U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME:

- Amargosa tryonia (*Tryonia variegata*)
- Ash Meadows pebblesnail (*Pyrgulopsis erythropoma*)
- Crystal springsnail (*Pyrgulopsis crystalis*)
- Fairbanks springsnail (*Pyrgulopsis fairbankensis*)
- distal-gland springsnail (*Pyrgulopsis nanus*)
- median-gland springsnail (*Pyrgulopsis pisteri*)
- minute tryonia (*Tryonia ericae*)
- Point of Rocks tryonia (*Tryonia elata*)
- sportinggoods tryonia (*Tryonia angulata*)
- southwest Nevada pyrg (*Pyrgulopsis turbatrix*)

LEAD REGION: California - Great Basin/Legacy Region 8

DATE INFORMATION CURRENT AS OF: February 2021

STATUS/ACTION

_X_ Species assessment - determined the information on the threats does not support a proposal to list the species

___ Listed species petitioned for uplisting for which we have made a warranted-but-precluded finding for uplisting (this is part of the annual resubmitted petition finding)

___ Candidate that received funding for a proposed listing determination; assessment not updated

___ New candidate

___ Continuing candidate

___ Listing priority number change
Former LPN: ___
New LPN: ___

___ Candidate removal: Former LPN: ___

___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on taxonomy, or biological vulnerability and threats, to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

Date when the species first became a Candidate (as currently defined): N/A

Petition Information:

___ Non-petitioned

_X_ Petitioned; Date petition received: February 17, 2009

90-day substantial finding FR publication date: September 13, 2011

12-month warranted but precluded finding FR publication date:

FOR PETITIONED SPECIES:

a. Is listing warranted? NO

b. To date, has publication of a finding been precluded by other higher priority listing actions? Yes, to the extent that these species were lower priority than higher-binned species per the National Work Plan. These species were determined to be bin ranking 5, and scheduled for the 12-month finding to be completed during Fiscal Year 2021.

c. Why is listing precluded? N/A

PREVIOUS FEDERAL ACTIONS

We published a 90-day finding in the *Federal Register* on September 13, 2011 (76 FR 56608), in which we determined that the petition presented substantial scientific or commercial information for 32 springsnail species indicating that listing may be warranted, including these 10 species.

ANIMAL/PLANT GROUP AND FAMILY

Six of the springsnails (genus *Pyrgulopsis*) reside within the family Hydrobiidae, and four (genus *Tryonia*) are within the family Cochliopidae. Both of these families are phylogenetically classified as Caenogastropoda clade, which is known as the most diverse group of gastropods.

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE

All of the species are known from the lower Amargosa Valley, Nye County, Nevada. The southwest Nevada pyrg is also known to occur in Clark County, Nevada, and Inyo and San Bernardino Counties, California.

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE

Same as above.

LAND OWNERSHIP

- U.S. Fish and Wildlife Service (Service), Ash Meadows National Wildlife Refuge (NWR)—Amargosa tryonia, Ash Meadows pebblesnail, Crystal springsnail, Fairbanks springsnail, distal-gland springsnail, median-gland springsnail, minute tryonia, Point of Rocks tryonia, and sportinggoods tryonia
- National Park Service (NPS), Death Valley National Park—Amargosa tryonia (Devils Hole), southwest Nevada pyrg
- Bureau of Land Management (BLM)—southwest Nevada pyrg
    - Red Rock Canyon National Conservation Area
    - Darwin Falls Wilderness
    - Argus Range Wilderness
    - Surprise Canyon Wilderness
    - Pleasant Canyon
- National Forest Service (Forest Service)—southwest Nevada pyrg
    - Spring Mountains National Recreation Area
    - Big Bear Lake Ranger Station and Mill Creek Canyon, San Bernardino National Forest
- Department of Defense (DoD), China Lake Naval Weapons Center—southwest Nevada pyrg
- Private lands—Amargosa tryonia
    - Adjacent to Ash Meadows NWR
    - Possibly within the towns of Shoshone and Tecopa, Inyo County, California
- Private lands—southwest Nevada pyrg
    - Within the unincorporated Cold Creek community
    - East and southeast of the unincorporated Lucerne Valley community

LEAD REGION CONTACT

Dan Russell, Regional Classification Program Coordinator, California - Great Basin/Legacy Region 8; (916) 978–6191

LEAD FIELD OFFICE CONTACT

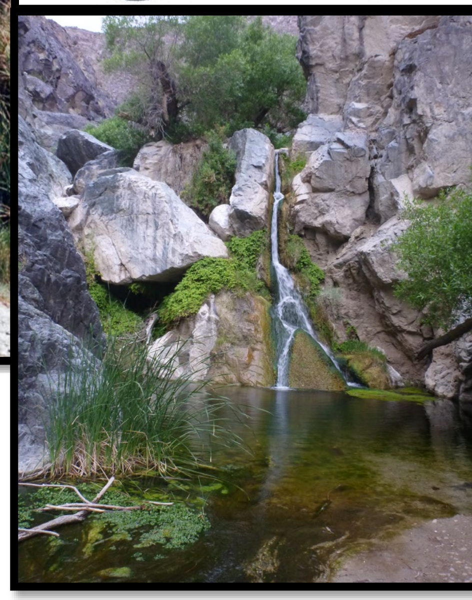
Glen Knowles, Field Supervisor, Southern Nevada Fish and Wildlife Office; (702) 515–5244

BIOLOGICAL INFORMATION

The ***Species Status Assessment Report for Nine Springsnails of Ash Meadows and the Amargosa Valley*** (January 2021, Version 1.0) and the ***Species Status Assessment for the Southwest Nevada Pyrg in Southern California and Nevada*** (February 2021, Version 1.0) are summaries of the best available scientific and commercial information regarding the biology and ecology of the 10 springsnails, and the threats and conservation efforts acting upon them. For further information, please refer to the Species Status Assessment (SSA) reports (Service 2021a, entire; Service 2021b, entire).

Kings Pool, Ash Meadow NWR. Photo Credit: Service

Photo credit: NDOW



Darwin Falls, Death Valley NP.
Photo Credit: Don Sada

Figure 1. Examples of spring habitats and shells of *Pyrgulopsis* sp.

Species Description

Species within each genus *Pyrgulopsis* and *Tryonia* appear relatively similar to inexperienced and unaided eyes, but have been described and differentiated based on subtle morphological characteristics using methods described by Hershler and Sada (1987, pp. 780–785) and Hershler (1989, pp. 176–179; 1994, pp. 2–4; 1998, pp. 3–11; 2001, p. 2), among others. In general, species of *Pyrgulopsis* and *Tryonia* are similarly sized. Freshly hatched *Pyrgulopsis* less than a week old may be less than 0.3 millimeter (mm) up to 0.8 mm (0.01 inch (in) up to 0.03 in) in total length (Mladenka and Minshall 2001, p. 208; Wells et al. 2012, pp. 74–75; Pearson et al. 2014, p. 66). The shell heights of adult *Pyrgulopsis* may range between approximately 1 and 5 mm (0.04 and 0.2 in) and have three to five whorls (Hershler 1998, pp. 4–9), whereas adult grated tryonia shell height may be approximately 3 to 7 mm (0.1 to 0.3 in) and have between five to nine whorls (Hershler 2001, p. 7). In general, species of *Pyrgulopsis* and *Tryonia* are morphologically similar with hardened shells and soft anatomy. Both have spiraling conic shells (one spiral is a whorl) with a shell opening (aperture) that can be sealed with an operculum when the soft anatomy is drawn into the shell (Burch 1982, pp. 64–65; 1989, p. 35). The soft anatomy includes a foot, head, and a mantle cavity where gills are protected by the shell (Burch 1989, p. 53; Brown and Lydeard 2010, p. 279; Pyron and Brown 2015, p. 386). When relaxed, the head and flat-bottomed foot can extend from the shell opening (Pyron and Brown 2015, p. 386). The foot is used for locomotion as mucous is secreted over a substrate (Pennak 1953, pp. 667–671; Brown and Lydeard 2010, p. 279).

Taxonomy

We have carefully reviewed the available taxonomic information and conclude that all 10 springsnail species are valid taxa. The scientific names for the species represent the most current taxonomic classifications.

Life History

Limited information is available specific to the life histories of the 10 springsnail species; most of the information used is inferred or generalized from closely related taxa. Less information is available on the life history of *Tryonia* relative to *Pyrgulopsis*. However, in general, data are available on springsnail species' size, and the timing and duration of life stages vary depending on environmental conditions.

Springsnails are dioecious (Hershler 1998, p. 10; 2001, pp. 3–5), where male and female organs occur in separate individuals, and they are sexually dimorphic (animals with different male and female forms). Females tend to be larger than males for both *Tryonia* than *Pyrgulopsis.* A full discussion of the species' life cycle is in the SSA reports (Service 2021a, pp. 30–32; Service 2021b, pp. 11–13).

Pyrgulopsis and Tryonia species are herbivores or detritivores that primarily graze on the periphyton of exposed surfaces of macrophytes (i.e., aquatic plants) and substrate (Mladenka 1992, pp. 46, 81; Hershler and Sada 2002, p. 256; Martinez and Thome 2006, p. 8; Pyron and Brown 2015, p. 401). Macrophytes include native species such as rushes (*Juncus* spp.), sedges (*Carex* spp.), or spikerushes (*Eleocharis* spp.); or nonnative species including watercress (*Nasturtium* spp.). Periphyton consists of algae, bacteria, detritus, fungi, diatoms, and protozoa contained within a matrix of polysaccharides (also known as biofilm) (Lysne *et al.* 2007, p. 649; Vu *et al.* 2009, p. 2,536). While periphyton is easier to acquire and is more nutrient-rich than macrophytes, macrophytes will be consumed if periphyton is depleted (Pyron and Brown 2015, p. 399).

Habitat—Spring Characteristics and Function

Desert springs support relatively small aquatic and riparian systems as surface flow (see Figure 1, above). They range widely in size, water chemistry, morphology, landscape setting, and persistence. They occur from mountain tops to valley floors, some of which occur in clusters (referred to as spring provinces), and are predominantly isolated from other aquatic and riparian systems. Springs occur where subterranean water under pressure reaches the earth's surface through fault zones, rock cracks, or orifices that occur when water creates a passage by dissolving rock. In general, most springs are unique given their distinct province influences of aquifer geology, morphology, discharge rates, and regional precipitation.

Spring hydrology depends on subterranean water flow through aquifers and precipitation that enters the soil and accumulates in aquifers where it is stored; this is influenced by characteristics of regional and local geology, and how water moves through an aquifer. Three aquifer types occur in arid parts of the U.S: mountain block, local, and regional aquifers. These aquifers differ primarily in their water transit time or residence time and water depth, which in turn affects water temperature, water chemistry, and spring discharge. Sada and Mihevc (2011, p. 2) describe these aquifers as follows:

- *Mountain block aquifer springs* have short residence times, so they are cooler and contain fewer dissolved chemical constituents than water in aquifers with longer residence time. These springs are generally small, often ephemeral, and occur in the mountains. Most springs occupied by the southwest Nevada pyrg are primarily this type.
- *Local aquifer springs* are generally warmer than mountain block aquifer springs and contain higher concentrations of dissolved chemical constituents. Also, springs fed by local aquifers are usually located on alluvial fans near the base of mountains, although they can occur in the central parts of some valleys, primarily in valleys without springs fed by regional aquifers.
- *Regional aquifer springs* have long residence times (generally hundreds to thousands of years) as well as high and constant discharge rates, warm temperatures, and elevated concentrations of dissolved chemical constituents. They generally occur on valley floors near the center of a valley. Springs discharging at Ash Meadows NWR and the surrounding area are primarily this type.

Freshwater springsnails are indicators of spring inhabitants or conditions of spring ecosystems, most of which are characterized by permanent water with variable discharge and flow rates. Springs that harbor springsnails may have a high mineral content but must be relatively unpolluted (Mehlhop and Vaughn 1994, p. 69). Where springsnails occupy a significant portion of a spring system, it is an indication that the spring ecosystem is functioning and intact (Mehlhop and Vaughn 1994, p. 69).

Species Needs

The current condition and potential future conditions of springsnail populations are most influenced by those species needs that are critical for survival and reproduction. Based on our review of the best available scientific and commercial information, and the knowledge and expertise of Service staff and other technical experts, we determined the following spring conditions are most critical in influencing the physical and biological needs of springsnails: (1) Sufficient water quality, (2) adequate substrate and vegetation, (3) free-flowing water, and (4) adequate spring discharge (Service 2021a, pp. 34–38; Service 2021b, pp. 15–18). When each of these physical and biological needs is satisfied and functioning within a spring, stable populations of springsnails are expected. Overall, the best available information indicates that the 10 springsnails' physical and ecological needs include:

(1) Water Quality—*Pyrgulopsis* and *Tryonia* species are sensitive to water quality and require specific parameters to thrive (Sada 2008, p. 59; Sada 2009, p. 3). Distribution of *Pyrgulopsis* within springs varies according to temperature, water chemistry (including carbon dioxide, dissolved oxygen, and conductivity), and flow regime (Hershler 1998, p. 11; Mladenka and Minshall 2001, pp. 209–211). Springsnails are typically most abundant at the spring source

and less abundant farther away from the springhead, which may be due to decreased water quality or increased variability in the environment (Hershler 1998, p. 11; Hershler and Sada 2002, p. 256; Martinez and Rogowski 2011, pp. 218–220). This gradient in abundance is evident in small springs (Hershler 1998, p. 11), including many that occur in Ash Meadows and across the varied range locations for the southwest Nevada pyrg. In addition to water quality changes occurring as a function of distance downstream (above), changes in temperature, dissolved oxygen, pH, conductivity, and other water quality metrics at the spring source may impact the ability of a species to survive in a particular spring. However, we do not know what the thresholds or limitations for these metrics are for the 10 springsnail species. Because the springs at Ash Meadows are typically outflows from deep regional carbonate aquifer, water quality parameters are likely to remain constant whereas the springs outside of Ash Meadows will vary more. For this analysis, we assume that water quality parameters are adequate if the species is observed within a site.

(2) Aquatic Vegetation and Substrate—Sufficient vegetation and substrate are species needs that may influence all life stages of a springsnail and its population's condition (Hershler and Sada 1987, p. 837; Hershler 1998, p. 14; Sada and Pohlmann 2006, p. 8). The amount of vegetation needed at a spring can be variable for springsnail species. While most springs contain vegetation, there are a few springs with springsnail populations that have minimal vegetation (but contain preferred substrate). Regarding substrate, many springsnails, including *Pyrgulopsis*, generally occur on hard substrates such as bedrock, gravel, and cobble, as well as on macrophytes like watercress (Hershler and Sada 1987, p. 837; Hershler 1998, p. 14; Sada and Pohlmann 2006, p. 8). Conversely, *Tryonia* occur on fine substrates such as sand along banksides (Sada and Pohlmann 2006, p. 8; Sada 2008, p. 64). The occupied substrates not only contain sources of food for all life stages, but also sites for adults to lay eggs.

Sufficient vegetation and substrate are species needs that may influence all life stages of a springsnail and its population's condition (Hershler and Sada 1987, p. 837; Hershler 1998, p. 14; Sada and Pohlmann 2006, p. 8). To evaluate the current and potential future conditions of this factor, we categorized data from surveys (Hershler and Sada 1987, entire; Sada 2008, unpubl.; U.S. Geological Survey (USGS) 2018, unpubl.; Service 2020, unpubl.; and for southwest Nevada pyrg, Sada 2016 and 2017, entire). Given the best available information does not allow us to categorize each springsnail habitat by substrate type and vegetation species, we categorized the known data using the following qualitative categories:

- High: Spring dominated by suitable vegetation and substrate for the species
- Moderate: Spring contains some suitable vegetation and substrate for the species
- Low: Spring predominantly lacks suitable vegetation and substrate for the species

(3) Free-Flowing Water—An important factor of water quantity for springsnails is the continuity of free-flowing water. Free-flowing water is a habitat need of springsnails at all life stages that may influence a population's condition, and in general, the presence of flowing water is indicative of robust populations. Since springsnails are restricted to perennial aquatic habitats throughout their life cycle, the timing, frequency, and duration of a spring's flow regime is

important to their viability (Hershler and Liu 2008, p. 92; Sada 2008, p. 59; Sada 2009, p. 2). Springsnails may be found in small seeps to large springs, so water depths can vary greatly (Hershler 1998, p. 11). The majority of springsnails occur in slow to moderate current (i.e., greater than 0 centimeters per second (cm/sec) to less than 40 cm/sec) (greater than 0 inch per second (in/sec) to 16 in/sec)). They also occupy springs with discharge rates ranging from less than 60 liters per minute (L/min) to 16,800 L/min (0.04 cubic feet per second (cfs) to 10 cfs) (Sada 2009, pp. 3–4). Spring discharge should be continuous and water should be free-flowing for these springs to persist.

Free-flowing water is a habitat need of springsnails at all life stages that may influence a population's condition. To evaluate the current conditions of this factor, we categorized information from survey reports and other sources as follows:

- High: Water is free-flowing without barriers
- Moderate: Water flows with partial barriers
- Low: Water flows are mostly or entirely blocked

(4) Adequate Spring Discharge—Adequate spring discharge is a habitat need of springsnails that may influence a population's condition (Hershler and Liu 2008, p. 92; Sada 2008, p. 59; Sada 2009, p. 2). Adequate spring discharge is important for springsnail viability, and changes to discharge rates may impact the ability of a species to survive in a particular spring; however, the thresholds or limitations for "adequate" spring discharge for the 10 springsnail species are unknown. In the assessment of the current condition of this factor, we assume that spring discharge is adequate if the species is observed in common or abundant numbers within a site.

When each of these physical and biological needs is present and functioning within a spring, it is expected that the spring is able to support populations of springsnails. More specific details about each of these species needs are described in section 3.3 of the SSA reports (Service 2021a, pp. 35–39; Service 2021b, pp. 15–18).

Historical Range/Distribution

Most springsnail species are endemic to a limited number of springs within a valley or hydrographic basin (Hershler and Sada 2002, p. 255). The current range and distribution of the 10 springsnails (as well as other springsnail species that reside within the Amargosa Desert, Las Vegas Valley, Eureka-Saline Valleys, Panamint Valley, Death Valley, Southern Mojave, and Santa Ana (Big Bear Lake, Mill Creek Canyon) regions of Nevada and/or California) likely are reflective of late Cenozoic regional hydrographic history. Springsnails have likely been transported by other means, such as human activities (Hershler and Sada 2002, p. 255; Hershler and Liu 2008, p. 99; Hershler *et al.* 2005, p. 1763).

Current Range/Distribution

Most springsnail species are endemic to a limited number of springs within a valley or hydrographic basin (Hershler and Sada 2002, p. 255). Elevations of the springs and spring

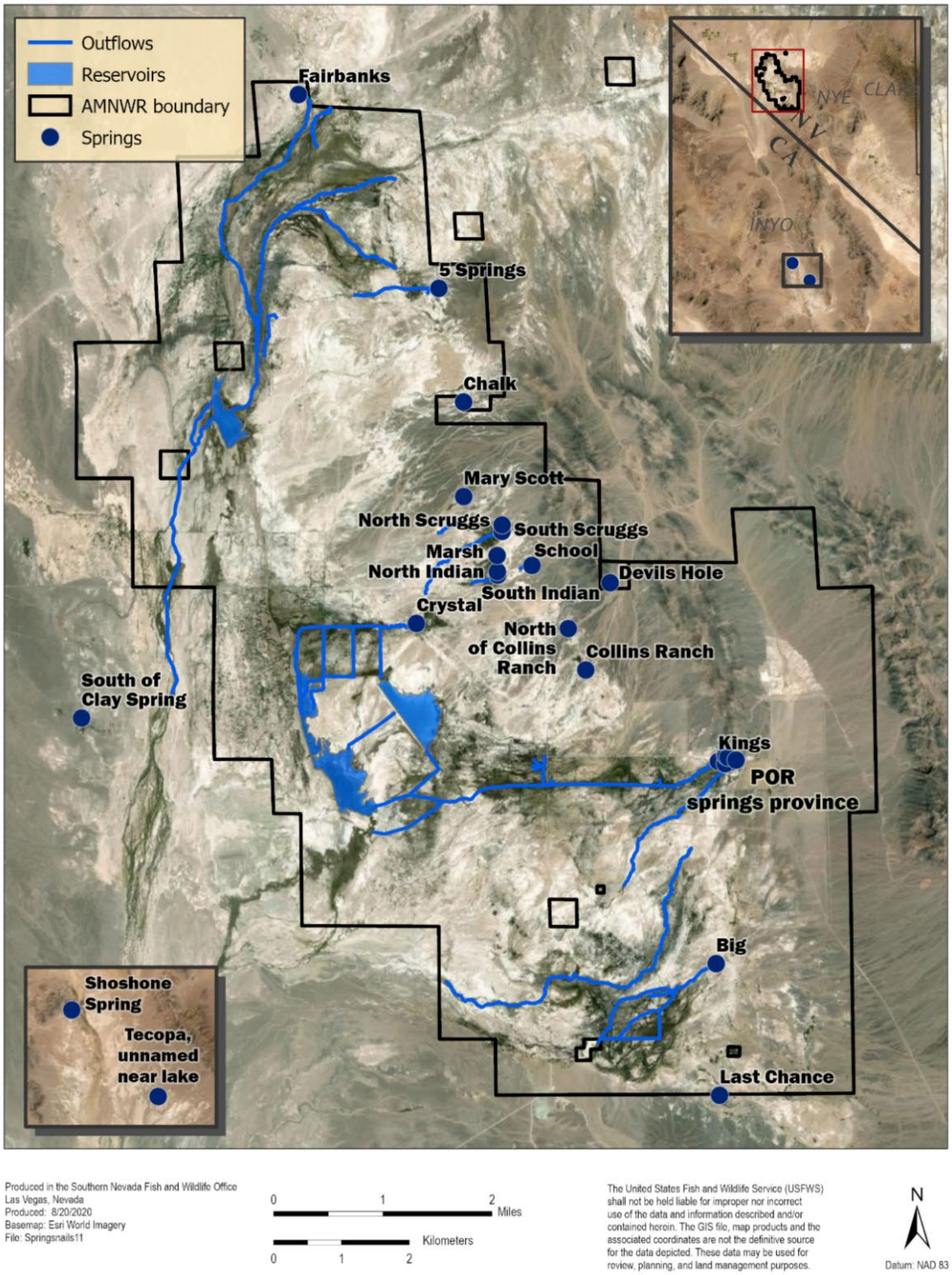


Figure 2. Historical and current range and distribution of selected springs occupied by Amargosa tryonia, Ash Meadows pebblesnail, Crystal springsnail, Fairbanks springsnail, distal-gland springsnail, median-gland springsnail, minute tryonia, Point of Rocks tryonia, and sportinggoods tryonia; Ash Meadows and surrounding Amargosa Desert.

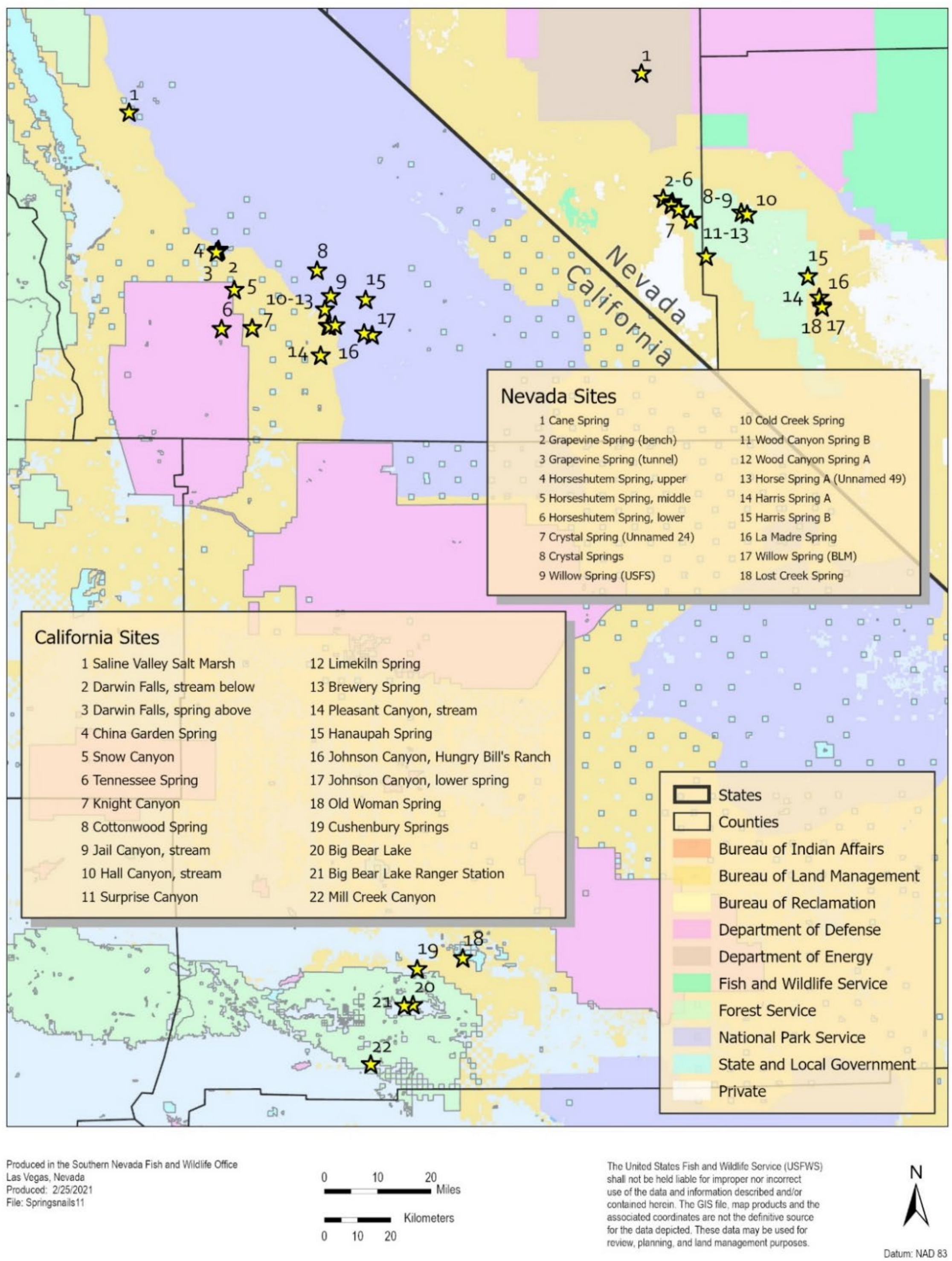


Figure 3. Current range and distribution of springs occupied by the southwest Nevada pyrg, overlaid on land ownership, illustrating the extensive Federal lands ownership across the species range.

provinces where these species occur in Nevada and California are typically below 2,200 meters (m) (7,218 feet (ft)) (Sada 2009, p. 3). See Figures 2 and 3 , and location information above (pp. 2–3).

BACKGROUND FOR POPULATION ESTIMATES

Survey data were compiled from multiple years of surveys and multiple surveyors. Methodologies to assess and describe abundance varied slightly between datasets. To address these variations, we used standardized relative abundance categories for each springsnail population based on catch per unit effort (CPUE). The number of springsnails in each category is consistent with those from historical surveys. CPUE is the average (mean) number of springsnails captured (catch), calculated by dividing the total number of springsnails captured by the number of grabs (unit of effort). For example, if 150 springsnails were captured in 10 grabs, the catch per unit effort would be 15. This assessment was used to determine abundance (scale below), and the extent of occupied habitat. The number of springsnails in each category follows those of Sada (2017, p. 30). The relative abundance categories are:

- *None* = catch per unit effort of 0 individuals;
- *Scarce* = average catch per unit effort less than 6 individuals;
- *Common* = average catch per unit effort between 6 and 20 individuals;
- *Abundant* = average catch per unit effort greater than 20 individuals.

Based on all the available information at each spring or spring province (e.g., species needs, threats, springsnail abundance, and other information), each habitat was categorized indicative of its condition to support springsnails. Habitat condition is classified into four levels relative to springsnails using expertise of Service staff, and other qualified resource professionals:

- *High* = spring ecosystem functioning near optimum; little room for improvement
- *Moderate* = spring ecosystem functioning somewhat well; some room for improvement
- *Low* = spring ecosystem functioning less than optimal; significant room for improvement
- *Dry* = no surface water

For most species, our recent survey data were collected from 2018–2020; however, some springs where species had previously been documented were not accessible, and others could not be located. In some cases the characterizations above were difficult to apply, and categorized as unknown (see Service 2021a, Appendix B; Service 2021b, Appendix B).

Species-level viability was estimated using habitat information and distribution of each species across the habitats. Viability scores were categorized as one of five sequential levels ranging from highest to lowest. Rankings are qualitative assessments of species viability based on the knowledge and expertise of Service staff, and other technical experts and resource professionals. Viability categories are defined as:

- *Very High* = species condition at optimum for resources available
- *High* = species condition is secure; but little room for improvement at 3Rs (resiliency, redundancy, and representation)

- *Moderate* = species condition at marginal levels; sustaining but room for improvement
- *Low* = species condition at marginal level; significant room for improvement at 3Rs
- *Very Low* = species condition near extirpation or extinction

SUMMARY OF THREATS

We define "threat" as any action or condition that is known to or is reasonably likely to negatively affect individuals of a species. This includes those actions or conditions that have a direct impact on individuals, as well as those that affect individuals through alteration of their habitat or required resources. The mere identification of "threats" is not sufficient to compel a finding that listing is warranted. Describing the negative effects of the action or condition (i.e., "threats") in light of the exposure, timing, and scale at the individual, population, and species levels provides a clear basis upon which to make our determination. In determining whether a species meets the definition of an "endangered species" or a "threatened species," we have to consider the factors under section 4(a)(1) and assess the cumulative effect that the threats identified within the factors—as ameliorated or exacerbated by any existing regulatory mechanisms or conservation efforts—will have on the species now and in the foreseeable future.

Current threats[1] and their impacts differ by spring and spring province, and are variously influenced by a combination of contemporary and legacy events in the history of the spring. In some instances, historical threats have been partially or fully mitigated (e.g., historical dredging is replaced with recovered riparian vegetation, or a change in ownership from private to refuge includes added protections/improvements to habitat), whereas at other locations historical events continue to impact the species or habitat at present (e.g., impoundment, invasive species, recreation). Additionally, in other parts of southwest Nevada and southeast California where the southwest Nevada pyrg resides, this same shift is evident over time even though these spring locations have changed in administrative ownership and varied regarding their protections and habitat improvements. Specific conservation measures are in place on most Federal lands to determine springsnail viability and vulnerability to extinction, and prioritize recovery actions.

In general, the most significant current threats on the landscape are composed of predation and competition from invasive aquatic species, and habitat modification (and direct loss of individuals) associated with vegetation and soil disturbance, recreation, spring manipulation, and various legacy effects. Threats are summarized below, with more detail presented in the "Factors That May Influence Species Needs" section of the SSA reports (Service 2021a, pp. 39–63; Service 2021b, pp. 19–41).

A variety of regulatory and voluntary conservation measures are currently in place to help reduce the potential negative impacts from some of the potential threats. Many threats are mostly historical or have stabilized over time, and have less effect on springsnail species needs.

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[1] We considered the potential impacts from parasitism, disease, and collection because they are known to impact similar springsnail species in the southwest and, therefore, may impact the springsnail species evaluated in these SSA reports. However, the best available scientific and commercial information does not indicate impacts from parasitism, disease, or collection specific to these 10 species.

However, there are also ongoing threats with substantial negative effects (e.g., old spring diversions, predation, competition), and future threats (e.g., increased groundwater pumping/altered precipitation and temperature) which conservation plans can help reduce. While we cannot definitively know to what extent these future threats may impact springs or spring provinces, we do know that there are land management and conservation plans in place on various lands that should provide protections for springsnail species and their needs. These include laws, regulations, policies, and management plans on Federal lands; state plans in Nevada and California; and other agreements and plans that cover Federal, State, or private lands. Plans may include specific conservation actions for springsnail species and protecting species needs, while others may include more broad protections for aquatic and riparian species habitat or protections from future water withdrawals. Such protections provide some assurances that current individual-level threat impacts will not become population-level impacts and that potential future threats will not occur or impact springsnail species needs. These measures are outlined in numerous land management and conservation plans listed in Appendix A of both SSA reports.

Predation and Competition

We found no documented observation of predation of any of the 10 species in this assessment; however, we assume predation occurs because it has been observed in other *Pyrgulopsis* species in similar environments with the same predator species. Natural predators of springsnails in the Southwest include waterfowl, shorebirds, amphibians, fishes, crayfish, leeches, and aquatic insects (Martinez and Thome 2006, p. 9). Damselflies (Zygoptera) and dragonflies (Anisoptera) have been observed feeding on snails (Mladenka 1992, pp. 81–82). Important nonnative species that have extirpated spring-dwelling taxa in the southwestern U.S. include crayfish (mostly *Procambarus* spp.), mosquitofish (*Gambusia affinis*), red-rimmed melania (*Melanoides tuberculata*), mollies (*Poecillia* sp.), goldfish (*Carassius auratus*), cichlids, and bullfrogs (*Rana castebeiana*) (Sada 2017, p. 11). At least two of the Ash Meadows area springsnail species (Fairbanks springsnail and sportinggoods tryonia at Fairbanks Spring) co-occur with nonnative fish and crayfish. The red-rimmed melania is known to occur at springs occupied by the nine Ash Meadows springsnail species, and it is unknown if this nonnative competitor occurs in springs occupied by the southwest Nevada pyrg. Competition between red-rimmed melania and springsnails appears to minimally influence the abundance of endemic springsnails at some sites (e.g., Fairbanks and Crystal springs), but it is unknown the level of impact at other sites where red-rimmed melania are abundant and springsnails are not. The current level of impact of red-rimmed melania has not been studied at Ash Meadows NWR or the surrounding area, and surveys are needed to determine its presence or potential impacts throughout the southwest Nevada pyrg's range.

Vegetation and Soil Disturbance

The primary cause of imperilment for springsnails is loss or alteration of habitat (Lysne *et al.* 2008, p. 464). Sources of stress such as wildfire, roads, recreation, and grazing and browsing (ungulate use) contribute to vegetation and soil disturbance at many springsnail locations where these 10 springsnail species occur. Vegetation and soil disturbance can affect springsnail needs by reducing water quality, loss or modification of substrate and vegetation, reducing free-flowing water, and potentially other specific direct impacts (i.e., loss of individuals, loss of bank/canopy cover that provides for breeding, feeding, shelter, and thermal protection).

There are few studies associated with spring systems and how they respond to human disturbance (Sada *et al*. 2015, p. 4). Species richness (total number of taxa in a sample) of spring-associated perennial plants and cover of native plants tend to decrease as intensity of disturbance increases, though species richness (but not cover of nonnative plants) tends to peak with intermediate disturbance, which include grazing, recreation, and water diversion (Fleishman *et al.* 2006, p. 1,091). Spring-fed aquatic and riparian communities may be resistant to minor disturbance but are affected by higher levels of disturbance (Sada *et al.* 2015, p. 3).

Moderately or highly degraded springs were found to be most common on BLM land, followed by private lands, Forest Service lands, and finally Service/NWR lands (Sada and Lutz 2016, p. iii). With the exception of two species—Amargosa tryonia and southwest Nevada pyrg—the other eight springsnails occur solely on lands managed within the Ash Meadows NWR and Devil's Hole (which is managed by the NPS). Many of these springs appear to have stabilized from anthropogenic disturbance or following restoration activities by the Service and NPS. For Amargosa tryonia, most sites occur on the Ash Meadows NWR. Only three historical locations outside of lands managed by the Service or NPS are recorded, two of which we have some information on the habitat quality. South of Clay Pits Spring (private) is notably degraded, while Shoshone Spring (private) was restored in recent years for native species. However, Amargosa tryonia does not occur at either of these sites based on recent surveys. Springs occupied by the southwest Nevada pyrg that are affected by anthropogenic influences are also naturalizing or stabilizing.

Water Pollution

Although hydrobiid snails as a group occur in a wide variety of aquatic habitats, each species is usually found within relatively narrow habitat parameters, and is likely sensitive to water quality (Sada 2008, p. 59). Potential sources of water pollution documented at springsnail locations within our analysis area that may impact current and future conditions of water quality include recreation and herbicide application. The level of effect these sources may have on water pollution has not been measured or sampled; however, we assume some level of water pollution is occurring if recreation or herbicide application has been documented at or near a spring.

- Recreational activities can affect water quality by introducing chemicals from sources such as soap and sun protection products, and we assume that if a spring is known to be used for recreational bathing, some level of water pollution is occurring (although no water quality sampling has been completed to evaluate this). Additionally, springsnails are known to tolerate low to moderate levels of these activities with no apparent population- or species-level effect to their overall numbers and distribution, particularly if the impacts are short-term (Sada 2017, entire). The best available information indicates that springsnails have persisted in these recreational areas, suggesting that no population-level impacts at historical or current levels have occurred, and this is not expected to change into the future for the 10 springsnail species.
- The application of herbicides on lands administered by state or Federal agencies occurs

under strict regulations and procedures (e.g., Service 2006, p. 41). Herbicide application on Federal land is also evaluated in accordance with the National Environmental Policy Act of 1970 (NEPA), while herbicide use on private land does not typically require NEPA analysis. Standard stipulations for herbicide use near riparian areas on Federal land typically require the use of a selective herbicide that is safe for uses in riparian zones and near aquatic sites using hand application methods. We expect any potential effects to springsnails from herbicides to occur at the individual, spring, or population level as opposed to rangewide impacts. The likely method of exposure would be from aerial drift or runoff from treated vegetation after a rain event, since aquatic herbicides are not typically applied to springs or streams. If herbicides are applied on Federal lands, use would follow the U.S. Environmental Protection Agency application schedules designed to minimize potential impacts to non-target plants and animals (e.g., Service 2006, p. 42). We cannot assess the potential impact of herbicides on privately-owned springs, but the best available information does not indicate that herbicides are being applied at springs where these 10 springsnail species occur.

- Specifically within the range of the southwest Nevada pyrg, chemicals released or resulting from fire suppression activities (e.g. fire retardant) that enter aquatic systems occupied by springsnails may be a threat to springsnails because of their toxicity. Contamination of aquatic systems can occur via direct application, wind drift, or runoff from areas treated upslope. The species' needs potentially affected include water quality, and substrate and vegetation. While some springs occupied by the southwest Nevada pyrg may have been influenced by fire, the best available information does not indicate that the southwest Nevada pyrg has been exposed to fire suppression chemicals.

Spring Modifications

Spring modifications include channel modification, surface water diversions, spring impoundments, and a reduction in surface or groundwater from sources that include groundwater pumping; municipal water use and irrigation; oil, gas, and mineral development; and altered precipitation and temperature from climate change. Such modifications may occur for development, management, or restoration purposes, which have been documented historically at the majority of springs and spring provinces, and therefore, all 10 springsnail species have one or more populations potentially impacted from spring modifications.

Changes in climate conditions that could potentially result in spring modifications have already been observed in the southwest region of the United States, and are expected to continue. Each of these four spring modification categories (i.e., groundwater pumping, municipal water use and irrigation, oil/gas/mineral development, and changing climate conditions) are summarized below, following hydrology and water management considerations within the predominant Ash Meadows portion of these species ranges. More detail on each of these categories, as well as hydrology and water management considerations, is available in the SSA reports (Service 2021a, pp. 39–43, 49–62) and recent publications (Halford and Jackson 2020, entire; Nelson and Jackson 2020, entire).

Hydrology Considerations at Ash Meadows

The numerous springs in the Ash Meadows discharge area (includes all springs associated with the Ash Meadows NWR and nearby on private lands) represent a unique feature in the Amargosa Desert. Outside of the Refuge, the surrounding landscape is characterized by expansive xeric habitats nearly devoid of surface water. Ash Meadows springs were formed because of a normal fault, referred to as the Gravity Fault, that bisects the Ash Meadows NWR. The Gravity Fault juxtaposes low-permeability clay on the west against permeable carbonate rock on the east (Winograd and Thordarson 1975; p. C82). The low-permeability clay downgradient of the fault is a hydraulic barrier that forces groundwater to move upward and discharge at land surface, where the water is used by phreatophytes and aquatic species (Halford and Jackson 2020, p. 129). When groundwater reaches the impermeable Gravity Fault, the groundwater moves upward through permeable lenses within overlying basin fill to discharge at Ash Meadows springs.

The Ash Meadows discharge area occurs at the terminus of a hydrologically significant feature referred to as the "megachannel" (Winograd and Pearson 1976, entire). The megachannel is an 80 km (50 mi) long by 40 km (25 mi) wide area of fractured carbonate rock with high transmissivities across large distances (24–32 kilometers (km) (15–20 miles (mi)) in short timespans (less than 2 years) (Halford and Jackson 2020, p. 127).

Effects of historical (1950–2020) and future (2021–2100) groundwater pumping on water levels in spring discharges in the Ash Meadows discharge area (including Devils Hole) were investigated recently (Halford and Jackson 2020, entire; Nelson and Jackson 2020, entire), which included multiple scenarios of groundwater pumping information. Nelson and Jackson's (2020, entire) scenarios were developed in coordination with State and Federal agencies to capture potential water use (but not based on specific future plans for water development), and applied a constant level of recharge estimated for the region. In short, model results indicate a variance of little reduction in water level relative to base-level at Devils Hole to a decline in water level (Nelson and Jackson 2020, p. 26). It is important to note that Nelson and Jackson (2020) used a constant rate of recharge based on long-term average precipitation for the region and that actual recharge has been greater than this over the last 20–30 years such that water levels in Devils Hole have been increasing despite historical and current regional groundwater pumping. Additionally, with regard to changes in water level discussed above, there is some uncertainty to consider with respect to individual spring discharges across Ash Meadows. Specific hydrologic connections associated with individual spring sources has not been investigated. In the absence of spring-specific hydrology information, it is expected that sources at high elevation and low discharge might be more vulnerable to general reduction in water levels.

Water Management Considerations at Ash Meadows

To ensure the amount of groundwater withdrawn from a hydrographic area over a period of time does not exceed the long-term recharge of the basin, the State designates basins to reflect water resources based on the extent of water development and water use, and the appropriation of water rights (Nevada Department of Conservation and Natural Resources (DCNR) 2017, entire; California Department of Water Resources 2020, entire). Any use of water requires a state permit with two exceptions. The first exception is that domestic wells do not require permits in either state, although in Nevada, this is true only if the well uses less than 6,814 L (1,800 gallons (g)) of water per day (Nevada Division of Water Planning 1999, p. 8-3). Although domestic wells do not require a permit, some oversight is provided by the requirement of a permit to drill a new well (Welden 2003, p. 8). The second exception is relevant only in Nevada where permits are not required for those uses that pre-date water law requirements (DCNR 2017, entire).

The springs in the Ash Meadows area where the 10 springsnails occur (noting that Amargosa tryonia and the southwest Nevada pyrg also occur outside of the Ash Meadows area; see "Current Range/Distribution," above) are included in Hydrographic Area 230, the Amargosa Desert (also includes parts of California), and are located within a designated basin (O-724). Also, the immediate area around the Ash Meadows NWR is protected by Nevada State Engineer Order 1197A (Nevada State Engineer 2018). This order protects the Refuge (by consequence of Devils Hole) from new applications for wells and changes in points of diversion on existing water rights that would occur within 40.2 km (25 mi) of Devils Hole. This order was enacted to protect the Federal water right to maintain a specified water level in Devils Hole. This order represents an increase in protection from the 2008 Order 1197, specifying similar regulations beginning at 20.1 km (10 mi) from Devils Hole.

These measures to conserve water in the Ash Meadows discharge area follow a long history of protective water management that includes extreme groundwater development and water level reductions in the 1970s (Dudley and Larson 1976, entire), and a 1976 Supreme Court decision (*Cappaert v. the United States*) to maintain suitable habitat in Devils Hole to ensure the survival of the Devils Hole pupfish irrespective of whether pumping or a combination of climate and pumping contribute to water-level decline. The impacts of groundwater withdrawal (at historically minimum levels) caused reductions in all of Ash Meadows springs, including both the largest springs (e.g., Fairbanks and Crystal springs), and relatively smaller springs (Point of Rocks, Five, and Collins Ranch springs), some of which were reported dry (Halford and Jackson 2020, p. 87). However, some springs [during the extreme water pumping period in the early 1970s] showed relatively small reductions in discharge, which indicates that individual spring response varies.

The most recent modeling of Halford and Jackson (2020, entire) outlines the presence of a megachannel, where pumping within which likely affects the Ash Meadows discharge area; the effects of which are not directly related to distance between pumping and the spring source, but instead governed by whether pumping occurs inside or outside the megachannel boundaries.

(1) Ground Water Pumping

Increased groundwater pumping[2] in Nevada and southeastern California is primarily driven by human water demand for municipal purposes, irrigation, and development for oil, gas, and minerals. Many factors associated with groundwater pumping can affect whether or not an activity will impact a spring, including the amount of groundwater to be pumped, the time period

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[2] The term *human water demand* describes groundwater pumping and withdrawal to support residential and metropolitan development. The phrase *additional impacts from oil, gas, and mineral development* encompasses all phases (i.e., exploration, development, production, and reclamation) of these types of projects.

of pumping, the proximity of pumping to a spring, depth of pumping, and characteristics of the aquifer being impacted. Depending on the level of these factors, groundwater withdrawal may result in no measurable impact to springs or may reduce spring discharge, reduce free-flowing water, dry springs, alter springsnail habitat size and heterogeneity, or create habitat that is more suited to nonnative species than to native species (Sada and Deacon 1994, p. 6). Reduced spring discharge may also decrease springbrook length and wetted width as well as diminish the total area of substrate and amount of primary and secondary production, thus adversely affecting food resources for springsnails (Sada 2017, pp. 7–8). Excessive groundwater withdrawal can lower the water table, which in turn will likely affect riparian vegetation (Patten 2008, p. 399).

Groundwater pumping initially captures stored groundwater near the pumping area until water levels decline and a cone of depression expands, potentially impacting water sources to springs or streams (Dudley and Larson 1976, p. 38). Spring aquifer source and other aquifer characteristics influence the ability and rate at which a spring fills and may recover from groundwater pumping (Heath 1983, pp. 6 and 14). Depending on aquifer characteristics and rates of pumping, recovery of the aquifer is variable and may take several years or even centuries to recover (Halford and Jackson 2020, p. 70; Heath 1983, p. 32). Yet where reliable records exist, most springs fed by even the most extensive aquifers are affected by exploitation, and springflow reductions relate directly to quantities of groundwater removed (Dudley and Larson 1976, p. 51).

A reduction in springflow from groundwater pumping both reduces the amount of water and amount of occupied habitat, and if the withdrawals also coincide with altered precipitation and temperature from climate change, even less water will be available. Across the Ash Meadows springs, discharge varies greatly, with some springs sufficiently low at present likely due to a combination of influences, both natural and anthropogenic; therefore, any future effects of groundwater withdrawal are of significant importance. Outside of the Ash Meadows area with respect to three springs historically occupied by Amargosa tryonia, it is unknown how discharge has been affected by groundwater pumping. For the widespread southwest Nevada pyrg, discharge varies greatly across its range.

(2) Municipal Water Use and Irrigation

Groundwater pumping for human water demand and associated development projects could impact springs and spring provinces where springsnails occur. When examining historical and current water use information to aid in understanding the level of impacts in the future, the best available information indicates that water use/pumping in the Las Vegas and Pahrump Valleys (which encompasses the complete current known ranges of nine of the springsnails and a portion of the southwest Nevada pyrg's range) resulted in reductions to groundwater elevations and historically affecting springs and springsnails (Deacon 2007, p. 688), including several springs that went dry in Pahrump Valley during the 1970s (Hershler 1998, p. 25). While some variability in well withdrawal trends exists, in general, an increase in groundwater withdrawals has occurred in most hydrographic areas since the 1950s (Green et al. 2011, p. 543). This likely reflects increasing human populations and water demands for human use. Because human populations in Nevada and California are expected to continue to increase (Garfin et al. 2014, p. 470), water demand would likely also increase. This increased demand represents a potential added pressure to the water that provides habitat for the 10 springsnail species.

Within the Ash Meadows area, and despite the recent studies demonstrating the relationship between regional groundwater pumping and its direct effects on the water availability, the absolute amount of water discharging from springs in the future is uncertain because it depends on both groundwater pumping and the future recharge to the system. Also, the variation in recharge due to climate change was not the focus of the above investigations; therefore, changes in precipitation will concurrently affect the ultimate discharge at springs. For the remainder of the range for the southwest Nevada pyrg, we cannot predict if or where groundwater pumping may occur.

(3) Oil, Gas, and Mineral Development

Oil, gas, and mineral development on public lands would likely occur in areas administered by the BLM, and could potentially interact with springsnails and their habitat on the Ash Meadows NWR or other protected springs. Fracking[3] is sometimes used as part of oil and gas development projects and has the potential to both contaminate and consume water resources (Al-Bajalan 2015, pp. 4–6; Mehany and Guggemos 2015, p. 172). Springs and springsnails may be impacted by oil and gas development if fracking is used and groundwater pumping occurs (see the effects of ground water pumping section, above). A considerable number of organic and inorganic compounds have been detected in shallow and deep drinking water outside the analysis area due to fracking chemicals (Al-Bajalan 2015, p. 6). If contaminants from fracking enter the groundwater and emerge at spring sources, springs and springsnails would likely be affected. However, at this time, the best available information indicates that there are no current or future-planned oil, gas, or mineral development projects within the watersheds where the 10 springsnail species occur.

(4) Altered Precipitation and Temperature from Climate Change

The southwest region where the 10 springsnail species occur is one of the hottest and driest areas of the United States, and climate change is likely to exacerbate these conditions. Average annual temperatures have increased almost 1.1 °C (2 °F) over the last century (Garfin et al. 2014, p. 464), and an additional increase of 1.9 to 5.3 °C (3.5 to 9.5 °F) is predicted to occur by the year 2100 (Walsh et al. 2014, p. 23). Average annual precipitation has been reduced in recent decades, both in precipitation and winter snowpack, and this pattern is expected to continue (Garfin et al. 2014, p. 465; Fig. 4.2). Coupled with an anticipated 70 percent increase in the human population by mid-century (Garfin et al. 2014, p. 470), these changes are of concern for springsnails because both human settlements and natural ecosystems in the southwestern U.S. are largely dependent on groundwater resources (such as areas that springsnails rely on) and decreased groundwater recharge may occur as a result of climate change (U.S. Global Change Research Group 2009, p. 133).

In order to identify changing climatic conditions more specific to sites where the 10 springsnail species occur in Nevada and California, we conducted a climate analysis using the Climate Mapper web tool (Hegewisch et al. 2020, website) to map real-time conditions, current forecasts,

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[3] Involves a mixture of chemicals and water to be pumped at high pressure into a drilled well to support the release of oil or gas from the fractured geologic formation.

and future projections of climate information related to agriculture, climate, fire conditions, and water. We also used climate projections from 20 climate models and 2 emission scenarios (Representative Concentration Pathway (RCP) 4.5 and RCP 8.5). Results from our analysis into the future for years 2040 and 2069 (Hegewisch et al. 2020, GIS data) predict increased air temperatures (average 2.88 degrees Celsius (°C) (5.18 °Fahrenheit (°F)) and increased precipitation (ranging from increases of 4.92 to 7.44 percent among the two emission scenarios) across the ranges of these 10 species, noting that the latter (i.e., increased precipitation) is a departure from the larger-scale southwest region modeling (Garfin et al. 2014, entire; Walsh et al. 2014, entire) described above. Therefore, for the 10 springsnail species, changes in temperature and precipitation have the potential to result in changes to springflow and springsnail habitat, although to what degree if any are difficult to predict with certainty.

SUMMARY OF CURRENT AND FUTURE CONDITIONS

Following is a summary of the resiliency, redundancy, and representation of each species. These summaries take into consideration each species' range/distribution, abundance, current known condition of each spring where each species occurs (see Section 5.1 in the SSA reports; Service 2021a, pp. 63–79; Service 2021b, pp. 41–63), threats, known or potential projects that may occur currently or into the future within or adjacent to spring habitat, cumulative effects[4], and existing conservation measures (the latter of which is detailed in Appendix A of both SSA reports) that are reducing the effects of threats.

Three future condition scenarios were evaluated and focused on springs maintaining springflow or discharge similar to current conditions, and varied reducuctions in springflow or discharge (Service 2021a, pp. 79–94; Service 2021b, pp. 63–71). We used our best judgement to predict how each species may respond to changed habitat conditions as a proxy for the species' estimated status in each future scenario.

1.0 Amargosa tryonia (*Tryonia variegata*)

Resiliency—Amargosa tryonia occurred historically at 21 locations in the Amargosa Valley region, most of which occurred on Ash Meadows NWR. Several springs exist where this species has lost historically-described habitat, including the presently recorded dry or drying habitats of Chalk Spring, North of Collins Ranch Springs, Near Crystal Reservoir Springs (USGS 2018, entire; Service 2020, entire), and the heavily modified South of Clay Pits Spring (USGS 2018, entire). Many of these sites exhibit a range of invasive species, historic and ongoing water diversions, and other periodic threats, likely contributing to this species varied abundance from abundant to scarce among sites. Despite the threats and some dry historical springs, the Amargosa tryonia currently occupies springs at 12 locations (individual springs and spring

[4] Threats both currently and in the future may act together to affect springsnails at springs or spring provinces. Predation and competition, vegetation and soil disturbance, water pollution, spring modifications, groundwater pumping, and altered precipitation and temperature may adversely affect a site if one, some, or all threats occur concurrently (both now and in the future). Many of the threats are either historical and have stabilized over time, or are current with low-level or individual-level impacts. Potential future conditions from groundwater pumping or altered precipitation and temperature could also produce individual-level effects, but may rise to population-level impacts at specific springs depending on the severity of effects to free-flowing water and spring discharge, and whether or not current threats are concurrently impacting the springs.

provinces) that are roughly spread across 3 general areas of the Ash Meadows NWR; all but one spring receive significant long-term protections within Ash Meadows NWR. The excepted spring occurs within the Refuge boundary as part of Death Valley National Park, where human disturbance is stabilized. The future scenarios are as follows:

- Scenario 1 presents a maintenance of water flow/discharge at current levels and resilient populations across the species range.
- Scenario 2 presents that some of the smaller or higher elevation springs could exhibit reduced discharge as demonstrated by a moderate climate change emission pathway model (RCP 4.5).
- Scenario 3 presents a greater reduction of flow/discharge compared to Scenario 2 as demonstrated by a high climate change emission pathway model (RCP 8.5), with the majority of springs exhibiting reduced flow/discharge or dry. The most significant threat into the future is the availability of adequate water and flow throughout the basin and region. Under all scenarios evaluated, multiple springs are projected to maintain varied resiliency into the future, although the current low flow springs could be less resilient to stochastic perturbations with the potential for some to become dry, especially under Scenario 3.

Redundancy—Recent surveys for Amargosa tryonia verified the species at one NPS location (Devils Hole) and 11 spring locations on the Refuge: Kings Pool, Point of Rocks spring province, Collins Ranch Spring, Five Springs province, Marsh Spring, Mary Scott Spring, North and South Indian springs, North and South Scruggs springs, and School Spring. Amargosa tryonia may also occur on private land at the South of Clay Pits Spring, and in Shoshone Spring on private land outside the Refuge. Amargosa tryonia is widespread regionally (compared to other Ash Meadows springsnails) and may occur at several (1 or 2) additional locations as springsnail surveys continue.

- Future: Amargosa tryonia is expected to continue to occur at multiple locations under all three scenarios, although potentially at fewer springs if significant water flow/discharge reductions occur. Should a catastrophic event occur and cause the loss of one or more populations, there are some to many others that would remain, indicating that the species overall could withstand the loss.

Representation—The species is relatively widespread across the Refuge, occurring in habitats of high elevation such as Devils Hole and Five Springs Province, moderate elevation such as North and South Indian Springs, and low elevation at the South of Clay Pits Spring. Habitats vary from large springs with high flow to small springs with little flow (or no outflow in Devils Hole). Occupied springs are also considerable geographic distances apart with correlative distinctive morphological variation evidenced across the range, and thus expected to confer genetic differences among demographically separated populations.

- Future: Amargosa tryonia's varied and widespread distribution, including its relatively broad environmental diversity, indicates a probability of it being able to adapt to changing environmental conditions, despite the possibility of some springs potentially exhibiting reduced flow/discharge or becoming dry in the future, primarily under a high climate change emission scenario.

2.0 Ash Meadows pebblesnail (*Pyrgulopsis erythropoma*)

Resiliency—The Ash Meadows pebblesnail historically and currently occurs on Ash Meadows NWR within habitat comprised of Kings Pool (one of the largest and high quality spring pools on the refuge) and Point of Rocks Spring Province (comprised of six springs, likely four of which are occupied by the species). Kings Pool and three of the Point of Rocks springs have been restored and the species is abundant, despite the Point of Rocks Spring Province location exhibiting dense sawgrass vegetation leading to overall lower quality habitat compared to Kings Pool. Regardless, all springs receive ongoing protection within the refuge, including management of some threats for the species' long-term benefit (e.g., designated boardwalks to reduce human disturbance), contributing to this species overall moderate to high condition.

- Future: The most significant threat into the future is the availability of adequate water and flow throughout the basin. Scenario 1 maintains water flow/discharge at current levels and resilient populations across the species range. Scenarios 2 and 3 suggest that the springs could exhibit reduced discharge as demonstrated by moderate or high climate change emission pathway models (RCP 4.5 and 8.5), and thus populations that have lowered resiliency than current levels. Regardless, the species is projected to withstand environmental stochasticity or periodic disturbances.

Redundancy—Ash Meadows pebblesnail is endemic to the Kings Pool and four of six springs/outflows at the Point of Rocks Springs Province. The outflows of the Point of Rocks Spring Province are geographically close (i.e., within 200 m (approximately 650 ft)).

- Future: The species is expected to continue to occur at these two separate and protected locations into the future under all three scenarios, with conditions projected from low to high depending on the severity of potential decreased water flow/discharge. Overall, general redundancy has historically been relatively low because this species has only been known to occur at these two locations. There is a low likelihood of a catastrophe occurring that would cause the loss of one or more populations.

Representation—Ash Meadows pebblesnail occurs in springs characterized by both large flow (Kings Pool), and moderate to small discharges from the Point of Rocks Spring Province. Any significant ecological differences among these habitats potentially contributing to representation are unknown; similarly, population genetic variability is unknown.

- Future: Although we do not expect any significant behavioral, ecological, or genetic variation within the Ash Meadows pebblesnail (given limited geographic proximity of the species range), its continued varied distribution at two locations suggests a probability of the species being able to adapt to changing environmental conditions. This is supported by the best available information on related species in the Ash Meadows area and within the southwest that demonstrates the adaptive capacity of springsnails (e.g., living and reproducing at variable water temperatures and under low flow/reduced water levels).

3.0 Crystal springsnail (*Pyrgulopsis crystalis*)

Resiliency—The Crystal springsnail historically and currently occurs within habitat comprised of a single large spring (Crystal Spring) that is approximately 1 m^2 (11 ft^2), the outflow of which composes the largest spring system at Ash Meadows NWR. Abundance of this species in a given year is difficult to quantify given survey challenges in this deep pool that are not logistically amenable to standard sampling. Current abundance is scarce via the capture methods outlined in the SSA report (Service 2021a, pp. 22–26) and abundance data will likely continue to vary. This spring (and springsnail) is secure in terms of natural fluctuations in discharge, which is also demonstrated with historical groundwater pumping information. Threats at this site include invasive species (both fish and invertebrates) that likely impact this system, but they increase with distance downstream and thus impacts at the spring orifice (where all of the Crystal springsnails reside) may be more limited. Also, some soil and vegetation disturbance from recreational activities is mitigated by trails and boardwalks. The site is located at the Visitor Center and Refuge Headquarters, and is considered both a restored spring with springsnails that appear resilient.

- Future: The most significant threat into the future is the availability of adequate water and flow/discharge. Scenario 1 maintains water flow/discharge at current levels and a resilient population. Scenarios 2 and 3 suggest that the spring could exhibit reduced discharge as demonstrated by moderate or high climate change emission pathway models (RCP 4.5 and 8.5), and thus the population could experience lowered resiliency than the current level. Regardless, the species is projected to withstand environmental stochasticity or periodic disturbances, especially given the spring's large size and high quality habitat present.

Redundancy—The Crystal springsnail is endemic to a single spring orifice at Crystal Spring on the Ash Meadows NWR; thus, redundancy has always been low. This spring is also one of the most protected sites at the Ash Meadows NWR. As initially described, and at present, all individuals occur at the orifice of the spring pool. The entire known habitat is approximately 1 m^2 (11 ft^2) of habitat surrounding the spring orifice.

- Future: Redundancy is expected to remain low, resulting in a higher risk of the species not being able to withstand catastrophes compared to springsnails that occur at multiple springs. However, there is a low likelihood of a catastrophe occurring that would cause the loss of the population.

Representation—Crystal springsnail has limited habitat, represented within a single, small population. We do not expect any significant behavioral, ecological, or genetic variation within the Crystal springsnail.

- Future: Representation is expected to remain low (little to no environmental diversity), which may indicate a low ability for the species to adapt to changing environmental conditions; however, we do not expect a wide variation in the environmental conditions at this large, protected spring.

4.0 Fairbanks springsnail (*Pyrgulopsis fairbankensis*)

Resiliency—The Fairbanks springsnail historically and currently occurs within habitat comprised of a single spring (Fairbanks Spring) within the Ash Meadows NWR, and is found at both the orifice and extending downstream at least 1,000 m (3,280 ft). The population is considered abundant overall. Fairbanks Spring is one of the larger springs on the Refuge, and has experienced historical human modifications of impoundment, as well as deepening and narrowing of the stream channel. The spring has been partially restored, although it supports predatory nonnative fishes and competitive nonnative snails. As a result of its current and continued protections within the refuge, it is considered secure in terms of natural fluctuations in discharge, which is demonstrated with historical groundwater pumping information. The present distribution has not changed since the species was first described.

- Future: The most significant threat into the future is the availability of adequate water and flow/discharge. Scenario 1 maintains water flow/discharge at current levels and a resilient population. Scenarios 2 and 3 suggest that the spring could exhibit reduced discharge as demonstrated by moderate or high climate change emission pathway models (RCP 4.5 and 8.5), and thus the population could experience lowered resiliency than the current level. Regardless, the species is projected to withstand environmental stochasticity or periodic disturbances, especially given the spring's large size and quality of habitat present.

Redundancy—The Fairbanks springsnail is endemic to a single spring outflow at Fairbanks Spring, which occurs on the northern extreme of the refuge; thus, redundancy has always been low. As initially described, and at present, individuals occur at the orifice of the spring pool and extend downstream.

- Future: Redundancy is expected to remain low, resulting in a higher risk of the species not being able to withstand catastrophes compared to springsnails that occur at multiple springs. However, there is a low likelihood of a catastrophe occurring that would cause the loss of the population.

Representation—Fairbanks springsnail has limited habitat, represented by a single but abundant population. We do not expect any significant behavioral, ecological, or genetic variation within the Fairbanks springsnail.

- Future: Representation is expected to remain low (little to no environmental diversity), which may indicate a low ability for the species to adapt to changing environmental conditions; however, we do not expect a wide variation in the environmental conditions at this large, protected spring.

5.0 Point of Rocks tryonia (*Tryonia elata*)

Resiliency—The Point of Rocks tryonia historically and currently occurs within the Point of Rocks Spring Province on Ash Meadows NWR, occurring in three of six springs distributed across an approximately 200 m (650 ft) area. The spring province is considered secure against most of the typical non-water supply types of spring modifications, with only limited impacts from human disturbance due to refuge management efforts. However, all Point of Rocks springs are characterized by low flow outflows, and the Point of Rocks tryonia occurs in these areas. These small seeps are sufficiently small such that water and springsnails are not always encountered on every survey, and the springs are susceptible to natural variation in discharge that result in near-dry conditions during drought. Species abundance varies among the three springs (most recent surveys indicated scarce abundance at two springs and abundant at the third), possibly due to low discharge environments that can be overgrown by grasses to the extent that little surface water is present.

- Future: The most significant threat into the future is the availability of adequate water and flow/discharge. Scenario 1 maintains water flow/discharge at current levels and moderately resilient populations. Scenarios 2 and 3 suggest that the springs could exhibit reduced discharge as demonstrated by moderate or high climate change emission pathway models (RCP 4.5 and 8.5), especially under Scenario 3 where springs could dry if flow is inadequate or ceases. Species abundance at the three springs is expected to fluctuate and/or vary from site-to-site into the future (similar to historical information).

Overall, the species is projected to withstand environmental stochasticity or periodic disturbances given the protections that the refuge affords the species, although at lowered resiliency than the current level if moderate or high emissions scenarios are realized.

Redundancy—The Point of Rocks tryonia is endemic to the Point of Rocks Springs Province, which is represented by six clustered small to moderate sized springs/outflows that are geographically close (within several hundred meters of each other) within the Ash Meadows NWR; the species was documented most recently at three of the springs. Thus, this species distribution represents three demographic units.

- Future: Redundancy is expected to remain relatively low given it occurs at only three spring outflows that are in close geographical proximity within a single province/location, resulting in a higher risk of the species not being able to withstand catastrophes compared to springsnails that occur at multiple springs over a wider geographic range. However, there is a low likelihood of a catastrophe occurring that would cause the loss of these protected populations on the refuge.

Representation—The Point of Rocks tryonia has limited habitat, and as described above, occurs within three of six small to moderate size springs that comprise a single location known as the Point of Rocks Spring Province. Population genetic variability is unknown, but given the approximate geographic distances across spring outflows (i.e., approximately 200 m (650 ft)), we do not expect adaptive differences. Significant behavioral, ecological, or genetic variation within the Point of Rocks tryonia are currently unknown, and each spring is characterized by similar ecological features.

- Future: Representation is expected to remain low (little to no environmental diversity) under Scenario 1, with lowered representation under Scenario 2 or 3 if current conditions deteriorate. However, we do not expect a wide variation in the environmental conditions at these protected springs.

6.0 Distal-gland springsnail (*Pyrgulopsis nanus*)

Resiliency—Distal-gland springsnail is known to historically occur at four springs centrally located and protected within the Ash Meadows NWR: Collins Ranch Spring, North of Collins Ranch Springs, Five Springs Province, and Mary Scott Spring. Five Springs Province (aptly named given it is composed of five small- to moderate-sized springs that distal-gland springsnail occupies) and Mary Scott Spring received channel modifications prior to the Refuge stewardship, and the Five Springs Province also supports invasive red-rimmed melania; both springs have since benefitted from restoration efforts by the refuge. The two seeps that comprise the North of Collins Ranch Springs may be dry at present and thus not considered to be currently occupied. Despite low spring discharge recorded in 2018 at Five Springs Province and Mary Scott Spring, as well as invasive species present at one of the three springs, the distal-gland springsnail is common in abundance at all three springs/spring province.

- Future: The most significant threat into the future is the availability of adequate water and flow/discharge. Scenario 1 maintains water flow/discharge at current levels and moderately resilient populations. Scenarios 2 and 3 project that the springs could exhibit reduced discharge as demonstrated by moderate or high climate change emission pathway models (RCP 4.5 and 8.5), especially under Scenario 3 where the Mary Scott Spring could dry if flow is inadequate or ceases. Overall, the species is projected to withstand environmental stochasticity or periodic disturbances given the protections that the refuge affords the species, although at lowered resiliency than the current level if moderate or high emissions scenarios are realized.

Redundancy—The distal-gland springsnail is endemic to three springs (including the Five Springs Province that consists of five small- to moderate-sized springs that are considered restored to semi-natural conditions) that are all centrally located within Ash Meadows NWR. The three spring sources are approximately 2.5 km (1.6 mi) and 3.2 km (2.0 mi) apart in linear fashion, north to south respectively. Outflows at Five Springs Province coalesce into a single stream, while Mary Scott Spring and Collins Ranch Spring are single, independent outflows. Redundancy is considered moderate given the species occurs in three separate locations on the refuge.

- Future: Redundancy is expected to remain moderate given it is projected to continue to reside at three separate spring locations under Scenario 1 and 2, and two locations under Scenario 3, resulting in a higher risk of the species not being able to withstand catastrophes compared to current conditions. However, there is a low likelihood of a catastrophe occurring that would cause the loss of these protected populations on the refuge.

Representation—Significant ecological differences among the habitats at the three spring locations that would potentially contribute to representation are unknown. Population genetic variability is similarly unknown, but given the moderate geographic distances among the three springs, we may expect some genetic differences among sites.

- Future: Representation is expected to remain moderate into the future under Scenario 1 because the springs are geographically separated on the Refuge. Representation is expected to be reduced to low under Scenario 2 or 3. The distal-gland springsnail's continued distribution in three separate springs that experienced historical modifications indicates a probability of it being able to withstand changing environmental conditions, and despite the possibility that the springs could experience reduced flow/discharge under Scenarios 2 and 3.

7.0 Median-gland springsnail (*Pyrgulopsis pisteri*)

Resiliency—The median-gland springsnail historically occurred in four springs and currently occurs in three springs within the Warm Springs area on Ash Meadows NWR: Marsh Spring, North Scruggs Spring, and School Spring. 35 years ago, these springs experienced significant impacts from impoundments, trampling from wild horses, and invasive fish; these impacts have ceased as a result of Refuge ownership and beneficial management to include removal of nonnative fish and structures that impacted free-flowing water. Abundance of the median-gland springsnail has varied over time, but most recently was considered scarce at Marsh Spring and common or abundant at Marsh and North Scruggs Springs, despite the presence of nonnative red-rimmed melania in the latter two springs.. Regardless, all springs receive ongoing protection within the refuge, including management of some threats for the species long-term benefit.

- Future: The most significant threat into the future is the availability of adequate water and flow/discharge. Scenario 1 maintains water flow/discharge at current levels and moderately resilient populations. Scenarios 2 and 3 suggest that the springs could exhibit reduced discharge as demonstrated by moderate or high climate change emission pathway models

(RCP 4.5 and 8.5), especially under Scenario 3 where springs could dry if flow is inadequate or ceases. Overall, the species is projected to withstand environmental stochasticity or periodic disturbances given the protections that the refuge affords the species, although at lowered resiliency than the current level if moderate or high emissions scenarios are realized.

Redundancy—The present distribution for the median-gland springsnail includes three small- to moderate-sized springs in close geographical proximity (Marsh Spring, North Scruggs Spring, and School Spring). Discharge from North Scruggs Spring coalesces with South Scruggs Spring approximately 30 m (98 ft) from the source, but the species does not occur in South Scruggs Spring. Thus, this species distribution represents three demographic units.

- Future: Redundancy is expected to remain relatively low given it occurs at only three springs in close geographical proximity, resulting in a higher risk of the species not being able to withstand catastrophes compared to springsnails that occur at multiple springs over a wider geographic range. However, there is a low likelihood of a catastrophe occurring that would cause the loss of these protected populations on the refuge.

Representation—As noted above, median-gland springsnail occurs in three nearby springs, all within the Warm Springs area, suggesting a low level of variation among them. All three habitats are geographically proximate (500 m; 1,640 ft), and characterized by similar ecological features.

- Future: Representation is expected to remain low (little to no environmental diversity), which may indicate a low ability for the species to adapt to changing environmental conditions; however, we do not expect a wide variation in the environmental conditions at these protected springs.

8.0 Minute tryonia (*Tryonia ericae*)

Resiliency—The minute tryonia is historically known from two springs (North Scruggs Spring and North of Collins Ranch Springs) on the Ash Meadows NWR, although the latter was recently reported as dry with dense vegetation in 2018 and nearly so in 2020. No significant impacts other than drought conditions are noteworthy, and it is unknown why the two small seeps that comprise the North of Collins Ranch Springs lack adequate discharge, despite protections by the refuge and lack of human disturbance. The North Scruggs Spring is the larger of the two with adequate discharge and its habitat has been restored by the refuge, including removal of some nonnative competitors and predators (although red-rimmed melania is still present). Minute tryonia were historically common in the sediments at these springs, although recent surveys indicate the species is considered scarce at North Scruggs Spring (additional surveys are necessary to determine presence of the species at North of Collins Ranch Springs).

- Future: The most significant threat into the future is the availability of adequate water and flow/discharge. Scenario 1 maintains the low flow/discharge at current levels with resiliency considered low. Scenarios 2 and 3 suggest that the spring (or both springs if the North of Collins Ranch Springs are not dry) could exhibit reduced or no discharge as demonstrated by moderate or high climate change emission pathway models (RCP 4.5 and 8.5). Species abundance at the spring(s) is expected to fluctuate and/or vary into the future (similar to historical information). Overall, the species is projected to withstand environmental stochasticity or periodic disturbances given the protections that the refuge affords the species, although at lowered resiliency than the current level if moderate or high emissions scenarios are realized.

Redundancy—The minute tryonia is currently known to occur at one small spring. The historical distribution includes another spring in close geographical proximity, but this spring was recently recorded as dry (however, future surveys are needed to confirm complete desiccation). Both springs are located in the central part of the refuge and are approximately 2 km (1.2 mi) apart. The entire known habitat is approximately 158 m (518 ft) of flow from the North Scruggs Spring orifice.

- Future: Redundancy is expected to remain low given it occurs at only one (or possibly two) springs; if still present at North of Collins Ranch Springs, the distance between the two springs would result in a lower risk of the species not being able to withstand catastrophes compared to springsnails that occur at two separate geographically separated springs. However, there is a low likelihood of a catastrophe occurring that would cause the loss of the North Scruggs Spring, especially given the protections afforded by Ash Meadows NWR via restoration efforts and ongoing mitigation efforts to offset threats.

Representation—Minute tryonia has limited habitat, currently represented by a single (possibly two but more surveys are necessary) population on the Ash Meadows NWR. We do not expect any significant behavioral, ecological, or genetic variation within the minute tryonia; thus, representation is considered low.

- Future: Representation is expected to remain low (little to no environmental diversity) under Scenario 1, with lowered representation under Scenario 2 or 3 if current conditions deteriorate. However, we do not expect a wide variation in the environmental conditions at these protected springs.

9.0 Sportinggoods tryonia (*Tryonia angulata*)

Resiliency—The Sportinggoods tryonia historically and currently occurs at three large springs on the Ash Meadows NWR: Fairbanks Springs, Crystal Spring, and Big Spring. All of these springs were subject to modifications in the past, such as channelization in Fairbanks Spring, water diversion at Big Spring, and direct pumping from Crystal Spring. While Refuge management has mitigated some of these threats today, the springs overall quality is considered high but reduced slightly due to the presence of aquatic invasive species, including red-rimmed melania, invasive fishes, and crayfish. The habitat at Big Spring is expected to be renovated to remove nonnative fishes in the near future (Lee 2017, pers. comm.). In general, these large springs are buffered against natural variation in spring discharge that may threaten springs of smaller sizes in times of drought, and appear to support springsnails with ongoing threats exclusive of water. Despite the presence of invasive species at these three springs, all three historically occupied springs are protected on the refuge with the species demonstrating fluctuations in abundance levels both temporally and within springs (which is typical for springsnails (Mladenka and Minshall 2001, Fig. 2; Martinez 2009; p. 31)), ranging from scarce to abundant. Currently, springsnails are abundant in Crystal Spring and scarce in Fairbanks and Big Spring (although for the latter, numbers of springsnails decrease significantly away from the spring source).

- Future: The most significant threat to this species across its range in the future is the potential for springflow reductions, and to a lesser degree nonnative species predation. Scenario 1 maintains water flow/discharge at current levels and moderately resilient populations across the 3-spring range. Scenario 2 projects reduced flow/discharge as demonstrated by a moderate climate change emission pathway model (RCP 4.5), with decreased but still moderate resilient populations at all three springs. Scenario 3 would further reduce resiliency to low at all three springs compared to Scenario 2 due to a higher climate change emission pathway model (RCP 8.5), thus decreasing the viability for this species in its three populations. Under all scenarios evaluated, all three springs are projected to maintain varied resiliency and abundance of springsnails into the future, with populations expected to withstand environmental stochasticity or periodic disturbances.

Redundancy—Recent surveys indicate this species is found at three springs (Fairbanks Spring, Crystal Spring, and Big Spring) that are geographically and demographically distinct, all occurring within Ash Meadows NWR.

- Future: The species is expected to continue to occur at these three separate and protected locations into the future under all three scenarios, with conditions varying from low to high. General redundancy has historically been relatively low because the species has only been known to occur in three springs/locations. Overall, there is a low likelihood of a catastrophe occurring that would cause the loss of one or more populations.

Representation—The habitats supporting the sportinggoods tryonia are characterized by similar ecological features. Any significant ecological differences among these habitats potentially contributing to representation are unknown; similarly, population genetic variability is unknown. However, each habitat is demographically independent and geographically isolated across the Refuge, spanning approximately 14.2 km (8.8 mi) north to south (Fairbanks Spring to Big Spring), and as such may contribute to population genetic differences; thus, representation is considered moderate.

- Future: Representation in the sportinggoods tryonia is derived from its distribution among three isolated springs, and potentially their ability to survive despite historical modifications. The latter also indicates some probability to adapt to changing environmental conditions, including reduced flow/discharge under Scenarios 2 and 3. Thus, representation is likely to remain moderate in the future.

10.0 Southwest Nevada pyrg (*Pyrgulopsis turbatrix*)

Resiliency—The southwest Nevada pyrg is known from 38 springs; however, additional surveys are necessary to confirm if the species no longer occurs at two of these sites, which would reduce the number of springs to 36. The springs are widespread across approximately 300 km (186 mi), 45 percent of which reside in Clark and Nye Counties, Nevada, and 55 percent of which reside in Inyo and San Bernardino Counties, California. Eighty-nine percent of these populations occur on Federal lands (Forest Service, BLM, NPS, and DoD lands), affording an elevated level of protection to the spring habitat and the species. The majority of spring systems where the species occurs are recovered or known to be stabilized following their past exposure to a variety of natural and anthropogenic perturbations. The future[5] scenarios are as follows:

- Scenario 1 suggests that the southwest Nevada pyrg would maintain its current level of resiliency across its range.
- Scenario 2 projects that some of the springs could exhibit reduced discharge as demonstrated by a moderate climate change emission pathway model (RCP 4.5), and

[5] The future use and subsequent future condition of four springs on private land is unknown.

water quality would remain adequate.

- Scenario 3 projects a greater reduction of flow/discharge compared to Scenario 2 as demonstrated by a high climate change emission pathway model (RCP 8.5), with many of the currently low-flow springs exhibiting reduced flow/discharge to the degree that they would be less resilient (potentially dryer conditions).

The only major threat to this species across its range in the future stems from the potential for springflow reductions. Under all scenarios evaluated, multiple springs are projected to maintain resiliency into the future, although the current low flow springs could be less resilient to stochastic perturbations, but not to a degree that populations would be lost.

Redundancy—Following taxonomic revisions in 2013, the southwest Nevada pyrg is currently known from 38 spring locations (noting that future surveys could determine the species to be extirpated from two springs). Regardless, the species exhibits a wide distribution across four counties and two states. Should a catastrophic event occur and cause the loss of one or more populations, there are many other springs/populations that would remain, indicating that the species overall could withstand the loss.

- Future: The southwest Nevada pyrg is expected to continue to occur at 36–38 springs throughout its widespread range into the future, albeit potentially at lowered resiliency if moderate or high climate change emission scenarios are realized.

Representation—Prior to 2013, the southwest Nevada pyrg was known to occur in springs that were approximately 70 km (43 mi) north to south and 55 km (34 mi) east to west. In 2013, after the Oasis Valley springsnail entity was reassigned after taxonomic evaluations (Hershler et al. 2013, pp. 27–52), the southwest Nevada pyrg's range was significantly expanded to approximately 300 km (186 mi) north to south and 200 km (124 mi) east to west in Nevada and California. The species is widespread across four counties in two states, occurring in habitats of primarily higher elevations above 4,000 ft (1,219 m) and as high as 2,069 m (6,788 ft)), but also lower elevations as low as 1,083 ft (330 m). Habitats vary from large springs with high flow to small springs with little flow (Service 2021b, Chapter 5, pp. 41–63). Occupied springs are far apart with the potential for genetic differences among demographically separated populations. The best available information at this time indicates that representation is high given the species is known to occur at 36 spring locations (some comprised of more than one spring, plus two additional historical springs of unknown current occupancy) within 8 different geographic areas in southwest Nevada and southeast California.

- Future: The southwest Nevada pyrg's varied and widespread distribution in southwest Nevada and southeast California, including its relatively broad environmental diversity, indicate it is able to adapt to changing environmental conditions, despite some springs being projected to have suboptimal conditions (i.e., reduced flow/discharge, although the species is expected to remain extant at all springs under all three scenarios) in the future. Representation is likely to remain high in the future.

FINDING

Section 4 of the Act (16 U.S.C. 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened

species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of "endangered species" or "threatened species" because of any of the following factors:
(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.

Status Throughout All of The 10 Springsnail Species Ranges

After taking into consideration the five factors and the threats (singly and cumulatively) summarized in the SSA reports, the best available scientific and commercial information indicate that the threats are already occurring or may occur with similar or increased intensity in the future. Despite limited species-specific information on how habitat change influences each species, springsnails in general seem resilient as a group, as evidenced by their present distribution,historical habitat manipulation, and the presence of invasive species. In the case of the springsnails that occur on Federal lands (i.e., Ash Meadows NWR, Death Valley National Park, BLM conservation and wilderness areas, as well as Forest Service and DoD lands), nearly all species have benefited from recovery actions to date. In many of these cases, actions include both habitat restoration activities and the protection of water resources (e.g., prohibition of new groundwater pumping within 40 km (25 mi) of Devils Hole). The notable reduction in water levels in Devils Hole and the low discharge from numerous Ash Meadows spring sources associated with a period of intense groundwater pumping for agriculture during the 1970s (Halford and Jackson 2020, p. 87; Nelson and Jackson 2020, p. 26) suggest most springsnail populations are resilient against some level of reduced discharge.

Despite general resiliency across all species, some historical populations have likely become extirpated (i.e., Amargosa tryonia, and possibly minute tryonia and distal-gland springsnail) (Service 2021a, Table 7.1) compared to historical information. These three species may have lost 4 of 19 (21 percent), 1 of 2 (50 percent), and 1 of 4 (25 percent), respectively, of the historically known spring populations; however, additional survey information is necessary to confirm or deny these potential extirpations. Fortunately, the habitat for the majority of the other Amargosa tryonia populations and the remaining minute tryonia and distal-gland springsnail populations have been stabilized as part of stream restorations and protections afforded by the Ash Meadows NWR.

Still, obligate aquatic taxa require water, and the most significant future threat for the Ash Meadows springs is the further reduction in springflow (this is of less concern for the southwest Nevada pyrg given it primarily occupies mountain block aquifer springs that are less likely to be influenced by groundwater withdrawals). Reduction in flow directly influences species needs of "adequate water supply" and "free-flowing water," as well as cascading effects of community structure and physiochemical parameters (Morrison et al. 2013, entire). In consideration of groundwater pumping and climate change, it is reasonable that springflow will change, but some uncertainty exists relative to the magnitude of risk during the next 50 years.

Recent modeling (i.e., Halford and Jackson 2020, entire; Nelson and Jackson 2020, entire) clearly demonstrates that regional groundwater withdrawal at current rates result in lowered water levels and spring discharges (Nelson and Jackson 2020, Figure 20 B, p. 26). However, uncertainty exists in the prediction of absolute and interannual variability of water levels due to uncertainty that surrounds the future magnitude and variability of recharge in the system. This uncertainty is further amplified by uncertainty of the impact of climate change on future precipitation, which will affect the magnitude of recharge. Water levels have risen in Devils Hole since the 1980s, indicating an increase in recharge, but it is unclear how recharge may affect the system in the future (Nelson and Jackson 2020, Figure 20 B, p. 26). For example, if there is a future prolonged drought where recharge declines from the current wet period, water levels in Devils Hole (and likely water levels and spring discharges in selected springs in the Ash Meadows NWR) would be expected to decline as a result of groundwater pumping where there is insufficient recharge to replenish the groundwater system.

Overall, the best available information indicates that the current level of threats are not resulting in significant effects to the resiliency, redundancy, or representation of each species, such that any of the springsnails' conditions cause them to meet the definition of an endangered species. In essence, there is no evidence to suggest that any of the threats are currently impacting the 10 species or their habitat to such a degree that they are causing or likely to cause significant population or rangewide-level impacts. Additionally, the best available data indicate that there are no projects or activities occurring or proposed that would result in significant negative effects to the species needs.

Given our finding that the 10 species are not in danger of extinction now (endangered species), we also consider whether any of the 10 springsnails are likely to become in danger of extinction in the foreseeable future. We considered the relevant risk factors acting on the species (including cumulative effects), existing regulatory measures and other voluntary conservation efforts in place, and whether we could draw reliable predictions about the status of the species in response to these factors. We considered whether we could reliably predict any future effects that might affect the status of each of the species, recognizing that our ability to make reliable predictions into the future is limited by the variable quantity and quality of available data about impacts to the springsnails and their responses to those impacts. ***The future timeframe for this analysis is approximately 50 years*** (Service 2021a, pp. 7, 24; Service 2021b, pp. vi, 8). This timeframe is based on our confidence in projecting threats and the species' response to the threats. We considered the biology of springsnails, along with our confidence in estimating future habitat changes relating to such factors as hydrology, climate change, groundwater management, and species recovery efforts. We did not extend our forecasting beyond this point (e.g., consideration of all available climate change models, such as those that extend approximately 100 years) due to increased uncertainty in the model results that far into the future. Additionally, given springsnail species have a short generation time (approximately 1 year), this timeframe allows us to forecast potential effects to the species over a relatively high number of generations.

As stated previously (see "Summary of Threats," above), the risk factors that may potentially affect the springsnails or their habitat either currently or in the future are: (1) Predation and competition (Factors C and E), (2) vegetation and soil disturbance (Factor A) (i.e., roads, wildfire, grazing and browsing ungulates, recreation, and nonnative or invasive species), (3) water pollution (Factor A) (i.e., recreation, herbicides, or oil/gas/mineral development), (4) spring modifications (Factor A), (5) groundwater pumping (Factor A) (i.e., municipal purposes, irrigation, or development associated with oil/gas/mineral extraction), and (6) altered precipitation and temperature from climate change (Factor A). Considering these risk factors, the most significant threat driving the species status both currently and into the future is the availability of adequate water and flow/discharge.

The best available information indicates that most threats are not likely to change from their current levels of impact, but groundwater pumping and changes in temperature and precipitation resulting from climate change may increase in intensity or magnitude in the future, resulting in a greater, negative effect on free-flowing water and adequate spring discharge. However, following our evaluation of the best available information, if these species needs are negatively affected in any given year(s), the magnitude of that effect is not likely to result in significant differences in the species' resiliency, redundancy, or representation such that any of the springsnails would meet the definition of a threatened species. Additionally, in many instances, existing regulatory or voluntary conservation benefits are expected to continue into the foreseeable future (described in Appendix A, current conditions, and future conditions sections of both SSA reports (Service 2021a; Service 2021b).

Taking into account the impacts of the most likely threats (individually and cumulatively) to each of the species, our projections for future conditions are that five springsnails (Amargosa tryonia, distal-gland springsnail, median-gland springsnail, sportinggoods tryonia, and southwest Nevada pyrg) will continue to be viable at multiple locations (three or more) with moderate or high levels of resiliency, redundancy, and representation. The multiple locations/springs for these species provide redundancy; each species would exist at their respective locations across all or in some cases a portion of their historical ranges, which provides an ability to withstand losses should any unlikely catastrophic event occur. For the other five springsnail species—Ash Meadows pebblesnail, Crystal springsnail, Fairbanks springsnail, Point of Rocks tryonia, and minute tryonia—whose populations and ranges have always been small, we find that these species have demonstrated their ability to withstand a broad range of environmental conditions (e.g., drought, spring modifications, and invasive species). Although such threats may have affected their physical and biological needs at times, overall, no threats are moving these species toward extinction. Additionally, the 10 springsnail species are expected to continue to be resilient based on our evaluation of the populations, and thus are projected to withstand stochastic events. Amargosa tryonia, Ash Meadows pebblesnail, distal-gland springsnail, median-gland springsnail, sportinggood tryonia, and southwest Nevada pyrg would likely continue to exhibit representation; in other words, multiple locations would continue to occur across the range of each species to maintain ecological and genetic diversity. For Crystal springsnail, Fairbanks springsnail, Point of Rocks tryonia, and minute tryonia, representation has historically been and is currently low, characterized by a small distribution. Additionally, there is no evidence of any significant loss of the species' physical and biological needs across the species' range currently, nor is there any evidence of declining numbers of springsnails at any of the locations (beyond the occasional fluctuations in species abundance that is typical among springsnail populations in the southwest).

With regard to potential future changes in climate conditions, projections reveal an overall low risk of these 10 species becoming in danger of extinction in the foreseeable future. As stated above in the "Summary of Threats" section, results from our analysis into the future for years 2040 and 2069 predict increased air temperatures (average 2.88 °C (5.18 °F)) and increased precipitation (ranging from increases of 4.92 to 7.44 percent among the two emission scenarios) where the 10 springsnails occur (Hegewisch et al. 2020, GIS data). The projected increase in precipitation is a departure from the larger-scale southwest region modeling (Garfin et al. 2014, entire; Walsh et al. 2014, entire) described above. Therefore, for all 10 species, changes in temperature and precipitation may result in changes to springflow and springsnail habitat that are difficult to predict with certainty. Therefore, the best available information suggests these potential changes are not significant enough to significantly adversely impact free-flowing water and adequate spring discharge in habitat of any of these species. Coupled with existing management and land protections over much of the spring habitat for the 10 species, and the springsnails' resiliency during events that have the potential to result in significant adverse response, we find that species needs will continue to be met for the 10 springsnail species into the foreseeable future. In some cases, there may be effects from one or more threats, although the level of impact is not anticipated to become significant such that the species needs would not be met in the foreseeable future. Therefore, none of the 10 springsnails are expected to become in danger of extinction throughout all of their ranges in the foreseeable future. Specific observations/notes related to each of the 10 species resiliency, redundancy, and representation are articulated in the "Summary of Current and Future Conditions" section, above

Status Throughout a Significant Portion of the 10 Springsnail Species Ranges

Under the Act and our implementing regulations, a species may warrant listing if it is in danger of extinction or likely to become so in the foreseeable future throughout all or a significant portion of its range. Having determined that each of the 10 springsnail species are not in danger of extinction or likely to become so in the foreseeable future throughout all of their ranges, we now consider whether any may be in danger of extinction or likely to become so in the foreseeable future in a significant portion of their ranges—that is, whether there is any portion of each of the species' range for which it is true that both (1) the portion is significant; and, (2) the species is in danger of extinction now or likely to become so in the foreseeable future in that portion. Depending on the case, it might be more efficient for us to address the "significance" question or the "status" question first. We can choose to address either question first. Regardless of which question we address first, if we reach a negative answer with respect to the first question that we address, we do not need to evaluate the other question for that portion of the species' range.

In undertaking this analysis for each of the 10 springsnail species, we chose to address the status question first—we considered information pertaining to the geographic distribution of both the species and the threats that each species faces to identify any portions of the range where the species is endangered or threatened.

Seven of the springsnails are narrow endemic species that function either as single populations or a few populations/springs that occur within a very small area. Specifically, Crystal springsnail, Fairbanks springsnail, Point of Rocks tryonia, and (possibly) minute tryonia each currently occur in single springs or spring provinces. Ash Meadows pebblesnail, distal-gland springsnail, and median-gland springsnail occur in two or three springs or spring provinces that are geographically close, ranging from a couple to a few hundred meters apart, to approximately 3.2 km (2.0 mi) apart in linear fashion between two of the three springs for the distal-gland springsnail. For these seven species, there is no biologically meaningful way to break these limited ranges into portions, and the threats that each species faces affect them throughout their entire ranges. This means that no portions of the species' ranges have a different status from their rangewide status. Therefore, no portion of the species' ranges can provide a basis for determining that these seven springsnail species are in danger of extinction in a significant portion of their ranges. Thus, we determine that Crystal springsnail, Fairbanks springsnail, Point of Rocks tryonia, minute tryonia, Ash Meadows pebblesnail, distal-gland springsnail, and median-gland springsnail are not likely to become in danger of extinction within the foreseeable future throughout all of their ranges. This is consistent with the courts' holdings in *Desert Survivors* v. *Department of the Interior*, No. 16-cv-01165-JCS, 2018 WL 4053447 (N.D. Cal. Aug. 24, 2018), and *Center for Biological Diversity v. Jewell*, 248 F. Supp. 3d , 946, 959 (D. Ariz. 2017).

Three springsnails have broader ranges such that we can examine the threats that each face because the springs or groupings of springs are all geographically distinct. First, the three springs where sportinggoods tryonia occurs are demographically independent and geographically isolated across the Ash Meadows NWR, spanning approximately 14.2 km (8.8 mi) north to south (Fairbanks Spring to Big Spring). Second, Amargosa tryonia occurs in different geographically isolated areas in the Amargosa Valley and mostly on the refuge, but is comprised of 21 locations/springs across three different geographic areas. Third, the southwest Nevada pyrg occurs in 36 springs that are widespread across approximately 300 km (186 mi), 45 percent of which reside in Clark and Nye Counties, Nevada, and 55 percent of which reside in Inyo and San Bernardino Counties, California. For each of these springsnails, we considered whether the threats are geographically concentrated in any portion of their ranges at a biologically meaningful scale, and whether any of the species have responded differently to those threats at different locations/springs. We examined the following threats (both singly and cumulatively) and the species' responses to these threats: (1) Predation and competition, (2) vegetation and soil disturbance (roads, wildfire, grazing and browsing ungulates, recreation, and nonnative or invasive species), (3) water pollution (recreation, herbicides, or oil/gas/mineral development), (4) spring modifications, (5) groundwater pumping (municipal purposes, irrigation, or development associated with oil/gas/mineral extraction), and (6) altered precipitation and temperature from climate change. The best available information, including survey reports, aerial imagery, and information from species experts, indicates that the threats affect each of the species throughout their ranges, noting that some springs may be affected by different sources, but the threat itself is consistent (e.g., water pollution from recreation at one spring compared to water pollution from herbicides at another spring, or predation from different species all resulting in loss of individuals). Likewise, the best available information on threats that may reduce the species needs of free-flowing water and spring discharge (i.e., ground water withdrawals, or changes in temperature and precipitation from climate change) indicate they are projected to affect each of these three species throughout their ranges. Though ground water withdrawals and changes in temperature or preciptation can negatively impact free-flowing water and spring discharge in springsnail habitat, both flow and abundance of springsnails are known to fluctuate in any given year. Overall, we found no concentration of threats nor any difference in the species' responses to threats at a biologically meaningful scale in any portion of the ranges for sportinggoods tryonia, Amargosa tryonia, and southwest Nevada pyrg. Therefore, no portion of these species' ranges can provide a basis for determining that they are in danger of extinction now or likely to become so in the foreseeable future in a significant portion of their ranges, and we find that each of these species are not in danger of extinction now or likely to become so in the foreseeable future in any significant portion of their ranges. This is consistent with the courts' holdings in *Desert Survivors* v. *Department of the Interior*, No. 16-cv-01165-JCS, 2018 WL 4053447 (N.D. Cal. Aug. 24, 2018), and *Center for Biological Diversity v. Jewell*, 248 F. Supp. 3d , 946, 959 (D. Ariz. 2017).

Determination of Status

The best available scientific and commercial information indicates that Amargosa tryonia, Ash Meadows pebblesnail, Crystal springsnail, Fairbanks springsnail, Point of Rocks tryonia, distal-gland springsnail, median-gland springsnail, minute tryonia, sportinggoods tryonia, and the southwest Nevada pyrg do not meet the definition of an endangered species or a threatened species in accordance with sections 3(6) and 3(20) of the Act. Therefore, we find that listing these species are not warranted at this time.

RECOMMENDED CONSERVATION MEASURES

Continue coordination efforts with the private landowners and Federal partners to conserve springsnails, spring habitats, and the waters that support them. Working with private landowners would be part of the overall conservation efforts outlined in the *Conservation Strategy for Springsnails in Nevada and Utah*[6] (Springsnail Conservation Team 2020, entire), determining on a case-by-case basis whether to engage private landowners collectively or individually working with them to undergo a more formal conservation agreement. Springs addressed in this analysis that may need conservation attention include (but are not limited to): Big Bear Lake, Cold Creek Spring, Grapevine Spring (bench), Horseshutem Spring (lower), and Willow Spring (BLM).

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment:
California: California Department of Fish and Wildlife
Nevada: Nevada Department of Wildlife

6 This conservation strategy is a comprehensive and proactive 10-year plan to protect 103 species of springsnails and their habitats (primarily springs) in relation to a 2018 Agreement signed by the States, Federal land and resource agencies, and the Nature Conservancy.

Indicate which State(s) did not provide any information or comments:
N/A

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: PAUL SOUZA Digitally signed by PAUL SOUZA Date: 2021.06.14 12:50:08 -07'00'

Regional Director, Fish and Wildlife Service Date

Concur: MARTHA WILLIAMS Digitally signed by MARTHA WILLIAMS Date: 2021.09.09 11:27:59 -06'00'

Principal Deputy Director, Exercising the Delegated Authority of the Director, U.S. Fish and Wildlife Service Date

Do not concur: ______________________

Principal Deputy Director, Exercising the Delegated Authority of the Director, U.S. Fish and Wildlife Service Date

Director's Remarks:

Date of annual review:
Conducted by: