet been documented at any of the reintroduction sites.

The purple cat's paw pearlymussel will be considered for removal from Endangered Species Act protection when the likelihood of the subspecies becoming threatened in the foreseeable future has been eliminated by the achievement of the following criteria:

Criterion 1. Through protection of existing populations and successful establishment of reintroduced populations or the discovery of additional populations, a total of at least six Ohio River system tributaries contain viable populations. These populations will be distributed within the Ohio River system as follows: one population in Ohio, one population in Indiana, one population in Illinois, two populations in Kentucky, and one population in Tennessee.

Captive propagation is ongoing and reintroductions have been initiated in five streams - one in Ohio, one in West Virginia, two in Kentucky, and one in Tennessee. Some of the individuals released into the species' historical range may have reached sexual maturity though no reproduction has been documented yet in any of the reintroduced populations.

This criterion has not been met. See explanation above in status of downlisting Criteria #1. In addition, there are no reintroduced populations in Illinois or Indiana.

Criterion 2. Two distinct naturally reproduced year classes exist within each of the six populations. Both year classes must have been produced within 10 years, and one year class within 5 years, of the downlisting date. Within 1 year of the recovery date, gravid females of the subspecies and its fish host must be present in each river.

This criterion has not been met. See explanation above in status of downlisting Criteria #2.

Criterion 3. Studies of the mussel's biological and ecological requirements have been completed, and recovery measures developed and implemented from these studies have been successful as evidenced by an increase in population density and/or an increase in the population size and the length of the river reach inhabited within each of the six populations.

This criterion has not been met. See explanation above in status of downlisting Criteria #3.

Criterion 4. No foreseeable threats exist that would likely threaten survival of any of these six populations.

Criterion 4 has not been met. Threats to the extant population in Killbuck Creek includes habitat degradation from agricultural activities in the watershed as well as oil and gas extraction wells

and pipelines. While foreseeable threats to the five reintroduced populations are minimal, stochastic events, such as spills and the potential for climate change effects (e.g., flooding, droughts, increased water temperatures), cannot be ruled out.

Criterion 5. Where habitat had been degraded, noticeable improvements in water and substratum quality have occurred.

Criterion 5 has not been met. However, efforts are currently underway to conduct dam removals on the Walhonding River in Ohio and Green River in Kentucky, which would restore sections of these streams to free-flowing systems and likely result in an increase the amount of available habitat for the species and its host fish.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

There is no new information on the species' biology and life history.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Although recruitment has occurred within the past several years based on the finding of young individuals, long-term viability of the Killbuck Creek population is questionable due to the very small population size that appears to be concentrated in one riffle. The species is likely extirpated from the Cumberland River as no individuals have been observed there in over 30 years. Reintroduced populations in the Walhonding River, Ohio River, Licking River, Green River, and Duck River currently only harbor juveniles and young adults and natural reproduction of the species has not yet been documented in these populations.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Since the completion of the last 5-year review, 44 purple cat's paw adults from Killbuck Creek and 33 captively propagated progeny have been genetically assessed at Virginia Tech using the mitochondrial DNA gene ND1(Jones 2019, unpublished data). Little to no genetic variation was observed at the ND1 gene overall, which indicates that the Killbuck Creek population has been through a recent bottleneck.

Fourteen nuclear DNA microsatellite loci were also screened to assess genetic variation for the 44 adults and 33 progeny. Heterozygosity and allelic richness values were moderately low but would not be considered extremely low, indicating that females are being fertilized by at least a few males in Killbuck Creek. It was also noted that the

progeny have slightly higher allelic richness than the adult broodstock, which likely reflects fertilization by multiple adult males (Jones 2019, unpublished data). Since all brood stock is coming from a lone natural population, representation and lack of genetic representation will remain of concern for the species.

2.3.1.4 Taxonomic classification or changes in nomenclature:

The purple cat's paw pearlymussel (*Epioblasma* (*=Dysnomia*) *obliquata obliquata* (*=E. sulcata sulcata*)) was described by Rafinesque (1820). Williams et al. (2017) used Turgeon et al. (1998), Serb et al. (2003), Sproules et al. (2006), their own unpublished research, and discussions with other experts on mussel systematics to develop a revised taxonomic classification and comprehensive list of the freshwater mussels of the United States and Canada that reflected recent refinement of mussel systematics. They determined that due to the distinctive shell morphology and distinctive geographical range of the subspecies, they reassigned the purple cat's paw name to "catspaw" and reassigned the subspecies to the species *Epioblasma obliquata*. The Service has neither recognized the change in name or nomenclature through the rule-making process.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

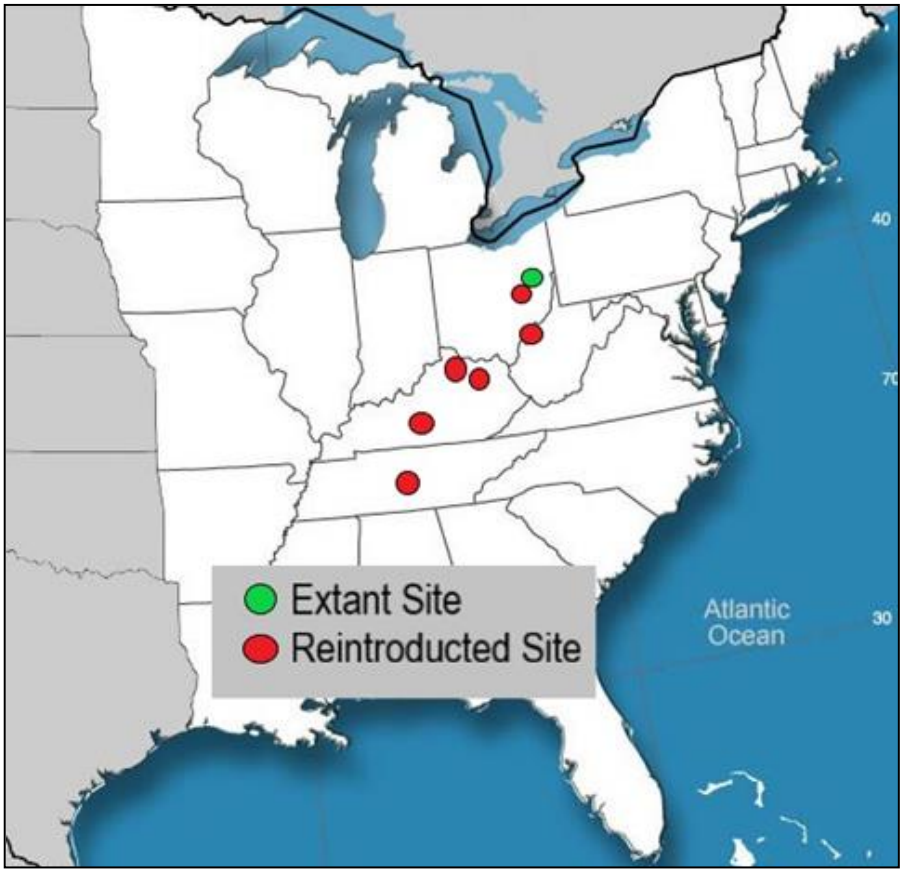
The purple cat's paw pearlymussel was historically distributed in the Ohio, Cumberland, and Tennessee River systems in Ohio, Illinois, Indiana, Kentucky, Tennessee, and Alabama (Bogan and Parmalee 1983; Isom et al. 1979; Kentucky State Nature Preserves Commission 1980; Parmalee et al. 1980; Stansbery 1970; Watters 1986). Currently, the subspecies occurs in the Ohio River and four of its tributaries (Killbuck Creek (OH), Walhonding River (OH), Green River (KY), Licking River (KY)) and one Tennessee River tributary (Duck River (TN)) (Figure 1). With the exception of the Killbuck Creek population, all of these populations were reintroduced into these streams in 2017.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

The Killbuck Creek watershed is predominantly agricultural with numerous oil and gas wells (Ahlstedt 2007). In 1997, Hoggarth and Ross reported that Killbuck Creek "provides high quality habitat and sufficient water quality" to support the purple cat's paw and 24 other mussel species. However, just a decade later, Ahlstedt (2007) reported that mussel habitat in Killbuck Creek is "severely degraded" with the creek entrenched among steep eroding banks. Deadfalls and debris piles are common in the creek and point bar formations are evidence of massive bed-load movement during high surface flows. Furthermore, Ahlstedt (2007) reports that sampling for purple cat's paw in the creek is difficult due to high sediment load causing very poor visibility, except during rare low-flow conditions. In 2012, a drought provided excellent sampling conditions which allowed biologists to locate living females and initiate captive propagation.

Dam removal efforts are underway on the Green River in Kentucky. In 2017, the Green River Lock & Dam 6 was removed. This restored eight additional miles of river to free-flowing condition downstream of the reintroduction locations in Mammoth Cave

Figure 1. Current Range of the Purple Cat's Paw Pearly Mussel



National Park. Efforts to remove Green River Lock & Dam 5 in the future are underway (Garland 2019, pers. comm.)

Planning for the removal of the low-head Six Mile Dam on the Walhonding River in Ohio is currently underway with tentative plans for removal in 2020 (Fleece 2019, pers. comm.). The dam is located upstream of the mouth of Killbuck Creek and downstream of the purple cat's paw reintroduction site. Once removed, the dam will restore 1.06 miles of the Walhonding River to its original free flowing condition. One dam, the Mohawk Dam, would remain on the river at the convergence of the Kokosing and Mohican River where they form the Walhonding River. The Mohawk Dam is a dry dam, holding back water only during a flood and releasing it slowly downstream.

2.3.1.7 Other:

N/A

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

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

We have no new information regarding the destruction, modification, or curtailment of the purple cat's paw habitat or range since the 2015 5-year review was completed. However, one dam removal on the Green River in Kentucky occurred in 2017 with a second dam removal being planned on the river. The Six Mile Dam on the Walhonding River in Ohio is scheduled for removal in the fall of 2020 and this project is currently undergoing formal section 7 consultation with the U.S. Army Corps of Engineers. These dam removal projects are anticipated to help restore sections of these rivers to habitat suitable for the purple cat's paw.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

We have no new information regarding overutilization of the purple cat's paw since the 2015 5-year review was completed.

2.3.2.3 Disease or predation:

The Recovery plan does not discuss disease or predation as limiting factors for this species. We have no new information on disease or predation that would indicate either is a limiting factor.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

We have no new information regarding inadequacy of existing regulatory mechanisms for protecting this species.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Climate change likely constitutes a threat for the species. Current climate change predictions in the Northern Hemisphere indicate warmer air temperatures and more intense precipitation events are likely to occur in the future (Hoegh-Guldberg et al. 2018). The predicted impacts on streams include changes in the distribution of algae, plankton, and fish, as well as changes in water temperatures and oxygen levels. Warming of waters in rivers and streams may make these habitats less suitable for their current fish and mussel fauna (IPCC 2014). Highly specialized species, such as freshwater mussels, are likely to be most susceptible to the additional stresses of a changing climate.

The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2014). Although the specific effects of climate change on the purple cat's paw pearlymussel are unknown, altered hydrology in rivers, increased frequency of extreme weather events, and a changing abundance and distribution of fish species have the potential to adversely affect this species. The magnitude of the climate change threat to the purple cat's paw pearlymussel is unknown.

Other threats to the species also exist in Killbuck Creek, where the substrate is severely embedded and largely comprised of hard pan, which doesn't allow for mussel colonization outside of the currently occupied riffles. The riparian zone is also impacted by timber removal, field crops, and cattle accessing the stream. Ahlstedt (2007) also noted that "fish are noticeably absent and Asian clams were abundant" in Killbuck Creek. Ahlstedt (2014) reported that Asian clams (*Corbicula fluminea*) appeared to have a massive die-off in 2011 but have appeared to rebound and are currently relatively common in the stream. It is interesting to note that the 2011 die-off correlates with the timing of the recent recruitment of purple cat's paw in Killbuck Creek. When Asian clam numbers were very low the purple cat's paw had successful recruitment. However, it is not known if these two events are related. However, it has been suggested that Asian clams may adversely impact native mussels by consuming a significant portion of their sperm (USFWS 1992) and that they may compete with native mussels for food and space (Sea Grant Pennsylvania, no date). The Killbuck watershed also contains many operating oil and gas wells, though it is unknown if these wells are impacting the creek.

2.4 Synthesis

The purple cat's paw pearlymussel is a federally listed endangered species that is currently known to occur in six streams. At the time of listing, the species was thought to be extant in the Cumberland River in Tennessee. However, no individuals have been documented in the Cumberland River in over 30 years and that population is likely extirpated. The Killbuck Creek population, first discovered in 1994, was thought to be viable in the first few years following discovery, based on sampling efforts. However, recent search efforts aimed at collecting adult purple cat's paw for captive propagation have found that the species is now quite rare in the creek, and habitat conditions have declined dramatically since the 1990s.

The biology of the purple cat's paw pearlymussel is similar to other bivalved mollusks belonging to the family Unionidae. However, due in large part to its rarity, relatively little is known about its specific life history requirements.

Survey work in Killbuck Creek for the purple cat's paw has occurred in 1994, 1995-1996, 1997, 2001, and 2006-2017 (Hoggarth et al. 1995; Hoggarth 1996; Hoggarth and Ross 1997; Ahlstedt 2007; Ahlstedt 2008; G.F. Zimmerman, Enviroscience Inc., in litt. 2009; Ahlstedt 2009; Ahlstedt 2010; Ahlstedt 2011; Ahlstedt 2012; Ahlstedt 2013; Ahlstedt 2014; Ahlstedt 2015; Ahlstedt 2016; Spaeth 2016, pers. comm.; Ahlstedt 2017). Live females were found in 2012 and captive

propagation was initiated the following spring using larvae extracted from females that were gravid. Additional females found in 2013-2017 have also been used for captive propagation.

Since the last 5-year review was conducted, there has been no new information on the species' biology or life history but the genetic of the Killbuck Creek population has been assessed. The genetic results indicate that the Killbuck Creek population has been through a recent bottleneck. DNA microsatellite loci were also screened to assess genetic variation for wild adults and their captively propagated progeny. Heterozygosity and allelic richness values were moderately low, but not extremely low. It was also noted that the progeny have slightly higher allelic richness than the adult broodstock (Jones 2019, unpublished data).

Currently, the species occurs in the Ohio River and four of its tributaries (Killbuck Creek (OH), Walhonding River (OH), Green River (KY), Licking River (KY)) and one Tennessee River tributary (Duck River (TN)). With the exception of the Killbuck Creek population, all of these populations were reintroduced into these streams in 2017 as juveniles and augmented with additional juveniles in 2018 and 2019. While some of the reintroduced individuals may be sexually mature, no reproduction has been documented yet.

The purple cat's paw pearlymussel should remain listed as *endangered* because threats have not been ameliorated, and the criteria for downlisting to threatened status have not been met. Threats persist for the remaining purple cat's paw pearlymussel populations, including habitat degradation and climate change. In sum, our current understanding of the purple cat's paw pearlymussel's status leads us to conclude that this species continues to be in danger of extinction throughout all or a significant portion of its range, thereby meeting the definition of endangered under the Endangered Species Act.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ No change is needed

RECOMMENDATIONS FOR FUTURE ACTIONS

Prevent extinction by continuing surveys to locate individuals to continue the captive propagation efforts.

Continue to rear juveniles in captivity for future augmentation, reintroductions, and to serve as broodstock for captive propagation.

Investigate potential sites for future augmentation or reintroduction of captivity reared juveniles and/or adults.

Update recovery criteria to address climate change.

Continue efforts to remove low head dams to improve/restore stream habitat for the purple cat's paw and its host fish.

5.0 REFERENCES

Ahlstedt, S.A. 2007. Federal fish and wildlife permit annual report (1-16-07), endangered species permit number: TE113009-0, Catspaw *Epioblasma obliquata obliquata*. 5 pp.

Ahlstedt, S.A. 2008. Federal fish and wildlife permit annual report (12-8-08), endangered species permit number: TE113009-0, Catspaw *Epioblasma obliquata obliquata*. 3 pp.

Ahlstedt, S.A. 2009. Federal fish and wildlife permit annual report (12-15-09), endangered species permit number: TE113009-0, Catspaw *Epioblasma obliquata obliquata* and White Catspaw *Epioblasma obliquata perobliqua*. 6 pp.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Purple Cat's Paw Pearlymussel

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Delisting Priority Number: N/A

Review Conducted By: Angela Boyer, Fish and Wildlife Biologist

FIELD OFFICE APPROVAL:

Lead Field Office Supervisor, Fish and Wildlife Service

Approve PATRICE ASHFIELD Digitally signed by PATRICE ASHFIELD Date: 2020.04.21 14:33:17 -04'00' Date _____