Socorro Isopod
(*Thermosphaeroma thermophilum*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Albuquerque, New Mexico

5-YEAR REVIEW
Socorro isopod (*Thermosphaeroma thermophilum*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Region: Region 2, Southwest, Susan Jacobson, Chief Threatened and Endangered Species, 505-248-6641; Wendy Brown, Recovery Coordinator, 505-248-6664; Brady McGee, Regional Recovery Biologist, 505-248-6657.

Lead Field Office: New Mexico Ecological Services Field Office, Susan Oetker, Fish and Wildlife Biologist, 505-761-4761.

Cooperating Offices: Brian Lang, Invertebrate Biologist, New Mexico Department of Game and Fish, 505-476-8108; Stephen Shuster, Northern Arizona University.

1.2 Methodology used to complete the review

This review was conducted through public review notification and a comprehensive review of all documents regarding Socorro isopod that were available to the U.S. Fish and Wildlife Service's (Service) New Mexico Ecological Services Field Office (NMESFO). The Federal Register notice (73 FR 14995) announced this review on March 20, 2008, and solicited new information about species biology, habitat conditions, conservation measures implemented, threats, trends, and significant portion of the range from other agencies, such as Federal and State, non-governmental organizations, academia, and the general public. No new information was received from this solicitation. The primary sources of information used in this analysis were the 1978 final listing rule (43 FR 12691), Socorro Isopod Recovery Plan (U.S. Fish and Wildlife Service 1982), peer reviewed literature, unpublished reports, and personal communication with Brian Lang, Invertebrate Biologist with the New Mexico Department of Game and Fish. This 5-year review document was drafted by Marilyn Myers, Senior Fish and Wildlife Biologist, and Susan Oetker, Fish and Wildlife Biologist, NMESFO.

1.3 Background

1.3.1 Federal Register Notice citation announcing initiation of this review: 73 FR 14995; March 20, 2008.

1.3.2 Listing history

Original Listing:
FR Notice: 43 FR 12690
Date listed: March 27, 1978
Entity listed: Species, *Exophaeroma* (sic) *thermophilus* (sic) = *Thermosphaeroma thermophilum*
Classification: Endangered

1.3.3 Associated Rulemakings: None.

1.3.4 Review History: A 5-year review was initiated on November 6, 1991 (56 FR 56882) for all species listed before 1991, but no document was prepared for this species. The species' status has been listed as "stable" in Recovery Data Call every year since 2000.

1.3.5 Species Recovery Priority Number at start of review: 2, indicating a species with high degree of threat and high recovery potential.

1.3.6 Recovery Plan or Outline

Name of plan: Socorro Isopod Recovery Plan
Date issued: February 2, 1982
Date of previous revision: The recovery plan has not been revised.

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate? No.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes.

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No.

2.3 Updated Information and Current Species Status

At the time the Socorro isopod was listed (43 FR 12680; March 27, 1978), virtually nothing was known of its life history, habitat requirements, or population dynamics. Since listing, many studies have been conducted that have added greatly to our knowledge of this species (Bowman 1981, Shuster 1981a,b, Jormalainen and Shuster 1994, Jormalainen et al. 1999, Jormalainen and Shuster 1999, Shuster et al. 2005, Lang et al. 2006). Because this is the first 5-year review conducted for the species, we provide an overview of the research that has

been done since 1978.

2.3.1 Biology and Habitat

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

The Socorro isopod is a rare crustacean that survives in only one spring located on private land in Socorro County, New Mexico. The habitat of the Socorro isopod consists of two concrete pools and the plumbing system of an abandoned bathhouse supplied with water from Sedillo Spring. Most of the isopod population is confined to the larger of the two pools, which is approximately 1 by 2.7 meters (3.3 by 8.8 feet). Water temperature is relatively constant throughout the year (31 – 33˚ C) (Shuster 1981a). Socorro isopods are crepuscular, burrowing into the substrates and hiding in cracks or under vegetation during the day.

Field and laboratory data indicate that the life span of the Socorro isopod is one year or less (Shuster 1981a). There is marked sexual dimorphism; males are much larger than females. In monthly samples collected from March 1978 to February 1979, the mean size of males ranged from 13.9 – 26.7 mm^2, while mean female size ranged from 8.5 mm^2 –15.4 mm^2 (Shuster 1981a). Sex ratio over the same time frame was consistently biased towards males and ranged from 1.2 – 5.5 (Shuster 1981a). Females are iteroparous (meaning many reproductive cycles over its lifetime) and breed throughout the year, although peaks in reproduction occur in the spring and fall. Males guard females prior to copulation, through the molting period. Gestation lasts approximately three weeks as fertilized eggs and developing young are retained in the female's marsupium (Lang 1998). Larger, older females have larger broods. Up to three broods of 3 – 20 individuals are produced. Juveniles (mancas) reach sexual maturity within 6 – 8 weeks, with males growing faster and maturing faster than females (Shuster 1981a,b).

Two types of feeding behavior have been observed in the field, grazing on vegetative matter (the thin film of blue-green that covers most surfaces within the pool or organic debris that falls into their habitat) and predatory feeding frenzies (Shuster 1981a). Feeding frenzies occurred when 10 – 30 isopods attacked an injured isopod, an apparently healthy isopod, or an insect larva. Cannibalism has been observed, with males more cannibalistic than females but both sexes and life stages (juvenile and adult) cannibalizing to some degree, even in the presence of alternative food (Shuster et al. 2005). Shuster (1981a) suggested food in the pools was most likely limiting based on the cannibalistic behavior and the fact that species richness in the spring was very limited, unlike many spring ecosystems.

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

Two estimates of population size were conducted in the mid-1970s, and both estimated the population to contain approximately 2,400 individuals (Hatch 1976, Shuster 1977). Although the population was nearly extirpated in 1988 when the spring went dry, the introduction of 50 individuals from a captive population, as well as animals that may have been flushed from the pipes into the pool, allowed the population to rebound. The population and habitat are currently considered very stable in both the native spring and the captive south pool (B. Lang, pers. comm., 2009). A population has been introduced to the captive north pool in the last several years and is currently stabilizing. In the fall of 2009, a vertical habitat structure will be introduced to the north pool, which should continue to stabilize that population (B. Lang, pers. comm., 2009). Density is greatest at the pool and run sites of the native spring, with density of mancas at the run site being much greater than at the valve of the spring and the pool (Lang et al. 2006).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

In less than six years of species management, captive subpopulations underwent significant genetic divergence from the natural population (Shuster et al. 2005). The genetic divergence occurred primarily at 2 of the 57 AFLP makers examined. Over the same six-year period, body lengths of captive isopods diverged significantly from those in the natural population, with average male and female body size increasing as much as two-fold compared to the natural population.

In 1998, tree roots occluded drainage to the spring, causing it to dry out. Subsequently, 500 animals from the University of New Mexico were released at the spring to repatriate the population. This has likely created a genetic bottleneck (Shuster et al. 2005).

2.3.1.4 Taxonomic classification or changes in nomenclature:

Thermosphaeroma thermophilum is a crustacean in the order Isopoda (pillbugs, sow bugs), family Sphaeromatidae. *T. thermophilum* was originally described as *Sphaeroma thermophilum* in 1897 (Richardson 1897). Richardson subsequently moved the species to the genus *Exosphaeroma* in 1905. Cole and Bane (1978) reviewed the genus while describing a new species and determined that some of the species that were included in *Exosphaeroma*, including *E. thermophilum*, did not conform to the generic description. Consequently, they described a new genus, *Thermosphaeroma*, which now includes *T. thermophilum* and seven other species (Cole and Bane 1978, Bowman 1981, Bowman 1985, Schotte 2000). It should be noted that

both the genus (*Exophaeroma*) and species (*thermophilus*) in the final listing rule (43 FR 12690) for the Socorro isopod were misspelled.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

Nearly all isopods in the family Sphaeromatidae inhabit marine or brackish waters. It is hypothesized that the ancestors of *Thermosphaeroma* inhabited the marine waters that once covered most of central and eastern Mexico, Texas, and New Mexico during the middle to late Mesozoic. As the water receded, the ancestral sphaeromatids were stranded in isolated bodies of water. The confinement to hot springs and evolution into several species (eight described thus far) is probably a recent event (Bowman 1981). *Thermosphaeroma* species occupy small, isolated thermal springs in the Chihuahuan Desert in New Mexico, Texas, and Mexico (Chihuahua, Durango, Aguascalientes). Bowman (1981) hypothesizes that the isopods have been successful in hot springs because of reduced competition and predation from aquatic insects, which are more abundant and prevalent in temperate waters.

Thermosphaeroma thermophilum is the most northern representative of *Thermosphaeroma*. The type locality for the species occurs in only one spring, the Sedillo Spring located on private land west of Socorro, New Mexico. Much of the flow from Sedillo Spring was diverted into a spa, referred to as "Evergreen" historically. The bathhouse was abandoned in the mid-1970s, although a small flow from the spring remained to supply irrigation water. The isopod is restricted to the remains of this plumbing system supplied with water from Sedillo Spring, which originates a few hundred feet away; consequently, the water quality and thermal characteristics are retained. A flow of five gallons per minute is transmitted from Sedillo Spring through the old plumbing system, maintaining the "natural" habitat of the species. It is estimated that Sedillo Spring originally had a flow of 151 – 172 gallons per minute. It is unknown if the Socorro isopod once occupied two adjacent thermal springs, Cook and Socorro Springs. Cook, Socorro, and Sedillo Springs are located about three miles west of Socorro, New Mexico and are capped for municipal and private water supply, eliminating the original habitat.

In addition to the natural habitat, the Socorro Isopod Propagation Facility was built in 1992. The facility is located near the native habitat on property owned by the city of Socorro. Two parallel artificial streams, each with four cement tanks, provide additional habitat for the isopod. Back-up populations are also maintained at the Albuquerque Biological Park, Northern Arizona University, and New Mexico Department of Game and Fish facilities in Santa Fe, New Mexico.

2.3.1.6 Habitat or ecosystem conditions:

The habitat of the Socorro isopod consists of two small concrete-formed pools with an interconnecting pipe, and a narrow partially confined stream below the lower pool. Temperature in the upper pool remains in the range of 27 – 33˚ C. A thin film of blue-green algae covers most of the surfaces at the pool.

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

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

The range of the Socorro isopod remains extremely limited. The primary threat to the species is loss of habitat. Municipal and private water developments have completely altered the natural habitat of this species by capping the original spring source and piping the water to alternate areas (Hatch 1976). The species currently occurs in pipes near its native spring, and any alteration of flow can be extremely detrimental to the species, including local events (blockage of flow) or landscape-wide changes to groundwater levels. In particular, disruption of thermal groundwater discharge of Sedillo Spring is a primary threat. In 1988, tree roots blocked drainage to the spring, and the species was extirpated from wild. Fortunately, captive populations existed at the University of New Mexico, and 500 individuals were reintroduced to old plumbing system of Sedillo Spring. The isopod population quickly rebounded and has been stable since (B. Lang, pers. comm., 2009).

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

There are no commercial or recreational uses of the isopod. Lack of access helps to prevent unauthorized collections. Individuals are removed from the habitat for scientific purposes, which must be permitted through section 10 scientific collecting permits. Although a variety of experiments have been conducted using Socorro isopod, the population numbers have remained stable and the experiments have led to a greater understanding of the biology of the species, enabling us to better protect it.

2.3.2.3 Disease or predation:

No diseases have been documented in the Socorro isopod populations. Cannibalistic behavior has been noted and is most pronounced when food is limited and inadequate microhabitat structure/diversity exists. Potential insect predators are typically preyed upon by the isopods. In 2007, a bullfrog was removed from the largest pool at Sedillo Spring (B. Lang, pers. comm., 2009),

although this has been the only incidence of bullfrogs at the spring. Non-native crayfish and the New Zealand mudsnail (*Potamopyrgus antipodarum*) could be problematic for the Socorro isopod if they are introduced to the spring, but the probability of such introduction is very low (B. Lang, pers. comm., 2009).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The Socorro isopod is federally and State listed as endangered (43 FR 12690, New Mexico Department of Game and Fish 2006). Critical habitat has not been designated for the species. All research activities are regulated by permits issued by the Service and New Mexico Department of Game and Fish. As described below, it is anticipated the climate change will have a significant impact on the water resources of the southwestern U.S. There are no regulatory mechanisms that address climate change.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Several biological traits have been identified as putting a species at risk of extinction (McKinney 1997, O'Grady et al. 2004). Some of these characteristics include the species having a localized range, limited mobility, and fragmented habitat (Noss et al. 2006, Fagan et al. 2002). The Socorro isopod has all of these characteristics. Having a small, localized range means that any perturbation (e.g., drought, water contamination) can eliminate the species. Having a high number of individuals at a site provides no protection against extinction. Noel (1954) noted that an amphipod (another aquatic invertebrate) in Lander Spring, New Mexico, was the most abundant animal present when she did her research. The species was extirpated from that site when the spring dried up (Cole 1985). Extremely limited dispersal capability effectively eliminates the ability of the isopod to find and disperse to other suitable habitats or to move out of habitat that becomes unsuitable. Consequently, they are unable to avoid contaminants or other unfavorable changes to their habitat. Severe drought, spring contamination, fire, or spring development (impoundment, dredging, piping, riparian management) could result in the extinction of the species.

The effect climate change will have on springs in New Mexico is unknown. However, the southwestern U.S. may be entering a period of prolonged drought (MaCabe et al. 2004, Seager et al. 2007). Seager et al. (2007) show that there is a broad consensus among climate models that the southwestern U.S. will get drier in the 21st century and that the transition to a more arid climate is already under way. Only 1 of 19 models examined showed a trend toward a wetter climate in the southwest (Seager et al. 2007). An increase in average mean air temperature of just under 1˚C (1.8˚F) has already been documented in New Mexico since 1976 (Lenart et al. 2007). Udall and Gates

(2007) found that multiple independent data sets confirm widespread warming in the western U.S.

In consultation with leading scientists from the southwest, the New Mexico Office of the State Engineer prepared a report for the Governor which made the following observations about the impact of climate change in New Mexico: warming trends in the American southwest exceed global averages by about 50 percent; models suggest that even moderate increases in precipitation would not offset the negative impacts to the water supply caused by increased temperature; temperature increases in the southwest are predicted to continue to be greater than the global average; the intensity, frequency, and duration of drought may increase (New Mexico Office of the State Engineer 2006).

Increased air temperatures lead to higher evaporation rates, which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge. Increased temperatures across the southwest may also increase the extent of area influenced by drought (Lenart 2003), decreasing groundwater recharge regionally, and consequently reducing spring discharge. Prolonged drought leading to diminishment or drying of the spring would have a negative impact on the isopod. The spring would not have to dry out completely to have an adverse effect on the species. Decreased spring flow could lead to a decrease in the amount of suitable habitat, increased water temperature fluctuations, lower dissolved oxygen levels, and an increase in salinity (MacRae et al. 2001). In addition, as water becomes increasingly scarce, conflict over its use becomes more intense. Human and/or cattle consumption of water would be expected to increase during drought in the absence of normal rainfall. Any of these factors, alone or in combination, could lead to either the reduction or extirpation of the population.

2.4 Synthesis.

The Socorro isopod is a rare crustacean that survives in only one spring located on private land in Socorro County, New Mexico. Critical habitat has not been designated. The effects of climate change, if they include widespread drought, decreased spring discharge, or a change in water chemistry is a newly recognized threat that could eliminate the species. Translocation to other springs, a criterion for delisting, is no longer viewed as a viable option. Because this species only occurs in one location where it could easily be extirpated by biological or environmental threats, we recommend that the Socorro isopod remain listed as endangered.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X_ No change is needed

3.2 New Recovery Priority Number: 5

Brief Rationale: The threats remain high, but intensive management is needed and the threats are not alleviated easily. Therefore, the recovery potential for the species is low.

3.3 Listing and Reclassification Priority Number: N/A.

Reclassification (from Threatened to Endangered) Priority Number: ____
Reclassification (from Endangered to Threatened) Priority Number: ____
Delisting (Removal from list regardless of current classification) Priority Number: ____

Brief Rationale:

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The Socorro Isopod Recovery Plan needs to be revised and updated. The recovery plan is out of date and does not contain objective, measurable recovery criteria, nor does it take into account the Socorro isopod propagation that has been implemented. Additionally, it calls for relocation of the isopod into new springs and seeps. After investigation into springs within the same complex of the isopod revealed they are no longer suitable habitat, and given the risky nature of introducing a species outside its range, it has been determined that reintroduction into additional springs is not feasible, nor recommended. Instead, focus should be placed on securing Sedillo Springs from threats such as dewatering and contamination.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Socorro isopod (*Thermosphaeroma thermophilum*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

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

Review Conducted By: Susan Oetker and Marilyn Myers, U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 10-5-09

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Approve Nancy G Gloman Date 11/24/09