Recovery Plan for the Three Forks springsnail (*Pyrgulopsis trivialis*), Version 1.0

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PURPOSE AND DISCLAIMER

This document presents the U.S. Fish and Wildlife Service's (USFWS) plan for the conservation of Three Forks springsnail. The recovery plan is the second part of the Service's 3-part recovery planning framework, and includes the statutorily required elements pursuant to section 4(f) of the Endangered Species Act (ESA). This recovery plan is informed by the first part of the framework, a Species Status Assessment (SSA). The SSA report delivers foundational science for informing decisions related to the Act and includes an analysis of the best available scientific and commercial information regarding a species' life history, biology, and current and future conditions that characterizes the species' viability (*i.e.*, ability to sustain populations in the wild over time) and extinction risk. **We have also prepared a Recovery Implementation Strategy (RIS), the third part of the framework. The RIS is an easily updateable operational plan that is separate and complimentary to the recovery plan that details the on-the-ground recovery activities needed to complete the recovery actions contained in the recovery plan.**

Recovery plans describe the envisioned recovered state for a listed species (when it should no longer meet the ESA's definition of a threatened species or endangered species) and include a recovery strategy, recovery criteria, recovery actions, and the estimates of time and cost needed to achieve it. Plans are published by the USFWS and are often prepared with the assistance of recovery teams, contractors, State agencies, and others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in plan formulation, other than the USFWS. They represent the official position of the USFWS only after they have been signed by the Regional Director as approved. Recovery plans are guiding and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and completion of recovery actions.

ACKNOWLEDGEMENTS

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RECOMMENDED CITATION AND ELECTRONIC AVAILABILITY

U.S. Fish and Wildlife Service. 2025. Recovery plan for Three Forks springsnail (*Pyrgulopsis trivialis*), Version 1.0. U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico, USA. 22 pp.

An electronic copy of this Final Recovery Plan will be made available on the ECOS species profile page

1. INTRODUCTION

This recovery plan describes criteria for determining when the endangered Three Forks springsnail (*Pyrgulopsis trivialis*) should be considered for downlisting and/or delisting, lists site-specific actions that will be necessary to meet those criteria, and estimates the time and cost to achieve recovery. This recovery plan is based on the Species Status Assessment for the Three Forks Springsnail (*Pyrgulopsis trivialis*), Version 1.0 (USFWS 2023 entire). The SSA details the life history, biology, current and plausible future status, and the threats that impact the species. On-the-ground activities thought necessary for implementing recovery actions can be found in the Recovery Implementation Strategy. These supplemental documents are available on the ECOS species profile page. The Recovery Implementation Strategy and SSA are developed separately from the Recovery Plan, allowing each document to be updated independently as needed.

Due to population declines and a reduction in distribution within its range, the Three Forks springsnail was federally listed as endangered with critical habitat under the ESA in 2012 (USFWS 2012 entire) and as a Species of Greatest Conservation Need, Tier 1 in Arizona. Tier 1 species are identified as those most at risk of extinction or extirpation and are prioritized for conservation (Arizona Game and Fish Department 2022 p. 14).

The Three Forks springsnail is a small hydrobiid snail that occurs in springs and seeps in the White Mountains in eastern Arizona (Figure 1). Each spring can have varying habitat characteristics, and the springsnail requires specific habitat requirements and parameters. There are a minimum of 26 springheads across three complexes that currently support or have the potential to support Three Forks springsnail (USFWS 2023 p. 12, 44). Of the 26 monitored springheads, three are not known to have historical occurrences, 11 are considered extirpated, and 12 have extant populations. Of the 12 extant populations, eight currently have a known average abundance of 50 or fewer springsnails, two have a known average abundance between 51 to 199 springsnails, and two have a known average abundance between 200 to 499 springsnails (USFWS 2023 p. 23, 44). Two populations are considered self-sustaining, and all others need some level of augmentation to persist into the future. Extant populations are within the Boneyard Creek Complex (seven populations of 12 springs) or Boneyard Bog Complex (five populations of nine springs). At the Three Forks Complex, springsnails had previously occupied at least five springs, but those populations are now considered extirpated (USFWS 2023 p. 13, 44).

The Three Forks springsnail's entire range is distributed within three complexes found within 5.95 kilometers (km) (3.7 miles [mi]), predominantly along a single drainage (*i.e.,* Boneyard Creek). Historically, only three complexes held all known genetic diversity. Any genetic diversity historically present at the Three Forks Complex was lost, and there is a high risk of losing remaining genetic diversity in the Boneyard Creek Complex because all extant populations are considered to have very low resiliency (ability to withstand stochastic disturbance events, an ability associated with population size, growth rate, and habitat quality: USFWS 2023 pp. 36-46). The Boneyard Bog Complex has two populations with moderate resiliency (USFWS 2023 pp. 40-46). This is the highest resiliency condition documented for any extant population, which is concerning because the Boneyard Bog Complex is within the highest

elevations of the watershed, at 2,575 meters (m) (8,450 feet [ft]), and therefore most likely to be impacted by environmental change and drought (USFWS 2023 pp. 25-26, p. 46). Conversely, the lowest elevation complex in the watershed is the Three Forks Complex. Given its elevation, at 2,507 m (8,228 ft), and location near the confluence of Boneyard Creek and the East Fork of the Black River, it is less likely to be as affected by environmental change because water inputs are received from a greater portion of the watershed, but all populations are extirpated and augmentation is necessary to reestablish populations.

The primary reason for the Three Forks springsnail population declines is believed to be invasive crayfish, which are known to prey upon the species. However, several other potential factors have been identified including habitat loss following wildfires, and the potential for environmental change and drought to alter or dry springhead habitat (USFWS 2012 pp. 23066-23071, 2023 pp. 24-32).

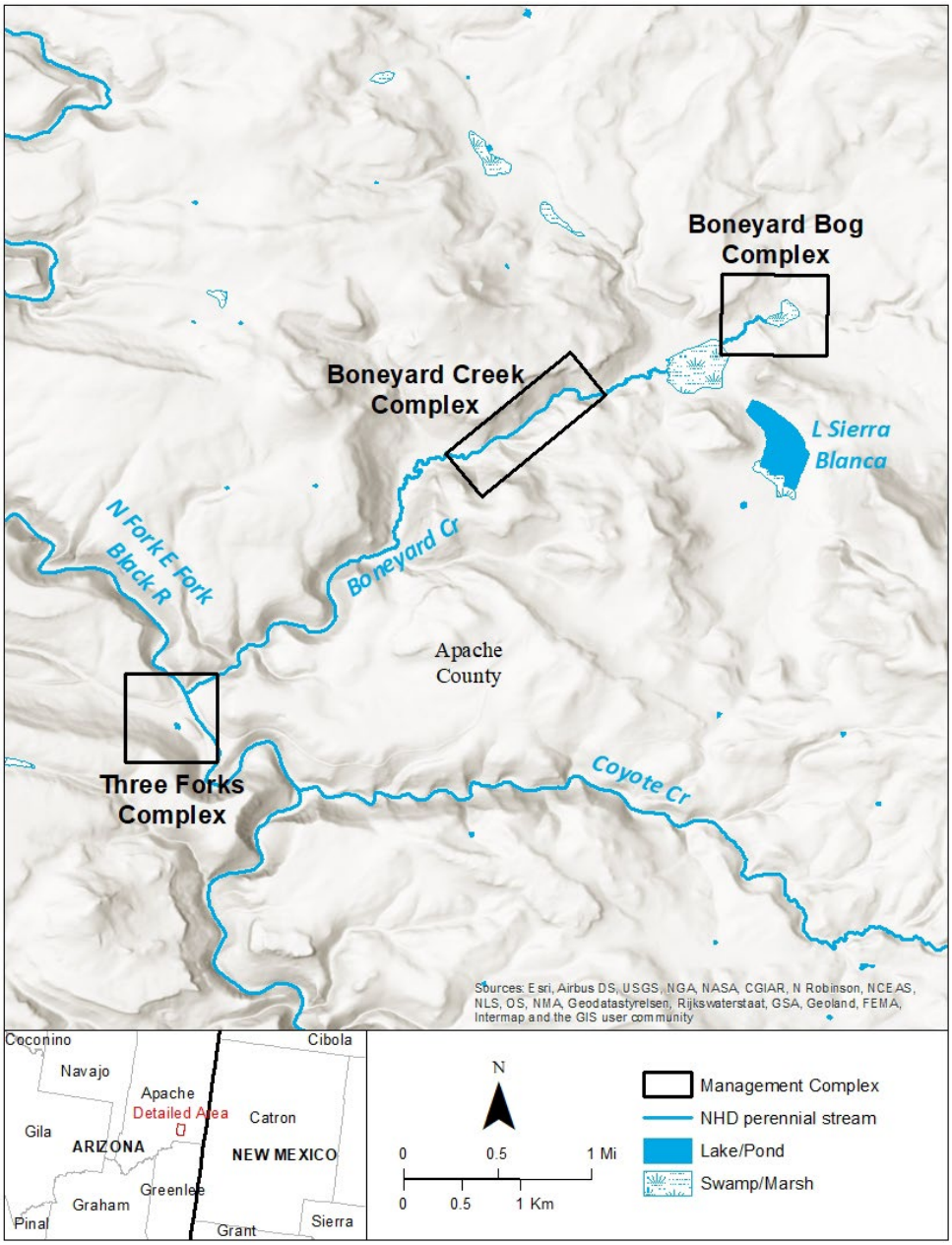

Figure 1. Locations of the Three Forks springsnail population complexes. NHD perennial streams indicates streams from the National Hydrological Database layers.

Threats

Under the ESA, a species is determined to be an endangered or threatened species based on any one, or a combination of, the five listing factors established under section 4(a)(1): (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. The greatest threats affecting the Three Forks springsnail are predation by non-native crayfish (Factor C and E) and environmental change

(Factor A and E). Therefore, protection and restoration of spring habitat is necessary to ensure the viability of the species. In addition, many populations are considered small, making them more susceptible to adverse effects from various threats including crayfish presence and other stochastic events.

Factor A: Multiple threats contribute to the loss and degradation of habitat throughout the species' range. Many of these threats (*e.g.*, drought, wildfire and suppression contaminants, flooding, erosion and deposition) are influenced by environmental change. The Three Forks springsnail requires spring environments that have sufficient flow volume, hard and vegetative substrates, and water quality to complete their life history (Martinez and Myers 2008 pp. 189–194, Martinez and Rogowski 2011 p. 218). Spring depth is too shallow to accommodate flow gauges in the majority of springs occupied by Three Forks springsnails. Therefore, flow is categorized by visual observation. Springsnails have been found in springs and seeps that are wet or have low to moderate flows. Rising temperatures, drought, and changes in precipitation patterns may alter flows or dry springs, resulting in degradation or loss of habitat through sedimentation or direct mortality via desiccation. Increased frequency of wildfire and associated use of fire suppression contaminants may result in direct mortality if chemicals reach and contaminate spring water. Post-wildfire flooding events may alter flows, resulting in degradation or loss of habitat through sedimentation or scouring. Trampling and grazing generates sediment, can erode springhead banks and channels, and potentially causes direct mortality from crushing (Folsom and Sorensen 2018 p. 8, Pagowski and Sorensen 2018 p. 15).

Factor B: There is no known threat to the species or habitat currently associated with overutilization for commercial, recreational, scientific, or educational purposes. Permitted surveying and collection is conducted with minimal impacts to the species. Surveys are not conducted annually to reduce potential impacts to habitat, and collections for translocation are conducted only when a population has sufficient abundance. These activities have promoted conservation of the species.

Factor C: Nonnative crayfish reduce species diversity and destabilize food chains in riparian and aquatic ecosystems through their effect on vegetative structure and stream substrate (*i.e.*, silt, sand, cobble, boulder) composition, and predation of eggs, larval, and adult forms of native invertebrate and vertebrate species (Fernandez and Rosen 1996 p. 3). Crayfish threaten the Three Forks springsnail by decreasing habitat quality and preying upon all springsnail life stages (Lodge and Lorman 1987 p. 594, Hanson et al. 1990 pp. 73–77, Lodge et al. 1994 p. 1276, Creed 1994 p. 2098, Sorensen 2021 pp. 13–15). Crayfish also burrow into stream banks, which increases bank erosion, stream turbidity, and siltation of stream bottoms (Fernandez and Rosen 1996 pp. 10–12). As crayfish invade the Three Forks springsnail's range, they consume and degrade habitat resources and prey upon springsnails themselves.

New Zealand mudsnails likely outcompete native springsnails for periphyton and exhibit faster growth rates in areas with native springsnail presence, while native springsnails exhibit slower growth rates when New Zealand mudsnails are present (Riley et al. 2008 p. 517). Currently, New Zealand mudsnails are not present within or near the range of the Three Forks springsnail. However, there is potential for this non-native species to be introduced into creeks and spring runs where springsnails occur either through passive transport from birds, ingestion and deposition by fish, or deposition by ungulates or recreationalists (California Department of Fish

and Wildlife n.d.). Research suggests that specific conductivity of water where Three Forks springsnails are extant may be sufficiently low to negatively influence growth and fecundity of the New Zealand mudsnail (Herbst et al. 2008 p. 331, Larson et al. 2020 p. 114, Sorensen 2021 pp. 16–17). Although not considered a significant threat at this time, additional research on the New Zealand mudsnail is needed to understand its full potential to occupy Three Fork springsnail habitat.

Within the Three Forks Complex, well prior to the extirpation of the Three Forks springsnail, exceptionally heavy parasitism was documented on the female springsnail's reproductive system (Taylor 1987 p. 31). Because the decline and subsequent extirpation of the springsnail in this Complex coincided with the arrival of crayfish, and parasites were not known to occur in more recently discovered populations in Boneyard Bog and Boneyard Creek, parasitism was not considered a threat to the species when listed (USFWS 2012 p. 23068). To date, there is no information to suggest that parasitism is occurring in extant populations. It is unknown what level of parasitism could have population level impacts on the Three Forks springsnail. Therefore, although parasitism is not currently considered a threat to the species, the potential effects of parasitism on the species warrants further investigation.

Factor D: The range of the Three Forks springsnail occurs almost entirely within U.S. Forest Service owned and managed lands. One inholding of private land occurs between the Boneyard Bog and Boneyard Creek complexes. Although it contains potential habitat, this property is not known to contain Three Forks springsnails. The species has full protection of the ESA and is a Tier 1 State Species of Greatest Conservation Need in Arizona. Contaminants from fire retardants were considered a threat due to lack of regulatory mechanisms to protect the species at the time of listing; however, since then the U.S. Forest Service and cooperating agencies have defined and adopted fire-retardant avoidance areas. Therefore, fire-retardant is not considered a major threat at this time. The U.S. Forest Service has implemented administrative closures for two complexes, Three Forks and Boneyard Bog. Administrative closures prohibit public access to these complexes. Although public access is permitted within the Boneyard Creek Complex, substantial public use has not been documented. Increased public use along Boneyard Creek, however, has been observed in recent years. Most extant populations in the Boneyard Creek Complex are protected by fenced enclosures to exclude elk, which may provide some protection from disturbance from human traffic. Fencing, however, does not provide remediation from the potential introduction of disease or invasive species.

Factor E: Other natural or manmade factors that could affect the continued existence of the Three Forks springsnail include drought and wildfires as influenced by environmental change and invasive species (see discussions above).

2. RECOVERY STRATEGY

The recovery strategy provides a concise overview of the envisioned recovered state for Three Forks springsnail, describes the USFWS's chosen approach to achieve it, and includes the rationale for why the approach was chosen. Specifically, the recovery strategy articulates how the plan's statutory elements (*i.e.*, recovery criteria, recovery actions, and estimates of time and cost) will work together to achieve Three Forks springsnail's recovery.

The ultimate goal of this recovery plan is to prevent the decline, and enhance the populations of, the Three Forks springsnail so that ESA protections are no longer necessary. To achieve this goal, it will be necessary to establish self-sustaining populations in at least three geographically distinct complexes distributed across the species' known or potential historical range. It will also be necessary to mitigate the threats from trampling, crayfish, and erosion/flood scouring. To achieve recovery of the Three Forks springsnail we need to: (1) Establish, and maintain, viable high condition populations in three distinct complexes; (2) restore, maintain and protect springsnail habitat to support viable populations in at least three distinct complexes; and (3) establish captive populations that are capable of supporting springsnail releases into the wild. Currently, wild populations are not robust enough to establish new populations of Three Forks springsnails solely through wild-to-wild translocation; therefore, establishment of captive populations to support population establishment in the wild is needed. Additionally, unoccupied springs, seeps, or runs may not be capable of supporting springsnails at this time and may need habitat modification or threat abatement measures prior to the release of springsnails.

Although there is limited information pertaining to the species' life history and environmental thresholds, the recovery plan aims to ensure that sufficient numbers of resilient populations are secured to support long-term viability of the Three Forks springsnail. Establishment and maintenance of a captive population will enable us to fill some of our data gaps pertaining to life history, as well as buffer effects of environmental change and stochastic events within the species' range. Establishing wild and captive populations and filling data gaps is dependent upon cooperative work with partners.

Because of the life history and threats to the Three Forks springsnail, efforts will focus on ameliorating the threat of crayfish and establishing captive populations to supplement wild populations. Finally, because of the uncertainty in how environmental change projections may manifest, implementing an adaptive management approach will be imperative.

3. RECOVERY CRITERIA

An endangered species is defined in the ESA as a species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. When we evaluate whether a species warrants downlisting or delisting, we consider whether the species meets either of these definitions. A recovered species is one that no longer meets the ESA's definitions of threatened or endangered. Determining whether a species should be downlisted or delisted requires consideration of the same five categories of threats (that is, the five threat factors, A-E) that were considered when the species was listed and are described in section 4(f)(1)(b)(ii) of the ESA.

Recovery criteria are statutorily required objective, measurable descriptions of a recovered state for Three Forks springsnail, as described in 4(f)(1)(b)(ii) of the ESA. They present our best assessment of a species' recovered condition at the time of recovery plan development. They describe the conditions of resiliency, redundancy, representation, and threat abatement that best represent the conditions when the species may no longer meet the definition of threatened or endangered. These criteria describe the demographic characteristics of a recovered population,

and threat alleviation necessary to maintain those recovered populations, both of which are necessary to ensure that the species is no longer in danger of extinction. Changes in available information, technologies, and our understanding of the species over time might mean that the recovered state envisioned by the recovery criteria differs from our assessment in a later status determination.

Downlisting Criteria

The following downlisting criteria, when met collectively, could indicate that the Three Forks springsnail may be reclassified as a threatened species.

Downlisting Criterion 1:

1. Throughout the range of the Three Forks springsnail at least 30 springs are occupied (*i.e.,* 30 populations) under the following conditions:
   a) Eight populations each have an average of at least 500 springsnails over 5 survey years with a catch per unit effort trend line showing a stable or increasing population.
      i) Six of these 8 populations are distributed across 3 complexes (2 populations in each complex). The remaining 2 populations can occur within or outside of the complexes.
   b) Fourteen populations each have an average of at least 200 springsnails over 5 survey years with a catch per unit effort trend line showing a stable or increasing population.
      i) Twelve of these 14 populations are distributed across 3 complexes (4 populations in each complex). The remaining 2 populations can occur within or outside of the complexes.
   c) Eight other populations have a catch per unit effort trend line showing a stable or increasing population, maintained over 5 survey years.

Rationale for Criterion 1

The entire known range of the Three Forks springsnail occurs along 6 kilometers (km; 3.7 mi) of perennial waterways. Because of this, events such as wildfire and drought pose a significant threat to the persistence of the species (Factor A). Such events are likely to increase in frequency and/or intensity from environmental change (Factor E). Maintaining at least three geographically distinct complexes helps mitigate these threats by ensuring that there are geographically separated complexes that can serve as areas for the species to persist when stochastic or catastrophic events occur. Further, because a population needs at least 500 springsnails to be considered highly likely to be self-sustaining into the future, at least two populations within each complex need to have this minimum population size. These measures help secure population resiliency and genetic and ecological representation across the species' range. Because surveys are not conducted for each population annually, to reduce potential impacts from disturbance, average population size is calculated using the data from the most recent 5 surveys conducted.

The Three Forks springsnail's lifespan is approximated at 15 months. Given the species' life history and survey frequency, this timeframe (5 survey years) provides sufficient insight into the population's stability for downlisting. The species is prone to naturally occurring population fluctuations and has limited dispersal abilities, which make it more vulnerable to habitat

degradation and loss (Factor A) due to environmental stochastic and catastrophic events, predation by crayfish (Factor C), and effects of environmental change (Factor E). Therefore, to maintain genetic and ecological representation and increase redundancy of the species across the potential historical range, at least 30 occupied springs are needed.

Downlisting Criterion 2:

2. Springsnail habitat is protected from trampling, wallowing, crayfish, and erosion/flood scour by the following:
   a) Habitat enclosures to protect springsnail habitat from trampling, wallowing, and crayfish for all logistically feasible populations are implemented and maintained long-term.
   b) Within the floodplain, erosion, sedimentation, and flood scour risk is effectively mitigated for all logistically feasible populations with an average of at least 200 springsnails.

Rationale for Criterion 2

The Three Forks springsnail has limited dispersal capabilities; therefore, it is highly susceptible to habitat degradation (Factor A) and predation by crayfish (Factor C). To mitigate these threats, the habitat within the springs and spring runs needs to be protected. Although crayfish removals occur opportunistically during annual surveys, to be effective in the long-term, habitat enclosures need to be installed and maintained. Habitat enclosures provide a physical barrier that mitigates crayfish access from springs, seeps, and spring run habitat. Placement of boulders on the upstream edge of springs could protect habitat from seasonal flooding that results in siltation and scouring. This protection may benefit springs within the floodplain that are offset from a creek edge. By protecting springs and seeps from both crayfish access and flood scour, populations are more likely to persist into the future, increasing redundancy across the landscape. Habitat protection may not be possible for all populations because the physical attributes at a spring site, such as proximity to creek edge or incompatible terrain, may prohibit installation of enclosures.

Downlisting Criterion 3:

3. Two captive populations are established and maintained to provide sufficient propagation for augmentation of wild populations.

Rationale for Criterion 3

The Three Forks springsnail currently occurs within a limited geographic area, few populations are large enough to serve as a source stock to support population augmentation or establishment, and the threats from habitat loss and degradation (Factor A), crayfish (Factor C), and effects of environmental change (Factor E) pose a significant risk to the persistence of the Three Forks springsnail. Therefore, having two refugia populations in captivity will provide assurance of Three Forks springsnail's persistence and will allow for critical information about species' life history and environmental thresholds/tolerances to be determined. Captive populations may have a higher carrying capacity per square foot than wild populations because of the controlled

environment, allowing for frequent and robust augmentation and establishment of wild populations.

Delisting Criteria

The following delisting criteria, when met collectively, may indicate that Three Forks springsnail no longer meets the ESA's definition of either a threatened species or endangered species, and may be removed from the Federal Lists of Endangered and Threatened Wildlife and Plants.

Delisting Criterion 1:

1. Throughout the range of the Three Forks springsnail at least 30 springs (*i.e.,* 30 populations) are occupied under the following conditions:
    a) Eight populations each have an average of at least 500 springsnails over 10 survey years with a catch per unit effort trend line showing a stable or increasing population.
        i) Six of these 8 populations are distributed across 3 complexes (2 populations in each complex). The remaining 2 populations can occur within or outside of the complexes.
    b) Fourteen populations each have an average of at least 200 springsnails over 10 survey years with a catch per unit effort trend line showing a stable or increasing population.
        i) Twelve of these 14 populations are distributed across 3 complexes (4 populations in each complex). The remaining 2 populations can occur within or outside of the complexes.
    c) Eight other populations have an average of at least 75 springsnails over 10 survey years with a catch per unit effort trend line showing a stable or increasing population.

Rationale for Criterion 1

The entire known range of the Three Forks springsnail occurs along 6 kilometers (km; 3.7 mi) of perennial waterways. Because of this, events such as wildfire and drought pose a significant threat to the persistence of the species (Factor A). Such events are likely to increase in frequency and/or intensity from environmental change (Factor E). Maintaining at least three geographically distinct complexes helps mitigate these threats by ensuring that there are geographically separated complexes that can serve as areas for the species to persist when stochastic or catastrophic events occur. Further, because a population needs at least 500 springsnails to be considered highly likely to be self-sustaining into the future, at least two populations within each complex needs to have this minimum population size. These measures help secure population resiliency and genetic and ecological representation across the species' range. Because surveys are not conducted for each population annually, to reduce potential impacts from disturbance, average population size is calculated using the data from the most recent 10 surveys conducted.

The Three Forks springsnail's lifespan is approximated at 15 months. Given the species' life history and survey frequency, this timeframe (10 survey years) provides sufficient insight into the population's stability for delisting. The species is prone to naturally occurring population fluctuations and has limited dispersal abilities, which make it more vulnerable to habitat degradation and loss (Factor A) due to environmental stochastic and catastrophic events,

predation by crayfish (Factor C), and effects of environmental change (Factor E). Therefore, to maintain genetic and ecological representation and increase redundancy of the species across the potential historical range, at least 30 occupied springs are needed. Additionally, eight of the 30 populations have the minimum population size considered sufficient to serve as refugia populations for the species into the future.

Delisting Criterion 2:

2. Springsnail habitat is protected from trampling, wallowing, crayfish, and erosion/flood scour by the following:
    a) Habitat enclosures to protect springsnail habitat from trampling, wallowing, and crayfish for logistically feasible populations are implemented and maintained long-term.
    b) Within the floodplain, erosion, sedimentation, and flood scour risk is effectively mitigated for all logistically feasible populations.

Rationale for Criterion 2

The Three Forks springsnail has limited dispersal capabilities, therefore, it is highly susceptible to habitat degradation (Factor A) and predation by crayfish (Factor C). To mitigate these threats, the habitat within the springs, seeps and spring runs needs to be protected. Although crayfish removals occur opportunistically during annual surveys, to be effective in the long-term, habitat enclosures need to be installed and maintained. Habitat enclosures provide a physical barrier that mitigates crayfish access from springs, seeps, and spring run habitat. Placement of boulders on the upstream edge of springs could protect habitat from seasonal flooding that results in siltation and scouring. This protection may benefit springs within the floodplain that are offset from a creek edge. By protecting springs and seeps from both crayfish access and flood scour, populations are more likely to persist into the future, increasing redundancy across the landscape. Habitat protection may not be possible for all populations, because the physical attributes at a spring site, such as proximity to creek edge or incompatible terrain, may prohibit installation of enclosures.

Delisting Criterion 3:

3. A captive population is established and maintained with an average abundance of 5,000 springsnails to support repatriation efforts. Alternatively, at least ten additional springs outside of currently known complexes are occupied, with at least two springs having a population with an average of 500 springsnails, and three springs having a population with an average of 200 springsnails, over 10 survey years with a catch per unit effort trend line showing a stable or increasing population.

Rationale for Criterion 3

Because of the limited geographic scope of the species' range, the threats from habitat loss and degradation (Factor A), crayfish (Factor C), and effects of environmental change (Factor E) pose a significant risk to the persistence of the Three Forks springsnail. Stochastic and catastrophic events could affect the entire species, and increasing effects of environmental change could alter

spring flow or result in spring drying. Therefore, to ensure the redundancy and representation of the Three Forks springsnail, having a refugia population is necessary. For the species to persist, a captive population, or additional wild populations, are needed and could serve as a refugia population.

4. RECOVERY ACTIONS

Recovery actions are the statutorily required, site-specific management actions needed to achieve recovery, as described in section 4(f)(1)(B)(i) of the ESA. The USFWS assigns recovery action priority numbers (1-3) to rank recovery actions. The assignment of priorities does not imply that some recovery actions are of low importance, but instead implies that lower priority items may be deferred while higher priority items are being implemented. Recovery action priority numbers are based on the following:

Priority 1: An action that must be taken to prevent extinction or to prevent the species from declining irreversibly.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery of the species.

Potential Partners

ACNC-PZ	Arizona Center for Nature Conservation - Phoenix Zoo
AZGFD	Arizona Game and Fish Department
USFS	U.S. Forest Service

Table 1. Recovery action summary table

Related Recovery Criterion	Recovery Action Priority Number	Recovery Action ID Number	Recovery Action	Additional Information	Site	Potential Partners
1	2	1.0	In extant and extirpated springs, conduct monitoring as outlined in the survey and monitoring protocol for metrics such as springsnail presence, relative abundance, habitat associations, water quality.	Use standardized survey and monitoring protocols with timed counts for relative abundance. Add and use tethered sample tiles for snail density estimates. Use enhanced habitat monitoring protocol for more detailed habitat data collection. Incorporate monitoring of spring volume discharge (perhaps with a portable measuring flume) and additional water quality and chemistry sampling (*e.g.,* dissolved oxygen, total dissolved solids, salinity, total alkalinity, nutrients, various metals, hydrocarbons and other pollutants). The latter could be done with water samples tested by a contracted lab, and from one or more springs in each spring complex.	Boneyard Bog Complex, Boneyard Creek Complex, Three Forks Complex	AZGFD, USFS, ACNC-PZ
1,3	3	2.0	Within potential historical range, conduct surveys in springs and seeps without known historical occupancy to identify new populations and identify springs and seeps with the potential to support population establishment.	No additional information.	Potential historical range	AZGFD, USFS
1,2,3	2	3.0	Within known or potential historical range, implement habitat restoration activities at springs and seeps to restore characteristics necessary for springsnail persistence.	No additional information.	Known and potential historical range	AZGFD, USFS

3	2	4.0	Maintain habitat and enclosures at modified springs across known and potential historical range.	Maintenance of enclosures is anticipated to be a minimal effort activity.	Boneyard Creek Complex, Three Forks Spring Complex, Boneyard Bog Complex	AZGFD, USFS
1,2,3	1	5.0	Install or improve habitat enclosures at springs that would benefit from predator exclusion and habitat improvements across known and potential historical range.	Enclosures within Three Forks and Boneyard Creek are authorized under previous cultural compliance. However, cultural resource surveys may be necessary prior to installing spring enclosures elsewhere within the watershed. If a cultural resource survey is needed.it will require funding and a contract. Reports require approval by the USFS, Arizona State Historic Preservation Office (SHPO), and AZGFD for their Environmental Assessment Checklist (EAC) process. Fencing materials will need to be purchased, transported, and installed. Crayfish barriers along the lower edge of these enclosures should be included.	Existing Complexes (*i.e.*, Boneyard Bog Complex, Boneyard Creek Complex, Three Forks Complex) and historical range	AZGFD, USFS
2,3	2	6.0	Within habitat enclosures, conduct crayfish removals prior to repatriation of springsnails.	Crayfish removal requires repeated efforts achieve depletion sampling. This work could be contracted or could rely on local volunteers (*e.g.,* an Eagle Scout project).	Existing Complexes (*i.e.*, Boneyard Bog Complex, Boneyard Creek Complex, Three Forks Complex) and historical range	AZGFD, USFS
1,2	1	7.0	Within habitat enclosures that are occupied by springsnails, conduct crayfish removals.	Opportunistic removals of crayfish during routine monitoring of springs. Targeted removal efforts after individual springs are modified with crayfish barriers.	Boneyard Bog Complex, Boneyard Creek Complex, Three Forks Complex	AZGFD, USFS, ACNA-PZ
1,3	1	8.0	Repatriate and augment existing populations to establish self-sustaining populations across known and potential historical range.	Use previous guidance in approved EAC and biological opinion on collecting and translocating snails from host sites to receiving sites. Use follow-up augmentation stockings to improve and maintain population abundance and genetic fitness / variability of repatriated and new populations of springsnails.	Boneyard Bog Complex, Boneyard Creek Complex, Three Forks Complex	AZGFD, USFS, ACNC-PZ

1,3	1	9.0	Establish new populations in springs and seeps with suitable habitat across known and potential historical range.	Use previous guidance in approved EAC and biological opinion on collecting and translocating snails from host sites to receiving sites. Use follow-up augmentation stockings to improve and maintain population abundance and genetic fitness / variability of repatriated and new populations of springsnails.	Existing Complexes (*i.e.*, Boneyard Bog Complex, Boneyard Creek Complex, Three Forks Complex) and historical range	AZGFD, USFS, ACNC-PZ
3	1	10.0	Establish and maintain captive populations in zoological or other facilities.	Use previous guidance in approved EAC and biological opinion on collecting and translocating snails from host sites to receiving sites. Use follow-up augmentation stockings to improve and maintain population abundance and genetic fitness / variability of repatriated and new populations of springsnails.	Phoenix Zoo Conservation Center AZGFD's Pinetop office wetland	AZGFD, USFS, ACNC-PZ
1,2,3	3	11.0	Conduct research to inform our understanding of Three Forks springsnail biology and ecology.	Research could follow a similar effort completed for Page springsnail conducted by the Phoenix Zoo. This research will inform our understanding of self-sustaining populations.	Known and potential historical range, and captivity	AZGFD, ACNC-PZ, Academic Institutions
1,2,3	3	12.0	Conduct research to inform our understanding of impacts from threats related to environmental change and human activities.	Research could be contracted to a university or other laboratory. Use captive-raised snail progeny for test trials, after a captive population is well established with sufficient numbers of springsnails for research purposes. Investigate fire-retardant solutions currently used by agencies with fire management responsibilities.	Known historical range and captivity	AZGFD, USFS, ACNC-PZ, Academic Institutions

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Table 2. Threats summary table

Threat Description	4(a)(1) Factor(s)	Recovery Criterion ID Number(s)	Recovery Action ID Number(s)
Reduced water flow and water quality	A and E	1, 2, 3	1, 2, 3, 4, 5, 8, 9, 10, 11, 12
Direct mortality through contaminants	A	1, 2	1, 2, 9, 10, 12
Changes to hard and vegetative substrate composition	A	1, 2, 3	1, 2, 3, 4, 5, 8, 9, 10, 11, 12
Increased sedimentation	A	1, 2	1, 2, 3, 4, 5, 8, 9, 10, 11, 12
Predation and resource competition	C and E	1, 2, 3	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12

5. ESTIMATED TIME AND COSTS TO ACHIEVE RECOVERY

Estimates of time and cost, as defined in section 4(f)(1)(B)(iii) of the ESA, must reflect, to the maximum extent practicable, the total amount of time and costs it will take to achieve the recovery (delisting) of Three Forks springsnail. The cost estimates provided do not account for possible future inflation.

We estimate that full implementation of the recovery actions will improve the status of Three Forks springsnail so that it could be delisted within 25 years, following the adoption of this recovery plan, and cost $910,000 dollars. We note that the recovery program may change over time, or the timeframe estimated to implement the recovery actions to achieve recovery of the species may take longer than expected. The recovery of Three Forks springsnail will depend largely on the commitment and the ability of the USFWS and partners to implement the recovery actions necessary to achieve the recovery criteria.

Table 3. Recovery action cost table

Recovery Action Number	Recovery Action Description	Total Recovery Action Cost
1	In extant and extirpated springs, conduct monitoring as outlined in the survey and monitoring protocol for metrics such as springsnail presence, relative abundance, habitat associations, water quality.	$277,000
2	Within potential historical range, conduct surveys in springs and seeps without known historical occupancy to identify new populations and identify springs and seeps with the potential to support population establishment.	$57,000
3	Within known or potential historical range, implement habitat restoration activities at springs and seeps to restore characteristics necessary for springsnail persistence.	$25,000
4	Maintain habitat and enclosures at modified springs across known and potential historical range.	$2,000

5	Install or improve habitat enclosures at springs that would benefit from predator exclusion and habitat improvements across known and potential historical range.	$68,000
6	Within habitat enclosures, conduct crayfish removals prior to repatriation of springsnails.	$6,000
7	Within habitat enclosures that are occupied by springsnails, conduct crayfish removals.	Included in actions 1 through 5
8	Repatriate and augment existing populations to establish self-sustaining populations across known and potential historical range	Included in actions 1 and 2
9	Establish new populations in springs and seeps with suitable habitat across known and potential historical range.	Included in actions 1and 2
10	Establish and maintain captive populations in zoological or other facilities.	$169,000
11	Conduct research to inform our understanding of Three Forks springsnail biology and ecology.	$86,000
12	Conduct research to inform our understanding of impacts from threats related to environmental change and human activities.	$220,000

6. LITERATURE CITED

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APPENDIX A. USFWS RESPONSE TO PEER AND PUBLIC REVIEW COMMENT

The draft Recovery Plan for Three Forks springsnail (*Pyrgulopsis trivialis*) was provided to the public for review and submission of written comments from December 19, 2024, to January 24, 2025. In addition, in accordance with our joint policy on peer review published in the Federal Register on July 1, 1994 (59 FR 34270), and updated guidance issued on August 22, 2016 (USFWS 2016b, entire), we solicited peer review of the draft Recovery Plan from four individuals with scientific knowledge of *Pyrgulopsis* (including Three Forks springsnail), their habitat, and threats. We received comments from two peer reviewers.

We reviewed all comments received for substantive issues and new information. Comments received were non-substantive or editorial in nature. Comments which required additional information for clarification are addressed below and have been incorporated into the Recovery Plan for Three Forks springsnail (*Pyrgulopsis trivialis*), Version 1.0 as appropriate.

Comment Summary	**FWS Response**
One commenter asked for clarification on how spring flow will be monitored.	We added additional information in Threats: Factor A of the Recovery Plan. Currently, spring depth is too shallow to accommodate flow gauges in the majority of springs occupied by Three Forks springsnails. Therefore, flow is categorized by visual observation. Springsnails have been found in springs and seeps that are wet, or have low and/or moderate flows.
One commenter expressed that keeping enclosures in perpetuity is a huge commitment, as they are high maintenance.	Enclosure maintenance does require resources and time commitments; however, unless another mechanism to effectively control crayfish is developed, we believe enclosures and associated long-term maintenance to be necessary.
One commenter indicated that enclosures create an edge effect from ungulates walking around the outside causing soil compaction and lack of vegetative cover.	Monitoring of existing springsnail enclosures has not yielded noticeable edge effects; therefore, we are confident in their efficacy. Current enclosures have been in place and monitored for up to 10 years and include photographic documentation.
One commenter requested clarification of Recovery Criterion 2 in relation to the intent to mitigate erosion, sedimentation, and flood scour risk for populations within a flood plain. Concern was expressed that, as written, language could be misconstrued to mean intent was to alter natural stream channel movements by channelizing or reducing normal overbank flows.	Information was added to Recovery Criterion 2 Rationale to clarify which populations may benefit from placement of boulders to protect springsnail habitat; that is, populations that that are within the flood plain but are offset from a creek edge. Placement of boulders along a creek edge could affect natural stream movement and will not occur.

One commenter thought crayfish monitoring and removal should be a more frequent or primary action.	Crayfish removals occur during routine surveys; however, to be effective over the long-term, enclosures need to be installed and maintained. The Priority 1 Recovery Action is to install the enclosures so that crayfish removal is effective and can be maintained. The Priority 2 Recovery Action is related to conducting crayfish removals once the enclosure is built. Opportunistic removals occur when crayfish are detected in springs during routine surveys regardless of enclosure status.
One commenter noted that cultural resource surveys and clearances are required by law for all ground disturbing activities.	In Table 1, Additional Information, we clarified that cultural resource surveys were conducted at Three Forks and Boneyard Creek. We also acknowledge that additional cultural resource surveys may be necessary prior to installing spring enclosures elsewhere within the watershed.
One commenter requested clarification on the threat of parasitism.	In Threats: Factor C, we added information to clarify our understanding of parasitism as a potential threat and the need for additional information.