Diminutive Amphipod
(*Gammarus hyalelloides*)
5-Year Status Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Austin Ecological Services Field Office
Austin, Texas
August 16, 2023

5-YEAR REVIEW
Diminutive Amphipod (*Gammarus hyalelloides*)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional or Headquarters Office:
Vanessa Burge, Recovery Biologist, Southwest Regional Office, Albuquerque, New Mexico, vanessa_burge@fws.gov

Lead Field Office:
Michael Warriner, Supervisory Fish and Wildlife Biologist, Austin Ecological Services Field Office, Austin, Texas, michael_warriner@fws.gov

Cooperating Field Office(s):
Not applicable

Cooperating Regional Office(s):
Not applicable

1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service or USFWS) is required by section 4(c)(2) of the Endangered Species ESA (ESA) to conduct a status review of each listed species once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the ESA. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review:

The Service conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the ESA (16 U.S.C. 1531 et seq.). The Service provides notice of status reviews via the *Federal Register* and requests information on the status of the species. Data for this status review were solicited from interested parties through a *Federal Register* notice announcing this review on January 11, 2023 (88 FR 1602). We considered both new and previously existing information from federal and state agencies, municipal and county governments, non-governmental organizations, researchers, and the general public.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review:

88 FR 1602, January 11, 2023

1.4.2 Listing history:

Original Listing
FR notice: 78 FR 41228
Date listed: July 9, 2013
Entity listed: Diminutive amphipod (*Gammarus hyalelloidesi*)
Classification: Endangered

Revised Listing, if applicable
FR notice: Not applicable
Date listed: Not applicable
Entity listed: Not applicable
Classification: Not applicable

1.4.3 Associated Rulemakings:

Critical habitat was designated for the diminutive amphipod at four units (i.e., Giffin, East Sandia, Phantom Lake, and San Solomon Springs) in Jeff Davis and Reeves counties, Texas on July 9, 2013 (78 FR 40970).

1.4.4 Review History:

Not applicable

1.4.5 Species' Recovery Priority Number at start of 5-year review:

No previously assigned recovery priority number

1.4.6 Recovery Plan or Outline

Name of plan or outline: Not applicable, no recovery plan at present
Date issued: Not applicable
Dates of previous plans/amendment or outline, if applicable: Not applicable

2.0 REVIEW ANALYSIS

Section 4 of the ESA (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 ESA 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 ESA requires that we determine whether a species meets the definition of "endangered species" or "threatened species" due to any of the five factors described below.

Section 4(a) of the Act describes five factors that may lead to endangered or threatened status for a species. These include: A) the present or threatened destruction, modification, or curtailment of its habitat or range; B) overutilization for commercial, recreational, scientific, or educational purposes; C) disease or predation; D) the inadequacy of existing regulatory mechanisms; or E) other natural or manmade factors affecting its continued existence.

The identification of any threat(s) does not necessarily mean that the species meets the statutory definition of an “endangered species” or a “threatened species.” In assessing whether a species meets either definition, we must evaluate all identified threats by considering the expected response of the species, and the effects of the threats—in light of those actions and conditions that will ameliorate the threats—on an individual, population, and species level. We evaluate each threat and its expected effects on the species, then analyze the cumulative effect of all of the threats on the species as a whole. We also consider the cumulative effect of the threats in light of those actions and conditions that will have positive effects on the species—such as any existing regulatory mechanisms or conservation efforts. The Service recommends whether the species meets the definition of an “endangered species” or a “threatened species” only after conducting this cumulative analysis and describing the expected effect on the species now and in the foreseeable future.

2.1 Distinct Population Segment (DPS) policy (1996):

No, this species is an invertebrate, so the DPS policy does not apply.

2.2 Updated Information and Current Species Status

2.2.1 Biology and Habitat

2.2.1.1 New information on the species’ biology and life history:

Noreika (2019, entire) and Texas Parks and Wildlife Department (2022, pp. 37-39, 58-73) investigated abundance, distribution, and mesohabitat associations of listed invertebrates (i.e., diminutive amphipod, Phantom springsnail, and Phantom tryonia) in the San Solomon Spring System (i.e., East Sandia, Giffin, Phantom Lake, San Solomon, and Phantom Lake Springs). The diminutive amphipod exhibited habitat associations with the presence of sand and gravel at East Sandia Spring and San Solomon Springs pool (Noreika 2019, p. 12).

2.2.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, birth rate, seed set, germination rate, age at mortality, mortality rate, etc.), or demographic trends:

Baseline population and density estimates for the diminutive amphipod (Table 1), from most sites occupied by the species, are provided by Noreika (2019, pp. 28-29) and Texas Parks and Wildlife Department (2022, p. 71). The privately-owned Giffin Spring was not sampled during those efforts. The diminutive amphipod was the third most abundant listed invertebrate collected from surveyed springs (Noreika 2019, p. 9). Population estimates of the Phantom springsnail and Phantom tryonia were not equitably distributed across all spring sites but rather centered at individual springs (i.e., Phantom Lake Spring and San Solomon Spring pool, respectively) (Texas Parks and Wildlife Department 2022, pp. 90-91). In contrast, diminutive amphipod numbers were relatively equitable across all surveyed springs, potentially reflecting the greater dispersal abilities of that crustacean (Texas Parks and Wildlife Department 2022, pp. 90-92).

Table 1. Estimated population sizes for the diminutive amphipod, 2017-2018 (Texas Parks and Wildlife Department 2022, p. 71).

Site	**Mean Population Estimate (minimum-maximum possible range)**
East Sandia Spring	2,517,251 (934,470-4,100,031)
West Sandia Spring	1,280,083 (337,763-2,222,403)
San Solomon Spring (canal, ciénegas, and pool combined)	39,027,642 (26,255,482-51,799,803)
Phantom Lake Spring	865,920 (115,233-1,616,607)

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

Adams et al. (2018, entire) investigated the evolutionary history (e.g., divergence time and diversification rates) of *Gammarus* species across the northern Chihuahuan Desert through analysis of nuclear and mitochondrial DNA. That research revealed that *Gammarus* populations assigned to the diminutive amphipod at Giffin, East Sandia, and San Solomon Springs were genetically distinct from *Gammarus* at Phantom Lake Spring and may constitute an undescribed species (Adams et al. 2018, pp. 750-754). Under that assertion, Phantom Lake Spring would be the only site known to host the diminutive amphipod. Published research to further confirm that finding has not been completed to date.

2.2.1.4 Taxonomic classification or changes in nomenclature:

No description of a putative new species at East Sandia, Giffin, and San Solomon Springs has appeared in the peer-reviewed literature to date. As a result, *Gammarus* populations at those springs and Phantom Lake and West Sandia Springs continue to be recognized as occupied by the diminutive amphipod until formal taxonomic revision occurs.

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

Survey efforts by Noreika (2019, p. 27) and Texas Parks and Wildlife Department (2022, p. 71) confirmed continued persistence of the diminutive amphipod at East Sandia, Phantom Lake, and San Solomon Springs as of 2018. West Sandia Spring was added as a new locality for the amphipod during that effort (Noreika 2019, p. 9; Texas Parks and Wildlife Department 2022, p. 21). The status of the species at Giffin Spring is unknown due to absence of sampling efforts at that site. Loss of pumped water and drying of aquatic surface habitats at Phantom Lake Spring in 2022 will likely result in the extirpation of the diminutive amphipod from that site (See 2.2.1.6 Habitat or ecosystem conditions, 2.2.17 Other, and 2.2.2.1 Present or threatened destruction modification, or curtailment of its habitat range).

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

San Solomon Spring System Water Quality

In 2018, Texas Parks and Wildlife Department developed recommendations for baseline monitoring of water quantity and quality parameters as well as aquatic fauna of the San Solomon Spring System (Texas Parks and Wildlife Department 2018, entire). Sampling efforts conducted by that agency and partners (e.g., Service and Texas State University) took place from 2017 to 2018 (Texas Parks and Wildlife Department 2022, entire). Water quality of sampled springs was generally of good quality with few detectable contaminants (Texas Parks and Wildlife Department 2022, pp. 77-89).

Phantom Lake Spring Augmented Water Supply and Restoration Efforts

Water exiting Phantom Spring Cave historically supported surface aquatic habitats (e.g., ciénega and irrigation canal) at Phantom Lake Spring. However, starting in the mid-20th century, flow from the cave declined until it ceased completely in 2000 (Brune 2001, p. 259; Ridgeway et al. 2005, p. 1). The U.S. Bureau of Reclamation (Bureau) voluntarily installed a pump inside the cave in 2001 to provide water to surface aquatic habitat, specifically a small artificial ciénega and irrigation canal (Figure 1; Ridgeway et al. 2005, p. 25; Bureau 2021, p. 1; Service 2021, pp. 2-3). That agency supported monitoring, maintenance, and replacement of the pump system from 2000 to 2022 (Bureau 2021, pp. 1-2). The property was transferred to the previous landowner in 2022 (See 2.2.1.7 Other; Bureau 2021, p. 1).

The pump system was originally installed as a short-term measure to support listed invertebrate and fish species at Phantom Lake Spring and would not operate indefinitely (Service 2004, pp. 4, 20; Service 2022, p. 2). Long-term benefits would only be possible if the pump saved the spring from complete failure and natural spring discharge return in the future (Service 2004, pp. 4, 20). In 2011, the Service installed and repositioned a new pump deeper into Phantom Spring Cave to address continuing declines in spring flow (Service 2022, p. 2). At the same time, the Service added a generator for back-up power and made improvements to the ciénega (Service 2021, p. 2). In 2014, the Service completed emergency repairs at Phantom Lake Spring to address flood-related erosion (Service 2022, p. 2). Prior to ownership transfer, the of Reclamation again replaced the pump system due to electrical malfunction (Bureau 2021, p. 3).

A habitat restoration effort was planned by the Service's Texas Fish and Wildlife Conservation Office for 2021 with the intent of improving aquatic habitat relied on by the diminutive amphipod and other listed species (Service 2022, p. 2). A goal of the restoration was to address the site's reliance on the pump system to maintain aquatic habitat. The habitat restoration project would have deepened the entrance of Phantom Spring Cave to better connect spring outflow with adjacent aquatic habitat, allowing pumping equipment to be removed (Service 2021, entire). However, the restoration did not prove feasible because excavation work encountered bedrock, which precluded establishment of a better connection between water exiting the cave and habitat occupied by listed species.

Figure 1. Water-filled ciénega at Phantom Lake Spring, August 2015. U.S. Fish and Wildlife Service.

Because the restoration could not be completed, surface aquatic habitat continued to be dependent on mechanically pumped water. As of February 2023, the pump at Phantom Spring Cave is no longer maintained by the property's new owner and surface aquatic habitat has been dewatered (Figure 2; See 2.2.17 Other and 2.2.2.1 Present or threatened destruction modification, or curtailment of its habitat range). As a result, habitat for the diminutive amphipod at Phantom Lake Spring has been eliminated.

Figure 2. Dewatered Phantom Lake Spring ciénega (i.e., gray, barren area), February 2023. Individual in background stands in front of Phantom Spring Cave. Water no longer flows from the cave's entrance due to loss of pumped water. Image courtesy of Mike Montagne, Texas Fish and Wildlife Conservation Office.

2.2.1.7 Other:

Phantom Lake Spring Ownership Transfer

In 2022, the Bureau transferred ownership of the 17.56 acres encompassing Phantom Lake Spring to the property's prior owner (Service 2022, p. 1). The Bureau acquired the property in 1945 as part of the Balmorhea Project to provide supplemental water to the Reeves County Water Improvement District (Simonds 1996, pp. 2-3). With declines in spring flow, the site was no longer a viable irrigation project (Bureau 2021, p. 1). Transfer of the property to the original owner, or their successors, was included as terms in the Bureau's Limiting Agreement and Contract for the Purchase of Phantom Lake Spring Water Rights, Land and Rights of Way. The Bureau was obligated to transfer the land as previously agreed.

2.2.1.8 Conservation Measures:

State Listing Status

On March 23, 2015, Texas Parks and Wildlife Department designated the diminutive amphipod as a State endangered species (40 *Texas Register* 1711). Parks and Wildlife Code (Chapter 68 Sec. 68.004) directs that any "fish or wildlife" species listed as federally endangered be listed as State endangered. In Texas, no person may "take, possess, propagate, transport, export, sell or offer for sale, or ship any species of fish or wildlife listed by the department as endangered (31 Texas Administrative Code §65.171)." These State regulations provide no protections for the species' habitat (e.g., maintaining spring flow), however.

Balmorhea State Park Habitat Conservation Plan

Texas Parks and Wildlife Department completed a Habitat Conservation Plan and received an incidental take permit (Service 2009, entire) in 2009 under section 10(a)(1)(B) (U.S.C. 1539(a)(1)(B)) of the Act for management activities at Balmorhea State Park (i.e., location of San Solomon Spring) [Texas Parks and Wildlife Department 1999, entire]. The diminutive amphipod and several other candidate and listed species were included as covered species in the permit (Service 2009, pp. 20-22).

The permit authorized ''take'' of the diminutive amphipod, which was a candidate at the time of issuance, in the State Park for ongoing management activities while minimizing impacts to the aquatic species. The activities included in the Habitat Conservation Plan are a part of Texas Parks and Wildlife Department's operation and maintenance of the State Park, including the drawdowns associated with cleaning the swimming pool and vegetation management within the refuge canal and ciénega. The Habitat Conservation Plan also calls for restrictions and guidelines for chemical use in and near aquatic habitats to avoid and minimize impacts to covered species (Service 2009, pp. 9, 29–32). The 2009 Habitat Conservation Plan expired in 2019. A new 10-year Habitat Conservation Plan was approved by the Service in 2020.

Texas Parks and Wildlife Department Spring System Biomonitoring Efforts

In 2016, Texas Parks and Wildlife Department established the Trans-Pecos Oil and Gas Working Group in response to increasing concerns regarding the discovery of a major unconventional oil and natural gas play (i.e., Alpine High Play) in the Delaware Basin of western Texas (Olson and Ailworth 2016; Land and Veni 2018, p. 5; Texas Parks and Wildlife Department 2022, p. 10). The footprint of the play encompassed much of Reeves County and the San Solomon Spring System itself (Land and Veni 2018, p. 13). Initial estimates placed potential numbers of hydraulically fractured wells in the play at 2,000 to 3,000 wells (Texas Parks and Wildlife Department 2022, p. 10).

Hydraulic fracturing is a process in which a mixture of water, chemicals, and proppant (e.g., sand) are injected into an oil and natural gas reservoir under pressure to fracture the reservoir rock and increase flow of those resources to the wellbore (Cook et al. 2015, p. 47; U.S. Environmental Protection Agency 2016, p. 3-3). Groundwater is the sole source of water for oil and natural gas extraction activities in the western Texas (Nicot et al. 2012, pp. 54, 56), with hydraulic fracturing relying upon significant volumes water to extract petroleum (Gallegos et al. 2015a, p. 5,842; Kondash et al. 2018, p. 2). How substantial increases in hydraulically fractured wells might impact spring flows was of primary concern along potential contamination of groundwater from petroleum extraction (Myers 2016, entire; Land and Veni 2018, pp. 5-6; Nunu and Green 2021, p. 4).

In collaboration with the Trans-Pecos Oil and Gas Working Group, Texas Parks and Wildlife Department developed and implemented a biomonitoring plan to evaluate and establish baseline data regarding water quantity, presence of contaminants, and status of aquatic fauna for the San Solomon Spring System (Texas Parks and Wildlife Department 2018, entire; Texas Parks and Wildlife Department 2022, entire). Monitoring efforts were conducted from 2017 to 2018 resulting in the most comprehensive evaluation of the spring system to date (Texas Parks and Wildlife Department 2022, pp. 43-315). These data will provide a much needed baseline by which to evaluate stressors to the spring systems and its dependent species. Additionally, concerns over the potential growth in oil and natural gas activity also spurred research by other entities (e.g., Big Bend Conservation Alliance) to better define the hydrogeology of the San Solomon Spring System (Land and Veni 2018, entire; Land et al. 2020, pp. 93-104; Nicot et al. 2021, entire; Nunu and Green 2021, entire).

Conservation Ownership

East and West Sandia Springs are still owned and managed by The Nature Conservancy. Texas Parks and Wildlife Department continues to own and manage San Solomon Spring. Ownership by those entities provides protection to spring outflow channels and the surrounding surface habitat. However, ownership does not provide groundwater protections needed to ensure adequate and ongoing spring flow quantity and quality. Both Giffin and Phantom Lake Springs are in private ownership with no documented conservation planning to protect listed species or their habitat.

Captive Husbandry

The Service's San Marcos Aquatic Resources Center evaluated captive husbandry of the diminutive amphipod. Captive propagation proved to be difficult (Texas Parks and Wildlife Department 2022, p. 94). Some success was realized with captive reproduction but maturation of juveniles to adults was not achieved (Texas Parks and Wildlife Department 2022, p. 94).

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

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

Declines in Spring Flow

Based on available data, San Solomon Spring has experienced long-term historical declines (i.e., since the 1920s) in flow that have persisted into the 2010s (Texas Parks and Wildlife Department 2022, pp. 17-18; Nicot et al. 2021, pp. 3, 91). That said, San Solomon Spring has never ceased flow in recorded history, still produces substantial amounts of groundwater, and is the largest spring to support diminutive amphipod populations.

The remaining springs that support that diminutive amphipods are smaller in size compared to San Solomon Spring, with lower flow volumes, and at increased risk to drying events and water quality degradation. Flow at Giffin Spring has held relatively constant over time but is typified by low volume discharge and recent decline (i.e., 2015) [Far West Texas Water Planning Group 2021, pp. 7-6-7-7; Nicot 2021, pp. 17, 91]. East and West Sandia Springs are also low discharge springs; historical trend data is not available for those springs (Nicot et al. 2021, pp. 3, 55).

The aquatic habitats of small, low flow springs such as Giffin, East Sandia, and West Sandia Springs are especially vulnerable to declines in groundwater levels. Reduced spring flow caused by decreased groundwater availability can result in to changes to water quality (e.g., increased temperature and decreased dissolved oxygen) and drying of spring pools and outflow channels (Murdoch et al. 2000, pp. 349-353).

Following transfer of the Phantom Lake Spring site from the Bureau to the original property owner in 2022, the pump providing water to the diminutive amphipod's aquatic habitat ceased function (Mike Montagne, personal communication May 20 and June 8, 2022). Service and Texas Parks and Wildlife Department staff visited the site in February 2023 and found that electrical connections had been removed making the pump inoperable (Montagne 2023, pp. 1-2). Phantom Spring Cave pool was dry and water level in the cave was very low at 0.2 meters (m) [0.6 feet (ft)]. Surface aquatic habitat had been dewatered with the exception of pooled rainwater. The continued presence of listed invertebrates was not assessed during this visit. It is likely that the diminutive amphipod's population experienced significant mortality due dewatering. In the absence of suitable aquatic habitat, the species will likely be extirpated from the site.

Climate Change

Climate change-driven aridity in western Texas may affect aquifer recharge, and spur municipal and industry (i.e., agriculture and petroleum interests) demands for increased groundwater pumping, potentially affecting spring flows (Mace and Wade 2008, pp. 657-658; Taylor et al. 2012, p. 3). Prolonged drought has the potential to drive demand for additional groundwater resources that could impact regional aquifer levels (Freese and Nichols, Inc. 2020, p. 7-7; Far West Texas Water Planning Group 2021, p. 7-11). Increases in air temperature, and other climate-change driven variables, could affect surface water quality of spring pools and outflows by decreasing dissolved oxygen levels and increasing metal toxicity (Murdoch et al. 2000, pp. 349-353).

As described in the final listing rule for the diminutive amphipod (78 FR 41244), reductions in or cessation of spring flow threaten the persistence of the diminutive amphipod. Causative agents contributing to reduced groundwater quantity are pumping from supporting aquifers to provide water for agricultural irrigation and petroleum extraction activities. Across the Chihuahuan Desert of Texas and Mexico, groundwater pumping and human disturbance has led to the loss or diminishment of spring habitat resulting in the extirpation or extinction of desert spring invertebrates (i.e., springsnails) [Hershler et al. 2014, pp. 51, 53, 56, 58, 59, 60-63].

Amphipods dependent on perennially flowing water often do not possess adaptations to survive loss of aquatic habitat (Covich and Thorp 1991, pp. 676-677; Glazier 1991, pp. 533-534; Strachan et al. 2015, pp. 60-70; Gilbert et al. 2018, p. 20). Other *Gammarus* species have experienced population extirpations due to the loss of perennial spring flow (Cole 1985, p. 102; Lang et al. 2003, pp. 48, 53; Gervasio et al. 2004, 521). It is likely that the diminutive amphipod is susceptible to extinction if perennial springflow of the San Solomon Spring System were to decline substantially or cease completely.

Increasing aridity (e.g., higher temperatures and more frequent and intense droughts) due to human-driven climate change could reduce recharge (i.e., precipitation) to the aquifers that support groundwater flows to the San Solomon Spring System (Patten et al. 2008, pp. 403-405, 409-410; Green et al. 2011, pp. 538-546; Kløve et al. 2014, pp. 252-253; Cole and Cole 2015, pp. 32-33; U.S. Global Climate Change Research Program 2017, p. 14). Downscaled climate projections for Reeves County were obtained from the U.S. Climate Resilience Toolkit (U.S. Federal Government, 2021). For the period 2024-2099, projections indicate that average daily maximum temperature will increase in that county from 28.3 °C (82.9 °F) in 2024 to 33.1 °C (91.5 °F) by 2099 under high emissions (Representative Concentration Pathway [RCP] 8.5). Under low emissions (RCP 4.5), average daily temperature will increase from 28.4 °C (83.2 °F) in 2024 to 30 °C (86 °F) by 2099. Number of days per year above 40.5 °C (105 °F) are projected to increase from 13.5 days in 2024 to 84.4 days in 2099 with high emissions and from 16.1 days in 2024 to 31.3 days under low emissions.

Accompanying higher temperatures is the potential for more frequent drought and increasing aridity for Texas and the southwestern U.S. (Seager et al. 2007, pp. 1181, 1183; National Oceanic and Atmospheric Administration 2016, p. 3; Park et al. 2017, pp. 71-72; Wendt et al. 2018, p. 587; Marvel et al. 2019, p. 64). Severe droughts in Texas are now much more probable than they were 40 to 50 years ago (Rupp et al. 2012, pp. 1053–1054). In 2011, Texas experienced the worst annual drought since record-keeping began in 1895 (Nielsen-Gammon 2012, pp. 61-94).

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

No new information.

2.2.2.3 Disease or predation:

No new information.

2.2.2.4 Inadequacy of existing regulatory mechanisms:

Maintenance and Protection of Spring Flow

County, regional, and state groundwater planning and management entities in Texas do not provide regulatory provisions to monitor, maintain, and protect spring flows across the San Solomon Spring System to support survival of listed species. Such provisions are absent from the Reeves County Groundwater Conservation District 2018 Management Plan, 2021 Region F Water Plan, 2022 Texas State Water Plan, and other water planning documents (Reeves County Groundwater Conservation District 2018, entire; Freese and Nichols, Inc., 2020. pp. 1-36-1-38, 1-40, 1-63, 6-12; Hutchison 2021, pp. 14-15, 17; Texas Water Development Board 2022, entire).

Future Groundwater Demands

Planning for future water needs in Texas is guided by projections developed by 16 regional water planning groups (Freese and Nichols, Inc. 2020, p. 1-1). The planning horizon for future water needs extends to 2070. Region E and F Water Planning Groups encompass western Texas and, more specifically, the regional flow paths that contribute groundwater to the San Solomon Spring System (Freese and Nichols, Inc. 2020, p. ES-6; Far West Texas Water Planning Group

2021, p. 1-32; Nicot et al. 2021, p. 92). Portions of Culberson, Jeff Davis, and Reeves counties lie within the footprint of that regional groundwater flow path.

Western Texas is largely dependent on groundwater to meet human-needs given a dearth of surface water resources (Freese and Nichols, Inc. 2020, pp. 5E-54-5E-55, 5E-59; Far West Texas Water Planning Group 2021, pp. 3-1, 3-22). Agricultural irrigation is the major groundwater consumer in Culberson, Jeff Davis, and Reeves counties with demands for that use sector projected to persist into 2070 (Freese and Nichols, Inc. 2020, pp. 1-22, 1-45, 2-15, 2-17; Far West Texas Water Planning Group 2021, pp. 2-7, 2-18, 4-2).

Both plans recognize drought as a persistent challenge to meeting future water needs (Freese and Nichols, Inc. 2020, pp. 7-1-7-19; Far West Texas Water Planning Group 2021, pp. 7-2-7-38). However, Region E and F Water Planning Groups do not include analysis of the effects of climate change on groundwater resources. Various water conservation measures are identified to address future shortfalls in supply (Freese and Nichols, Inc. 2020, pp. 6-2-6-10; Far West Texas Water Planning Group 2021, pp. 5-24-5-37). Other measures include expanded use of groundwater for meeting water needs (Freese and Nichols, Inc. 2020, p, 6-10; Far West Texas Water Planning Group 2021, pp. 5-2, 5A-6, 5A-43-5A-44). Increased use of groundwater into the future would have the potential of reducing groundwater flow to the Solomon Spring System.

2.2.2.5 Other natural or manmade factors affecting its continued existence:

No new information.

2.3 Synthesis

The diminutive amphipod is restricted to isolated desert springs and ciénegas in the Chihuahuan Desert of western Texas. Multiple springs across this region have experienced severe declines in flow or complete loss of perennial flow due to groundwater pumping. Flow at Giffin, Phantom Lake, and San Solomon Springs all experienced some degree of historical decline since the early to mid-20th century. This phenomenon, coupled with human alteration and disturbance of spring habitats, has resulted in the extirpation or extinction of other desert spring invertebrates from the region.

The diminutive amphipod persists at three sites in conservation ownership (i.e., East Sandia, West Sandia, and San Solomon Springs). The species' status at privately-owned Giffin Spring is unknown. Aquatic habitat at Phantom Lake Spring has been dewatered due to loss of mechanically pumped water. The diminutive amphipod will likely be extirpated from this site due to loss of aquatic habitat.

The aquifers that support flow of the San Solomon Spring System are under pressure from groundwater pumping to meet needs of agricultural irrigation and petroleum extraction activities. Groundwater will continue to be the primary source for future human water needs as the local area has few surface water resources. Demands from irrigation and petroleum sectors for groundwater are projected to persist into 2070. The effects of increased aridity on groundwater resources (i.e., aquifer levels and spring flows), as a result of climate change, is not incorporated into regional water planning efforts. No regulatory mechanisms exist to protect and maintain adequate springs flows to support diminutive amphipod populations at any site.

The diminutive amphipod requires adequate volumes of suitable quality groundwater to persist within the San Solomon Spring System. Threats to groundwater quantity and quality continue to be imminent and will persist into the future. These stressors endanger the continued persistence of the diminutive amphipod. At this time, we do not recommend a change in listing status for the diminutive amphipod.

3.0 RESULTS

3.1 Recommended Classification:

No change is needed

3.2 New Recovery Priority Number (indicate if no change; see 48 FR 43098):

5C

Brief Rationale:

The diminutive amphipod faces a high degree of threat related to adequate groundwater quantity and quality. Intensive management is needed to alleviate those threats. Given the species limited range and imminence of threats, recovery potential is low. Threats to the diminutive amphipod are groundwater pumping to support agricultural irrigation and petroleum extraction. There are currently no regulatory provisions in place at the local, county, or state level to protect and maintain adequate spring flows to support diminutive amphipod populations.

3.3 Listing and Reclassification Priority Number, if reclassification is recommended (see 48 FR 43098):

Reclassification (from Threatened to Endangered) Priority Number: Not applicable
Reclassification (from Endangered to Threatened) Priority Number: Not applicable
Delisting (Removal from list regardless of current classification) Priority Number: Not applicable

Brief Rationale:

Not applicable

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Develop a species status assessment and recovery plan that contains measurable objectives and criteria for the diminutive amphipod.

- Surveys are needed at Giffin and Phantom Lake Springs to assess species persistence and population sizes.

- Research regarding the environmental tolerances (i.e., water quality parameters) of the diminutive amphipod is needed to assess the species' risk to changing habitat conditions and potential contaminants.

- Continue water quantity and quality monitoring at accessible spring sites.

- Maintenance and perpetuation of adequate spring flows and water quality across the San Solomon Spring system should be incorporated into local and regional water planning management strategies. Because the groundwater flow path that sustains the San Solomon Spring System underlies multiple counties, coordination among groundwater conservation districts and regional planning groups is critical to achieve this action. The effects of climate change on groundwater resources should be included in regional water planning efforts.

- Examine genetic variability among populations of the diminutive amphipod to assess gene flow, population structure, and estimate population sizes.

- Continue efforts to develop captive husbandry and propagation of the diminutive amphipod. Investigate the feasibility of establishing a refugia population.

5.0 REFERENCES

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of Diminutive Amphipod (*Gammarus hyalelloides*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: Not applicable

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service, Austin Ecological Services Field Office, Austin, Texas

Approve KAREN MYERS Digitally signed by KAREN MYERS Date: 2023.08.16 12:03:58 -05'00' ____