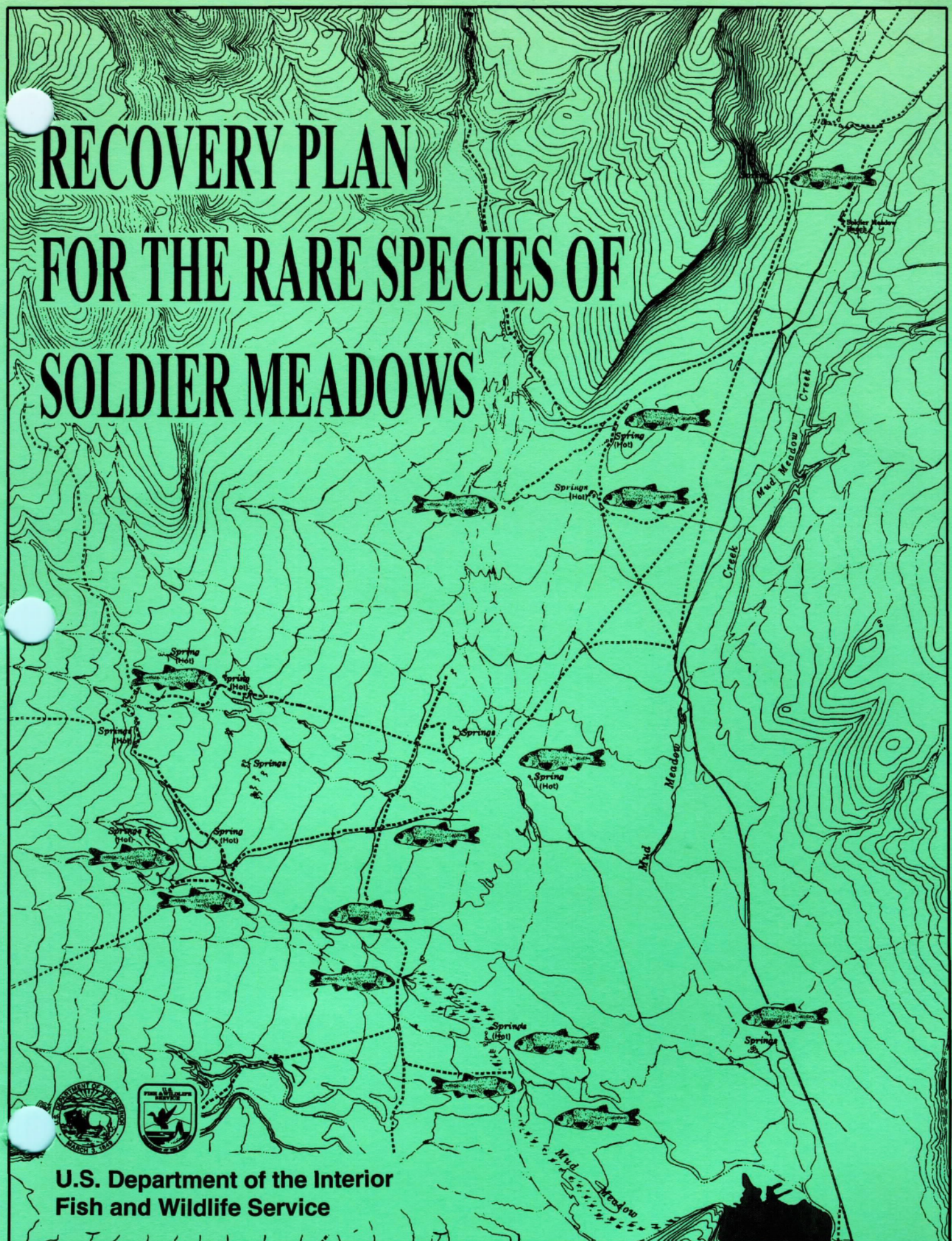
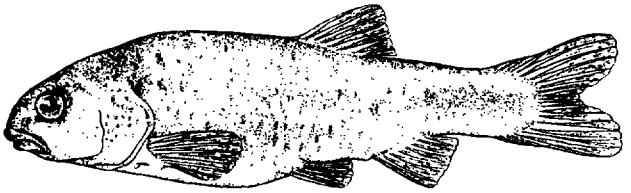
RECOVERY PLAN FOR THE RARE SPECIES OF SOLDIER MEADOWS



U.S. Department of the Interior
Fish and Wildlife Service



"Ecosystems have no useless parts, and we are foolish to think they do. Species, including endangered ones, are stabilizers. What the hump is to the humpback chub, endangered species are to humans."

Holmes Rolston III - Battle Against Extinction 1991

RECOVERY PLAN

FOR THE RARE SPECIES OF

SOLDIER MEADOWS

U.S. Fish and Wildlife Service
Region 1
Portland, Oregon

Approved: _____
Regional Director, U.S. Fish and Wildlife Service

Date: 5/27/97

This Recovery Plan covers one federally listed fish species (desert dace), one plant species of concern (Soldier Meadows cinquefoil), and four undescribed hydrobiid snail species in Soldier Meadows.

DISCLAIMER

Recovery plans delineate reasonable actions believed to be required to recover or protect listed species. Plans published by the U.S. Fish and Wildlife Service are sometimes prepared with the assistance of recovery teams, contractors, State agencies, and other affected and interested parties. Recovery teams serve as independent advisors to the Service. Plans are reviewed by the public and submitted to additional peer review before they are adopted by the Service. Objectives of the plan will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not obligate other parties to undertake specific tasks and may not represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

By approving this document, the Regional Director certifies that the data used in its development represents the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in development of the plan are available in the administrative record, located at the Nevada State Office of the U.S. Fish and Wildlife Service, Reno, Nevada.

Literature Citation of this document should read as follows:

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EXECUTIVE SUMMARY OF THE RECOVERY PLAN FOR THE RARE SPECIES OF SOLDIER MEADOWS

Background: Soldier Meadows is located in western Humboldt County, Nevada. At least 49 thermal springs are located in the valley, and wetland vegetation is abundant despite generally arid conditions. The area supports six rare endemic species including a threatened fish, a plant species of concern, and four undescribed hydrobiid snail species.

Current Species Status: The desert dace (*Eremichthys acros*) was listed as threatened on December 10, 1985, with critical habitat (50 Federal Register 50304). It occupies eight thermal springs and approximately 5 kilometers (3.1 miles) of spring outflow stream habitat. Although no recent population estimate is available, average minnow trap catch rates of up to 21.8 fish per trap per hour have been documented.

The Soldier Meadows cinquefoil (*Potentilla basaltica*) (= basalt cinquefoil) was designated as a category 1 candidate species on February 21, 1990 (55 Federal Register 6184). This species was subsequently removed from candidate status and is now considered a "species of concern." It occupies alkali meadow, seep, and marsh habitats bordering thermal springs, outflow streams, and depressions. Soldier Meadows contains 10 subpopulations of Soldier Meadows cinquefoil. An estimated 84,650 individuals are distributed on approximately 28 hectares (69 acres). Several thousand additional Soldier Meadows cinquefoil were recently discovered in Ash Valley, Lassen County, California.

The four hydrobiid snail species in Soldier Meadows are members of the genus *Pyrgulopsis*. They were only recently identified, and taxonomic descriptions are in preparation. Limited surveys show that the snails are distributed in a north-south pattern in Soldier Meadows. Three species occur at one to three sites each and only occur in Soldier Meadows. The fourth snail species occurs at one site in Soldier Meadows and in a spring to the north, near Summit Lake.

Habitat Requirements and Limiting Factors: Desert dace are restricted to spring pools and outflow streams varying in temperature from 18.0 to 40.5 degrees Celsius (64 to 104 degrees Fahrenheit). Seasonal water temperature variations affect fish distribution within the spring systems. Stream habitats (23-29 degrees Celsius, 73-84 degrees Fahrenheit) downstream of spring orifices generally have the highest fish densities; however, cooler temperatures of 21-24 degrees Celsius (70-75 degrees Fahrenheit) are required for spawning. Desert dace are omnivorous, but feed primarily on periphyton (substrate algal layer) and filamentous algae. Threats to the species when listed included habitat modifications due to agricultural diversions, geothermal exploration and development, and introductions of nonnative fishes and associated parasites. Increasing recreational use of the spring systems is a new potential threat.

Soldier Meadows cinquefoil require moist soils, but only tolerate shallow standing water. Plants typically occur on fine clay soils with an evaporative crust of mineral salts. Potential threats to the species include habitat modifications from recreational use of the spring systems, trampling and overgrazing by livestock and wild horses and burros, and competing nonnative plants.

Hydrobiid snail species require high-quality, well-oxygenated, flowing water and tolerate only limited variations in environmental conditions. Members of the genus *Pyrgulopsis* typically occur within or just downstream from spring sources, but may be more abundant farther downstream. They feed on algae. Limiting factors for the species in Soldier Meadows have not been identified. However, any substantial alteration to occupied spring systems, especially changes in water quality and quantity, could potentially harm these species.

Recovery Objective: This plan seeks to achieve delisting of desert dace and to ensure the long-term conservation of Soldier Meadows cinquefoil and hydrobiid snail species.

Recovery Criteria: Desert dace will be considered for delisting when 1) historical habitat in the one dewatered stream channel on public land is restored so that it supports desert dace; 2) the population in each of the eight historically occupied spring systems is stable or increasing in size and comprising two or

more age-classes for 3 years, 3) reproduction and recruitment are documented from each historically occupied spring system with suitable water temperatures for 3 years; and 4) habitat modification, nonnative fishes, and parasites no longer threaten the long-term survival of the species.

The long-term conservation of Soldier Meadows cinquefoil will be ensured when 1) the abundance and distribution of Soldier Meadows cinquefoil is stable or increasing within the 10 known subpopulations in Soldier Meadows for 3 years, and 2) habitat modification and competing nonnative plants no longer adversely affect the long-term survival of the species.

The long-term conservation of hydrobiid snail species in Soldier Meadows will be ensured when 1) the abundance and distribution of each of the four species has been documented, 2) the abundance and distribution of each of the four species is stable or increasing within the known sites for 3 years, and 3) there are no existing threats to long-term survival of these species.

These recovery criteria are preliminary and may be revised on the basis of new information (including research specified as recovery tasks).

Actions Needed:

1. Aquatic and riparian habitat restoration and management.
2. Population monitoring.
3. Research.
4. Public information and education.

Implementation Participants: The Bureau of Land Management and Nevada Division of Wildlife will be assisting the U.S. Fish and Wildlife Service in implementing recovery actions. For activities occurring on private land, landowner participation is also needed.

Costs ($1,000's) 1997-2000:

Year	Need 1	Need 2	Need 3	Need 4	Total
1997	110	0	0	5	115
1998	90	44	15	20	169
1999	65	44	0	15	124
2000	25	44	0	20	89
Total	290	132	15	60	497

Date of Recovery: If recovery tasks are undertaken as scheduled, desert dace could be recovered in the year 2001.

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DEFINITION OF RECOVERY

Recovery is the process by which the decline of an endangered or threatened species is stopped or reversed, and threats to its survival are neutralized, so that its long-term survival in the wild can be ensured.

I. INTRODUCTION

A. Overview

Soldier Meadows is located in an alluvial basin, approximately 6.5 kilometers (4 miles) in diameter, at the extreme northwestern edge of the Black Rock Desert in western Humboldt County, Nevada (Figure 1). At least 49 thermal springs are located in the valley (Grose and Keller 1975), and wetland vegetation is abundant despite generally arid conditions. The area supports six rare endemic species: one fish, one plant, and four snails.

The springs in Soldier Meadows are of artesian origin and occur along the intersection of two geologic fault trends, in a cluster arrangement (Nyquist 1963). Soldier Meadows comprises approximately 5 percent of the Soldier Creek (= Mud Meadow Creek) drainage basin, and drainage occurs in a general southeasterly direction toward the Black Rock Desert. Isotopic analyses of spring water reveal that it originated as precipitation, however, exact recharge sources and rates are unknown (USGS 1975). Water quality varies greatly among the springs (Nyquist 1963, Sinclair 1963). The high temperatures of the springs (maximum temperature 53.9 degrees Celsius, 129 degrees Fahrenheit) have been attributed to groundwater descending to great depths within the artesian structure before returning to the surface (Nyquist 1963).

The springs are between 1,320 and 1,395 meters (4,331 and 4,577 feet) in elevation and apparently remained partially isolated above the highest inundation level of ancient Lake Lahontan (1,333 meters; 4,374 feet) during the Pleistocene Epoch (La Rivers 1962, Willden 1964, Smith and Street-Perrott 1983). Hubbs and Miller (1948) suggested that Soldier Meadows may have been a marshy embayment of an arm of Lake Lahontan during its highest stage.

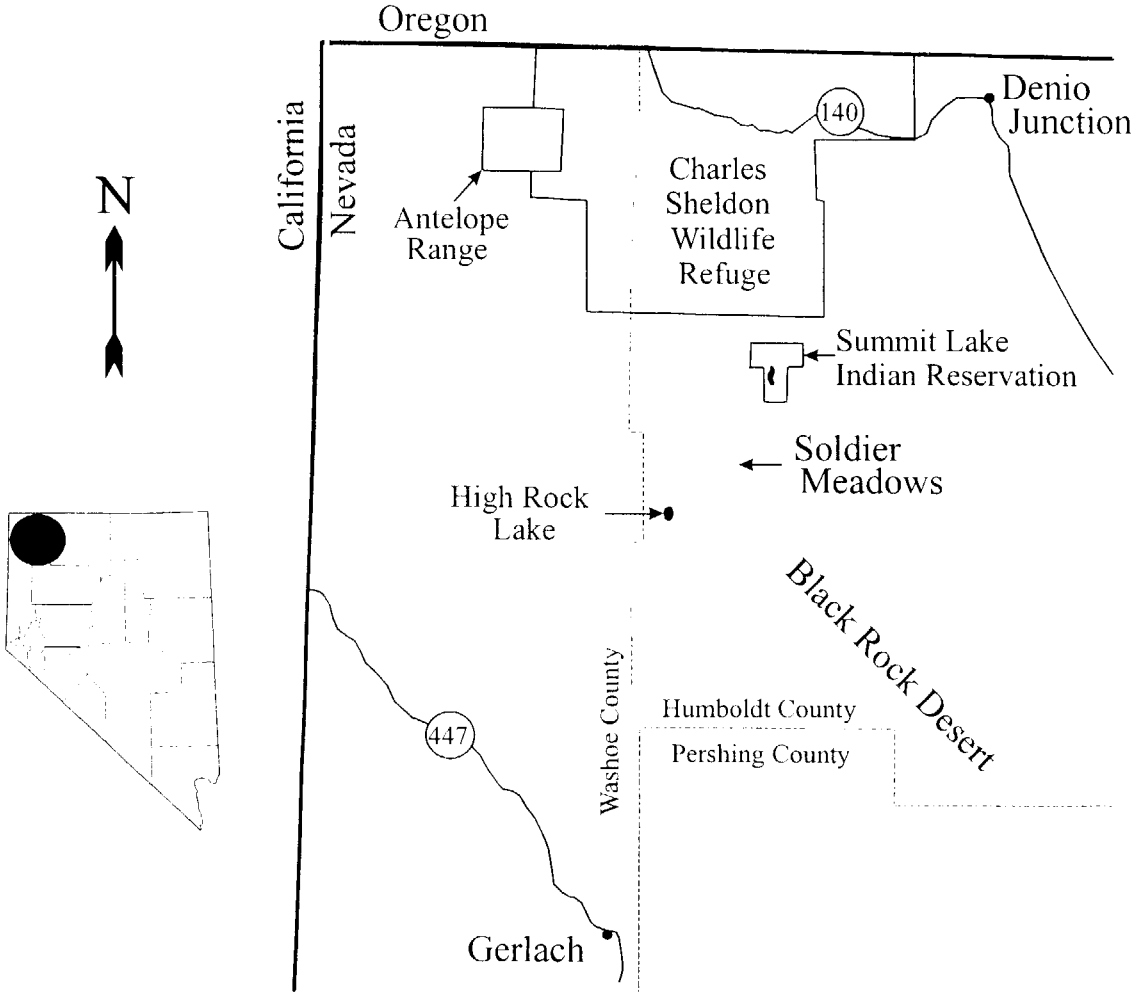

Figure 1. Geographic location of Soldier Meadows, Humboldt County, Nevada.

The desert dace (*Eremichthys acros*) was federally listed as threatened under the Endangered Species Act of 1973, as amended, on December 10, 1985, with critical habitat (50 Federal Register 50304). A threatened species is considered likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The U.S. Fish and Wildlife Service assigned desert dace a recovery priority of 7C indicating it is the only species within the genus *Eremichthys*, there is a moderate degree of threat to its continued existence, and it has a high potential for recovery [each listed species is ranked from 1 (highest) to 18; C indicates potential conflicts in species recovery].

The Soldier Meadows cinquefoil (*Potentilla basaltica*) (= basalt cinquefoil) was designated as a category 1 candidate species pursuant to the Endangered Species Act on February 21, 1990 (55 Federal Register 6184). Category 1 candidate status indicated that the Fish and Wildlife Service had substantial information on file regarding biological vulnerability and threats to support a proposal for listing Soldier Meadows cinquefoil as a threatened or endangered species. However, in July 1995, the status of this species was reevaluated, as a small disjunct population of Soldier Meadows cinquefoil was recently discovered on private lands in Lassen County, California. Because previously known populations of this species occurred mostly on Federal lands where a management plan was being developed and additional information was needed on the recently discovered population, the Soldier Meadows cinquefoil was reclassified as a category 2 candidate species. Category 2 candidate status indicated that although proposing the cinquefoil for listing was possibly still appropriate, a proposed listing rule could not be prepared without additional data. The Soldier Meadows cinquefoil is now considered a "species of concern" according to a Fish and Wildlife Service policy issued February 27, 1996, regarding all former category 2 candidate species.

The hydrobiid snails in Soldier Meadows have no protected status. However, they are discussed in this recovery plan due to their restricted distributions, sensitivity to habitat disturbance, and their presence in spring systems with desert dace.

B. Species Descriptions

Desert Dace

The desert dace (Figure 2) was first collected in 1939 and was described by Hubbs and Miller (1948). No taxonomic revisions have occurred since that time (La Rivers 1962, Nyquist 1963, Coburn and Cavender 1992). The species' key identification characteristic is a prominent horny sheath on each jaw. Coloration is olive-green above with yellow reflections and indistinct black mottling on the sides; the belly is silvery. A green stripe is typically present on the sides. Maximum size is approximately 60 millimeters (2.4 inches) standard length (measured from the tip of the snout to the last tail vertebra) (Hubbs and Miller 1948), and their life span is likely 1 to 3 years (Ono et al. 1983, Sigler and Sigler 1987). Technical descriptions of desert dace may be obtained from Hubbs and Miller (1948) and La Rivers (1962).

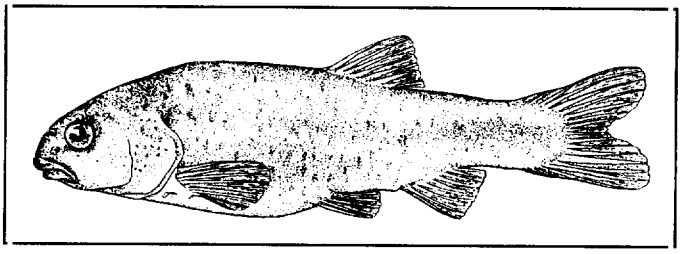

Figure 2. Desert dace (Reprinted by permission from La Rivers, I. 1962. *Fishes and Fisheries of Nevada.* University of Nevada Press, Reno).

Soldier Meadows Cinquefoil

The Soldier Meadows cinquefoil (Figure 3) was first identified in 1982. The type specimen was collected in 1983, and the species was described by Tiehm and Ertter (1984). Soldier Meadows cinquefoil are low growing, rhizomatous, perennial plants with pinnate, basal leaves forming rosettes. These basal leaves (6-12 centimeters, 15.2-30.5 inches long; 10 to 15 pairs of subopposite leaflets) are bluish-green and essentially hairless, but become dark reddish-brown with age.

The stems, maximum length 50 centimeters (20 inches), are also nearly hairless and become purplish with age. Soldier Meadows cinquefoil flowers are small and have five (sometimes four) bright yellow, obovate petals 4.8-6.3 millimeters (0.19-0.25 inch) long and 2.6-3.8 millimeters (0.1-0.15 inch) wide with a shallow notch at the tip (Knight 1990).

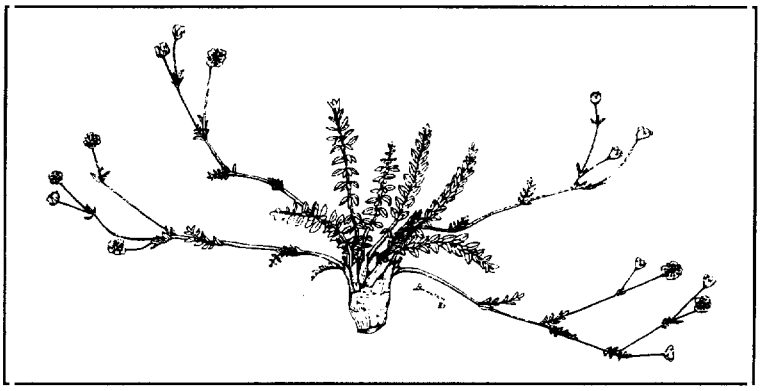

Figure 3. Soldier Meadows cinquefoil (Reprinted by permission from *Brittonia*, 36(3):229, A. Tiehm and B. Ertter/S. Branton Whetstone and L. Vorobik, Copyright 1984, The New York Botanical Garden).

The Soldier Meadows cinquefoil is one of five closely related species of *Potentilla* (Ertter 1993). The species is similar to members of the genus *Ivesia.* Earlier, Kartesz (1987) questioned the taxonomic treatment of Tiehm and Ertter (*Potentilla* vs. *Ivesia*), but no taxonomic revisions have been published. Technical descriptions of Soldier Meadows cinquefoil may be obtained from Tiehm and Ertter (1984) and Knight (1990).

Hydrobiid Snails

The family Hydrobiidae consists of approximately 1,000 species of aquatic snails worldwide (Mehlhop 1996). Springsnails indicate that spring systems are functioning and water bodies are permanent. The presence of hydrobiid snails in Soldier Meadows was first documented by Nyquist (1963) and later by Landye (Bio-Geo Southwest, *in litt.* 1982). At least four species in the genus *Pyrgulopsis* are endemic to the area, and taxonomic descriptions are in preparation (Dr. Robert Hershler, Smithsonian Institution, *in litt.* 1996). Hydrobiid snails are generally

only 1-2 millimeters (0.04-0.08 inch) in size, and their life span is typically 1 year (Mehlhop 1996). The species in Soldier Meadows are gill breathing and restricted to aquatic habitats (Hershler, *in litt.* 1996).

C. Distribution and Abundance

Desert Dace

Desert dace currently inhabit eight major springs and approximately 5 kilometers (3.1 miles) of outflow stream habitat in Soldier Meadows (Figure 4). These springs and outflow streams are contained within an area of approximately 1,550 hectares (3,830 acres). Some spring outflows discharge directly into either Soldier Creek or Mud Meadow Reservoir, while others terminate in wet meadows. All available habitats with permanent flows of suitable temperatures in Soldier Meadows are currently occupied by desert dace (Vinyard 1988, 1996). Except during extreme overland flow conditions, movement of desert dace between disjunct spring systems is likely infrequent, due to physical and water temperature barriers . In 1965, the desert dace population was estimated to be at least 100,000 individuals (Bureau of Sport Fisheries and Wildlife 1973). In 1977, the population was estimated at 50,000-100,000 individuals (Mr. V.G. Stickley *in litt.* 1977, as cited in FWS 1984). No recent population estimate is available. However, average minnow trap catch rates of up to 21.8 fish per trap per hour have been documented (Vinyard 1988).

Critical Habitat

Critical habitat (Figure 4) was designated for desert dace when the species was listed and at that time consisted of both private (21.9 hectares, 54.1 acres) and public (3.6 hectares, 8.9 acres) lands. Section 3 of the Endangered Species Act defines critical habitat as 1) the specific areas within the geographical area occupied by the species at the time it is listed that contain physical or biological features essential to the conservation of the species and that may require special management considerations or protection, and 2) specific areas outside the geographical area occupied by the species at the time it is listed that are determined to be essential for the conservation of the species.

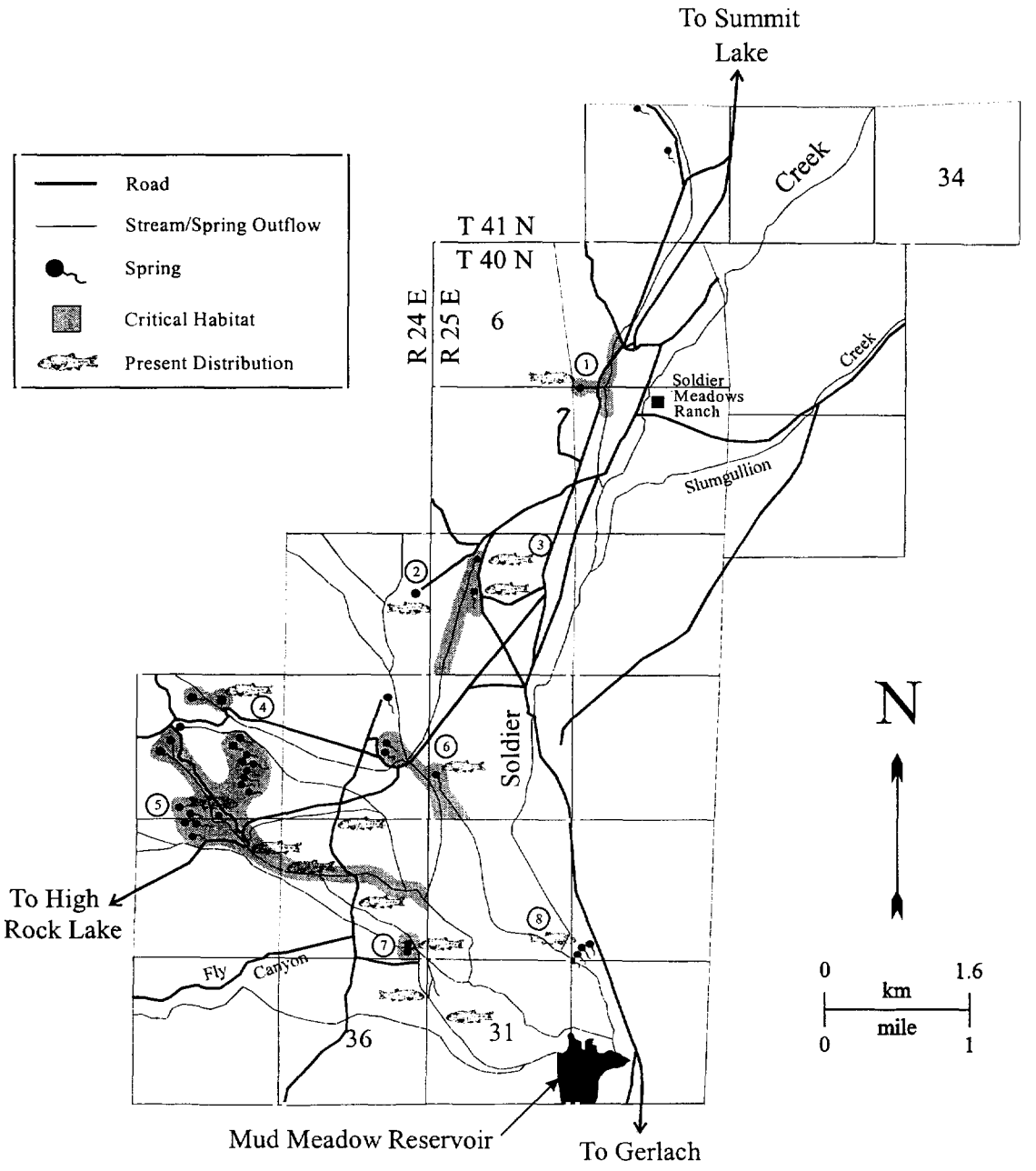

Figure 4. Distribution and critical habitat of desert dace in Soldier Meadows, Humboldt County, Nevada.

Desert dace critical habitat includes all thermal springs and outflow streams, plus surrounding riparian areas within a distance of 15.25 meters (50 feet), located within the following section and fractional section boundaries in Humboldt County: T40N, R25E, SW¼ Sec. 5, NW¼NW¼ Sec. 8, W½ Sec. 18, W½SW¼ Sec. 19; T40N, R24E, Sec. 23, N½SE¼ and S½NE¼ Sec. 24, SE¼ and N½ Sec. 25, N½ Sec. 26, of the Mount Diablo Meridian and Base Line (MDMBL) (50 Federal Register 50304). The aquatic habitat within these designated boundaries is somewhat transient, shifting in response to seasonal and other climatic factors. Not all currently occupied habitats are included within the designated critical habitat.

Soldier Meadows Cinquefoil

Soldier Meadows cinquefoil are distributed in 10 subpopulations within Soldier Meadows (Figure 5). These subpopulations are closely associated with the thermal spring systems and cover an area of approximately 28 hectares (69 acres). Areas surrounding all springs and seeps in Soldier Meadows have been surveyed for Soldier Meadows cinquefoil, and no additional subpopulations have been located (Knight 1990). The identified subpopulations contain plants of all size classes and are estimated to contain approximately 84,650 individual plants (Table 1), although individual plants are difficult to distinguish (Knight 1990).

Soldier Meadows cinquefoil were believed to be geographically restricted to Soldier Meadows until a new population was found in northeastern California in the early 1990's. This newly discovered population consists of several thousand individuals located on private lands in Ash Valley, Lassen County, California. Plants in this population were found on the sub-alkaline border between a meadow and a sagebrush-conifer plant association, in an area disturbed by the presence of a berm near a road. While similar habitat exists in the vicinity of Ash Valley, Soldier Meadows cinquefoil have not been observed there in the past, nor has the species been found in suitable habitats located between Ash Valley and Soldier Meadows [Mr. Gary Schoolcraft, Bureau of Land Management (BLM), pers. comm. 1994].

Table 1. Estimated numbers of Soldier Meadows cinquefoil by subpopulation (See Figure 5) in Soldier Meadows, Humboldt County, Nevada (From: Knight 1990).

Subpopulation Number	Estimated Number of Plants in 1990
1	35,000
2	5,000
3	300
4	500
5	750
6	3,000
7	25,000
8	5,000
9	100
10	10,000
Total	84,650

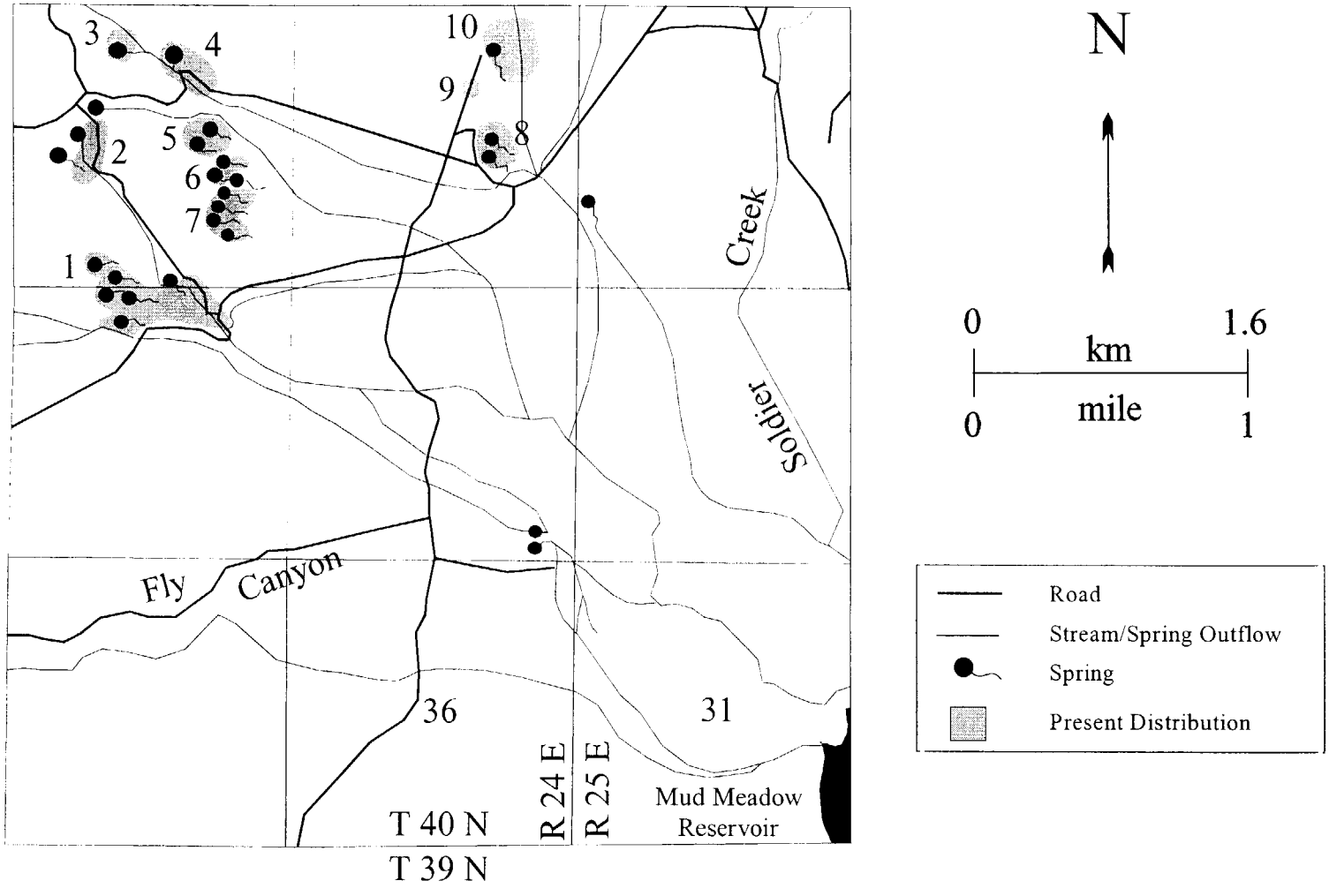

Figure 5. Distribution of Soldier Meadows cinquefoil in Soldier Meadows, Humboldt County, Nevada.

Hydrobiid Snails

Hydrobiid snails were reported from three springs in Soldier Meadows by Nyquist (1963). Later surveys in 1978-79 documented snails in a total of five springs (Landye, *in litt.* 1982). Vinyard (1988) made reference to the presence of hydrobiid snails in two spring systems during 1987-88 fish surveys. Hershler (*in litt.* 1996) has identified four hydrobiid snail species in Soldier Meadows, which are distributed in a north-south sequence (Figure 6). Three species are known from one to three sites each and only occur in Soldier Meadows. The fourth snail species occurs at one site in Soldier Meadows and in a spring to the north, near Summit Lake.

Snails are documented as being abundant in three springs, common in one spring, and scarce in one spring (Hershler 1995). However, accurate data on abundance and exact distribution of known snail species within these spring systems is not yet available. Due to their minute size, hydrobiid snails are slow to disperse, but they may be passively transported by floodwaters or birds. An exhaustive survey of all springs in Soldier Meadows has not been completed, so additional snail populations or even new species may still be discovered.

D. Habitat and Life History

Desert Dace

Habitat - Desert dace occupy a variety of habitats in Soldier Meadows including spring pools up to 15 meters (50 feet) in diameter and 3.4 meters (11.2 feet) deep; outflow streams typically less than 0.3 meter (1 foot) deep; alkali marsh areas with overland flow among cattails (*Typha domingensis*), hardstem bulrush (*Scirpus acutus*), and other herbaceous plants; artificial impoundments; and earthen irrigation ditches.

Springs and outflow streams in Soldier Meadows are typically surrounded by alkali marsh and alkali meadow herbaceous communities (Nachlinger 1991). In ungrazed or lightly grazed areas, emergent vegetation completely encloses some outflow stream reaches. Algae occurring in the spring systems are diatoms and

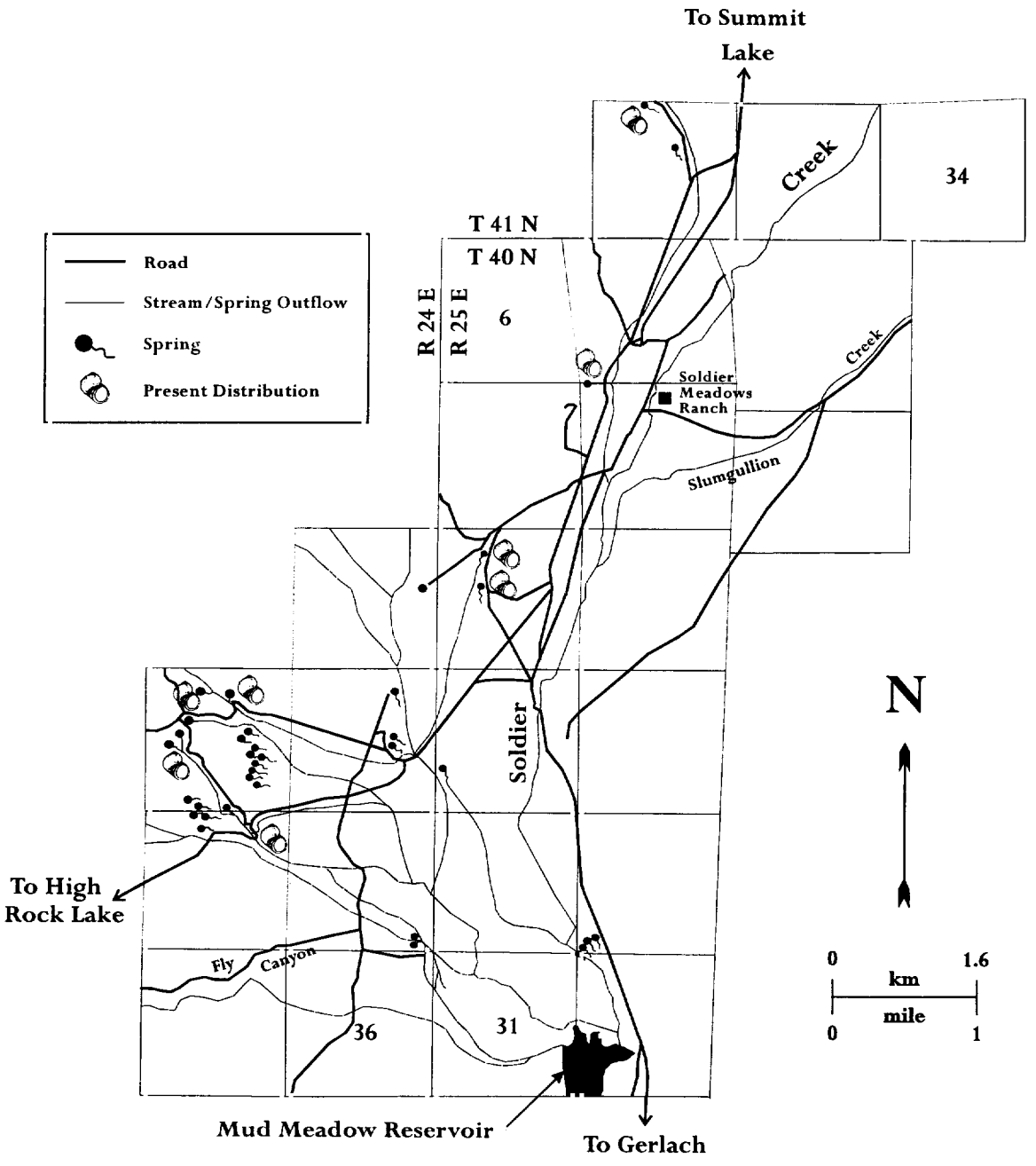

Figure 6. Distribution of hydrobiid snails in Soldier Meadows, Humboldt County, Nevada.

various filamentous species (*Lyngbya* spp., *Oedogonium* spp., *Rhizoclonium* spp., and *Spirogyra* spp.) (Nyquist 1963). Substrate composition in the spring pools and outflow streams is variable and includes silt, sand, pebbles, and rocks.

General water quality characteristics within desert dace habitat are as follows: dissolved oxygen 0.4-12.6 milligrams per liter (1 milligram per liter = 1 part per million) (Nyquist 1963, Vinyard 1988); total dissolved solids 163-171 milligrams per liter (parts per million) (Nyquist 1963); conductivity 190-650 micromoles per square centimeter (29.5-101 micromoles per square inch) (Vinyard 1988); and pH 7.1-9.1 (Nyquist 1963). Discharge velocities in springs with desert dace range from 15.06 to 88.66 liters per second (0.53 to 3.13 cubic feet per second) (Vinyard 1988).

Desert dace have the highest temperature tolerance of any minnow in western North America (Nyquist 1963) and occupy habitats varying in temperature from 18.0 to 40.5 degrees Celsius (64 to 104 degrees Fahrenheit). Water temperature is a determining factor in desert dace distribution within a spring system. Cooler habitats (23-29 degrees Celsius, 73-84 degrees Fahrenheit) downstream of springheads generally have the highest fish densities. Within the outflow streams, desert dace occur predominantly in upstream sites with higher velocities, but also occupy lower velocity reaches where water temperatures are relatively high (Vinyard 1988). Dace may be distributed as far as 2.4 kilometers (1.5 miles) downstream of a springhead (Vinyard 1988). However, distribution apparently shifts seasonally according to water temperature. In the summer, springhead pool temperatures may exceed desert dace tolerance limits and the fish move downstream. As stream temperatures decrease in winter, the species' range contracts upstream.

Reproductive Biology - Ovaries of sexually mature desert dace contain ripe eggs throughout the year, and reproduction in the wild has been documented in March, May, and November (Nyquist 1963). Desert dace have also reproduced under artificial laboratory conditions in April (Nyquist 1963). Size at sexual maturity has not been reported in the literature; however, specimens reared in the laboratory spawned at 13 months of age (Nyquist 1963). Hubbs and Miller (1948)

reported that female desert dace greatly outnumbered males in their collections (100 females:35 males).

Desert dace spawning has been documented in two spring systems at Soldier Meadows (Nyquist 1963). Desert dace were twice observed spawning in one outflow stream, approximately 64 meters (210 feet) below the springhead. Environmental conditions at the spawning site were as follows: temperature 21 degrees Celsius (70 degrees Fahrenheit); dissolved oxygen 2.0 milligrams per liter (parts per million); pH 7.7; sand and pebble substrate; depth 8 centimeters (3 inches); stream width 60 centimeters (24 inches); and water velocity 20.5 liters per second (0.72 cubic foot per second). Specific environmental conditions at the spawning site within the second spring system with documented reproduction were not reported. However, water temperatures ranged from 30 degrees Celsius (86 degrees Fahrenheit) at the springhead to 24 degrees Celsius (75 degrees Fahrenheit) at the lower limit of occupied habitat, depths were typically less than 15 centimeters (6 inches), and the substrate consisted of alluvium and rock (Nyquist 1963). Desert dace have spawned successfully in aquaria with dense algal growth and pebble substrates (Dr. Gary Vinyard, University of Nevada, Reno, pers. comm. 1994). Fifteen desert dace maintained in an aquarium by Nyquist (1963) produced a total of 13 offspring.

Desert dace eggs are probably unattended and adhesive (Sigler and Sigler 1987). The duration of egg incubation is unknown, but is likely relatively short (2 weeks or less) because of the high water temperatures (Vinyard, pers. comm. 1994). Larval and juvenile desert dace likely inhabit shallow, shoreline areas of the outflow streams, sheltering among aquatic and emergent vegetation (Vinyard, pers. comm. 1994). In one impounded outflow stream, larval dace have been observed among emergent vegetation in still water less than 5 centimeters (2 inches) deep.

Food Habits - Desert dace are omnivorous, as indicated by pharyngeal teeth (located in the throat) with both hooked and faceted grinding surfaces (Hubbs and Miller 1948, La Rivers 1962), gut contents (Nyquist 1963), and visual observations (Nyquist 1963). However, a long, extensively-coiled intestine (greater than twice the standard length) and the unique horny sheaths on both

jaws, indicate adaptations for herbivory. Hubbs and Miller (1948) stated that the sharp-edged jaw sheaths were likely used for feeding by grazing. Desert dace are reported to feed primarily on filamentous algae, diatoms, aquatic vegetation, zooplankton, snails, and aquatic insect larvae (Nyquist 1963, Ono et al. 1983). However, Nyquist (1963) also reported that in aquaria, large desert dace preyed upon smaller fishes. La Rivers (1962) considered desert dace the top vertebrate species in the thermal spring systems of Soldier Meadows.

Associated Fishes - In addition to desert dace, three other native fishes are present in Soldier Meadows: speckled dace (*Rhinichthys osculus* ssp.), tui chub (*Gila bicolor* ssp.), and Tahoe suckers (*Catostomus tahoensis*). Desert dace are sympatric (occur in same geographic area) with the speckled dace and tui chub. After desert dace, speckled dace are the most abundant fish in Soldier Meadows (Vinyard 1988). Speckled dace occupy spring systems throughout Soldier Meadows and are most abundant in outflow streams with cooler water temperatures (6.1-28.6 degrees Celsius, 42-83 degrees Fahrenheit) and higher dissolved oxygen levels. Tui chub occupy warmer habitats (21.6-28.5 degrees Celsius, 71-83 degrees Fahrenheit), including impoundments (Vinyard 1988). No concerns have been identified regarding the status of these other three native fishes.

An introduced species, the Lahontan redside (*Richardsonius egregius*), is believed to be present in Mud Meadow Reservoir and in cooler downstream reaches of Soldier Creek. Lahontan redside were introduced into nearby Summit Lake around 1971 (Mr. William Cowan, FWS, pers. comm. 1994).

Soldier Meadows Cinquefoil

Habitat - Soldier Meadows cinquefoil occupy alkali meadows, seeps, and occasionally marsh habitats bordering thermal springs, outflow streams, and depressions in Soldier Meadows. Plants typically occur on fine clay soils with an evaporative crust of mineral salts, often located in areas just upstream of springheads (Knight 1990). Soldier Meadows cinquefoil are also found in habitats adjacent to upstream reaches of spring outflows. However, plants are not

found farther downstream, possibly due to higher nutrient concentrations, richer soils, or increased salt accumulations (Knight 1990).

The majority of the plants occur in alkali meadows and seeps; alkali marshes provide habitat only where standing water is shallow (Nachlinger 1991). These 3 plant communities each provide habitat for over 60 plant species; most species are common to all 3 communities (Nachlinger 1991). Some of the more common native plant taxa found in association with Soldier Meadows cinquefoil include rubber rabbitbrush (*Chrysothamnus nauseosus*), greasewood (*Sarcobatus vermiculatus*), desert saltgrass (*Distichlis spicata* var. *stricta*), wire rush (*Juncus balticus*), rabbitsfoot grass (*Polypogon monspeliensis*), alkali muhly (*Muhlenbergia asperifolia*), slender goldenweed (*Haplopappus racemosus*), and Nevada blue-eyed grass (*Sisyrinchium halophilum*).

In Soldier Meadows, alkali meadows typically have moist to saturated soils and are dominated by short to moderately tall perennial grasses and herbs (Nachlinger 1991). The meadows can be fairly open or have dense plant cover. Alkali seeps may have saturated soils or shallow standing water. As in alkali meadows, alkali seep vegetation is short to moderately tall and can approach total cover. However, alkali seep communities are dominated by grasses (Nachlinger 1991). Alkali marshes typically have standing water of variable depth and a high cover density of medium tall to tall vegetation, primarily grasses (Nachlinger 1991).

Phenology and Reproductive Biology - Soldier Meadows cinquefoil begin flowering in May and continue throughout the summer; seeds have been collected into October (Knight 1990). Soldier Meadows cinquefoil are capable of self-pollination (Knight 1990); insect pollination has not been observed. Individual plants have been transplanted to containers but do not survive past 3 years (Knight 1990).

Hydrobiid Snails

Research on the habitats and life histories of hydrobiid snail species in Soldier Meadows has not been done. However, collection reports indicate the snails occur in flowing water typically just downstream from the springheads (Hershler

1995). They have been observed on small rocks and cobbles in one spring outflow stream. Nyquist (1963) reported snails from spring systems with the following physical and chemical characteristics at the spring sources: water depths of 20-28 centimeters (8-11 inches); substrates of alluvium, sand, gravel, and rock; dissolved oxygen levels of 0.4-7.2 milligrams per liter (parts per million); pH 7.1-9.0; and temperatures of 19-57 degrees Celsius (66-135 degrees Fahrenheit).

E. Reasons for Listing and Current Threats

Habitat Alteration - The physical alteration of spring systems in the Soldier Meadows ecosystem began well over 100 years ago. Historical use of the springs was primarily related to non-intensive agricultural activities. The U.S. Army established an encampment in the area in 1866, which was abandoned by late 1868 (Carlson 1974, Wheeler 1985). The military plowed and leveled some land to grow hay for cavalry horses and used the springs to irrigate the fields (Carlson 1974, Wheeler 1985). The first water rights for the Soldier Meadows area were issued in 1869 to a private livestock company, specifically for irrigation (Nyquist 1963). Subsequent modifications to the spring systems for irrigation and livestock use have occurred under various private landowners.

Some spring outflow streams were permanently dewatered when flows were diverted into earthen ditches or pipes for irrigation purposes. Other spring outflows were only partially or seasonally diverted. In addition to irrigation use during the growing season, water from the springs was also diverted at other times of the year to leach salts from the soil. Nyquist (1963) was the first to document substantial ongoing habitat modifications (large-scale water diversions) within the Soldier Meadows ecosystem resulting in the direct loss of desert dace. He identified these activities as a threat to the continued existence of the species. Desert dace were left stranded in dry channels when the natural outflow streams were permanently or seasonally dewatered, and dace entering the diversions were stranded in the irrigated fields. In spring systems where water temperatures near the springheads exceeded the upper tolerance limit of desert dace, outflow streams provided the only suitable habitat for the fish. Dewatering may have also adversely affected hydrobiid snail populations. However, historical distribution data are lacking for these species.

Diversion ditch and pipeline construction activities in the vicinity of the spring systems likely directly eliminated some Soldier Meadows cinquefoil. However, changes in soil moisture conditions due to water redistribution likely had more substantial adverse effects on the cinquefoil population.

Soldier Meadows has historically been used for livestock grazing, and the spring systems have been used specifically for stock watering. Private landowners created pools on several outflow streams to serve as stock watering ponds (and also to create head for irrigation systems). The combined presence of water and lush riparian vegetation surrounding the spring systems, in an otherwise arid environment, has concentrated livestock and wild horse and burro use. Many spring systems have experienced heavy grazing pressure as a result. An evaluation of the direct and indirect effects of grazing on desert dace, Soldier Meadows cinquefoil, and hydrobiid snails has not been done. However, Vinyard (1988) reported that desert dace were abundant in grazed as well as ungrazed reaches of spring outflows. Also, Nachlinger (1991) observed apparently healthy Soldier Meadows cinquefoil within trampled areas. Herschler (1995) reported that hydrobiid snails were abundant in three springs and scarce in one spring, although all had moderate levels of habitat disturbance, including grazing.

The desert dace, Soldier Meadows cinquefoil, and hydrobiid snail occupy habitats within an area classified by the U.S. Geological Survey as a Known Geothermal Resource Area. This area was the subject of intensive geothermal exploration in the 1970's. Exploration drilling indicated the maximum temperature of the aquifer supplying the springs (65 degrees Celsius, 149 degrees Fahrenheit) was insufficient for economic development (BLM 1983). No further exploration or development has occurred since. However, future exploration and development of this type could affect the aquifer supplying the thermal springs with potential adverse effects on desert dace, Soldier Meadows cinquefoil, and the hydrobiid snails. Some of these species' habitats are now within a designated Area of Critical Environmental Concern (ACEC) and protected from exploration and development activities (See Conservation Measures).

Recreational use of the spring systems in Soldier Meadows includes bathing in the thermal springs and camping in the immediate vicinity of the spring systems.

Bathers have constructed rock dams and excavated the spring outflows to create relatively deep pools with silt and sand substrates. Although most of the created pools are upstream of occupied desert dace habitat, hydrobiid snails do occur in these areas. The rock dams farthest downstream may be a barrier to seasonal desert dace migrations. The impoundments are likely less suitable habitat for the dace and snails than the natural stream channel. Excavation of the stream bed and use of the pools temporarily increases turbidity and sedimentation downstream. Frequent, long-term use of the pools may disrupt normal behavioral patterns of desert dace in the immediate vicinity and downstream. Currently, these activities may only reach a level of concern during intensive use periods (i.e., holiday weekends). Snail populations could also be affected by prolonged recreational use of the springs. Individuals may be crushed by bathers and their habitat may be silted over.

Soap and shampoo are being used by campers in the pools, which may have potential toxic effects on fish and snails downstream, as well as long-term effects on water quality. Another concern is the reported use of dry chlorine to control the parasitic flukes (Family Schistosomatidae) causing swimmer's itch in a couple major springs (Mr. Richard T. Heap, Jr., Nevada Division of Wildlife, *in litt.* 1996]. This practice has the potential to eliminate most aquatic life in these spring systems. Other potential water quality problems relate to the lack of restroom and waste disposal facilities and the increasing numbers of campers.

Due to their proximity to the springs, Soldier Meadows cinquefoil are subject to damage associated with camping (i.e., campfires, tents) and bathing activities and associated pedestrian and vehicle traffic. As many as 60 people have camped at the springs during a single holiday weekend (Mr. Arn Berglund, BLM, pers. comm. 1995). Recreational use associated with the springs was estimated at approximately 2,000 12-hour visitor days per year in 1993 (Berglund, pers. comm. 1993). However, visitor numbers increased sharply to approximately 3,000-4,000 visitor days per year between 1994-95 (Ms. Desna Young and Ms. Susan Lynn, Public Resource Associates, *in litt.* 1996). Visitor numbers may be underestimating actual visitation by missing short-term (2-3 hour) visits. August through October is the highest recreational use period for Soldier Meadows. Camping is limited to 14 consecutive days year-round.

Roads are prevalent throughout Soldier Meadows, and most of the springs are either adjacent to or at the terminus of a road. Established roads frequently cross through outflow streams inhabited by desert dace and hydrobiid snails (Figures 4 and 6) and either cross through or border several Soldier Meadows cinquefoil subpopulations (Figure 5). Off-road vehicles are also randomly driving through dace, snail, and cinquefoil habitats and creating new roads and stream crossings. Stream habitat at crossings with frequent vehicle use is typically degraded into wide pools of predominantly silt substrate and reduced flow velocities. Road crossings are likely a substantial periodic source of turbidity and siltation and thus, may negatively affect additional desert dace and snail habitat downstream. Off-road vehicle use, particularly the creation of new roads, may adversely affect Soldier Meadows cinquefoil. Plants within and adjacent to existing roads are often flattened and lack flower stalks.

Nonnative Species - Approximately 2 kilometers (1.24 miles) of lower Soldier Creek were impounded by a dam built in 1960. The impoundment, Mud Meadow Reservoir, created habitat suitable for nonnative fishes immediately downstream of occupied desert dace habitat (Figure 4). Although not stocked by the Nevada Division of Wildlife, channel catfish (*Ictalurus punctatus*) and largemouth bass (*Micropterus salmoides*) have been collected in Mud Meadow Reservoir. These nonnative species can potentially access some desert dace habitats through Soldier Creek and one other spring outflow stream flowing directly into the reservoir. However, none have ever been reported to occur in the spring systems.

In September 1995, approximately 40 nonnative goldfish (*Carassius auratus*) were observed in a single pool in a downstream reach of one spring outflow tributary to Mud Meadow Reservoir. Goldfish have been observed to prey upon juvenile dace where escape cover is limited (Heap, *in litt.* 1996). These fish likely originated from the reservoir, and their current distribution in the spring system is unknown. The presence of nonnative species is usually detrimental to native fishes due to competition; predation on eggs, larvae, and adults; and introductions of parasites and diseases (Deacon et al. 1964, Wilson et al. 1966).

Anchor worm copepods (*Lernaea* spp.) are known to parasitize desert dace (Vinyard, pers. comm. 1994). Anchor worm infestations cause lesions with tissue

damage and blood loss and expose fish to secondary infections from bacteria, fungi, and viruses (Piper et al. 1982). Severe infestations may cause reduced fecundity or even death. Parasites and disease-causing organisms are typically present in aquatic environments. However, outbreaks of disease among fish can frequently be linked to some form of stress that increases their susceptibility. Vinyard (pers. comm. 1994) reported that in an August 1994 collection, nearly 30 percent of the desert dace captured were infested with anchor worms; some dace had as many as four parasites attached. It is unknown if the dace in all eight spring systems are equally affected and whether or not the extent of parasitism varies seasonally. Heap (*in litt.* 1996) indicated that the presence of anchor worms in the desert dace population was cyclical and apparently did not noticeably affect fish vigor or mortality rates. Vinyard (pers. comm. 1994) indicated that desert dace might experience some form of drought-related stress.

The wetland plant communities occupied by Soldier Meadows cinquefoil have also been subject to numerous nonnative species introductions. Common nonnative plants include smotherweed (*Bassia hyssopifolia*), goosefoot (*Chenopodium* spp.), Russian olive (*Elaeagnus angustifolia*), fescue (*Festuca* spp.), peppergrass (*Lepidium perfoliatum*), alfalfa (*Melicago sativa*), common sow-thistle (*Sonchus oleraceus*), and cocklebur (*Xanthium strumarium*) (Nachlinger 1991). These species may potentially compete with or replace Soldier Meadows cinquefoil in disturbed areas or under conditions favoring their growth.

F. Conservation Measures

Desert Dace

The State of Nevada listed desert dace as a rare species on March 29, 1974, because the species existed in only small numbers and could become endangered if its environment was degraded. This State designation provided the first legal protection for the species. The Endangered Species Committee of the American Fisheries Society (AFS) recognized desert dace as threatened (by American Fisheries Society definition) in 1979 because of the potential destruction, modification, or curtailment of its habitat and because of its restricted range

(Deacon et al. 1979). The Fish and Wildlife Service classified the desert dace as a category 1 candidate for listing under the Endangered Species Act in 1982 (47 Federal Register 58454).

Habitat for desert dace (and for Soldier Meadows cinquefoil and endemic snails) has historically been privately owned by Soldier Meadows Ranch. These habitats are within the Bureau of Land Management's Soldier Meadows Allotment (Allotment) (136,994 hectares; 338,512 acres). Effective September 6, 1982, the Bureau of Land Management designated approximately 125 hectares (309 acres) of desert dace habitat on public land within the allotment as the Soldier Meadows Desert Dace Area of Critical Environmental Concern (Figure 7) (48 Federal Register 2598). An Area of Critical Environmental Concern is defined by the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.) as an area within the public lands where special management attention is needed to protect and prevent irreparable damage to important historical, cultural, or scenic values; fish and wildlife resources; or other natural systems or processes. The Bureau of Land Management completed a Desert Dace Habitat Management Plan (HMP) for the Area of Critical Environmental Concern on April 15, 1983. Expansion of the Area of Critical Environmental Concern is under consideration to include all occupied habitat for desert dace, Soldier Meadows cinquefoil, and snail species.

On April 22, 1983, the Fish and Wildlife Service received a petition from the Desert Fishes Council to list the desert dace under the Endangered Species Act. Over the next year, the Fish and Wildlife Service reviewed the status of the dace and determined that listing was warranted. The desert dace was proposed for listing as a threatened species on May 29, 1984, due to threats from ongoing habitat modifications, recent introductions of nonnative fishes and associated disease organisms, and potential renewed geothermal exploration and development in Soldier Meadows (49 Federal Register 22355).

Just prior to publication of the listing proposal, the Bureau of Land Management designated the habitat in the Area of Critical Environmental Concern as the Soldier Meadow Desert Dace Research Natural Area (RNA) (March 1, 1984) (49 Federal Register 7665). Designation of the Research Natural Area was intended

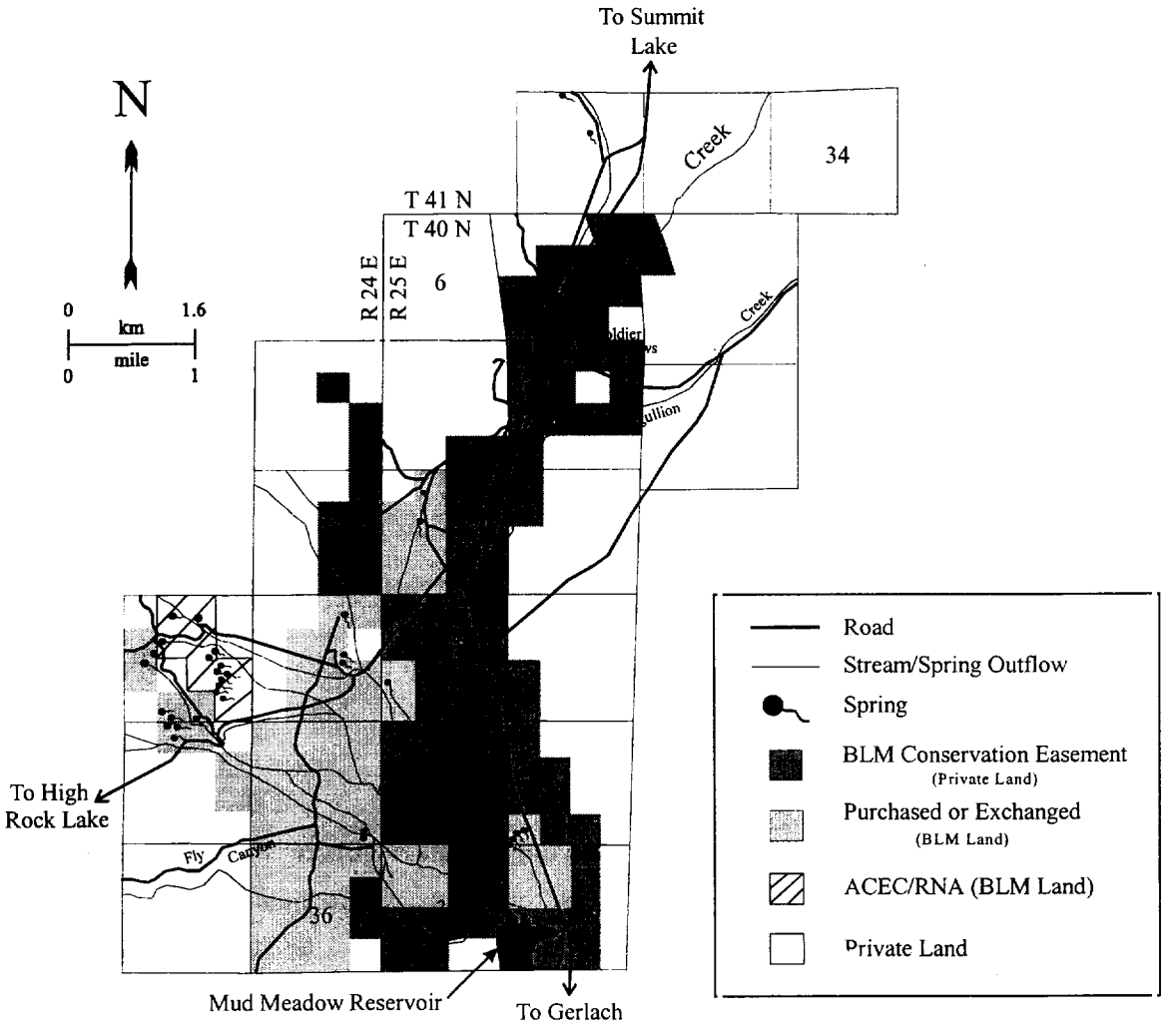

Figure 7. Bureau of Land Management ACEC/RNA, conservation easement, purchased, and exchanged lands, and private lands, Soldier Meadows, Humboldt County, Nevada.

to maintain and protect that portion of the Soldier Meadows ecosystem on public lands providing habitat for desert dace. Research Natural Area designation permitted scientific research of the thermal spring habitats and public day-use (i.e., hunting) but limited certain activities believed to be detrimental to desert dace habitat (e.g., road or utility rights-of-way, land disposal, campgrounds, motorcycle races, gravel pits, etc.). Research Natural Area designation also provided a means of funding management actions identified in the Desert Dace Habitat Management Plan.

With only one exception, all of the thermal spring systems occupied by desert dace in the early 1980's were on private land (Soldier Meadows Ranch). The one spring system on public land inhabited by desert dace was the result of an August 1975 dace transplant by the Bureau of Land Management and the Nevada Division of Wildlife (BLM 1983). Due to the limited extent of occupied habitat on public land, management options for desert dace under the Habitat Management Plan were restricted. Therefore, the Bureau of Land Management and the Nevada Division of Wildlife captured 50 to 60 desert dace (mostly fry) from the 1 occupied spring on public land (Humboldt County: T40N, R24E, NE¼ Sec. 23, Mount Diablo Meridian and Base Line) and transplanted them to two other springs on public land (Humboldt County: T40N, R24E, NW¼ Sec. 23; T40N, R25E, NW¼ Sec. 18, Mount Diablo Meridian and Base Line) on November 1, 1984. The Bureau of Land Management also initiated temperature and flow monitoring in two major spring systems for a period of 3 years beginning November 7, 1984. As a result of subsequent land acquisitions (see Land Exchange), six of the eight spring systems with desert dace are now on public land, and the other two are under a conservation easement.

In 1985, the Endangered Species Committee of the Desert Fishes Council added desert dace to their list of vulnerable species (as defined by the International Union for Conservation of Nature and Natural Resources) (Williams et al. 1985). This designation did not provide any legal protection for the species. However, the desert dace was federally listed as threatened pursuant to the Endangered Species Act later that year (December 10, 1985). A special rule under section 4(d) of the Endangered Species Act was incorporated into the listing to allow take of desert dace in accordance with State laws and regulations for educational and

scientific purposes, enhancement of propagation or survival of the species, zoological exhibition, and other conservation purposes consistent with the Endangered Species Act. Only limited research on desert dace has been performed since the species was listed. Vinyard (1988) completed a status survey during 1987-88 and reported on desert dace relative abundance and distribution, habitat use, and associated fishes. Vinyard (1996) provided updated distribution and abundance data, as well as documenting adverse effects of habitat modification in one spring system.

Fly Canyon Road passes through the Allotment's Hot Springs pasture and crosses several spring outflow streams occupied by desert dace and designated as critical habitat. Due to vehicle traffic, the crossings had eroded into wide, shallow pools with silt substrate. In September 1995, the Bureau of Land Management installed small bridges (cattle guards) over three stream channels to eliminate stream-bank erosion and downstream sedimentation. The Bureau of Land Management also repaired two sections of the road that were eroding because of a breached irrigation ditch and inadequate culverts. These repairs will minimize future degradation of desert dace habitat in these areas.

Soldier Meadows Cinquefoil

The Fish and Wildlife Service published an updated notice of review for plants on February 21, 1990 (55 Federal Register 6184) and included Soldier Meadows cinquefoil as a category 1 candidate for listing based upon information on threats to the species provided in March 1989 by the Northern Nevada Native Plant Society's Rare Plant Committee. Given evidence of various threats to the survival of the species, in 1990, the Nevada Natural Heritage Program recommended Soldier Meadows cinquefoil be federally listed as a threatened species under the Endangered Species Act and added to the State of Nevada's list of Critically Endangered Plants under Nevada Revised Statute 527.260.300 (Knight 1990). The State did not take action on this recommendation, however, because the majority of Soldier Meadows cinquefoil subpopulations in Soldier Meadows came under Federal jurisdiction in 1993, and State protection was deemed unnecessary. Although no specific management actions for Soldier Meadows cinquefoil have occurred, the Fish and Wildlife Service has made conservation recommendations

for Soldier Meadows cinquefoil in informal consultations for desert dace under section 7 of the Endangered Species Act and has provided technical assistance regarding the species to the Bureau of Land Management.

Soldier Meadows cinquefoil was not considered in the Bureau of Land Management's Area of Critical Environmental Concern/Research Natural Area designations pertaining to desert dace habitat, because the plant had only been recently identified and described and had no Federal protective status. However, the Area of Critical Environmental Concern/Research Natural Area encompasses approximately 30 percent of the areal extent and about 35 percent of the of individuals of Soldier Meadows cinquefoil in Soldier Meadows.

On July 14, 1995, the status of this species was reevaluated. A small disjunct population of Soldier Meadows cinquefoil had recently been discovered on private lands in Lassen County, California. Because previously known populations of this species occurred mostly on Federal land and additional information was needed on the recently discovered population, Soldier Meadows cinquefoil was reclassified as a category 2 candidate species. However, category 2 species are no longer considered candidates and are now considered "species of concern" according to a Fish and Wildlife Service policy issued February 27, 1996.

Hydrobiid Snails

The Smithsonian Institution has recently completed an extensive springsnail survey in the Great Basin area, including Soldier Meadows (Hershler 1995, Hershler, *in litt.* 1996). A Memorandum of Understanding is being developed between the Fish and Wildlife Service, U.S. Geological Survey-Biological Resources Division, Bureau of Land Management, National Park Service, Forest Service, and the Smithsonian Institution to gather information and develop management policies to conserve springsnails throughout the Great Basin. Development of Great Basin springsnail conservation agreements are planned on a site by site basis, including Soldier Meadows.

Land Exchange

In 1992, The Nature Conservancy (TNC) negotiated a land purchase and conservation easement with the owners of the 5,670-hectare (14,010-acre) Soldier Meadows Ranch. The ranch is a working livestock operation with guest facilities in Soldier Meadows and on the surrounding plateau country. Negotiations included purchase of 736 hectares (1,820 acres) of desert dace habitat and a conservation easement for 2,084 hectares (5,150 acres) (Figure 7). The Nature Conservancy subsequently transferred these lands, at cost, to the Bureau of Land Management for permanent protection in January 1993. In a separate transaction involving a value-for-value land exchange between the Bureau of Land Management and Soldier Meadows Ranch, the Bureau of Land Management acquired an additional 106 hectares (262 acres) of desert dace habitat.

With sale of the desert dace habitat, Soldier Meadows Ranch retained its water rights, but agreed to a Water Management Plan and Covenant denoting restrictions on water uses by the ranch, in perpetuity. Under this plan, Soldier Meadows Ranch agreed to discontinue water diversions and other water uses except for livestock watering on the land purchased by The Nature Conservancy and Bureau of Land Management. The ranch also agreed to prohibitions on introductions of nonnative and/or predatory fish or invertebrates to waters on the easement lands and surrounding public lands. Other livestock and guest ranch operations, including water diversions on the easement lands, and use of the spring adjacent to the ranch (Humboldt County: T40N, R25E, NW¼NW¼ Sec. 8, Mount Diablo Meridian and Base Line) were not affected by the plan and covenant. In addition, the general provisions of the conservation easement specified that no geothermal exploration or development would occur on easement lands, in perpetuity.

Soldier Meadows Allotment Management Plan

Habitats for desert dace, Soldier Meadows cinquefoil, and the hydrobiid snails are within the Hot Springs pasture of the Bureau of Land Management's Soldier Meadows Allotment. Between 1988 and 1992, the allotment was grazed by livestock under a 2-year deferred/rest rotation grazing system on a 4-year cycle,

with grazing in the Hot Springs pasture (1,972 animal unit months) during the period April 16-June 15.

Upon finalization of the Bureau of Land Management's Full Force and Effect Multiple Use Decision for the Soldier Meadows Allotment on December 10, 1993, use of the Hot Springs pasture was changed to the period November 16-December 31, and animal unit months were decreased to 1,726. These changes in livestock use for the Hot Springs pasture were intended to lessen the potential for adverse effects on the habitat from grazing and protect desert dace and Soldier Meadows cinquefoil populations.

The Bureau of Land Management's 1993 decision also addressed wild horse and burro use within the allotment. Analysis of monitoring data indicated that wild horse and burro numbers were contributing to the Bureau of Land Management's failure to meet the objectives of the 1988 allotment evaluation within the Hot Springs pasture. The 1993 decision implemented appropriate management levels for wild horses and burros, requiring removal of wild horses and burros to prevent further deterioration of rangeland resources. Gather efforts were undertaken in 1994 and 1996. Burro numbers are currently at or below management levels, and horse numbers are approaching management levels.

A study is in progress to evaluate the effectiveness of the new grazing system and gather in minimizing adverse effects on desert dace and Soldier Meadows cinquefoil habitats. The study will provide data on desert dace and Soldier Meadows cinquefoil populations in grazed and ungrazed (fenced exclosures) habitats. If the study reveals that the grazing system is having adverse effects on desert dace or Soldier Meadows cinquefoil populations or their habitats, the Bureau of Land Management will consider these data when amending the AMP. Allotment re-evaluation is currently scheduled for 2001.

Soldier Meadows Activity Plan

The Bureau of Land Management is preparing a draft Soldier Meadows Activity Plan (SMAP), which will integrate all resource management activities for the area encompassing the Soldier Meadows Basin. The Soldier Meadows Activity Plan

addresses preservation and protection of desert dace and Soldier Meadows cinquefoil and their habitats, other wildlife resources, cultural resources, recreation and grazing management, and mineral and geothermal management. It is also intended to promote interagency cooperation for management and research activities. Scoping meetings were held in February 1997 to determine public concerns, which are being incorporated into the draft Soldier Meadows Activity Plan. The draft Soldier Meadows Activity Plan will then be released to the public for comment and undergo National Environmental Policy Act review prior to finalization.

G. Recovery Strategy

The strategy for recovery that is detailed in the stepdown outline to follow begins with the restoration and management of desert dace, Soldier Meadows cinquefoil, and hydrobiid snail habitats on public lands and under easement. Monitoring is proposed for each species to collect the baseline data necessary for assessing population trends and habitat conditions. For desert dace, the potential threat of nonnative fishes will be eliminated by removing these species from the spring systems and preventing their reentry. For Soldier Meadows cinquefoil, a research project is recommended to determine the species' breeding system and pollinators. Research data will be used to ensure that future management actions give full consideration to potential interrelationships of plants and pollinators. Finally, public information and education will be necessary to keep interested and affected parties informed of recovery activities and to create an avenue for their involvement. This task is particularly important for Soldier Meadows because of the numerous and varied interest groups.

II. RECOVERY

A. Objective and Criteria

The objective of this recovery plan is to 1) improve the status of desert dace so it may be delisted and 2) ensure the long-term conservation of Soldier Meadows cinquefoil and hydrobiid snail species. All recovery criteria are preliminary and may be revised on the basis of new information (including research specified as recovery tasks). If recovery tasks are undertaken as scheduled, desert dace could be recovered by the year 2001.

Desert dace may be considered for delisting when:

1) Historical habitat in the one dewatered stream channel on public land (T40N, R24E, Sec. 25 and 26) is restored so that it supports desert dace;

2) the desert dace population in each of the eight historically occupied spring systems is stable or increasing in size and comprising two or more age-classes for 3 years;

3) reproduction and recruitment are documented from each historically occupied spring system with suitable water temperatures for 3 years; and

4) habitat modification, nonnative fishes, and parasites no longer threaten the long-term survival of the species.

Before delisting may occur, the Fish and Wildlife Service must determine that the following five listing factors no longer cause the endangerment of the fish: 1) the present or threatened destruction, modification, or curtailment of the species' habitat or range; 2) overutilization for commercial, recreational, scientific, or educational purposes; 3) disease and predation; 4) inadequacy of existing regulatory mechanisms; and 5) other human-made or natural factors affecting the continued existence of the species (50 CFR 424.11). The final decision regarding delisting would be made only after a thorough review of all relevant information

by the Fish and Wildlife Service in accordance with appropriate regulations (50 CFR 424).

Long-term conservation of Soldier Meadows cinquefoil will be ensured when:

1) The abundance and distribution of Soldier Meadows cinquefoil is stable or increasing within the 10 subpopulations in Soldier Meadows for 3 years, and

2) habitat modification and competing nonnative plants do not threaten the long-term survival of the species.

Long-term conservation of hydrobiid snail species in Soldier Meadows will be ensured when:

1) The abundance and distribution of each of the four known species has been documented,

2) the abundance and distribution of each of the four species is stable or increasing within the known sites for 3 years, and

3) there are no existing threats to long-term survival of these species.

One stated purpose of the Endangered Species Act is to conserve ecosystems upon which endangered and threatened species depend. Actions taken to recover desert dace and conserve Soldier Meadows cinquefoil and hydrobiid snail species will give due consideration to the needs of all native fishes, invertebrates, and plants and should improve the overall health of the Soldier Meadows ecosystem.

Prior to implementing any task identified in this recovery plan, the lead agency must comply with all applicable provisions of the Endangered Species Act, as well as the National Environmental Policy Act of 1966. All necessary Federal, State, and local permits or authorizations must be obtained. Landowner permission must be obtained if the activity will occur on private land.

B. Outline of Recovery Actions

1. Restore and manage desert dace, Soldier Meadows cinquefoil, and hydrobiid snail habitats

Recovery of desert dace and conservation of Soldier Meadows cinquefoil and hydrobiid snails requires eliminating or minimizing known and potential threats to existing populations within Soldier Meadows. Habitat modification is the key factor in the decline of the dace and cinquefoil and has the potential to adversely affect snail populations in the future. Because Soldier Meadows is a multiple-use area, restoration and management of specific aquatic and riparian habitats will require substantial planning to be effective over the long term. Measures undertaken to restore and manage these habitats will benefit desert dace, Soldier Meadows cinquefoil, hydrobiid snails, and all associated native aquatic and riparian species, as well as accommodate multiple uses.

Nearly all habitats occupied by desert dace, Soldier Meadows cinquefoil, and hydrobiid snails are currently on public land managed by the Bureau of Land Management. Thus, the Bureau of Land Management has a significant role in recovery and conservation of these species. The Bureau of Land Management has implemented protection and restoration measures for desert dace habitat (See Conservation Measures), which have likely benefited hydrobiid snail populations as well. Soldier Meadows cinquefoil have also benefited from these actions due to their proximity to the spring systems. However, additional measures are required for these species to meet the recovery and conservation criteria.

11. Desert dace habitat restoration

Due to recent land purchases, exchanges, and easements, the Bureau of Land Management now owns or manages additional desert dace habitat. The outflow of one spring system with desert dace now on public land remains in an irrigation ditch. Dace are less abundant in this ditch than in other natural channels (Berglund, pers. comm. 1995; Vinyard 1996). Thus, flows should be restored to the dewatered historical outflow

channel (T40N, R24E, Sec. 25 and 26). Although dewatered, the historical channel itself remains intact, and both the aquatic and riparian communities should recover rapidly once flows are restored. Desert dace salvaged from the irrigation ditch should be relocated into the historical channel.

Nonnative fishes in Mud Meadow Reservoir and in tributary spring outflow streams are a potential threat to desert dace due to potential predation, competition, and introductions of parasites. Surveys to determine the distribution and abundance of nonnative fishes within and with access to desert dace habitats should be completed. All nonnative fishes located in the spring systems should be eliminated, and their reentry should be restricted through a fish barrier or other control measures. All native aquatic species in Soldier Meadows should benefit by eliminating or reducing interactions with nonnative fishes.

12. Recreation management

Current levels of recreation use (i.e., camping, hot springs bathing, off-road vehicle use, etc.) within the Soldier Meadows Allotment are likely adversely affecting desert dace, Soldier Meadows cinquefoil, and hydrobiid snails and their habitats. Existing and potential problem areas have been identified, as well as locations for recreation use compatible with species recovery and conservation. Specifically, camping areas should be relocated outside of riparian areas, creation of additional bathing pools should be prohibited, the two farthest downstream bathing pools should be removed, off-road vehicle use through springs and Soldier Meadows cinquefoil habitats should be restricted, and problems with human sanitation should be resolved. Individuals using the area should be discouraged from disposing of trash or other potentially harmful substances in the spring systems and riparian areas.

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1. Restore and manage desert dace, Soldier Meadows cinquefoil, and hydrobiid snail habitats

Recovery of desert dace and conservation of Soldier Meadows cinquefoil and hydrobiid snails requires eliminating or minimizing known and potential threats to existing populations within Soldier Meadows. Habitat modification is the key factor in the decline of the dace and cinquefoil and has the potential to adversely affect snail populations in the future. Because Soldier Meadows is a multiple-use area, restoration and management of specific aquatic and riparian habitats will require substantial planning to be effective over the long term. Measures undertaken to restore and manage these habitats will benefit desert dace, Soldier Meadows cinquefoil, hydrobiid snails, and all associated native aquatic and riparian species, as well as accommodate multiple uses.

Nearly all habitats occupied by desert dace, Soldier Meadows cinquefoil, and hydrobiid snails are currently on public land managed by the Bureau of Land Management. Thus, the Bureau of Land Management has a significant role in recovery and conservation of these species. The Bureau of Land Management has implemented protection and restoration measures for desert dace habitat (See Conservation Measures), which have likely benefited hydrobiid snail populations as well. Soldier Meadows cinquefoil have also benefited from these actions due to their proximity to the spring systems. However, additional measures are required for these species to meet the recovery and conservation criteria.

11. Desert dace habitat restoration

Due to recent land purchases, exchanges, and easements, the Bureau of Land Management now owns or manages additional desert dace habitat. The outflow of one spring system with desert dace now on public land remains in an irrigation ditch. Dace are less abundant in this ditch than in other natural channels (Berglund, pers. comm. 1995; Vinyard 1996). Thus, flows should be restored to the dewatered historical outflow

channel (T40N, R24E, Sec. 25 and 26). Although dewatered, the historical channel itself remains intact, and both the aquatic and riparian communities should recover rapidly once flows are restored. Desert dace salvaged from the irrigation ditch should be relocated into the historical channel.

Nonnative fishes in Mud Meadow Reservoir and in tributary spring outflow streams are a potential threat to desert dace due to potential predation, competition, and introductions of parasites. Surveys to determine the distribution and abundance of nonnative fishes within and with access to desert dace habitats should be completed. All nonnative fishes located in the spring systems should be eliminated, and their reentry should be restricted through a fish barrier or other control measures. All native aquatic species in Soldier Meadows should benefit by eliminating or reducing interactions with nonnative fishes.

12. Recreation management

Current levels of recreation use (i.e., camping, hot springs bathing, off-road vehicle use, etc.) within the Soldier Meadows Allotment are likely adversely affecting desert dace, Soldier Meadows cinquefoil, and hydrobiid snails and their habitats. Existing and potential problem areas have been identified, as well as locations for recreation use compatible with species recovery and conservation. Specifically, camping areas should be relocated outside of riparian areas, creation of additional bathing pools should be prohibited, the two farthest downstream bathing pools should be removed, off-road vehicle use through springs and Soldier Meadows cinquefoil habitats should be restricted, and problems with human sanitation should be resolved. Individuals using the area should be discouraged from disposing of trash or other potentially harmful substances in the spring systems and riparian areas.

13. Area of Critical Environmental Concern/Research Natural Area expansion

Due to recent land purchases, exchanges, and easements, the Bureau of Land Management now owns and/or manages desert dace habitat not included in the 1982 Area of Critical Environmental Concern/Research Natural Area. This Area of Critical Environmental Concern/Research Natural Area includes less than 10 percent of known desert dace habitat. The Area of Critical Environmental Concern/Research Natural Area also includes only approximately 30 percent of the known Soldier Meadows cinquefoil habitat in Soldier Meadows. Area of Critical Environmental Concern designation can provide additional protection for these habitats (i.e., providing additional environmental oversight for geothermal and mineral leasing) with special management consideration being given to designated areas. Expanding the Area of Critical Environmental Concern/Research Natural Area to include all known habitat for desert dace and Soldier Meadows cinquefoil would provide some long-term protection and benefits for both species, as well as protecting additional snail populations.

2. Monitor desert dace, Soldier Meadows cinquefoil, and hydrobiid snail populations

Population monitoring is necessary for desert dace, Soldier Meadows cinquefoil, and hydrobiid snail species to determine whether or not recovery criteria have been met. Regular monitoring will provide data to evaluate population stability and health (i.e., age-class structure, population size, reproductive success, seasonal variability, and distribution) and to evaluate the effectiveness of specific habitat restoration and management activities. Also, potential problems (i.e., parasitism, nonnative fish invasions, recreational use, etc.) can be identified in a timely manner during monitoring. The monitoring should be done seasonally for desert dace using standardized electrofishing or minnow trapping. Monitoring for cinquefoil and snail species should occur at least annually. Data from monitoring should be used

to develop reliable long-term data sets. Results of monitoring should be analyzed and management activities modified accordingly.

3. Determine Soldier Meadows cinquefoil breeding system and pollinators

Little information is available regarding the breeding system of Soldier Meadows cinquefoil, and no pollinators have been identified. Information is needed on pollination biology, seed production and viability, and asexual propagation. Determination of the breeding system and pollinators will increase understanding of population viability and ecosystem interactions and will enhance species management capabilities.

4. Provide public information and education

Public information and education are necessary to meet recovery criteria (eliminate threats) for desert dace and to conserve Soldier Meadows cinquefoil and hydrobiid snails. Outreach activities should be directed at recreational users, local landowners, and the general public, where appropriate. Due to the remote location of Soldier Meadows, public cooperation and support for recovery efforts will be especially vital in limiting future adverse modifications to desert dace, Soldier Meadows cinquefoil, and hydrobiid snail habitats.

Outreach activities should have a focal point near the spring systems, especially those used for camping and bathing. Items that may be used to reach interested and affected publics include press releases, feature articles, fact sheets, interviews, presentations, brochures, kiosk displays, and nature trails. Fact sheets and brochures should be made available to the public at an interpretive display in Soldier Meadows. Interpretive materials should emphasize the importance of all Soldier Meadows ecosystem components.

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IV. IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows outlines actions and estimated costs for the recovery program. It is a guide for meeting the recovery objective discussed in Part II of this recovery plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs. These actions, when accomplished, should bring about the recovery of desert dace and long-term conservation of Soldier Meadows cinquefoil and hydrobiid snail species. It should be noted that the estimated monetary needs for all parties involved in recovery are identified, and this Implementation Schedule reflects the total estimated financial requirements for the recovery and conservation of these species.

Priorities in Column 1 of the following Implementation Schedule are assigned as follows:

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

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

Priority 3 - All other actions necessary to meet the recovery objectives.

Recovery Plan Implementation Schedule

Priority Number	Task Number	Task Description	Task Duration (Years)	Responsible Parties	Total Cost ($1,000's) 1997-2000	Cost Estimates ($1,000's) FY 1997	FY 1998	FY 1999	FY 2000
2	11	Desert dace habitat restoration	2	BLM* FWS NDOW	40 15 10	30 5 5	10 10 5	0 0 0	0 0 0
2	12	Recreation management	Continual	BLM* FWS	150 45	30 10	50 15	50 15	20 5
2	13	Area of Critical Environmental Concern/Research Natural Area expansion	1	BLM*	30	30	0	0	0
2	2	Monitor desert dace, Soldier Meadows cinquefoil, and hydrobiid snail populations	3	BLM* FWS NDOW	90 30 12	0 0 0	30 10 4	30 10 4	30 10 4
2	4	Provide public information and education	Continual	BLM* FWS	30 30	0 5	10 10	10 5	10 10
3	3	Determine Soldier Meadows cinquefoil breeding system and pollinators	1	FWS*	15	0	15	0	0

Definitions for terms and acronyms used in Implementation Schedule:

Continual = Task will be implemented annually until no longer required for recovery.

Total Cost = Projected cost of task from start to completion.

Responsible Parties (* = Lead Agency):

BLM = Bureau of Land Management

FWS = Fish and Wildlife Service

NDOW = Nevada Division of Wildlife

V. APPENDICES

A. PUBLIC AND PEER REVIEW

A draft of this recovery plan was made available to the public for comment as required by the 1988 amendments to the Endangered Species Act of 1973. The public comment period was announced in the Federal Register on March 7, 1996 and closed on May 6, 1996. Copies of the draft plan were also provided to qualified members of the academic and scientific community for peer review. The Fish and Wildlife Service solicited and/or received comments on the document from the academic and scientific community, private individuals, industry representatives, and Federal, State, and local agencies listed below. Before completion of this final recovery plan, the Fish and Wildlife Service received a total of six response letters and e-mail correspondence, as indicated by an asterisk (*), and telephone comments from one individual (**). The comments provided were considered in preparation of this final recovery plan and incorporated, as appropriate. Other significant comments are addressed by the Fish and Wildlife Service in Appendix B. All letters and correspondence received are on file at the Fish and Wildlife Service's Nevada State Office in Reno.

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B. SIGNIFICANT COMMENTS RECEIVED AND FISH AND WILDLIFE SERVICE RESPONSES

This section summarizes specific comments received on the draft recovery plan and provides the Fish and Wildlife Service's response to *substantial* comments *not* addressed by changes in the text. Specific comments that reoccurred in separate letters are addressed only once.

Comment (C): A single document should be produced that would serve both as a recovery plan and an activity plan for multiple use management of Soldier Meadows.

Response (R): The Fish and Wildlife Service is required by law in section 4 of the Endangered Species Act to develop and implement recovery plans for the conservation and survival of threatened species, such as the desert dace. The only exception is if such a plan will not promote the conservation of the species. Recovery plans must incorporate specific information including descriptions of site-specific management actions; objective, measurable criteria for downlisting or delisting; and time and cost estimates. In this recovery plan, the Fish and Wildlife Service has referenced the Bureau of Land Management's Soldier Meadows Activity Plan, a multiple use management plan that is currently in the preliminary draft stage. Bureau of Land Management's Soldier Meadows Activity Plan will incorporate appropriate recommendations from the recovery plan and will ultimately be the document governing land use activities for the majority of Soldier Meadows.

C: Achieving desert dace recovery will require more than 3 years. The Resource Manager must demonstrate that threats have been eliminated before the 3 years of population monitoring should be implemented.

R: The Fish and Wildlife Service agrees that recovery will require more than 3 years. The recovery plan specifies that 4 years are required for recovery. The tasks that have been identified to reduce and eliminate threats to desert dace are

scheduled to begin the first year this recovery plan is implemented and may continue into the second year, as necessary. Monitoring is scheduled to start in the second year and continue for 3 years. Tasks that might be continued into the second year (i.e., nonnative fish control and recreation management) are not necessarily incompatible with monitoring activities. In any event, desert dace will not be delisted if there are existing or potential threats to the species, regardless of the 3-year monitoring period.

C: The recovery criterion concerning desert dace parasites may not be achievable.

R: The recovery criterion in question states that ". . . parasites no longer threaten the long-term survival of the species." This does not mean to imply that there would be no parasites in the desert dace population, merely that the rate of parasitism does not represent a threat to the survival of the species. The rate of parasitism will be monitored as described earlier to determine the effects on the species.

C: A survey of all Soldier Meadows springs for snail fauna should be conducted prior to initiation of recovery activities such as habitat restoration, especially rerouting flows and eradicating nonnative fishes.

R: Snail surveys would be conducted prior to initiating specific habitat restoration activities, but would likely be restricted to potentially affected areas. One goal of habitat restoration activities is to restore the natural suite of species, including hydrobiid snails. Rerouting of flows into the historical stream channel will be a slow and gradual procedure. As the mobility of hydrobiid snails is low and they may occur in the ditch downstream of the cutoff to the historical channel, a transfer of snail-occupied substrates may occur to assist snail fauna in colonizing the historical channel and retain genetic diversity. Any nonnative fish control measures would be designed with consideration to other native aquatic species present. Currently, habitats with nonnative fishes are on the extreme

lower portions of spring outflows and at least 1.6 kilometers (1 mile) from any known snail populations.

C: The Soldier Meadows cinquefoil is no longer a candidate species, and it should be deleted from the recovery plan.

R: The Soldier Meadows cinquefoil was removed from candidate status based on 1) progress by the Bureau of Land Management towards developing and implementing the Soldier Meadows Activity Plan, which would incorporate protective measures for the plant, and 2) inclusion of the species in this recovery plan. Both plans, if successfully implemented, would remove or reduce existing and future threats to the species. If removed from the recovery plan, the status of the species may need to be reevaluated. The Soldier Meadows cinquefoil may need to be listed unless protective measures are implemented and threats are reduced or eliminated.

C: The Bureau of Land Management is being locked into completing tasks under the implementation schedule for Soldier Meadows cinquefoil, which the Fish and Wildlife Service is no longer considering for listing. This species should not receive special management consideration.

R: Responsible agencies are designated for all recovery tasks in the Implementation Schedule. The Fish and Wildlife Service has no specific legislative mandate to require other Federal agencies to carry out specific actions for recovery of listed species or conservation actions for species of concern. However, the Endangered Species Act requires that Federal agencies utilize their authorities to carry out programs for the conservation of endangered and threatened species. Also, section 4 of the Endangered Species Act gives designated agencies the authority to carry out tasks identified in recovery plans. The Implementation Schedule serves to inform those agencies of the need for these actions and to justify seeking funds to complete them. Conservation of Soldier Meadows cinquefoil through careful planning efforts rather than through listing under the Endangered Species Act could provide multiple benefits to

Bureau of Land Management, including retaining management flexibility, reducing conflicts with future resource management, and alleviating the potential need for more restrictive land policies in the future. If early conservation efforts are unsuccessful, it may eventually become necessary to list the species because of population declines. The costs of recovery would be much higher than early conservation efforts, since measures needed to reverse further declines would be more extensive. In addition, the Bureau of Land Management has signed a Memorandum of Understanding with the Fish and Wildlife Service and other Federal agencies to work together to achieve a common goal of conservation of species that are tending toward Federal listing through protection and management of their habitats and the ecosystems upon which they depend.