PETITION TO LIST THE LEAST CHUB (*Iotichthys phlegethontis*) AS A THREATRENED SPECIES

CENTER FOR BIOLOGICAL DIVERSITY
CONFEDERATED TRIBES OF THE GOSHUTE RESERVATION
GREAT BASIN CHAPTER OF TROUT UNLIMITED
UTAH CHAPTER OF THE SIERRA CLUB

June 19, 2007

Mr. Dirk Kempthorne, Secretary of the Interior
Office of the Secretary
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

Mr. Kempthorne,

The Center for Biological Diversity, Confederated Tribes of the Goshute Reservation, Great Basin Chapter of Trout Unlimited, Utah Chapter of the Sierra Club, and Noah Greenwald hereby formally petition the U.S. Fish and Wildlife Service (FWS) to list the least chub (*Iotichthys phlegethontis*) as threatened or endangered pursuant to the Endangered Species Act (herein after the "Act" or "ESA"), and to designate critical habitat for it concurrent with listing. Petitioners file this petition under the ESA, 16 U.S.C. sections 1531-1543 (1982). This petition is filed under 5 U.S.C. section 553(e), and 50 C.F.R. part 424.14 (1990), which grants interested parties the right to petition for issuance of a rule from the Assistant Secretary of the Interior. The petitioners request that Critical Habitat be designated as required by 16 U.S.C. 1533(b)(6)(C) and 50 CFR 424.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553). Petitioners realize this petition sets in motion a specific process placing definite response requirements on the FWS and very specific time constraints upon those responses.

Addressing the decline of the least chub by protecting the fish under the ESA will serve to restore and maintain the health not only of this unique species, but of the aquatic ecosystems in the watersheds subject to this petition.

Petitioners:

The petitioners are conservation organizations and a Native American Tribe. Failure to grant the requested petition will adversely affect the aesthetic, recreational, commercial, research, and scientific interests of petitioning organizations' members and of the citizens of the United States. Aesthetically, recreationally, and commercially, the public shows increasing demand and concern for wild ecosystems and for biodiversity in general.

Center for Biological Diversity is a conservation organization dedicated to preserving all native wild plants and animals, communities, and naturally functioning ecosystems in the Northern Hemisphere.

The Confederated Tribes of the Goshute Reservation is located on the Nevada-Utah border in Snake Valley. The tribes have a long term interest in the least chub, and the water and land of Snake Valley.

The Great Basin Chapter of Trout Unlimited seeks to conserve, protect, and restore the Great Basin's native and coldwater sportfish and conservation fisheries and their aquatic-riparian watersheds.

Utah Chapter of the Sierra Club is a group of members and volunteer activists dedicated to preserving and enjoying the land and quality of life in Utah and the West.

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I. INTRODUCTION

The least chub (*Iotichthys phlegethontis*) is a rare species of minnow, endemic to Utah and restricted to Utah's part of the ancient Bonneville Basin. There are currently six known, wild, extant populations of least chub, and four refuge populations established through transplant in various locations within the range of the species. The few wild populations we know of are not for a lack of looking. In the last nine years the Utah Division of Wildlife Resources UDWR has undertaken over 120 surveys in what was considered to be the best suspected least chub habitats remaining. Still, only six wild, extant populations are known today.

The least chub has experienced dramatic population and distribution declines throughout its range. This species has been extirpated from the majority of historic habitats where it once existed and currently persists in only a few isolated spring complexes along the Wasatch Front, the Sevier River basin and the Utah West Desert. Many of the extant populations are small and fragmented. The main threats to the least chub populations include increased urbanization, water development, livestock impacts, and predation and competition impacts from introduced nonnative species.

Of great concern for this species is future water withdrawals from the Snake Valley aquifer that are currently proposed to support human population growth in Southern Nevada. Las Vegas is seeking rights to withdraw up to 25,000-30,000 acre-feet a year of groundwater from Snake Valley, currently the "stronghold" for the least chub. Total annual recharge of the Snake Valley hydrologic basin is estimated to be around 100,000 acre-feet a year. The best science available so far tells us that groundwater withdrawal proposed in Snake Valley could potentially cause significant drawdown of the Snake Valley water table, with repercussions for all aquatic species and wetland systems that rely on consistent spring discharge. Repercussions in this case for the least chub could be catastrophic.

The listing of chub as a threatened or endangered species under the Endangered Species Act will help prevent the extinction of this species and the destruction of the ecosystems on which it depends.

II. NATURAL HISTORY

A. SETTING

The Bonneville Basin within Utah encompasses the area that was covered by ancient Lake Bonneville (Figure 1) and which lies within the Great Basin Ecoregion of North America. The Great Basin Ecoregion is distinguished geologically by its characteristically parallel north-south mountain ranges that are separated by broad, alluvial desert basins and valleys (Christiansen 1951). In Utah, the steep, gravelly slopes of these ranges are prominently marked by benches and other shore features of Lake

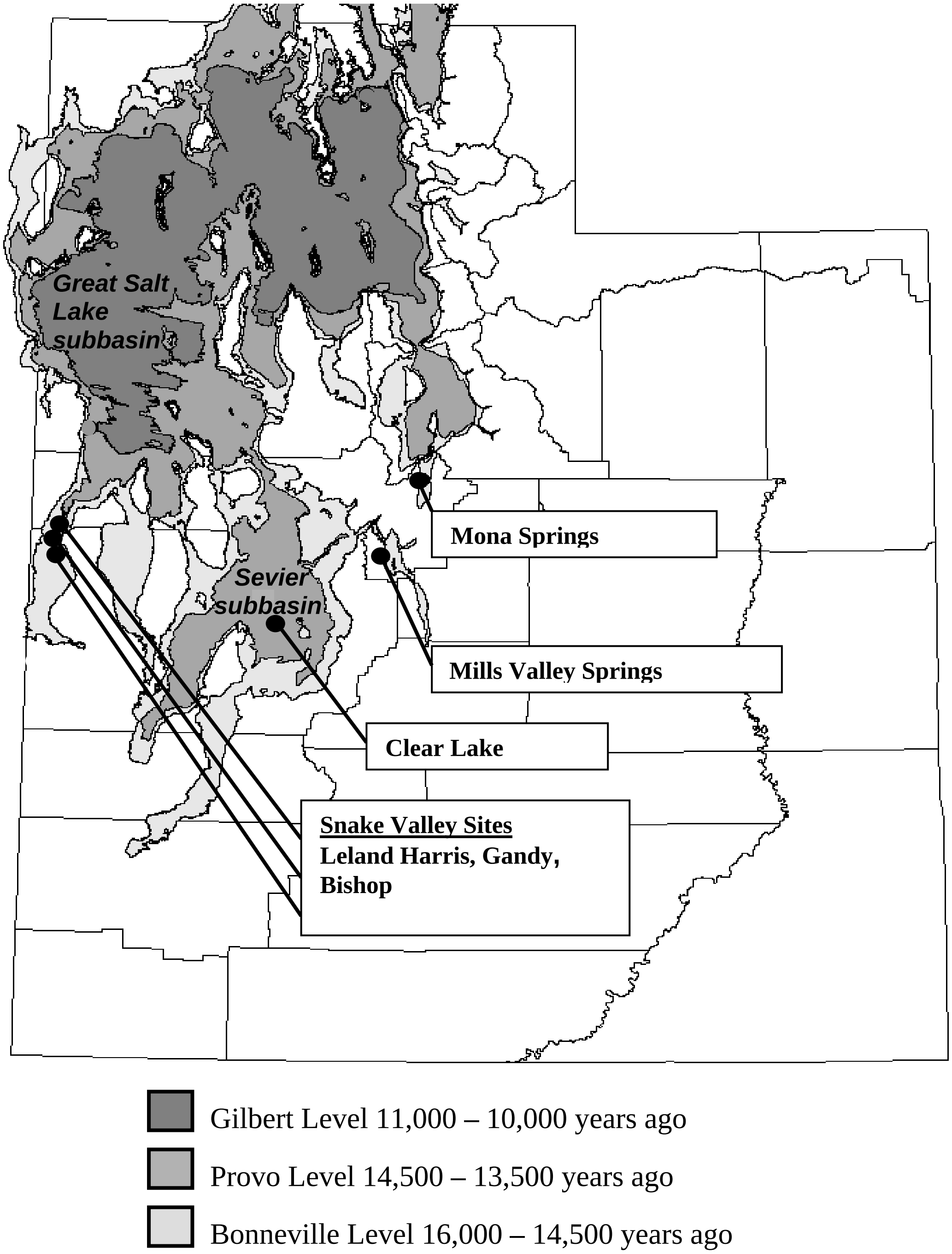

Figure 1. Current distribution of least chub (wild populations) in relation to the receding Lake Bonneville shorelines. Reprinted from Mock and Bjerregaard. 2006.

Bonneville. Numerous springs are present at the base of the mountains (Bick 1966) and on the valley floors. Over time, several aquatic species existed as relict populations in these springs and associated marshes, including the least chub, Columbia spotted frog (*Rana luteiventris*), and several species of mollusks. Populations of these species, however, are rare and in some areas declining. The rapid deterioration of these aquatic environments, primarily from water development and/or agricultural practices, has caused other unique Bonneville Basin species, such as *Rhinichthys osculus relictus,* a subspecies of speckled dace, to become extinct (Hubbs et al. 1974).

B. DESCRIPTION

The least chub (*Iotichthys phlegethontis*) is a small monotypic minnow (Figure 2) that swims in rather dense, well-ordered schools (Bailey 2006). This cyprinid is typically less than 6.35 cm long, and is characterized by a very oblique (upturned) mouth, 34 to 38 large scales along the side, and absence of a lateral line. It has a deeply compressed body, with the dorsal origin behind the insertion of the pelvic fin. The least chub's caudal peduncle is slender, the dorsal fin rays number eight or (rarely) nine, and it has eight anal fin rays. The pharyngeal teeth are in two rows, 2,5-4,2 (Sigler and Miller 1963).

The colorful least chub has a gold stripe along its blue sides with white-to-yellow fins. Males are olive-green above, steel blue on the sides, and have a golden stripe behind the upper end of the gill opening. The fins are lemon-amber, and sometimes the paired fins are bright golden-amber. Females and young are pale olive above, silvery on the sides, and have watery-white fins. The females have silvery eyes with only a little gold coloration, rather than gold as in the males (Sigler and Miller 1963). The least chub was believed to be short lived, until recent studies have shown least chub to live up to 7 years of age (Mills et. al. 2004a).

Figure 2. Adult least chub. *Photo by Mark Belk, Brigham Young University.*

C. TAXONOMY

The least chub is a minnow of the family Cyprinidae, and is the sole representative of the genus *Iotichthys*. It was described by E.D. Cope (*Clinostomus phlegethontis*) from specimens collected in the Beaver River, southeastern Bonneville Basin, in 1872 by Dr. H.C. Yarrow and H.W. Henshaw (Cope and Yarrow 1875 in Hickman 1989). The genus was revised several times from *Clinostomus*, to *Gila* (Cope and Yarrow 1875*),* to *Phoxinus* (Jordan and Gilbert 1883), to *Hemitremia* (Jordan 1891), to *Leuciscus* (Jordan and Evermann 1896, who also listed it in the subgenus *Iotichthys*), and finally to *Iotichthys* (Jordan et al. 1930) (Hickman 1989).

D. REPRODUCTION/ONTOGENY/GROWTH

The age at first reproduction for least chub is probably around 1 yr, but this needs to be experimentally determined (personal communication Eric Wagner, Logan Fisheries Experiment Station, October 2006). Researchers at the Fisheries Experiment Station have observed reproduction in females that were >=1.1 g. Mature males develop a lateral red stripe during spawning season. Spawning takes place chiefly during spring, and when water temperatures reach 16ºC (Sigler and Sigler 1987). Although peak spawning activity occurs in May, the reproductive season lasts from April to August, and perhaps longer depending on environmental conditions (Bailey 2006). Field studies have shown that changes in photoperiod or light intensity, rather than increasing water temperature, initiate the onset of egg development and spawning (Bailey 2006).

Least chub are polyandrous broadcast spawners over vegetation, primarily algae (Bailey 2006). The adhesive eggs then sink and usually attach to the underwater vegetation. Females produce anywhere from 300 to 2,700 eggs (Sigler and Sigler 1987). Least chub are intermittent spawners (Bailey 2006), sometimes producing only a few eggs at any time, and eggs are usually released over an extended period (Crawford 1979). They do not build nests or guard their young. Eggs, about 3.4 mm in diameter, are adhesive and demersal (Bailey 2006, E. Wagner et al., unpublished data). Eggs hatch after about two days without parental care, in water that is about 22^{o} (Crawford 1979) and begin exogenous feeding after 5-6 days at 18 C (Wagner et al. 2005). Fry average 5.5-6.0 mm between hatching and initiation of exogenous feeding (Wagner et al. 2005).

In spring environments, chub often spawn in adjacent marsh habitat and then move back into the springs after spawning (Bailey 2006). The presence of submerged vegetation provides an important habitat for eggs and young larvae by furnishing needed oxygen and food (Crist and Holden 1980). Least chub have been found to reproduce in marshes where temperature, alkalinity, pH, and conductivity are at a maximum for the marsh. The reproductive and survival strategies attributed to least chub, such as spawning over an extended period, broad tolerances to high variability in water quality, and the ability to mature in as little as one year, allow the least chub to successfully reproduce in the fluctuating environment of spring/marsh complexes (Hickman 1989).

Least chub are believed to have an average life span of about three to six years (Mills et al. 2004a, Bailey 2006). Maximum size for least chub is about 6.5 cm, and growth is relatively rapid. In laboratory studies, specific growth rates of 2.06 to 3.38%/day have been recorded (Wagner et al. 2006). A recent study (Mills et al. 2004a) determined least chub growth rates and estimated longevity in wild populations by analyzing annular rings found on otoliths. The authors determined that least chub growth rates appear to be greatest in the summer months, and that least chub in wild populations live significantly longer than those in captivity. The analysis clearly indicated that least chub can live up to six years, which suggests that environmental conditions and different aging techniques (otloliths versus scales) could explain the discrepancy in estimates of longevity of least chub between wild and captive populations.

E. DIET

Least chub are thought to be opportunistic feeders, with their diets related to the abundance or availability of food items during different seasons and from different habitat types (Crist and Holden 1980; Lamarra 1982). Common food items include algae, diatomaceous material, and midge adults, larvae, and pupae (Sigler and Sigler 1987). They also eat copepods, ostracods, and whatever invertebrates are available (Hickman 1989). Workman et al. (1979) found that the diet of 121 least chub collected from various areas consisted of approximately 50% insects, 30% crustaceans, and 20% algae. They observed a reduced selection of algae during the winter and spring months. The least chub is of value as a natural predator of mosquito larvae (Rees 1945, Wagner at al. 2005), although mosquito larvae appears to be a seasonal food item.

F. ASSOCIATED SPECIES OF INTEREST

In general, if least chub and their habitats are conserved, other species of concern stand to benefit. These species include Columbia spotted frog (*Rana luteiventris*) which is also a Conservation Species in Utah, the California floater (*Anodota califoriensis*) which is a Species of Special Concern, and Ute Ladies'-tresses orchid (*Spiranthese diluvialis*), a federally threatened wetland plant. There are currently three species of spring snail (*Pyrgulopsis kolobensis*, *P. peculiaris*, and *P. anguina*) that occur in Snake Valley and almost nowhere else (*Pyrgulopsis kolobensis* occurs in one other local – adjacent Spring Valley), and which currently are offered no special protection at all. The presence of other native fish like speckled dace (*Rhinichthys osculus*) and Utah chub (*Gila atraria*) offers some competitive pressure on least chub but does not appear to have a detrimental affect on least chub populations.

G. HABITAT REQUIREMENTS

Historically, least chub inhabited a variety of habitat types in different environments, including both lotic and lentic (Lamarra 1982; Sigler and Sigler 1987). The species is typically found in association with moderate to dense vegetation and in areas with moderate to no current (Sigler and Miller 1963). Pools containing least chub can vary from 0.1 m to 3.6 m deep (Osmundson 1988). Substrates of ponds containing least chub are usually composed of silt, organic material, or some combination of the two. Occasionally substrates will include clays.

Least chub is a generalist and has broad tolerance limits to many water quality parameters that allows it to exist in the severe environment of the springs and marshes in Snake Valley of Utah's West Desert (Lamarra 1982). In general, the springs where least chub are still found naturally exhibit cool and stable temperatures, relatively low, stable dissolved oxygen values, and low conductivities (Perkins et al. 1998). Marshes with least chub typically have higher temperatures, conductivity, pH and dissolved oxygen than springs containing least chub (Hickman 1989). Marsh habitats with least chub also exhibit wide diurnal fluctuations in dissolved oxygen due to higher daytime primary productivity. The daily temperatures in the marshes can fluctuate between 15^{o} and 32^{o} C (59^{o} - 90^{o} F; Crist and Holden 1980). In occupied least chub habitats for which there are current data (Fridell et al. 1999, Richards and Wilson 1999), surface water temperature ranges from 10^{o} to 29^{o} C, dissolved oxygen ranges from 0.1 to 9.8 mg/L, and pH ranges from 7.3 to 8.9. Seasonal water quality changes in marsh and stream habitat result in least chub movement back and forth between different habitat types, especially between springs and marshes (Crist and Holden 1980).

While substrate type appears to be insignificant, the presence of aquatic vegetation is a key habitat component for least chub (Crist and Holden 1980). Bottom and poolside vegetation are very important to least chub, which are very adept at diving into bottom vegetation or retreating rapidly into rushes when disturbed (Bailey 2006). The presence of submerged vegetation provides an important habitat for eggs and larvae by furnishing needed oxygen and food (Crist and Holden 1980). Typical least chub habitat features a variety of herbaceous emergent, floating, and submergent vegetation. Vegetation most commonly associated with least chub includes: bullrush (*Scirpus* sp.), sedges (*Carex* spp.), cattails (*Typha* sp.), duckweed (Lemnaceae), rushes (*Juncus* spp.), watercress (*Nasturtium officinale*), grasses (Graminae) and algae. Additional species of vegetation found associated with the Snake Valley populations include saltgrass (*Distichilis spicata*), Elodea (*Elodia* sp.), pondweed (*Xanthium spinosum* and *X. strumarium*), giant reed (*Phragmites*) and sandbar willow (*Salix* sp.) (Wilson and Whiting 2002, Wheeler and Fridell, 2004, Wilson and Mills 2004, Wheeler et al. 2005.)

III. SPECIES OCCURRENCES AND POPULATION STATUS

A. HISTORIC AND CURRENT DISTRIBUTION

The Least chub is endemic to the Bonneville Basin of Utah where it was once widely distributed (Bailey 2006). Over the past 15,000 years, least chub persisted in relict wetlands pockets left by the receding Lake Bonneville and Lake Provo (Fig. 1), where it occupied a variety of habitats including rivers, streams, springs, ponds, marshes and swamps (Sigler and Miller 1963).

In the eastern half of the basin, least chub occurred historically (1800's) in streams, freshwater ponds, and wetlands near the Great Salt Lake, in Utah Lake, Beaver River, Parowan Creek, Clear Creek, Provo River, in tributaries of the Sevier River and in Utah Valley (Cope and Yarrow 1875, Jordan 1891, Sigler and Sigler 1987), and likely in the lower Bear River Basin (Thompson 2005). In the West Desert, least chub occurred historically in the Little Salt Lake in Iron County (Hubbs and Miller 1948), and several spring complexes in Snake Valley, including Leland Harris Springs (including Miller Spring), Gandy Salt Marsh, Bishop Springs, Callao Springs, and Redden Springs (Workman et al. 1979, Osmundson 1985). Since more collectors were active in the Wasatch Front during this period (1800's), there were likely many other historic least chub sites in the West Desert that were never discovered.

The earliest records for least chub were by Dr. H.C. Yarrow and H.W. Henshaw in 1872 from the Beaver River, Utah (Cope and Yarrow 1875). They noted that this species was abundant in the areas where they made their collections. In 1889, D. S. Jordan collected least chub from the Provo River drainage and noted that they were “extremely common in the pools of water about the mouth of the Provo River and in the carp ponds next to Utah Lake” (Jordan 1891). Jordan and Evermann (1896) stated that the least chub occurred in “tributaries of Great Salt Lake and Sevier Lake” and that they were “excessively common in ponds and warm pools”. V. M. Tanner (1936) noted that the distribution of least chub included the Beaver River, Parowan Creek and Clear Creek. He also stated that it was “found in the Provo River and fresh water ponds around the Great Salt Lake. Tanner collected several specimens from the Provo River in 1931 as well.

Least chub have also been collected from the northeastern edge of the Bonneville Basin in Salt Lake and Davis counties. The Michigan Museum of Zoology contains specimens that were in a small brook outside of Salt Lake City in 1871 and again in 1933. Pendleton and Smart (1954) collected least chub in 1953 from Big Cottonwood Creek, in Salt Lake County and G. Smith collected least chub near Centerville in 1964 and in Farmington Bay, Davis County, in 1965 (Hickman 1989, Thompson, 2005).

There have been over 50 wild occurrences of least chub known in Utah since records have been kept, and in most cases the species was reported to be abundant where found. So far, most of those wild populations have been extirpated. A decline in the abundance of least chub was first noted in the 1940’s and 1950’s (Holden et al. 1974). In the late 1970’s, in an extensive least chub survey conducted by Workman et al. (1979) throughout the Bonneville Basin, the only least chub populations located were from Snake Valley, including the Gandy Marsh complex, Leland Harris Spring complex, Callao Spring complex, Twin Springs and Redden Springs. No least chub were recorded in the lower reaches of the Ogden River, Big and Little Cottonwood Creeks, Provo River, or from numerous springs and ponds in Juab, Millard and Tooele counties. Osmundson (1985) surveyed the same sites as Workman et al. did in 1977 and only found least chub in the Gandy Salt Marsh complex and Leland Harris Spring complex. Shirley (1989) surveyed the Callao spring complex but did not collect any least chub in these springs. Rosenfeld found a few least chub in Redden Springs during 1984 and indicated that they were not very abundant (Hickman 1989). They have since been extirpated at both of these sites, as was confirmed by Crist (1990).

By 1996, the known distribution of least chub consisted of one spring complex in the Utah Lake drainage (Mona Spring complex), one spring complex in the Sevier River basin (Mills Valley), and three spring complexes in Snake Valley (Leland Harris Springs, Gandy Salt Marsh, and Bishop Springs). This decline has been attributed to urbanization, water development projects, livestock impacts, and the introduction and proliferation of nonnative species (see Section IV). Since 1996 one new, wild population has been discovered (the Clear Lake population).

B. CURRENTLY KNOWN, EXTANT, WILD POPULATIONS

Currently, there are only six known, wild, extant populations of least chub (Figure 3). Least chub historically and currently occur in three geographically isolated areas in the Utah portion of the Bonneville Basin. These areas have been separated by the Utah

Division of Wildlife Resources (UDWR) into three Geographic Management Units (GMUs) for least chub (Figure 4) that are based on hydrologic subregions (USGS 1974). These units include the West Desert GMU, Wasatch Front GMU and the Sevier River GMU.

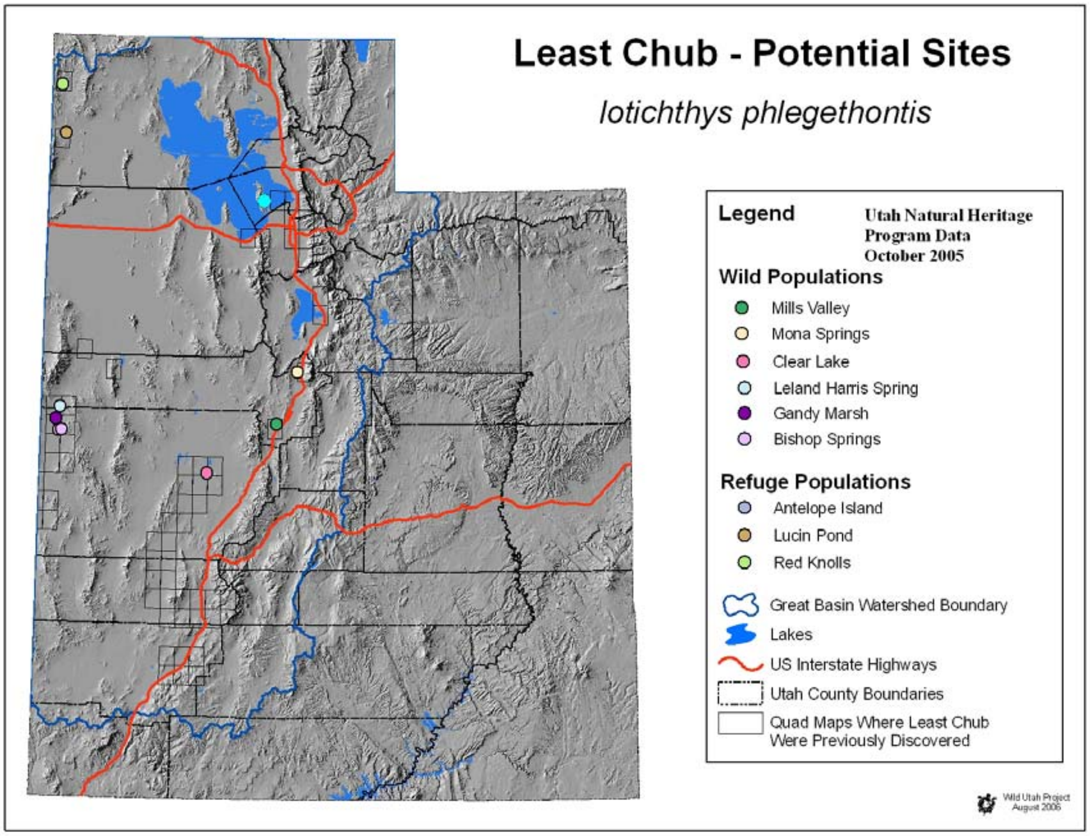

Figure 3. Extant, wild populations of least chub that are currently known, and established refuge sites (the newest refuge site, established at the end of 2006, has not yet been monitored for success and is not shown on this map).

1 Mona Population

This population is located in a spring complex along Current Creek, in the Utah Lake drainage in the Wasatch Front GMU. This site is immediately west of the town of Mona, Juab County, UT. Significantly, this is the only known, wild population of least chub in this GMU. The Wasatch Front GMU is comprised of eleven hydrologic subunits. Subunits where historic records and/or empirical evidence indicate the historic presence of least chub include Lower Bear River, Utah Lake, Spanish Fork, Provo River, Jordan River, and in the Lower Weber River (Bailey et al. 2005, Bailey 2006).

The Mona population was discovered in 1995. This spring complex is currently also occupied by spotted frog which is also listed as a State Conservation Species, and California floater which is listed as a State Species of Special Concern. This habitat is one of the few areas where these three species still occur sympatrically.

The habitat at the Mona site is a spring and pond complex tied to Current Creek. Tall bunchgrasses comprise the uplands between the ponds. Russian olive (*Elaeagnus angustifolia*) is a problem at most of the ponds. Phreatophytic plants at the pools containing least chub include algae (*Chara spp*.), wire grass (*Juncus arcticus*) olney threesquare (*Scirpus americanus*), duckweed (*Lemnaceae*), watercress (*Nasturtium officinale*), and sedges (*Carex* spp.). In the ponds containing least chub, water temperature ranges from 13.5 ^{o} to 17.6^{o} C, dissolved Oxygen ranges from 3.48 to 3.99 mg/L, pH seems to be a constant 7.5, and substrate consists of organic silt (Wilson and Whiting 2002).

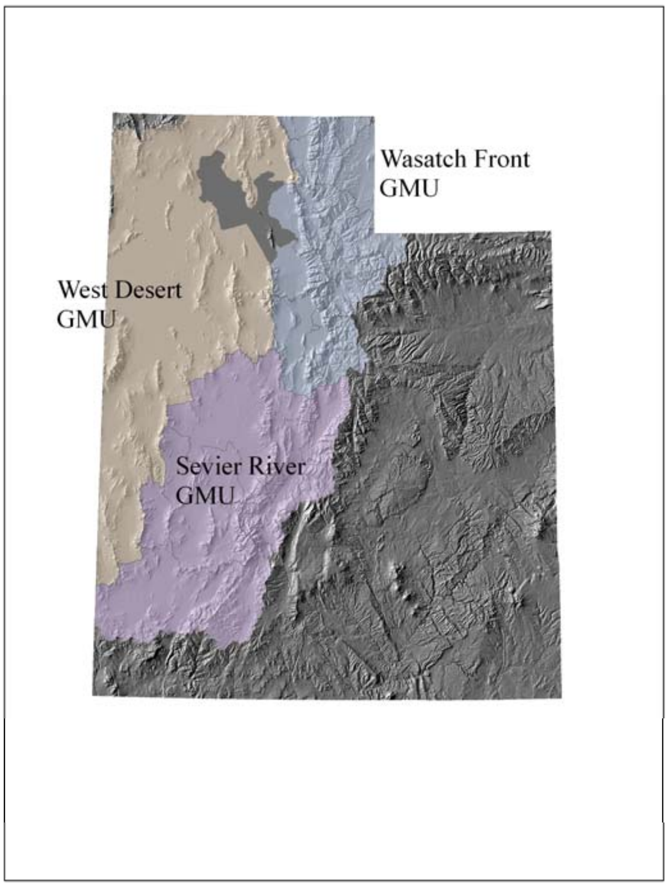

Figure 4. The three least chub Geographic Management Units (GMUs): Wasatch Front GMU, West Desert GMU, and Sevier River GMU. Based on hydrologic drainages.

In 1998 the Utah Reclamation Mitigation and Conservation Commission (URMCC) funded the Division and US Bureau of Reclamation (BOR) to acquire lands and waters on the Mona Springs Complex near the town of Mona. A total of 85.5 acres of the 105 designated acres were acquired soon afterward, and the remaining 19 acres were purchased in 2006. In 2000 the UDWR implemented habitat enhancement actions on the property to improve riparian conditions, slow spring succession, and improve water quality. These actions included preventing livestock access to least chub habitat via an electric fence that was constructed around the spring complex.

This population has been carefully monitored since 1995. Starting in the late 1990's, both the number of sites where least chub were captured at the Mona site, and the total number of individuals captured at those sites, began to decline precipitously[1] (Table 1). The 2005 field season found that two of the eight sites sampled at Mona Springs contained least chub (Table 1). Least chub comprised 1% (n=6) of all fish captured at the Mona site, with five least chub caught in new pond 3 and one least chub caught in new pond 7. Western mosquitofish were the most abundant species captured, comprising 56% (n=433) of all fish captured. Other species captured included plains killifish (*Fundulus zebrinis*), Utah chub, fathead minnows (*Pimephales promelas*), rainwater killifish (*Lucania parva*), and redside shiners (*Richardsonius balteatus*). Least chub mean total length was 45.4 mm at Mona in 2005. 15,000 least chub from the Mona population stock at the Wahweap State Fish Hatchery (see Refuge Populations, below) were stocked back into the Mona Spring complex on October 28, 2005. 2006 monitoring of this population has not yet been summarized at the time of writing.

One of the current threats to the Mona population and its habitat is residential development. Urban and suburban development affects least chub and their habitats in a number of ways, the most significant of which is water diversion for additional human development, both from surface flows and connected groundwater. Human occupation near streams and springs also increases the potential for the introduction of nonnative plants and animals that can adversely affect the least chub. In terms of residential development near the population site, there is currently an expanding suburban development about 1¼ miles away from the ponds. UDWR hopes to "hold the line" of suburban development at the railroad tracks (3/4 of a mile from the current residences and 1/2 mile from the Mona population site). There seems to be little doubt that suburban growth will eventually extend right up to the tracks (personal communication, Mike Mills, UDWR Central Region, September 2006). However, to "hold the line" here will require that the current landowner between the railroad tracks and the Mona population site does not sell to developers. He has recently indicated that he does not intend to sell (personal communication, Mike Mills, UDWR Central Region, September 2006).

The worst situation facing the chub at the Mona site is mosquitofish presence. Mosquitofish pose a threat because they are known to prey upon both eggs and juveniles of other fish species (Meffe 1985, Sigler and Sigler 1987). In the late 1990's, UDWR began detecting large numbers of mosquitofish at the Mona site. In 1999 the UDWR conducted a nonnative fish removal project in a segment of the Mona spring complex (Wilson et al. 1999). At the time of this project, a small number of least chub had been captured in only one of 12 monitoring sites during the two previous years of monitoring

[1] This is what triggered an aggressive non-native removal program starting in 2000. As detailed later in this section, this program has thus far proven to be unsuccessful in either permanently removing mosquitofish from the Mona Springs complex, or bringing up numbers of least chub.

(Richards and Wilson 1999, Wilson et al. 2000) and the population was considered to be at serious risk of extirpation. The project was conducted in the segment of the complex where least chub had been most recently detected (Site 5). Prior to nonnative fish removal, a wooden drop structure was constructed at the outflow of Site 5 to prevent re-invasion of nonnative fishes after the project. A total of 1,269 fish were captured. Nonnative fishes comprised 39 percent (n = 489) of the catch. Least chub comprised 12 percent of the catch (n = 146). Subsequent monitoring revealed that mosquitofish had quickly re-invaded the treatment area. A muskrat had burrowed around the drop structure, creating an underground corridor between Site 5 and the rest of the spring complex.

In response to the poor outcome of the 1999 control effort, in 2000 UDWR conducted another nonnative fish removal project at the Mona spring complex. Approximately 400 minnow traps were set daily for 19 nights. Native fish were identified and enumerated and nonnative fishes were removed from the spring complex. A total of 41,054 fish were captured. Nonnative fishes comprised 90 percent of the catch. Mosquitofish comprised 61percent (n = 25,080) of all captured nonnative fishes. Overall, 41,000 non-native fish were removed from the Mona springs complex. In 2001 the UDWR confirmed that the 2000 removal effort did not achieve the desired results.

In the fall of 2001 UDWR conducted an additional non-native removal operation. All nonnative fish caught (35,000) were euthanized, and native fish other than least chub were released outside of the treatment area. Least chub were held in a live cage located in site 5 and were then released into sites 10 and Northwest 4. The least chub captured in the 2000 removal effort were released back into sites 5 and 10, with a temporary fish barrier having been installed at the outlet of site 5. This barrier was compromised by muskrat activity, and was moved farther down the outlet. However, it appears that a subsurface connection to some other area must be present in site 5, as large numbers of fish have returned to this site, despite the barrier and low water conditions in the outlet channel.

In the fall of 2002 UDWR tried again. Approximately 19,000 non-natives (again, mostly mosquitofish), were removed this time. Of the remaining least chub salvaged (149 were sent to the Wahweap State Fish hatchery and the Fisheries Experimental Station to establish refuge populations), 50 were reintroduced into ponds NW 4 and NW 10, a couple hundred were released into Pond 5, and 400 least chub were transplanted into (just created) New Pond 3, which has a diversion structure blocking outflow and serving as a fish barrier. At the time of the release, New Pond 3 was thought to be unoccupied by fish. The 2004 sampling in new pond 3 verified the presence of YOY least chub, but also provided evidence of western mosquitofish and plains killifish in the pond (Wilson and Mills 2004).

In 2003 UDWR tried yet again to remove mosquitofish and again the effort was unsuccessful. There was not a non-native removal program in 2004. One of the problems UDWR is encountering at Mona is that the downstream users back up the waters for storage during the irrigation season, thus flooding the population site/spring complex and creating ideal breeding habitat (warm, shallow pools) for both mosquitofish and mosquitoes (personal communication, Chrissie Wilson, UDWR, October 2005). It appears the only solution is for UDWR to drain the entire system dry for about 6 months to try to kill off the mosquitofish, and then reintroduce least chub. The problem with this solution is two-fold: (1) for an effective removal effort to remain mosquitofish-free, the Division would have to convince the downstream users to suspend water impoundment, and (2) the entire spring/marsh complex is joined together and to the spring heads in a subterranean system of "catacombs" and would probably be hard to completely drain.

The UDWR sums up the Mona mosquitofish problem the 2006 Seven-Year Assessment of the Least Chub Conservation Agreement and Strategy: "The population decline at the Mona Springs Complex has been attributed to the presence of nonnative fishes, particularly mosquitofish (*Gambusia affinis*). Extensive efforts to control mosquitofish in the spring complex have been unsuccessful and the least chub population numbers continue to decline. These results suggest that, unless complete eradication can be achieved, the threat posed by mosquitofish cannot be reduced for any significant amount of time, and a temporary reduction does not induce a positive least chub population response. The small population size, coupled with the results of the nonnative fish removal efforts, indicate that this population may be extirpated in the near future unless dramatic action is taken" (Bailey 2006).

2. Mills Valley Population

This population is one of two populations known in the Sevier River GMU (the other population is the Clear Lake population). Water in the Sevier River Basin historically flowed into pluvial Sevier Lake, but for the most part is currently diverted for agricultural purposes.

The Mills Valley population was discovered in 1996. The population site occurs in the Lower Sevier River subunit north of Sevier Bridge Reservoir (Yuba Reservoir) in Mills Valley, in southeast Juab County, UT. Most of Mills Valley is privately held. However, it is believed that the majority of least chub occupied habitat is on the Meadows Wildlife Management Area (WMA), which is owned by UDWR. The vast majority of least chub annual monitoring occurs on the WMA…it is rare that UDWR is allowed access to monitor on the adjacent private lands.

The Mills Valley spring complex is couched within a 2-3 km wide and ~15 km long valley. Pools and ponds dot the landscape, with a mixture of wetland, upland and facultative wetland vegetation in between. There are dozens and dozens of springheads through the complex, which are likely hydrologically tied to the Sevier River, while also fed by snowmelt from Canyon Mountains to the West. Pools containing least chub at this population site have substrate depths ranging from 0.09 m to 0.91 m, water temperatures ranging from 10.1° to 19.3° C, dissolved Oxygen ranges from 8.9 to 10.2 mg/L, pH ranges from 8.0 to 9.0, and substrate consists of organic silt (Wilson and Whiting 2002, Wilson and Mills 2004).

The Mills Valley population site has been closely monitored by UDWR since 1998. Overall, the population appears to be relatively stable (Table 1), with least chub accounting for 95% - 99% of all fish captured at the three monitoring sites from 2002 – 2005 (Wilson and Mills 2004, unpublished Central region 2005 monitoring report). Least chub mean total length was 32.7 mm in 2005. 2006 monitoring of this population has not yet been summarized at the time of writing.

Threats to this population include:

- *Potential for peat mining in the area*. The primary landowner in the valley illegally mined peat in the late 1990's, and was afterwards asked to do some restitution, including removal of a road that was built. In 2002 a permit was requested to legally carry forth with peat mining in the same wetlands (this time to remove all the wetlands). In late 2004 an appraisal was done to ascertain the true value of the land, and whether mining peat would be economically viable or profitable. The appraisal concluded there was peat in the Valley, but likely not enough to be worth mining. With that knowledge, UDWR offered the landowner $280,000 for the property. The landowner believes the property is worth more, and filed for and received a permit to commence with peat mining (personal communication, Mike Mills, UDWR, September 2006). As of the time of this writing, no peat mining had occurred in Mills Valley.
- *Livestock grazing*. In return for permitted access to cross private lands to get to the UDWR-owned Meadows WMA, UDWR allows one of the two livestock owners in Mills Valley the right to graze 80 AUMs of cattle in the Mills Valley population site. Livestock have impacted chub habitat in the population site, especially along the east side of the WMA, by degrading water quality and reducing vegetation. In the 2002 Monitoring Summary for the Central Region, it reports that ungulate damage at sites containing least chub in Mills Valley was "moderate to severe." There is another stockowner that runs cattle to the north of the WMA, but a fence keeps these cattle from entering the WMA. However, least chub are also known to exist on private lands outside of the WMA, so least chub outside of the WMA are likely heavily impacted by cattle.
- *Non-native species*. While mosquitofiah are not known to inhabit this site, there are fathead minnow and carp presently in Mills Valley (personal communication, Krissy Wilson, UDWR, August 2006).
- *Potential oil and gas exploration*. Oil and gas leases have been sold by the Bureau of Land Management (BLM) in Mills Valley. Those who hold the leases have run 3 or 4 seismic lines through the valley to ascertain whether commercially viable deposits of oil and/or gas are there (personal communication, Mark Pierce, Fillmore BLM office, August 2006). The BLM is waiting to see whether these tests result in the filing of Applications for Permits to Drill.

3. Clear Lake Population

This population is one of two populations known in the Sevier River GMU (the other population is the Mills Valley population). The Clear Lake population was discovered by UDWR employee K. Wheeler in 2003 in the Clear Lake Waterfowl Management Area. This waterfowl reserve, owned and operated by UDWR to provide waterfowl habitat, lies on the southern edge of the historic Bonneville Basin, south of Delta, within Millard County. The shallow reservoir, several hundred acres in size and rich in bulrush dominated emergent wetlands, is the key feature at the WMA. However, there is also a series of dike-created ponds fed by springs to the north. Because all the ponds are fed from Spring Lake, and some of them dry (at least seasonally), fish distribution recedes and spreads out with the water to ponds and ditches throughout the system.

In the summer of 2003, after 299 trap hours a total of 34 least chub were captured at this site. This was the first documentation of least chub in Clear Lake. In 2004 it was similarly noted that few least chub were caught (only 20 total). Bailey (2006) surmises that it is likely that least chub and other native fish populations were reduced during past rotenone treatments to eradicate common carp (before anyone knew least chub existed in the Clear Lake WMA).

Threats to this population site are various, but limited. The revised, 2005 Least Chub Conservation Agreement and Strategy (LCAS) reports that distribution of least chub in the Clear Lake refuge is "limited by seasonal drying." Also, as mentioned above carp have been documented in the lake, and were removed by the hundreds in the past (Least Chub Conservation Team, LCCT, meeting minutes, December 19, 2003). More treatments will likely be required to fully eradicate this invasive species (Bailey 2006).

The Clear Lake population does not yet have an established genetic refuge population. The LCCT is currently searching for a suitable site. Much of the area in the southern Bonneville Basin that likely contained least chub in the past has been severely affected by water diversion, habitat alteration for reservoirs, interaction with non-native species, and lowering of the water table from extended drought and utilization of wells and pumps for agriculture and urban use. These factors would probably eliminate most of the currently known, potential areas as suitable refuge sites for the chub (Bailey 2006).

Table 1. Number and percentage of springs where least chub were captured at the six wild, extant population complexes. 2006 monitoring data was not yet available at the time of writing.

YEAR	Leland Harris	Gandy	Bishop Springs	Mills Valley	Mona	Clear Lake
1993	07 of 11 (64%)	22 of 50 (44%)	11 of 13 (85%)	pop unknown	pop unknown	pop unknown
1994	08 of 12 (67%)	18 of 50 (36%)	07 of 13 (54%)	pop unknown	pop unknown	pop unknown
1995	10 of 12 (83%)	15 of 50 (30%)	05 of 11 (45%)	pop unknown	07 of 12 (58%)	pop unknown
1996	08 of 12 (67%)	15 of 50 (30%)	08 of 13 (61%)	pop unknown	06 of 12 (50%)	pop unknown
1997	10 of 12 (83%)	13 of 50 (26%)	05 of 13 (26%)	pop unknown	07 of 12 (58%)	pop unknown
1998	09 of 12 (75%)	15 of 51 (29%)	09 of 13 (69%)	05 of 08 (63%)	01 of 12 (8%)	pop unknown
1999	10 of 12 (83%)	15 of 51 (29%)	07 of 13 (54%)	02 of 06 (33%)	01 of 12 (8%)	pop unknown
2000	09 of 12 (75%)	15 of 52 (29%)	08 of 13 (61%)	01 of 06 (16%)	03 of 13 (23%)	pop unknown
2001	07 of 12 (58%)	11 of 52 (21%)	08 of 13 (61%)	14 of 25 (56%)	03 of 12 (25%)	pop unknown
2002	09 of 12 (75%)	11 of 52 (21%)	09 of 13 (69%)	03 of 03 (100%)	02 of 13 (15%)	pop unknown
2003	08 of 12 (67%)	08 of 52 (15%)	05 of 13 (38%)	03 of 03 (100%)	01 of 13 (7%)	03 of 06 (50%)
2004	08 of 12 (67%)	09 of 52 (17%)	07 of 13 (54%)	03 0f 03 (67%)	not sampled	04 of 07 (57%)
2005	04 of_04* (100%)	12 of 52 (23%)	10 of 13 (77%)	03 of 03 (100%)	02 of 08 (25%)	05of 07 (71%)__

* Trap stations at Leland Harris were reduced to 4 in 2005 due to the new monitoring protocol (see discussion below)

4. **Snake Valley Populations**

The Snake Valley Hydrologic Subunit of the West Desert GMU is located between the Deep Creek Mountains and the Snake Range (to the west) and the Confusion Range to the east. Three of the six known, extant, wild populations of least chub are found here, on either side of the Juab/Millard County line (Bailey 2006). The Snake Valley hydrologic subunit is only one of two hydrologic subunits within the West Desert GMU where least chub were known to occur historically (the other subunit is the Tooele Valley subunit, Bailey 2006). Within Snake Valley, least chub were historically known from other sites besides the three that are now extant, including Callao Spring and the Redden Spring complexes (Bailey 2006). These wild populations have been extirpated since their discoveries (Crist 1990, Bailey 2006).

The three, known, extant wild populations of least chub in the Snake Valley include the Leland Harris (including Miller Spring), the Bishop Springs, and the Gandy Marsh Populations. These populations are spatially isolated from each other but are likely to share hydrologic connections during periods of high flow. Whether such connections lead to the exchange of individuals between sites is unknown.

In the Snake Valley, least chub occur in small desert springs with little fish diversity. Where least chub are present, they typically occur in numbers that reflect the available water volume in the spring. Spotted frog are also present in Snake Valley.

Vegetation most commonly associated least chub population sites in Snake Valley includes olney threesquare (*Scirpus americanus*), common threesquare (*S. pungens*) , softstem bulrush (*S. validus*), clustered field sedge (*Carex praegracilis*), common cattail (*Typha domingensis*), common spikerush (*Eleocharis palustris*), duckweed (*Lemna sp*.), cutleaf water parsnip (*Berula erecta*) and waterfern (*Azolla mexicana*) (Wheeler et al. 2004).

<u>*Leland Harris Population.*</u> T14S, R18W, Sections 28,29, 32 and 33. Gandy 7.5' Quad. In 1970, R.R. Miller collected the first least chub from the Leland Harris spring complex (Sigler and Sigler 1963). This population site is in a spring/marsh complex, just north of the Juab/Millard County line. Twelve springheads west of a playa discharge enough water to be interconnected in the spring, but generally are not connected in the summer months (personal communication, Kevin Wheeler, UDWR Southern Region, August 2006). UDWR monitoring stations are at each of these springs. In some years of good discharge and outflow, the outflows from these springs can connect with the outflow of Miller Spring, which is generally lumped with the Leland Harris population site for conservation and monitoring purposes. Nearly all of the land in this area is publicly owned, principally by the BLM, though there are a scattering of State Institutional Trust Administration (SITLA) parcels in the area.

Least chub populations at Leland Harris have remained relatively stable since annual monitoring began in 1993. While population numbers appeared to spike upwards in the most recent (2005) monitoring season reported by UDWR (Table 2), this is because these numbers reflect the new UDWR monitoring protocol (see discussion below) that utilizes a much greater trapping effort in order to get enough data to determine meaningful analysis of least chub length/frequency distribution between years to compare age-class structure.

Springs containing least chub at Leland Harris have water depths ranging from 0.02 m to 8.0 m, water temperatures ranging from 13.0 ^{o} to 17.4 ^{o} C, pH ranging from 7.9 to 8.3, and substrate consists of organic silt. While the springs at the Leland Harris complex are generally connected to one another via marshes and wetted habitats in the spring, they are generally unconnected for the rest of the year…often even without outflow from the springs after the spring season ends (personal communication, Kevin Wheeler, UDWR Southern Region, August 2006).

The Leland Harris population site is located within the BLM Partoun grazing allotment. The Partoun allotment is a “community allotment.” Thus, it is very large and accommodates a handful of permit holders who run their stock together, in this case using a 4-pasture rotational grazing system. The Partoun allotment accommodates both cattle and sheep, though the sheep stay higher up on the benches and avoid the springs. The Leland Harris spring complex is grazed from 11/01 to 4/30. The 2004 monitoring summary classified most springs in this complex as having low ungulate damage and minimal bank disturbance (Wheeler et al. 2004). However, springs 9, 10 and 2-B were classified as having moderate ungulate damage.

In BLM’s February, 2006 oil and gas lease sale, multiple parcels were sold north and west of Miller Spring, part of the Leland Harris population site (personal communication, Mark Pierce, BLM Fillmore Office, August 2006). The BLM is waiting to see whether this results in the filing of Applications for Permits to Drill.

While Miller spring is considered part of the Leland Harris complex, it is far enough away from Leland Harris proper that outflows of the two sites are not always connected (this is particularly true in drier years). Miller spring has also not been monitored as often as the rest of the complex in recent years, partly because it occurs on private land. The monitoring efforts that have been conducted in recent years have been unsuccessful at capturing any least chub (personal communication, Mike Mills UDWR Central Region, September 2006). Miller spring is considered to be very good least chub habitat, partly because there is an agreement with the landowner regarding the grazing system, and this also entails a fence around the main springhead and associated pond at Miller spring. After the UDWR removed non-natives from Miller Spring in 2001 (personal communication, Kevin Wheeler, UDWR Southern Region, August 2006), UDWR sought to ensure chub presence in the spring and reintroduced Leland Harris least chub into the spring in 2005. In the spring of 2006 UDWR employee Kevin Wheeler visually spotted least chub in the marsh below the spring, but did not see any in the spring itself (personal communication, Kevin Wheeler, UDWR Southern Region, February 2007). Official UDWR monitoring was conducted in the fall of 2006 at Miller Spring, but the UDWR Central Region. Traps were sent in both the spring and the marsh but no least chub were found (personal communication, Kevin Wheeler, UDWR Southern Region, February 2007).

Gandy Marsh Population. T15S, R18W, Sections 19, 30 and 31, Gandy 7.5’ Quad. The first recorded collection of least chub in Snake Valley was by C.L. Hubbs in 1942 at the Gandy Marsh complex Sigler and Sigler 1963). This population site occurs south of the

Leland Harris marsh complex and north of the Bishop Springs complex, just south of the Millard/Juab county line. Fifty-two small volume springheads west of a playa discharge enough water to be interconnected in the spring, but generally are not connected in the summer months (personal communication, Kevin Wheeler, UDWR Southern Region, August 2006). UDWR monitoring stations are at each of these springs.

All of the land in this area is publicly owned, principally by the BLM. The Gandy population site is located within the BLM Gandy grazing allotment. Two permitees run cattle on this allotment; one of the permitees has 105 cows on the allotment from 5/16 to 02/01, the other runs 488 cows from 11/01 to 4/30. There are currently two exclosures in place at Gandy to keep livestock out of the most important least chub habitat.

Springs containing least chub at this site have water depths ranging from 0.4 m to 3.5 m, water temperatures ranging from 12.0 ^{o} to 19.8 ^{o} C, dissolved oxygen ranging from 1.64 to 5.54 mg/L, pH ranges from 7.9 to 8.3. Substrate of the majority of sites in the marsh complex are organic with an occurrence of silt to a lesser extent (Wheeler et al. 2004). Length frequency distributions of least chub at Gandy Marsh during the 2005 field season show that the majority of fish collected were between 36 and 53 mm in length (Wheeler and Fridell 2005). Mean length of least chub captured at Gandy Marsh was 42.7 ± 4.2 mm.

Overall trends for this population complex are down over time. Number and percentage of springs where least chub have been captured have been slowly and consistently going down over the years from 22 of 50 sites (or 44% of sites sampled) in 1993 to 9 of 52 sites (or 17% of sites sampled) in 2004. Additionally, total numbers of fish caught over time seem to be declining (Table 2). Drought over the past 5 or 6 years in Snake Valley could be contributing to this decline. In the 2004 monitoring summary report for Snake Valley, Wheeler et al. (2004) note that "the ongoing drought continues to affect water levels at the Gandy Marsh complex. Although the water levels were higher in 2004 than previous years, most of the water was still confined to spring heads." Degradation of habitat due to livestock grazing could potentially be another reason for the decline. Livestock grazing impacts least chub habitat by trampling shorelines, reducing vegetation, decreasing water quality, and accelerating succession of spring complexes.

Currently, most of the Gandy salt marsh area is under lease for potential oil and gas exploration. The potential drillers in this area are currently "blocking up lease parcels all around the Gandy salt marsh area" (personal communication, Mark Pierce, BLM Fillmore Office, August 2006), but there has not as of yet been any Applications for Permits to Drill (APD) in this area (personal communication, Mark Pierce, BLM Fillmore Office, August 2006).

Bishop Springs Population. T16S, R18W, Sections 6, 7, 8, 15, 16, 17, 20, 21, 22. Gandy 7.5' Quad. This spring complex is the most extensive of the occupied least chub sites in Snake Valley. Discharge rates at the four large springs containing least chub (Foote Reservoir, Central Spring, and both of the Twin Springs) are much greater than the smaller springs found at Gandy and Leland Harris. The outflow from these four springs join together in an extensive, wetted complex of marshlands, seeps, and braided channels which flow (eventually) to the West, and even can pass Gandy salt marsh.

Springs and pools within the Bishop spring complex containing least chub have water depths ranging from 0.3 m to 2.0 m, water temperatures ranging from 15.2 ^{o} to 21.0 ^{o} C, dissolved oxygen ranging from 4.83 to 8.05 mg/L, and pH ranging from 7.9 to 8.3. Organic material and clay constituted the major substrates at all Bishop Springs sites (Wheeler et al. 2004).

Least chub length frequency distributions for Bishop Springs show that most fish collected during the 2005 field season were between 36 and 53 mm in length (Wheeler and Fridell 2005). Mean length of least chub captured at Bishop Springs was 42.4 ± 3.5 mm.

Overall trends for this population complex have been variable over time. Number and percentage of springs where least chub have been captured exhibited a somewhat downward trend from 1993 to 2004 (Table 2)[2]. The variability detected in the Bishop Springs least chub population is primarily due to periodic de-watering associated with the diversion of Foote Reservoir. Since 1996, this area has annually dried and refilled, likely acting as an ongoing population sink for least chub produced in other portions of Bishop Springs (i.e. Twin Springs and Central Spring).

The Bishop Springs pond complex is fed partly by a number of individual springheads, and partly by outflows from the small Foote Reservoir, which is in turn spring-fed. The landowner who owns the water rights at Foote intends to use the water storage for local crops (personal communication, Krissy Wilson, UDWR, August 2006). Dewatering at Foote reservoir may be one of the potential threats to this population complex. In the 2004 monitoring summary report for Snake Valley, Wheeler et al. (2004) note that “for the first time since 1996, water levels at Bishop were high enough to sample fish at all sites….[p]reviously, northern and western portions of Bishop Springs dried annually due to dewatering at Foote Reservoir.” However, recently the UDWR entered into an agreement with the water rights owner (though Foote Reservoir is on state land) that he will leave a portion of the water in the reservoir each year, to ensure downstream flows into the marsh complex (personal communication Kevin Wheeler, UDWR Southern Region, August 2006, personal communication, Krissy Wilson, UDWR, August 2006). This year, due to this new protocol, the marsh/wetland complex downstream of the reservoir is more extensive than it has been in years (personal observation, ALJ, personal communication Kevin Wheeler, UDWR Southern Region, August 2006).

There are other threats to the chub at Bishop Springs to consider. In the 2004 monitoring summary report for Snake Valley, Wheeler et al. (2004) note that black spot cysts appeared on many least chub and Utah chub captured throughout Bishop Spring.” And in

[2] The 2005 numbers for Bishop should be considered in a separate light - this number reflects the new monitoring protocol that utilizes a much greater trapping effort than usual, in order to get enough data to determine meaningful analysis of least chub length/frequency distribution between years to compare age-class structure

the 2005 monitoring report, Wheeler and Fridell (2005) reported black spot cysts "on many fish of all species captured, however it was concentrated in the Twin Springs outflows and Central Springs areas." There are also non-native species in the population complex, namely large-mouth bass (*Micropterus salmoides*) and bullfrogs (*Rana catesbeiana*).

The Bishop springs population site is located within the BLM Gandy grazing allotment. Two permitees run cattle on this allotment; one of the permitees has 105 cows on the allotment from 5/16 to 02/01, the other runs 488 cows from 11/01 to 4.30. The bulk of the Bishop springs population site is not protected from livestock grazing (i.e. Central Springs and the wetland complex downstream from Foote reservoir), but part of the Twin Springs complex is protected via a fence. This fence includes about half of the least chub habitat within the exclosure; the other half is made available for wild horses to water. Wheeler et al. (2004) noted that "ungulate damage was low at all monitoring sites within the Bishop springs population site, however, at Twin Springs South, livestock have severely impacted banks, resulting in shallower water, and increased surface areas and sedimentation of the spring." In addition, grazing impacts along the marsh edges in the spring/marsh complex downstream from Foote reservoir are quite obvious (personal observation, ALJ).

Table 2. Total numbers of least chub collected in Snake Valley

Year	Leland Harris	Gandy Springs	Bishop Springs
1999	595	732	39
2000	332	583	48
2001	210	755	53
2002	243	519	54
2003	81	137	36
2004	242	120	16
2005	1355*	173	78

*this number reflects the new monitoring protocol that used a much greater trapping effort than usual, in order to get enough data to determine meaningful analysis of least chub length/frequency distribution between years to compare age-class structure

With the above threats already acting on Snake Valley, proposed groundwater pumping from the Snake Valley carbonate aquifer to support human population growth in Southern Nevada may be particularly insidious. The proposed withdrawals could impact ground water levels, and thus spring discharge and pond levels, in the Snake Valley (Kirby and Hurlow 2005). More discussion on this ground water pumping project can be found below, in section IV.

C. REFUGE POPULATIONS

The goals behind refuge establishment include eventual establishment of two separate refuge populations for each wild population to ensure genetic redundancy in case of catastrophic loss of any wild population. In 2004 the Least Chub Conservation team determined that a minimum of 200 least chub individuals should be used to establish range expansion populations.

1. Antelope Island

After a failed attempt to establish a refuge site for the Mona population in 2000 in Antelope Island South Pond, UDWR tried again to establish Mona fish on Antelope Island, in the Garden Creek Pond located at the base of the island's mountains north of the old ranch on the east side of the island (UTMs 0401400E, 4533200N). The objectives of this transfer were to establish a genetic refuge for the Mona spring complex population, and develop a brood stock for re-introductions into suitable habitats in the Wasatch Front GMU. Despite the location of Antelope Island in the West Desert GMU, this site was considered acceptable for a Wasatch Front GMU brood stock due to its relative proximity to the Mona spring complex population and other historic Wasatch Front habitats.

Garden Creek is the only stream on Antelope Island with a perennial flow. The man-made pond along this creek is 0.1 acres with a maximum depth of six feet. In 2004, about 950 least chub (progeny of the Mona Springs population, raised at the Wahweap State Fish Hatchery) were released in Garden Creek Pond. Monitoring was first completed in September 2005, using the new UDWR monitoring protocol (Wilson et al., in review, see description below for Lucin monitoring). Capture rate was ten least chub/trap hour and multiple age classes were observed, indicating successful reproduction and recruitment during 2004-2005 at Garden Creek Pond. 2006 monitoring also reflected evidence of recruitment and good representation of adults and Young of the Year (roughly 20% of individuals caught were less than 35 mm, reflecting YOY, personal communication with Paul Thompson, UDWR Northern Region, January 2007).

2. Lucin Pond

Lucin Pond is a man-made pond near the old railroad grade in Lucin, Box Elder County (UTMs 0257300E 4580900N). The pond was originally built to provide water to cool locomotive steam engines. Old (30-40 ft. high) cottonwoods at the site provide shade in the summer. The water source for the pond is numerous springs on the Pilot Range mountains; the water arrives to Lucin pond via a pipe. Thompson (2005) notes the various problems that have occurred with the pond's water level over the past several years, including multiple breaks in the water line on Pilot Mountain, problems with outflow pipes on the pond, problematic livestock troughs in the area, etc.

Least Chub were transplanted from the Gandy and Leland Harris Population in Snake Valley into Lucin Pond in 1989. A few years later, it was assumed that the transplant "did not take." Then in 1998, a total of 98 least chub were caught in this pond, indicating that a new population had been successfully established after all (Thompson 1999).

Lucin Pond has been monitored since 1998. Between 1998 and 2003, however, least chub were monitored with wire minnow traps (before the switch to mesh traps in 2004) and the timing of monitoring, number of trappings/year and the effort also varied. Catch-per-unit-effort varied from 1.7 – 33.0/trap hour during this period. In 2004 the Least Chub Conservation Team began reviewing and revising the monitoring protocol for least chub. The main recommendations were to compare least chub length/frequency distribution between years to compare age-class structure. In 2004, 257 least chub were captured at the Lucin site to obtain length/frequency distributions. Wilson et al. (in review) determined that lengths from 100 least chub would adequately describe populations, so the 2005 monitoring effort captured 102 least chub. The majority of the Lucin population is adult fish between 40-55 mm. Total Length (TL). Although the mean TL of the least chub population at Lucin only increased by 1.2 mm between 2004 and 2005, this was a significant increase (Thompson 2005). 2006 monitoring found "pretty good recruitment, all things considered" (personal communication with Paul Thompson, UDWR Northern Region, January 2007) with YOY comprising about 20% of individuals caught.

Mosquitofish were first observed at Lucin Pond in 2003, after they were illegally introduced to the pond two or three years prior. The UDWR concluded in its 2005 monitoring report (Thompson 2005) that "mosquitofish are likely limiting recruitment within this population." Although least chub TL was not measured between 1998 and 2003, few < 35mm (YOY) fish were captured during this time. This may be because wire minnow traps are not as effective at capturing smaller least chub. A recent study conducted by researchers from Brigham Young University, however, did not capture many small least chub with mesh minnow traps in the same location (Thompson 2005, citing personal communication with Mark Belk, PI of study). This led Thompson to conclude that the lack of smaller chub in Lucin (as witnessed by the significant increase of average size of least chub between 2004 and 2005) pointed to mosquitofish likely limiting recruitment at Lucin, and that "this least chub population may not be able to persist." Thompson also noted that catch rates have appeared to decline since the introduction of mosquitofish at Lucin in 2000 or 2001, with least chub catch-per-unit-effort the lowest in 2005 since monitoring began in 1998. Visual assessment of the shallow areas of Lucin Pond indicate that the mosquitofish population is increasing yearly, and least chub are no longer present in any shallow habitat (Thompson 2005). This report also concludes that "both length/frequency [measurements] and catch-per-unit-effort indicate that mosquitofish are having a negative impact on the Lucin least chub population and mosquitofish control effort may be necessary to maintain this population."

The temperature at Lucin is cooler than other natural habitats still containing wild populations of least chub (Mills et al. 2004a). Lucin has a mean annual temperature of 8^o or 9^o C. It is likely that this cooler temperature is due to the pipe that feeds Lucin Pond freezing in the winter (Mills et al. 2004a). This factor might help least chub persist in Lucin Pond, even in the presence of mosquitofish, because least chub tend to do better in cooler habitats (Mills et al. 2004b). Mosquitofish thrive in warm water because they evolved in subtropical environments of the southeastern U.S (Courtenay and Meffe 1989), whereas least chub historically occupied a variety of habitats including those with both warm and cool temperatures (Sigler and Miller 1996).

3. Red Knolls
This pond is a fenced, human-augmented pond on BLM land in extreme northwest Utah, Boxelder County (UTMs 0262800E, 4616900N). The pond was treated in 2003 with rotenone to remove goldfish. In 2005, 250 chub were transplanted from Bishop Springs to this refuge site. The 2006 monitoring indicated that least chub are now doing well at Red Knolls, with 90% of individuals caught ranging between 26 and 35 mm in length (personal communication with Paul Thompson, UDWR Northern Region, January 2007).

4. Atherle Reservoir
Also known as the Walt Fitzgerald Management Area, this UDWR property is south of the Tooele Army Depot just west of the small town of Faust. The Reservoir captures water on Faust Creek. Although the UDWR originally intended for this area to be managed for upland game, it is no longer considered to be suitable upland game habitat. In 2006 the UDWR targeted the area for a least chub introduction, and created a refuge site for the Mills Valley population.

The management unit is considered to be good chub habitat. There is a series of artificial ponds covering over 700 acres. The area is currently free of mosquitofish. The Central Regional Office of UDWR transplanted 19,000 Wahweap hatchery-reared fish from the Mills Valley line in October 2006 (personal communication, Mike MIlls, UDWR, January 2007). This site will be monitored in 2007.

Fish hatcheries

Wahweap Hatchery. In 2002, the first group of (100 disease-free) least chub from the Mona population site was transplanted to the Wahweap State Fish Hatchery in Big Water, Utah. The first transplant of (618) least chub from the Mills Valley population site to the Fish Hatchery occurred in 2004. These breeding stocks have been kept in three separate ponds at the facility (two ponds contain Mills Valley stock and one contains Mona stock). Through subsequent transplants of fish from both the Mona and Mills Valley populations, and breeding at the facility, there are currently about 100,000 least chub of the Mona stock and 25,000-30,000 individuals of the Mills Valley stock at the facility (personal communication, Quentin Bradwisch, September 2006).

Fisheries Experiment Station. In 2002, the first group of (80) least chub from the Mona population site was brought to the State's Fisheries Experiment Station (FES) in Logan, Utah. The first transplant of (81) least chub from the Mills Valley population site to the Fish Hatchery occurred in 2004. These breeding stocks have been kept in separate facilities. The breeding and holding situation at FES is a little different than that of Wahweap; at FES the fish are kept in hatchery raceways instead of ponds or pools. Therefore, it is impossible for FES to maintain the kind of numbers or densities of least chub that occur at Wahweap. Through subsequent transplants of fish from both the Mona and Mills Valley populations, and breeding at the facility, there are currently about 2,000 least chub of the Mona stock and 1,000 individuals of the Mills Valley stock at the facility (personal communication, Eric Wagner, FES, September 2006).

Failed refuge sites

Harley Saunders Pond. This is a privately owned pond in northwestern Box Elder County. In 1987, 95 least chub from Gandy Salt Marsh were introduced into Harley Saunders Pond. Three fish surveys since then have only produced speckled dace. The UDWR proclaimed the 1987 transplant unsuccessful (Thompson 2004).

Walter Springs. Walter Springs is one of many natural springs in Fish Springs National Wildlife Refuge (FSWR). The Refuge is located between the Dugway Range and the Fish Springs Range, just south of the Dugway Proving Ground and the Tooele County line in Juab County. The FSWR is a large spring complex, consisting of 15-20 springheads and associated marshes connected by surface and groundwater flows spread over approximately 40 km^2. Dikes and other man-made structures have created the majority of pools on the refuge. Walter Spring feeds an average-sized pool for the Refuge, with a surface area of 320 m^2 and maximum depth of 3.0 m.

In 1996, after mosquitofish were removed from Walter Spring (via draining and rotenone), UDWR transplanted least chub from the Leland Harris population site to Walter Spring. From 1997 to 2001, monitoring efforts confirmed that the populations were persisting in Walter Spring (Wilson 1999, Wilson and Whiting 2002). However, surveys in 2002 confirmed that the least chub population was nearly extirpated, most likely due to the re-invasion of mosquitofish into the pond when the dike on the east side of the spring eroded in the late 1990's, allowing the spring to be re-invaded by mosquitofish (Wilson and Mills 2004). Mosquitofish accounted for 100% of the fish caught in this refuge site in 2002 and 98% of the fish caught in this refuge site in 2004 (Wilson and Whiting 2002, Wilson and Mills 2004). During that time (2002 and 2003 surveys), a total of seven least chub smaller than 30 mm were found at the site (Mills et al. 2004b). Least chub are now considered to be extirpated at this site. There are currently efforts to make use of alternative water bodies at the Fish Springs National Wildlife Refuge as an additional genetic refuge for least chub.

Deadman Springs. In 1995 UDWR reintroduced least chub to Deadman Spring in Fish Springs National Wildlife Refuge. In 1998 and 1999, monitoring efforts confirmed that the populations were persisting in Walter Spring (Wilson and Whiting 2002). Surveys in 2000 - 2002 confirmed that the least chub population was extirpated, most likely due to the re-invasion of mosquitofish, which accounted for 98% of the fish caught in this refuge site in 2002 and 100% of the fish caught in this refuge site in 2004 (Wilson and Whiting 2002, Wilson and Mills 2004). Least chub are now considered to be extirpated at this site. There are currently efforts to make use of alternative water bodies at the Fish Springs National Wildlife Refuge as an additional genetic refuge for least chub.

Antelope Island South Pond. In 2000 The UDWR transferred least chub from the Mona spring complex to a large pond on Antelope Island. This is a man-made, spring fed pond in the southeastern portion of Antelope Island State Park. Sixty-nine least chub trapped during a nonnative removal project at the Mona population site were transferred to Antelope Island in December 2000. In September of 2001, 9 wire minnow traps (18 trap hours) resulted in the capture of no fish at the Antelope Island refuge site. However, four cloth minnow traps (2 trap hours) resulted in the capture of 68 mosquitofish. Thousands of mosquitofish were observed while sampling. A salvage effort was initiated in the Antelope Island pond in October of 2002. Thirty-six least chub (0.028/trap hour) were collected and transported to FES. Approximately, 3,000-5,000 mosquitofish were removed. During the summer of 2003, the Least Chub Technical Team agreed that the Antelope Island South pond should be treated with rotenone, which was done the following fall. Sampling in March of 2004 indicated that all fish in the pond likely were winter-killed.

D. GENETIC RELATIONSHIPS BETWEEN POPULATIONS

In 1998, Utah State University initiated a population genetics study to determine the genetic relationship of all wild least chub populations at the time. This included all wild population covered in this status review except Clear Lake (which hadn't been discovered at the time of initiating the study), Lucin Pond refuge, and Walter Springs refuge (which was still extant at the time of this study). Karen Mock was the Principle Investigator for this analysis.

The results of this genetic analysis (Mock and Miller 2003), which included amplified fragment length polymorphism (AFLP) analysis and mitochondrial DNA sequencing, suggested pronounced but temporally shallow genetic structuring among the Mills Valley, Mona, and three Snake Valley populations, following patterns of recent and historical hydrogeographic isolation (see Figure 1, pg 4). Interestingly, although these three population sites are roughly the same latitude, they lie in distinct sub-basins. The most genetically divergent population is Mona Springs located in the extreme southeastern reach of the Great Salt Lake sub-basin, followed by the Mills Valley population in the Sevier sub-basin (Figure 1). The three Snake Valley populations (Leland Harris, Bishop Springs and Gandy Springs) were genetically similar (consistent with their spatial proximity to one another) and in yet a different sub-basin. Each sub-basin represents a different arm of ancient Lake Bonneville, and each has a unique prehistory of isolation as the ancient lake receded (Figure 1).

The following excerpts are taken from Mock and Miller 2003:

Mitochondrial sequencing analysis revealed 14 distinct mitotypes in Least Chub across all populations, most differing by only one or two silent nucleotide changes. The mitotypes present in the Mona Springs population were not shared by any of the other populations, and appeared to be a monophyletic group. However, the differences between the Mona Springs mitotypes and the other mitotypes seen in Least Chub were very small. With the exception of Mona Springs, there seemed to be little or no mitochondrial structuring among the populations. There was a single common mitotype, found in all populations except Mona Springs, from which all the other mitotypes appear to have been derived.

All of the populations except Lucin Pond contained at least two mitotypes. This suggests that the Lucin Pond population may have lower overall genetic diversity (possibly due to a bottleneck created when the population was established). However, each population was represented by sequences from only 4 or 5 individuals, so additional mitochondrial diversity may have easily been missed.

Amplified Fragment Length Polymorphism (AFLP) analysis yielded 70 polymorphic loci, which were scored and used in subsequent analyses. There was significant structuring among populations (θ = 0.45, 95% c.i. 0.38 . 0.51...The two measures of nuclear genetic diversity used in this study, percent polymorphic loci and heterozygosity, gave somewhat inconsistent patterns among populations. However, none of the populations were particularly homogeneous, including the populations established by translocation. Overall, the Bishop Springs and Gandy Salt Marsh populations appeared to be the most diverse, and the Mills Valley population was the least diverse by both measures.

Principle coordinates analysis of the Lucin Pond population and the naturally occurring Snake Valley populations and the [unweighted pair group method with arithmetic averages (UPGMA)] dendrogram of populations indicate that the Lucin Pond refugium population seems to be more closely allied with the Gandy Springs and Bishop Springs populations than the Leland Harris Springs population. However, weak clustering of all of these populations was evident, suggesting a mixed source for the Lucin Pond population.

The Mona Springs and Mills Valley Spring populations of Least Chub were divergent from each other and from the Snake Valley populations with respect to AFLP allele frequencies. The Mona Springs population was also divergent from all other populations with respect to mitochondrial cytochrome b sequences, with sequence differences varying from 1-4 base pairs. The most common mitotype in the species was shared by all populations except Mona Springs. Overall, these data suggest that most of the extant Least Chub populations have either diverged recently (likely post-Pleistocene) from each other, since there are no deeply divergent mitotypes present and little phylogeographic structure with respect to mitochondrial sequences. These findings are consistent with their presence in a large panmictic population (Lake Bonneville and associated marshes) followed by isolation as the lake receded, beginning approximately 14,000 years ago. Based on the general geography of the recession of Lake Bonneville, the Mona Springs population likely became isolated from the Mills Valley Springs and Snake Valley populations prior to the hydrologic separation of Mills Valley Springs from the Snake Valley (Currey et al. 1984), a sequence supported by the topology of the UPGMA dendrogram and the mitotype network.

In 2003, the Clear Lake population was discovered, and Dr. Mock was again commissioned to determine how the genetics of this new population compared to what was known for the other five wild, extant populations. Mock (and Bjerregaard, 2006) used six individuals from the Clear Lake population to obtain three sequences from the cytochrom b gene and these were added to the original dataset on the other known least chub populations (Mock and Miller 2003). Then, Amplified fragment length polymorphism (AFLP) analysis was performed on all Clear Lake least chub samples and thre results scored along with those from the other populations (Mock and Miller 2003), using 41 of the original DNA samples from the original analysis, in order to assure reproducibility. Divergence among the six wild populations was assessed using an unweighted pair group method with arithmetic averages (UPGMA)] dendrogram.

The results of the Clear Lake genetic analysis revealed that the level of genetic diversity in the Clear Lake population is similar to other populations of least chub, although diversity indices were slightly lower for Clear Lake than those for the three Snake Valley populations, and slightly higher than those for either the Mona Springs or Mills Valley populations. The Clear Lake population was also found to be significantly differentiated from the Mills Valley population in terms of AFLP allele frequencies, suggesting that gene flow between these populations is restricted. Of the six individuals from the Clear Lake population used in the analysis, five were found to have the common ancestral mitotype found in all other least chub populations, and one had a mitotype not previously observed. This new mitotype differed from the common mitotype by a single mutation, and fit with the phylogeny described by Mock and Miller (2003) for the species (a common, widespread haplotype with multiple minor local variants). Such phylogenies are thought to be a signature of a demographic expansion following a bottleneck, possibly reflecting late Pleistocene fluctuations in Lake Bonneville levels (Currey et al. 1984, Jarrett and Malde 1987, Currey 1990).

UPGMA dendrogram linking Clear Lake to the other least cub populations (Figure 5) led to estimates of population-level structuring in the species decreasing slightly, with the Mills Valley population and Clear Lake populations clearly linked. This is consistent with their location in the Sevier sub-basin. The remainder of the dendrogram topology was unchanged from Mock and Miller (2003), and is consistent with the degree of geographic isolation among the naturally-occurring populations. The Snake Valley populations are closely associated with one another other, while the Mills Valley and Mona Springs populations were distinct from each other and from the Snake Valley populations. The Mona population continues to be an exception to the species-wide pattern, suggesting that it may have a distinct evolutionary history (Figure 5).

Based on the results of these genetic analyses of all known extant least chub populations (Mock and Miller 2003, Mock and Bjerregaard, 2006), the USFWS currently considers the West Desert populations (Gandy, Leland Harris and Bishop Springs) to be a separate, distinct population segment (DPS) from the Wasatch Front and Sevier populations (Mona, Mills Valley and Clear Lake).

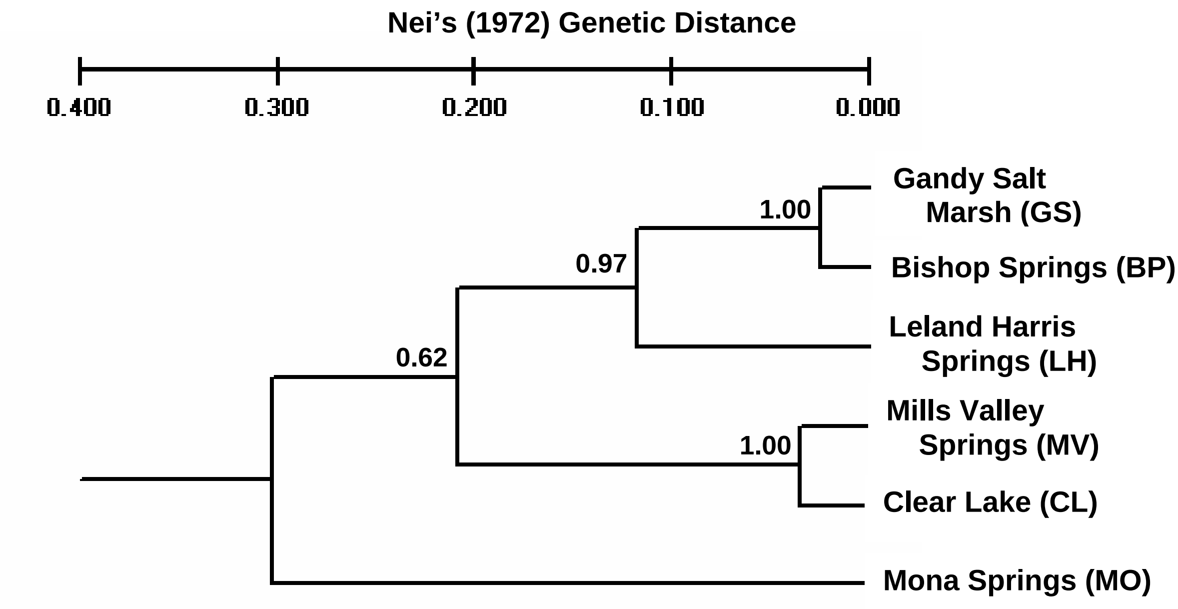

Figure 5. UPGMA dendrogram of extant Least Chub populations based on data from 70 polymorphic AFLP loci. Bootstrap proportions (1000 replicates) are shown at nodes. Figure from Mock and Bjerregaard, 2006.

E. OCCURRENCE SUMMARY/POPULATION STATUS

There are six known, wild, extant populations of least chub. The few wild populations we know of are not for a lack of looking. In recent years UDWR has conducted surveys in areas where least chub were known to occur or may have historically occurred (also see Bailey 2006 for list of all sites surveyed). Surveys in the Wasatch GMU have been carried out at 13 separate sites in the Lower Weber River and Jordan River subunits. Surveys in the West Desert GMU have been conducted at 45 separate sites in the West Great Salt Lake and North great Salt Lake subunits. Surveys in the Sevier River GMU were carried out at 64 separate sites (including 14 stations on the Sevier River) in the Lower, Middle, and Upper Sevier subunits and the San Pitch subunit. No least chub were found to occupy these sites (Thompson 1999, Thompson 2004, Thompson 2005, Bailey 2006). In many instances, the presence of *Gambusia sp*. was the likely reason for local extirpations at those sites where least chub were known to have once occurred, in addition to water impoundments and urban development.

There are currently four, extant refuge populations of least chub. Three of these refuge sites (all but Lucin Pond) have been established since 2004. There have been a number of attempts to create new refuge sites that have failed because transplanted fish did not persist in those locations. All refuge sites are human-created ponds or natural springs that have been augmented to improve habitat conditions for least chub. Most of the current wild populations are also modified by humans to some degree, if only through placements of drop structures to control outflow (such as in Clear Lake, Leland Harris, Gandy and Mills Valley), or are subject to some seasonal water impoundment that backs water up over the spring/marsh complex (such as with the Mona population).

Currently, the UDWR has only rough estimations of population numbers at the occurrence sites. Division biologists typically use the presence of reproduction as an indication of a viable population. Body length measurements are taken from sampled least chub during monitoring efforts. These measurements are broken into size classes whereupon biologists determine the extent of recruitment occurring in any given population (Bailey 2006).

In summary, there are currently six known wild, surviving populations of least chub, with four (very recently established) refuge population sites. As discussed further below, none of these remaining wild populations (save perhaps the Clear Lake Population) are free from threats.

IV. PRESENT OR THREATENED DESTRUCTION, MODIFICATION OR CURTAILMENT OF HABITAT OR RANGE

Habitat loss and degradation have been indicated as major causes of the declines in least chub populations and distribution (Holden *et al.*1974; Hickman 1989; Crist 1990). Loss and degradation of chub habitat, across its range, have thus far mostly been attributed to livestock grazing and water withdrawal and diversion, with oil and gas exploration and urban development implicated to a lesser extent (Bailey et al. 2005, Bailey 2006).

A. LIVESTOCK GRAZING

Bailey (2006) reports on a recent study that is now in prep, titled "Determining potential restoration, enhancement, translocation, and range expansion sites for spotted frog (*Rana luteiventris*) and least chub." This study reported that "nearly 100% of least chub sites have been impacted by livestock in recent (<10) years" (Bailey 2006). Numerous other reports and studies link livestock trampling and grazing with fish habitat degradation (water quality, vegetation type, habitat morphology, etc.) in springs (see references below). The majority of occupied and unoccupied chub habitats are currently not protected against grazing practices, and those that are have only recently been fenced.

Livestock grazing has both direct and indirect effects on least chub habitat. Livestock can directly affect chub habitat through removal of wetland and riparian vegetation (Schulz and Leininger 1990, Armour et al. 1991, Fleishner 1994). Loss of wetland and riparian vegetation caused by grazing in turn raises water temperatures (Storch 1979) and reduces bank stability (Duff 1979, Hubert et al. 1985). Direct and indirect effects on least chub habitat also occur through increased sediment in the water column due to a variety of livestock actions, including bank trampling and vegetation loss (Pearce et al. 1998). Livestock physically alter banks through trampling and shearing, leading to bank erosion (Armour et al. 1991, Trimble and Mendel 1995).

Livestock also indirectly impact native fish, including least chub, by altering the composition and community structure of the aquatic fauna. The aquatic invertebrate community may change because of sediment deposition or nutrient impoverishment or enrichment (Li et al. 1994, Tait et al. 1994, Jones et al. 1997). This change in the food base may contribute to a change in the fish community (Covich 1999). Livestock grazing has also contributed significantly to the introduction and spread of nonnative aquatic species through the proliferation of ponded water in stock tanks (Simms 1997, Sponholtz et al. 1997).

Currently, the livestock grazing impacts evident at the Mills Valley population site are considered to be some of the worst grazing impacts to existing wild chub habitat. In return for access across private lands to get to the Mills Valley population site, UDWR allows grazing in the population site which has led to rather severe impacts in some places. Especially along the east side of the population site, cattle have affected least chub habitat by degrading water quality and reducing vegetation. The 2002 Monitoring Summary for the Central Region reports that ungulate damage at sites containing least chub in Mills Valley was “moderate to severe.”

The other least chub population sites have had variously documented cases of livestock impacts. For example, there are reported and obvious impacts of livestock grazing on the 19 acre portion of the Mona population site that was just (2006) purchased by the UDWR (though this situation should now improve that UDWR has purchased this final parcel). At the Leland Harris population site, UDWR reports moderate ungulate damage at some of the ponds. At Twin Springs South of the Bishop population site, UDWR reports that livestock have severely impacted the banks of the spring. Additionally, there are various impacts of cattle around the edges of all least chub habitat downstream of Central Spring and Foote Reservoir at the Bishop Springs site.

B. MINING, INCLUDING OIL AND GAS LEASING AND EXPLORATION

Mining can negatively impact least chub populations by polluting streams or reducing stream flows through water used for mining operations. Peat mining may be a future threat to the Mills Valley population. Most of Mills Valley is privately owned. The landowner illegally mined peat in the late 1990’s, and was afterwards asked to do restitution, including removal of a road that was built. In 2002 the landowner requested a permit to legally carry forth with peat mining in the same wetlands (this time to remove all the wetlands). In late 2004 the land was appraised to ascertain whether mining peat would be economically viable or profitable. The appraisal concluded there was peat in the Valley, but likely not enough to be worth mining. With that knowledge, UDWR offered the landowner $280,000 for the property. The landowner believes the property is worth more, and filed for and received a permit to commence with peat mining (personal communication, Mike Mills, UDWR, September 2006). As of the time of this writing, no peat mining had occurred in Mills Valley.

Oil and gas leasing and exploration has also occurred, and is ongoing in areas occupied by least chub. In BLM’s February, 2006 lease sale multiple parcels were sold north and west of Miller Spring, part of the Leland Harris population site. Currently, most of the Gandy salt marsh area is under lease. The lease holders in this area are currently "blocking up lease parcels all around the Gandy salt marsh area" (personal communication, Mark Pierce, BLM Fillmore Office, August 2006), but there has not as of yet been any Applications for Permits to Drill (APD) in this area. Even if APDs are filed, there are already directional drilling stipulations attached to these leases, with the intent to minimize any impacts to Gandy salt marsh (personal communication, Mark Pierce, BLM Fillmore Office, August 2006).

There has also been leasing on BLM sections in Mills Valley, and multiple seismic lines have been tested in Mills Valley, to ascertain oil and gas deposits underneath the valley. The lease holders have promised to avoid spring and marsh habitat within those seismic lines (personal communication, Mark Pierce, BLM Fillmore Office, August 2006). The Fillmore office of the BLM would "not be surprised" to see Applications for Permits to Drill (APDs) fairly soon in Mills Valley (personal communication, Mark Pierce, BLM Fillmore Office, August 2006).

Oil or gas exploration and/or development in least chub habitat could result in various impacts to springs, marshes, riparian and other associated vegetation. Seismic (shot hole) exploration requires the use of vehicles such as drilling rigs and recording trucks (Evans 1997), which can crush vegetation and compact soils. Routes used for seismic exploration often turn into established roads (Belnap 2002, Conway 2002). Surface activities associated with drilling, including increased drilling site preparation under water hauling, could impact water quality. Drilling activities may also release drilling fluids into the aquifer or may fracture underground geologic features that are associated with spring discharge (60 Fed Register 50520).

C. URBAN DEVELOPMENT

Urban and suburban development affects least chub habitat in a number of ways. There is the direct alteration of streambanks, floodplains and wetland habitat by construction of buildings, gardens, pastures, roads, etc. Also very direct is the diversion of increased amounts of water for additional human development, both from surface flows and connected groundwater (Folk-Williams 1991, Glennon 1995). On a broader scale, urban and suburban development alters the watershed with consequent changes in the hydrology, sediment regimes, and pollution input (Dunne and Leopold 1978, Reid 1993, Waters 1995). Human occupation near streams and springs also increases the potential for introduction of nonnative plants and animals (including pets) that can adversely affect aquatic species such as the least chub (USFWS 2001). On that note, as suburban population growth starts to encroach on natural spring and wetland habitat, there are increased chances of children playing in sensitive spring and marsh habitat, doing everything from muddying waters to releasing goldfish to bucketing fish over drop structures and diversion dams.

The population of least chub most at risk from increased urban/suburban development is the Mona population. The Mona area is currently experiencing comparatively rapid growth, and there is an expanding suburban development about 1¼ miles away from the ponds that house least chub at the Mona site. UDWR hopes to "hold the line" of suburban development at the railroad tracks (3/4 of a mile from the current residences and 1/2 mile from the Mona population site). There seems to be little doubt that suburban growth will eventually extend right up to the tracks (personal communication, Mike Mills, UDWR Central Region, September 2006). However, to "hold the line" here will require that the current landowner between the railroad tracks and the Mona population site does not sell to developers. He has recently indicated that he does not intend to sell (personal communication, Mike Mills, UDWR Central Region, September 2006). Also, throughout the Utah Lake hydrological subunit (which contains the Mona Population), residential development and agricultural and municipal water development projects have impacted least chub by converting habitats into residential areas and altering natural flows.

D. WATER WITHDRAWAL AND DIVERSION

Predictable water levels have been identified as important in the life history of least chub (Lamarra 1982; Crist and Holden 1980). Maintenance of certain water levels is particularly key because levels must be high enough to allow the fish to migrate between springs and surrounding marshes as environmental conditions change. Not only can reduced water supply diminish the amount of least chub habitat, and thus the capacity of an area to support least chub, but lowered water levels may also cause niche overlap with other species. These overlaps may increase hybrid introgression and interspecific competition (Crawford 1979, Lamarra 1981, Mills 2004). Lastly, maintenance of water levels and discharge volumes is critical in preserving natural sediment transport processes, thereby maintaining underwater habitat configurations and reducing aquatic vegetation encroachment into sensitive spring areas.

Water levels in pools containing least chub that are spring fed (basically all the habitat currently occupied by wild least chub populations) are in turn dependent on stable, functioning aquifers that enable water tables near to surface to allow for consistent rates of spring discharge. Water development, especially ground water pumping, could significantly lower the water table, possibly drying up or lowering the water level in springs and marshes populated by least chub.

Dewatering at Foote reservoir is one of the threats to the Bishop Springs population complex. In the 2004 monitoring summary report for Snake Valley, Wheeler et al. (2004) note that "for the first time since 1996, water levels at Bishop were high enough to sample fish at all sites….[p]reviously, northern and western portions of Bishop Springs dried annually due to dewatering at Foote Reservoir."

Several water development activities (e.g. irrigation practices) have also altered the habitat of least chub along the Wasatch Front. Most springs along the Wasatch Front have been significantly altered as a result of diversion, capping, and pumping activities. Inundation by reservoirs in this area has also negatively impacted least chub habitat. Continued human population growth in the Wasatch Front GMU will likely increase pressure for water development and diversions. This could be a significant future impact to the Mona population. Altered flow regimes caused by dams and diversions have already been blamed for declines in native fishes elsewhere in the desert Southwest (CBD 2003).

Currently, the level of ground water pumping in Snake Valley is pretty low, with a handful of farmers and ranchers pumping from local wells in order to water livestock and grow limited crops such as hay. However, the State Institutional Trust Administration (SITLA) is looking into drilling additional groundwater wells on many of their state parcels to increase their value to prospective buyers (personal communication, Mark Pierce, Fillmore BLM office, September 2006).

Snake Valley and the Southern Nevada Water Authority.
The most significant threat to the Snake Valley least chub populations is future water withdrawals from the Snake Valley aquifer that are currently proposed to support human population growth in Southern Nevada. The agency charged with supplying water to Las Vegas, the Southern Nevada Water Authority (SNWA), has proposed drilling nine ground water pumping stations just inside Nevada from the Utah/Nevada border in Snake Valley, and withdrawing up to 25,000 to 30,000 acre feet a year of ground water (Schaefer and Harrill, 1995, BLM 2006). The nine wells will likely be placed precisely at the point where water from creeks coming off of the Snake Range become subterranean and enter Utah's portion of Snake Valley (McDonough 2006). If all permits are granted, SNWA hopes to ensue with pumping in 2015. Even though SNWA's formal proposal calls for pumping about 25,000 acre-feet of water per year from Snake Valley, SNWA actually has applications on file with the Nevada State Engineer for pumping up to 50,665 acre feet per year from the valley. SNWA has identified nine "points of diversion" in Snake Valley consisting of preliminary estimates of between 15 to 25 groundwater production wells (GWD Final Scoping Package).

As is typical of most Great Basin valleys, the groundwater beneath Snake Valley is contained within two separate aquifers, one sitting on top of the other (Van Liew 2006). The upper aquifer, called an unconfined aquifer, resides in the alluvial material formed from the erosion of the surrounding mountain ranges, and is typically referred to as the local water table. The lower aquifer is part of a larger hydrologic area known as the Great Salt Lake Basin, which consists of a regional confined (artesian) aquifer whose water is contained within the fractured carbonate rock that resulted from the formation of the Basin and Range province. SNWA proposes to access this deeper, confined aquifer.

A few hydrogeologic studies of the Snake Valley aquifer have already been conducted and shed light on the kinds of impacts the SNWA pumping project in Snake Valley might have on the three wild least chub population complexes found there. The most widely cited analysis was conducted by Kirby and Hurlow (2005), which in turn relies heavily on the research and predictions contained in the previous study conducted by the USGS (Schaeffer and Harrill 1995). Kirby and Hurlow (2005) should be referred to for more information on the geologic setting of Snake Valley and the geologic and hydrologic specifics of the deep carbonate aquifer and the shallower, alluvial fill aquifer that underlie Snake Valley. Total annual recharge of the Snake Valley hydrologic basin is estimated to be around 100,000 acre-feet a year (Hood and Rush 1965, Carlton, 1985, Utah

Department of Natural Resources 2006). Principle sources of recharge are snowmelt from the Snake Range to the West, and infiltration of precipitation and surface runoff throughout the topographically lower parts of Snake Valley (Hood and Rush, 1965, Carlton, 1985).

Kirby and Hurlow (2005) predict significant impacts to the Snake Valley aquifer due to the proposed groundwater pumping. The following is an excerpt from this study:

> *Withdrawal from the nine wells in western Snake Valley and from other wells in the proposed SNWA well system, especially those in Spring Valley, will significantly affect the dynamics and overall budget of the Snake Valley ground-water system (Schaeffer and Harrill, 1995). The effects cannot be precisely predicted with available data, but the following changes are likely to occur:*
>
> *(1) Ground-water levels will decline in both the basin-fill and carbonate aquifers.*
>
> *(2) Recharge to the Snake Valley ground-water system will decrease by the 25,000 acre-feet per year (31 hm^3/yr) withdrawn from the SNWA wells and by 4,000 acre-feet per year (5 hm^3/yr) that presently enters the Snake Valley ground-water system as underflow from Spring Valley to the west (Carlton, 1985). The underflow will likely be eliminated due to reversal of current potentiometric surface gradients.*
>
> *(3) Discharge at major springs will decrease by at least 10 percent, as indicated by the example of Twin Springs in northeastern Snake Valley (Schaffer and Harrill, 1995). Discharge at other springs closer to the well field, such as the Big Spring complex in western Snake Valley, will likely decrease by a greater amount.* [later in report Kirby and Hurlow cite Schaefer and Harrill, 1995 who predicted reduction or cessation of spring flow in Snake Valley due to proposed pumping].
>
> *(4) Evapotranspiration in Snake Valley will decrease by about 40 percent (Schaeffer and Harrill, 1995, p. 34). Although decreased evapotranspiration may result in more ground water available for withdrawal, the ecological impact of this decrease would be substantial and water rights at the affected springs could be adversely impacted.*
>
> *(5) Subsurface outflow from Snake Valley, estimated at about 25,000 to 35,000 acre feet per year (31 - 43 hm^3/yr) (Carlton, 1985), would be reduced due to reversal of potentiometric-surface gradients in Snake Valley. This reduction in subsurface outflow may eventually cause decreased discharge at important regional springs north and northeast of Snake Valley.*
>
> *Time-step models of the effect of the proposed ground-water withdrawals on ground-water levels show downward deflection of the local potentiometric surface within Snake Valley (Schaefer and Harrill, 1995) (figure 12). The magnitude of the modeled drawdown cone is greater than 100 feet (31 m) for*

parts of western Millard County near Garrison. Local ground-water level drawdown, near Baker, Nevada reaches 100 feet (31 m) just after the 10-year time step (figure 12). Sequential time steps show a broadening cone of drawdown, which extends up to 30 miles (42 km) east into Utah (Schaefer and Harrill, 1995) (figure 12). Discharge at important springs in Wah Wah Valley and Tule Valley may also decrease. The ground-water model of Schaefer and Harrill (1995) assumes a simplified regional aquifer system consisting of upper and lower layers, which correspond to the unconsolidated basin-fill and carbonate aquifers, respectively.

By far the most important "take home message" from Kirby and Hurlow's study is that, once ground water pumping commences at wells at the base of the Snake Range, spring discharge at springheads throughout Snake Valley can expect to decrease by an amount and at a rate that is as of now impossible to predict. SNWA itself has already acknowledged that its Snake Valley pumping will affect springs and spring-dependent species, as well as groundwater dependent plant communities and riparian areas (GWD Final Scoping Package). As all least chub populations in Snake Valley currently rely on constant, predictable spring discharge (even if very small amounts), one is only left to predict that the consequences of future ground water pumping could be, at the least significant, and at the worst catastrophic, for this species in Snake Valley. The argument that the aquifer is a renewable resource is also in dispute: subsequent conversations with Kirby reveal that the water proposed to be pumped from these deep wells may have been put down in the aquifer in prehistoric times, and its possible the area's complex geologic structure, if shifting has occurred at all, could now carry mountain runoff laterally miles away before entering any aquifer (McDonough 2006).

One another point to note is that, even if SNWA is not granted the rights to pump Snake Valley's aquifer, it still may be granted the rights in adjacent Spring Valley. Hydrological studies have noted that reductions in the water table in the Spring Valley aquifer could also decrease the present flow of some water (estimated at about 4,000-5,000 acre feet a year) through the alluvial aquifer that connects to, and deliver additional ground water to, Snake Valley (Harrill et al. 1988)

The USFWS 1995 proposal to list the least chub as endangered cited the existing and foreseeable surface and ground water pumping conditions in Snake Valley at the time as already being a threat to least chub persistence: "[p]resent water withdrawals from surface and underground sources are estimated at 10% of the total yearly recharge rate… (t)hese rates do not appear to be threatening to least chub habitat. However, additional proposed wells in the southern part of Snake Valley and surrounding areas could lower the water table, resulting in drying up or lowering the water level in springs and marshes populated by least chub."

Of significance, in 1995 the amount of water withdrawals occurring at that time in Snake Valley were considered a problem for least chub, yet no mention was made of the SNWA proposal in the federal register, which could take up to an additional 25% of the aquifer's recharged water annually. If the pumping situation in Snake Valley in 1995 was seen as problematic enough to warrant an endangered listing for least chub back then, the current SNWA proposal should certainly be seen as something of a problem now.

In summary, based on the research done to date and summarized above, the proposed ground water pumping in Snake Valley (and adjacent Spring Valley) by SNWA could potentially cause significant drawdown of the Snake Valley water table, with potentially severe repercussions for least chub and all aquatic species and wetland systems that rely on consistent spring discharge.

V. OTHER NATURAL OR MANMADE FACTORS AFFECTING THE CONTINUED EXISTENECE OF LEAST CHUB

A. PREDATION, COMPETITION, AND DISEASE

Hickman (1989) considered least chub to be "constantly threatened" by the introduction and presence of nonnative species. Surveys of spring complexes indicate that where nonnative fishes have been introduced, few if any least chub remain (Osmundson 1985). Introduced game fishes, including largemouth bass (*Micropterus salmoides*), rainbow trout (*Oncorhynchus mykiss*), common carp (*Cyprinus carpio*), and brook trout (*Salvelinus fontinalis*) are predators on least chub, and these species have been regularly stocked into least chub habitat (Workman *et al*. 1979; Sigler and Sigler 1987; Osmundson 1985; Crist 1990). In addition to game fish, other nonnative fishes also have been released into least chub habitat. The mosquitofish (*Gambusia affinis*), rainwater killifish (*Lucania parva*), and plains killifish (*Fundulus zebrinis*) have been introduced into least chub habitats, have similar diets to the least chub and are considered potential competitors.

The mosquitofish poses a direct threat to the least chub because of its known aggressive predation on eggs and young of other fishes (Meffe 1985; Sigler and Sigler 1987, Sigler and Miller 1996, Mills et al. 2004b). Mosquitofish are also known to be competitively superior to some native fish (Lydeard and Belk 1993, Mills et al. 2004)

A recent study (Mills et al. 2004b) on interactions between mosquitofish and least chub found that mosquitofish have a two sided effect on Young of the Year (YOY) least chub through both predation and competition. The mechanism of interaction between the two species switches from predation to competition as least chub size increases. The effects of predation are most pronounced on the smaller size classes of least chub (affecting both survivorship and growth), while the effects of competition have more of an impact on the larger fish. These data suggest that YOY least chub pass through a time period in which their size makes them more vulnerable to predation by mosquitofish. This threat of predation results in a shift in both behavior (more time spent stationary in presence of mosquitofish), and habitat usage as the least chub seek refuge from predation under covered habitat. However, in these refuge habitats the least chub may have to compete with small mosquitofish that are also attempting to avoid predation by adult mosquitofish (Mills et al. 2004b).

The UDWR sums up the mosquitofish problem, in regards to the declining Mona population, in the 2006 Seven-Year Assessment of the Least Chub Conservation Agreement and Strategy: “The population decline at the Mona Springs complex has been attributed to the presence of nonnative fishes, particularly mosquitofish (*Gambusia affinis*). Extensive efforts to control mosquitofish in the spring complex have been unsuccessful and the least chub population numbers continue to decline. These results suggest that, unless complete eradication can be achieved, the threat posed by mosquitofish cannot be reduced for any significant amount of time, and a temporary reduction does not induce a positive least chub population response. The small population size, coupled with the results of the nonnative fish removal efforts, indicate that this population may be extirpated in the near future unless dramatic action is taken” (Bailey 2006).

Mosquitofish are also a very significant threat to the Lucin (refuge) population. Thompson (2005) reports that “both length/frequency [measurements] and catch-per-unit-effort indicate that mosquitofish are having a negative impact on the Lucin least chub population and mosquitofish control effort may be necessary to maintain this population.”

The introduction of nonnative fish poses a threat to least chub throughout the Wasatch Front GMU through increased predation, competition, and risk of disease. Plains killifish (*Fundulus zebrinus*) and/or mosquitofish are present in many of the habitats historically occupied by least chub in this GMU. Other nonnative species such as brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) currently occupy or could possibly invade historic least chub habitat. Predation by these species remains a threat to least chub in this GMU. Non-native fish are much less of a problem in Snake Valley, though goldfish and large-mouth bass are known to occur in Bishop Springs.

Other potential predators on least chub include frogs, ducks, gulls, herons, and egrets (Osmundson 1985; Sigler and Sigler 1987). Under normal situations, predation from these sources would not negatively affect healthy populations of least chub. However, the effects of predation from the above combined sources could result in further depletions of already fragile populations.

Disease or incidence of parasitism are not presently major factors affecting least chub. However, a single parasite called blackspot (*Neascus cuticola*) is known to infest least chub, although all infested least chub examined thus far have appeared to be robust and in good condition (Bailey 2006). In the 2004 monitoring summary report for Snake Valley, Wheeler et al. (2004) note that blackspot cysts appeared on many least chub and Utah chub captured throughout Bishop Spring.

In 2006 it was discovered that there was a parasitism problem with the least chub that had been collected from the Leland Harris population site to begin the new stocking operation for another attempted transplant in the Fish Springs Wildlife Refuge. These fish were checked for disease at the Fisheries Experiment Station. Since it was discovered that the batch of 60 chub were carrying eight kinds of parasites and nematodes, it was decided that the fish would be transplanted into temporary holding facilities on site at FSWR, and Young-of-the-Year will then be transplanted into the first pond in 2007.

B. OVER UTILIZATION FOR COMMERCIAL, RECREATIONAL, SCIENTIFIC OR EDUCATIONAL PURPOSES

Currently, over-utilization for commercial, recreational, scientific or educational purposes does not pose a threat to least chub.

C. HYBRIDIZATION

Hybrid introgression between least chub and the Utah chub (*Gila atraria*), and also with speckled dace (*Rhinichthys osculus*), has been reported (Behnke 1985). It was also reported that reproductive isolating mechanisms have apparently broken down in some areas due to habitat alteration and degradation, and that this has resulted in overlaps of reproductive niches and breakdowns of behavior due to overcrowding (Crawford 1979; Lamarra 1981). Least chub hybrids have been reported from springs near Callao, Utah, where least chub once existed (Behnke 1985).

That said, a recent molecular diversity study of least chub populations revealed no evidence for hybridization between least chub and Utah chub and suggest that previous hybridization reports may have been due to a misidentification of specimens (Mock and Miller 2003).

D. MOSQUITO ABATEMENT PROGRAMS

Another potential threat to the least chub is a proposed mosquito abatement program for Juab County. The BLM has rejected the County's request to implement a mosquito control spraying program in marsh and spring areas on BLM administered lands. The rejection does not prevent the county from spraying on privately owned lands. The effect of a mosquito control spraying program on least chub is uncertain. Past studies (Workman et al. 1979) indicate that much of the least chub diet is composed of insects, including mosquito larvae. To date, no studies have been undertaken to determine the effects of chemical toxins on the least chub or its habitat.

E. STOCHASTIC DISTURBANCE AND POPULATION ISOLATION

Because of the reduced distribution and isolation of remaining least chub populations, the species could be at risk independent of any other factors, such as non-native fish or habitat degradation. There is a substantial body of literature on the risks that small, isolated populations face, including environmental and demographic stochasticity (e.g. Gilpin and Soulé 1986, Goodman 1987, Mode and Jacobson 1987, Lande 1993). Even though the least chub has evolved to deal with fluctuating marsh conditions, these concerns still apply to this species, and should be considered in addition to and in concert with the particular threats outlined above.

F. DROUGHT AND CLIMATE CHANGE

Prolonged drought in Utah could potentially act in concert with one or more of the above threats to add additional stress to least chub. In particular, in unpredictable and stochastic environments (like deserts), the sequence of good and/or poor quality seasons can be important in determining the long-term dynamics of a population (EDF 1995). The impacts of prolonged drought conditions could exacerbate the effects of all the other threats to least chub described in this petition.

In the 2004 monitoring summary report for Snake Valley, Wheeler et al. (2004) noted that "the ongoing drought continues to affect water levels at the Gandy Marsh complex. Although the water levels were higher in 2004 than previous years, most of the water was still confined to spring heads. Drought over the past five or six years in Snake Valley could be contributing to the decline of the population at Gandy.

Due to the recent concerns about the five year drought in Utah, the UDWR compared a series of abiotic and biotic factors with the presence and size of least chub (Bailey 2006). These analyses were conducted to determine a possible correlation of the drought with least chub abundance or body length. For this study, field measurements were used from annual surveys of average pool length, width and depth to determine average pool volume. An analysis of covariance was used to determine the effects of pool volume on least chub abundance. Time was a used as a covariate given that the water levels may have changed from year to year. The UDWR used a least squares regression of least chub body length on pool volume to determine a possible correlation of available habitat on body size.

UDWR did not find significant effects of the drought on the west desert least chub populations. There was no correlation between least chub abundance or body length with average pool volume. There was a significant correlation between least chub abundance and pool volume where time was the covariate in the Gandy population. In the pools where least chub was present there was no significant correlation between least chub abundance or body length to pH, conductivity, dissolved oxygen or water temperature (not shown). Body size of least chub was not affected by habitat size. Least chub growth rate and fecundity does not appear to be correlated to pool (habitat) volume. The results of this study suggest that the chief potential threat of drought to least chub is not the reduction in pool size, but rather the eventual disappearance of springs, pools, or marsh complexes (i.e. in the case of an extreme or extended drought event)

It is possible that climate change, rather than drought, could be a more serious potential threat to least chub. Climate change - specifically an increase in global temperatures including those in western North America - is a very real threat to all native species, but in particular to those species that cannot migrate (such as fish confined to a given spring complex or pond). The likelihood of warming temperatures in the next 50 years is essentially certain, and scientists no longer dispute the advent of global warming.

During the past century, global surface temperatures have increased by 1.1°F, but this trend has dramatically increased to a rate approaching 3.6°F/century during the past 25 years, the fastest rate of warming in the past 1000 years (IPCC 2001). Temperatures during the latter period of warming have increased at a rate comparable to the rates of warming that conservative projections predict will occur during the next century with continued increases of greenhouse gases. As global warming progresses, maximum high and minimum low temperatures are expected to increase, as are the magnitude and duration of regional droughts (IPCC 2001). Thus, the ecological effects of warming temperatures and droughts associated with global warming are likely to impact the Great Basin Desert. Among those effects are decreased duration and depth of winter snowfall (IPCC 2001), earlier spring runoff and decreased water availability, decreased productivity and cover of herbaceous vegetation and thus increased soil erosion, and unprecedented rates of vegetation shifts due to die off, especially along boundaries of semi-arid ecosystems (Allen and Breshears 1998, Davenport et al. 1998, Wilcox et al. 2003). These changes may pose threats to native aquatic species as the quality and quantity of aquatic, riparian, and mesic upland ecosystems decline with decreased water availability.

Of particular concern should be the potential for future declines in snowpack in the Deep Creek and Snake Mountains, which are the chief source of groundwater recharge into the Snake Valley aquifer. Constant spring discharge in Snake Valley is essential for the future conservation and security of all least chub populations in Snake Valley. Discharge rates, in turn, are tied to a stable aquifer, which is in turn tied to recharge rates and pathways that are still not completely understood. However, if (for example 100 years from now) snowpack rates are, say, 20-40% less in these mountain ranges than they typically are today, one should assume this could have an impact on hydraulic heads tied to the deep carbonate aquifer that is dependent on snowmelt runoff. This prediction is not a mere guess: Hoerling (2006) recently examined temperature data collected by scientists' worldwide to inform a new assessment of climate change in Utah and Colorado. His analysis predicts a five degree rise in temperatures in this region by 2050, and perhaps as early as 2020. This will undoubtedly lead to a reduced snowpack in mountains ranges in Utah and neighboring Nevada.

McCarty (2001) summarized the potential impacts of impeding climate change to rare species when he stated "conservation scientists need to look at climate change as a current, not just a future, threat to species. Although a causal link to climate cannot yet be rigorously demonstrated, the consistent patterns indicate that the prudent course for conservation is to take these changes seriously. Certainly, cases such as the extinction of the golden toad are of immediate concern, but the changes in climate need to be taken into account as a possible factor contributing to declines in other species."

G. CUMULATIVE EFFECTS

Perennial stream and spring/marsh systems in the current and historic range of the least chub have been impacted by a combination of the activities discussed above, leading to cumulative and synergistic effects that have resulted in substantial loss and degradation of habitat.

One example of cumulative effects can be seen with the impact of lowered water tables (for example through diversion of surface waters or ground water pumping). Lowered water levels may lead to niche overlap with other species, which in turn may exacerbate the threat of hybrid introgression or interspecific competition (Crawford 1979, Lamarra 1981). This impact has actually been witnessed through recent research; mosquitofish tend to out-compete least chub in the shallow waters (Mills et al. 2004b). Other examples would include a population site that is experiencing both water pollution and increased numbers of mosquitofish, or a site that is experiencing seasonal drying along with high parasitic loads. Another example could be the cumulative effects of both future climate change and periodic drought, likely to result in, again, lowered water tables with various concomitant effects. The inescapable climate change that we are looking at will almost certainly threaten to be an additional source of stress for species already threatened by local environmental changes, exacerbating the impacts of habitat degradation, for example, and increasing the risk of extinction for those species.

In general, there are a myriad of cumulative effects that are currently, or could potentially in the near future, impact populations of least chub. As surmised above, these effects can occur whenever and where-ever more than one stress is acting on a population at the same time, such as at Bishop Springs where dewatering of Foote Reservoir has been occurring concurrently with drought.

VI. HISTORY OF LEGAL STATUS

In 1972, and again in 1979, least chub was recognized as a threatened species by the Endangered Species Committee of the American Fisheries Society (Miller 1972; Deacon et al. 1979). In 1980, the U.S. Fish and Wildlife Service (USFWS) reviewed existing information on least chub and determined that there was insufficient data to warrant its listing as endangered or threatened. This finding was based on status reviews conducted by the Service. On December 30, 1982, the Service classified this species as a Category 2 Candidate Species (47 FR 58454). After preparation of a 1989 status report, the Service reclassified least chub as a Category 1 Candidate Species (54 FR 554).

In 1995, the Service determined that listing least chub as an endangered species was warranted and, on September 29, 1995, proposed to list the species as endangered with critical habitat, pursuant to the Endangered Species Act (ESA, 60 FR 50518). At the time of the issuing of the Federal Register notice, the least chub was only known to exist in four or five locations in Snake Valley. Moreover, at that time least chub had not been collected outside of Snake Valley since 1965 (Hickman 1989), and field data indicated that chub were declining there as well, with least chub extirpated from Bagley Ranch and Redden Spring complexes in Snake Valley, and even the strongholds of Leland Harris and Gandy salt marshes were reporting presence of chub in less springs than were known previously. Chief reasons the Service gave for an endangered listing included predation by introduced nonnative fishes, direct physical habitat loss and habitat degradation (including possible impacts from livestock grazing, and oil and gas exploration and production).

Subsequent to the proposed listing by the USFWS, a technical team was formed by the UDWR and the Least Chub Conservation Agreement and Strategy (LCAS, see following section) was drafted to outline actions necessary to prevent listing under the ESA. The improved status of the species soon afterwards and the commitments made by signatories to the Conservation Agreement of 1998 (Perkins et. al., 1998) led the USFWS to withdraw the listing proposal on July 29, 1999. The improved status entailed the discovery of the Mona and Mills Valley populations (in 1995 and 1996 respectively), and what was hoped to be successful transplants of chub into Walter and Deadman springs in the Fish Springs Wildlife Refuge. The commitments included extensive surveys; enhancement, maintenance and habitat protection projects, and additional reintroduction efforts. Many of these commitments were underway at the time of the 1999 federal register notice (64 FR 41061).

Due to persistent threats and its limited distribution, least chub was classified as a Utah Sensitive Species in 1997 (Utah Division of Wildlife Resources 1997). Due to its status as the subject of a conservation agreement, least chub are currently classified on the Utah Sensitive Species List as a Conservation Species (UDWR 2005). Least chub is currently categorized by the Utah Natural Heritage Program as a G1 species globally and an S1 species statewide, though neither of these rankings are legal designations. These rankings indicate extreme rarity or other factor(s) making the species especially vulnerable to extinction or extirpation (typically 5 or less occurrences or very few remaining individuals or acres, Utah Natural Heritage Program website 2006).

VII. INADEQUACY OF EXISTING REGULATIONS

Analyzing recovery and delisting of endangered and threatened species, Doremus and Pagel (2001) conclude that “Although the USFWS tends to focus on biological threats, it is logical that the inadequacy of existing regulatory mechanisms is decisive. Species adequately protected by background law or other means against habitat destruction, overexploitation, and other human activities do not decline to the point of endangerment.”

There are at present no specific Federal protections for least chub. Generalized Federal protections found in BLM Resource Management Plans, and other statutory, regulatory or policy provisions have been inadequate to check the decline of this species. Relevant Federal statutes, regulations and plans are discussed, by agency, below.

A. U.S FISH AND WILDLIFE SERVICE

As described above, in 1995, the U.S. Fish and Wildlife Service determined that listing least chub as an endangered species was warranted and in 1995 proposed to list the species as endangered with critical habitat. Shortly afterwards, the LCAS was drafted to outline actions necessary to prevent listing under the ESA. Due to two new wild populations being discovered (bringing the total up to five), transplants of least chub into Fish Springs Wildlife Refuge, and various commitments made by the LCAS signers, the

USFWS withdrew the listing proposal in 1999. Unfortunately, even with the good intentions of the LCAS, today it is clear that the least chub is no better off than it was in 1999 when the Service withdrew the listing proposal. It is still only known to still exist in the wild from a handful of places on earth, the establishment of persistent, refuge populations in natural habitats has been extremely slow with highly variable results, and nearly all known extant populations of least chub (both wild and refuge) are still subject to a variety of human cause threats ranging from mosquitofish to livestock grazing to oil and gas leasing and exploration.

The Fish and Wildlife Service has no specific authority at present to take actions for recovery of least chub. Least chub is not found on any National Wildlife Refuge. Most authorities of the Fish and Wildlife Service generally provide for technical assistance and consultation with State, Tribal, private, and Federal entities. However, even where consultation is mandatory, such when there is a federal nexus of some sort, consideration or implementation of Fish and Wildlife Service recommendations is discretionary on the part of the other agency or entity.

B. BUREAU OF LAND MANAGEMENT

Wild least chub populations currently occur on BLM lands in all three population sites (Gandy, Bishop and Leland Harris) in Snake Valley. The Red Knolls refuge population site is also on BLM lands. BLM is also overseeing potential oil and gas development in Mills Valley, immediately adjacent to the Mills Valley population site. Currently, the Leland Harris site experiences moderate grazing damage and oil and gas lease sales. Most of the Gandy salt marsh area is under lease for potential oil and gas exploration. Grazing impacts have also been noted at the Bishop Springs site. Management of least chub habitat on BLM lands is likely inadequate to prevent further decline of the species in Snake Valley.

A significant portion of BLM's involvement in least chub management occurs through their involvement with the Least Chub Conservation team and LCAS (which is discussed in the Utah/UDWR section below). Major BLM statutes that provide for consideration or protection of natural resources include the Federal Land Policy and Management Act of 1976 and the National Environmental Policy Act of 1969. None of these statutes provide specific protections for least chub and have not prevented the decline of this species. The 1934 Taylor Grazing Act and other livestock grazing statutes, along with the 1872 Mining Act and other mineral-related laws have been among the most adverse statutes affecting least chub habitat on BLM lands.

Because any water pipeline for Snake Valley will cross BLM lands, the agency will be responsible for determining the environmental impacts of water withdrawal under NEPA. This environmental review is unlikely to prevent water withdrawal or even substantial mitigation. Indeed, the BLM withdrew protests last year to the adjacent Spring Valley SNWA water rights applications, even though the project is expected to have serious environmental impacts.

C. U.S. ARMY CORPS OF ENGINEERS

The U.S. Army Corps of Engineers administers issuance of dredge and fill permits under section 404 of the Clean Water Act. Bailey (2006) sates: “Since least chub usually occur in wetlands, any mitigation will be handled through the Army Corps of Engineers via the 404 permit process. The Corps **usually** consults with Division and Service personnel when assessing impacts on wetlands and when assigning appropriate mitigation.” (emphasis added). These permits regulate a wide variety of activities in streams and wetlands in both the historic and extant range of least chub. Under the regulations and policies governing implementation of this program, there is substantial latitude for allowing extensive destruction and degradation of stream habitats, including those that could potentially support least chub. The 404 program and its administration is clearly inadequate to maintain habitat that will support least chub.

D. STATE OF UTAH, AND UTAH DIVISION OF WILDLIFE RESOURCES

The state of Utah has no substantial laws or regulations to protect the least chub. Due to persistent threats and its limited distribution, least chub was classified as a Utah Sensitive Species in 1997 (Utah Division of Wildlife Resources 1997). Due to its status as the subject of a conservation agreement, least chub are currently classified on the Utah Sensitive Species List as a Conservation Species (UDWR 2005).

Currently, five least chub populations occur on state-owned lands. This includes the Clear Lake population at the Clear Lake Wildlife Management Area (WMA), the Mills Valley population at the Meadows WMA, the Mona population (site recently purchased by UDWR), the Atherle refuge population at the Atherle WMA, and the Antelope refuge population at Antelope Island State Park. There are also widely scattered State Institutional Trust Administration (SITLA) parcels in the part of Snake Valley that contains the three populations there.

The state of Utah is about to enter into an agreement with the State of Nevada over the future shared groundwater resources in Snake Valley. Negotiations are underway between the states regarding this complicated agreement. The Utah legislature sought to pass legislation in the 2007 session that would require the Department of Natural Resources (DNR) and the governor to hold off on finalizing an agreement with Nevada until the Basin and Range Carbonate Aquifer System Study (BARCASS) was completed, as well as monitoring data from 20 test wells the Utah Legislature appropriated funds for in the same general session. However, the bill did not pass. DNR has indicated that an agreement concerning the amount of acre-feet Nevada would be able to pump could be signed before the BARCAS study is complete and the data from the test wells is gathered.

Least Chub Conservation Agreement and Strategy

This section will chiefly focus on the state’s Least Chub Conservation Agreement and Strategy (LCAS), as the technical team that drafted it was convened by the UDWR and most implementation actions are similarly undertaken by UDWR. This agreement and strategy, and the actions and elements linked to it, dwarfs other conservation efforts taken on behalf of the least chub. The purpose of the LCAS, adopted in 1997 and updated in 2005, is to describe specific actions and strategies required to expedite and implement conservation measures for least chub. These measures are being taken as a cooperative effort among resource agencies and private landowners. The goal of these actions is to ensure the long-term conservation of least chub within its historic range. The general conservation approach focuses on two main objectives. The first objective is to eliminate or significantly reduce threats to least chub and its habitat to the greatest extent possible. The second is to ensure the continued existence of the chub by restoring and maintaining a minimum number of least chub populations throughout its historic range, and within the three Geographic Management Units (GMUs).

The LCAS lists various conservation actions or elements that will eliminate or reduce threats to least chub as well as expand its range back into historic localities. These actions are being taken by the various signers of the LCAS, which include the UDWR, the US FWS, the BLM, the Bureau of Reclamation, the Utah Reclamation Mitigation and Conservation Commission, the Confederated Tribes of the Goshute Reservation, and the Central Utah Water Conservancy District. The elements, and whether the goals relating to those elements have been met, are discussed below:

1. Habitat Enhancement

Proposed: One of the chief goals in this effort is to enhance and/or restore habitat conditions in designated areas throughout the historic range of least chub. This includes using methods such as bank stabilization, enhancement of native vegetation, dredging of springheads, riparian/spring fencing, and implementing compatible grazing practices.
Completed: About seven or eight habitat enhancement projects have been completed at various least chub population sites (both wild and refuge sites) ranging from alteration of grazing management to removal of exotic plants to construction of outflow structures. Potentially much more work remains to be done on this front.

2. Habitat Protection

Proposed: The chief goal in this effort is to protect and enhance habitat through regulatory mechanisms, land acquisition, conservation easements, cooperative agreements and/or MOU's with both private landowners and other agencies.
Completed: In 1998 the Utah Reclamation Mitigation and Conservation Commission (URMCC) funded the Division and US Bureau of Reclamation (BOR) to acquire lands and waters on the Mona Springs Complex near the town of Mona. A total of 85.5 acres of the 105 designated acres were acquired soon afterward, and the remaining 19 acres was purchased in 2006. UDWR also renewed the lease on Lucin Pond.

3. Restore Hydrologic Conditions

Proposed: The chief goal in this effort is to maintain, restore and augment where possible the natural hydrologic characteristics and water quality of occupied and potential least chub population sites. This will be achieved through acquisition, easement, MOUs, and/or cooperative agreements.

Completed: The UDWR entered into an agreement with the water rights owner of Foote Reservoir that he will leave a portion of the water in the reservoir each year, to ensure downstream flows into Bishop Springs.

4. Nonnative Control

Proposed: The chief goal in this effort is to selectively control nonnative species that negatively impact least chub via predation and/or competition. This will be achieved through control and/or modification of stocking, introductions, and spread of nonnative aquatic species, exploring options to utilize least chub as a method of mosquito abatement in lieu of using nonnative western mosquitofish, and reducing or eliminating detrimental species where feasible. One of the expected products of this conservation element is new research identifying the negative impacts of nonnatives on least chub.
Completed: A study on the interactions between mosquitofish and least chub was funded and completed. Another study on whether least chub could be effective in mosquito control was also completed. In 2002 the Memorandum of Understanding (MOU) between the UDWR and the Mosquito Abatement District was finalized to reduce the spread of mosquitofish in Utah. Efforts were made 5 years in a row to eradicate mosquitofish from the Mona population site (although it has not proven to be successful, populations of rainwater and plains killifish were dramatically reduced through these efforts). In 1999 the UDWR removed rainbow trout from Miller Spring (Leland Harris population site) in conjunction with a dredging project. The Red Knolls Pond refuge site was chemically treated with rotenone to remove goldfish in 2003, before least chub were introduced into the pond.

5. Range Expansion

Proposed: This element involves (1) locating and assessing current least chub populations in Utah, (2) completing life history studies that will establish the environmental and specific habitat requirements for least chub, (3) conducting genetic research to determine the levels of molecular diversity within and between populations of least chub, (4) determine the number of individuals and habitat requirements needed to maintain a viable population, and (5) expansion of least chub populations and distribution through introduction or reintroduction into appropriate areas from either transplanted least chub or least chub raised in a hatcheries. This last element involves establishing introduction, reintroduction, and transplant protocols, and establishing at least two refuges for each wild population and maintaining least chub hatching and rearing facilities using wild populations as broodstock.
Completed: Statewide inventories for least chub have been completed for the West Desert GMU (45 survey sites), and are ongoing in the Wasatch Front (13 survey sites so far) and Sevier River GMU's (64 sites so far). Through surveys, one new population (Clear Lake) have been discovered since the USFWS withdrew its least chub listing proposal in 1999. Three studies have been funded, and are in various stages of completion, to ascertain least chub growth rates and to identify important habitat characteristics required by least chub and identify new potential refuge sites. Genetic studies have been completed and are reported above. The UDWR has not determined the number of individuals and habitat requirements needed to maintain a viable population, citing prohibitive costs for an Population Viability Analysis (Bailey 2006). Transplants of least chub into new refuge

sites has had variable results. Four attempted refuge sites have failed. Currently, the Mona population is “backed up” at only one refuge site (Antelope Island), the Bishop Springs population is backed up at only one refuge site (Red Knolls), and Mills Valley is backed up at only one refuge site (Atherle Reservoir, as of late 2006). The Lucin Pond refuge site is an interesting situation, where the Leland Harris and Gandy populations have had a joint refuge site established which currently houses those two populations (or rather a hybrid population of the two genetic lines) together. If one discounts Lucin as a proper refuge site (since it does not contain a pure strain), then currently only three of the six wild, extant least chub populations are properly backed up at refuge sites. The LCAS calls for two separate refuges for each wild population. In addition, UDWR has not yet developed a formal introduction, reintroduction, and transplant protocol, although the UDWR did ascertain that when establishing these refuge populations from wild populations, a minimum of 200 individuals should be moved (Bailey 2006).

6. Monitoring

Proposed: The chief goal in this effort is to detect changes in population distribution, health and security over time. The signers of the LCAS propose to accomplish this by using protocols to track least chub distribution, making evaluations of population health and security, and monitoring size class frequency within defined sampling populations. This involves collecting and establishing baseline habitat conditions at all occupied least chub locations. UDWR Biologists are monitoring additional parameters (e.g., water level, precipitation), as necessary, to help interpret population fluctuations and develop a Habitat Management Plan for each least chub population. The establishment of baseline population data will be used to monitor effectiveness of conservation actions over time. Evidence that populations are dropping to low levels will trigger additional study and appropriate conservation actions.

Completed: A power analysis on the monitoring program in Snake Valley was conducted in 2003. The analysis reported the probabilities of detecting population changes in least chub if monitoring were conducted every ½ year, every year or every other year. The results suggested a similar detection ability in monitoring least chub populations among the different time intervals. In 2004 a comparison of various gear types revealed that minnow traps and seines are most efficient at capturing least chub for monitoring purposes. The UDWR also adopted the monitoring protocol to annually capture 100 least chub from each population, with individuals’ length used to construct a histogram for each population, which will in turn be used for documenting reproduction, recruitment, and presence of adult fish. All known populations of least chub (both refuge and wild) are monitored every year. No Habitat Management Plans for least chub populations have been created yet.

7. Mitigation

Proposed: The chief goal in this effort is to develop site-specific mitigation for proposed water development and future habitat alteration, where needed.

Completed: Numerous development projects have been assessed by the UDWR’s Habitat Section. In each case, various mitigation options were offered to offset the negative affects of poor grazing practices, road construction, water development and urban construction. In many of these instances, the UDWR worked closely with the US Army

Corps of Engineers to develop appropriate mitigation. All stream alteration permits are reviewed and approved by the Habitat section of UDWR. If the proposed stream alteration disturbed or destroyed least chub habitat the permit was denied or an alternative alteration was suggested. Bailey (2006) sates: "Since least chub usually occur in wetlands, any mitigation will be handled through the Army Corps of Engineers via the 404 permit process. The Corps **usually** consults with Division and Service personnel when assessing impacts on wetlands and when assigning appropriate mitigation." (emphasis added).

*8. **Regulation***
Proposed: This element involves maintaining and enforcing current Utah Division of Wildlife Resources code regulations that prohibit the collection, possession, transportation, and importation of least chub and nonnative species.
Completed: The regulations referred to above have been adhered to.

*9. **Information and Education***
Proposed: The chief goal in this effort is to increase public awareness and support for the conservation of least chub.
Completed: A demonstration project involved translocation of least chub into a pond on an elementary school campus in southern Utah. Also, basic natural history information on the least chub is available through the UDWR website.

Success of the Conservation Agreement and Strategy
In assessing the current status of the least chub, it is important to look at the Least Chub Conservation Agreement and Strategy, and ascertain how many of which types of goals have been met between 1999 (when the commitments made in the LCAS led the U.S Fish and Wildlife Service to withdraw its 1995 listing proposal) and the present time. In that intervening time, one new wild population (Clear Lake) has been discovered, and the total number of refuge populations has increased by one (three of the refuge sites in existence before 1999 have been extirpated and "replaced" by four new ones…but bear in mind three of those four have been established within the past three years, so it's too early to claim success on all of them). While progress has been made towards some of the LCAS goals such as habitat enhancement and protection, surveying for new populations, improving monitoring techniques and ongoing least chub behavioral and genetic research, the "bottom line" status of both wild and refuge populations in existence has not improved a great deal since 1999. Currently, the Mona population is "backed up" at only one refuge site (Antelope Island), the Bishop Springs population is backed up at only one refuge site (Red Knolls), and Mills Valley is backed up at only one refuge site (Atherle Reservoir, as of late 2006). The Lucin Pond refuge site houses a hybrid population from Leland Harris and Gandy Marsh. If one discounts Lucin as a proper refuge site (since it does not contain a pure strain), then currently only three of the six wild, extant least chub populations are properly backed up at refuge sites. More troubling, the fact that the UDWR admits that the Mona "population may be extirpated in the near future unless dramatic action is taken" (Bailey 2006) indicates that the UDWR may face a situation where they will just have to "write off" this population in the wild.

The assessment of status of the least chub must be made in the light of knowledge, now in existence thanks to the LCAS, of the likelihood of new, wild populations being discovered. Since the LCAS was adopted in 1998, UDWR has undertaken over 120 surveys in what was considered to be the best suspected least chub habitats remaining. More surveys are underway, and scheduled for the next year or so. This exhaustive search, which has so far only led to the discovery of one additional wild least chub population (Clear Lake), suggests the inevitable possibility that all of the existing wild populations of least chub are known and accounted for, and no new ones will be discovered.

Another parameter worth measuring is the UDWR budget for least chub conservation over the years. This program, even after the adoption of the LCAS, has generally been poorly funded. For example, the 2005 least chub budget for UDWR was $33,000 (the most recent year for which financial data is available).

Another factor to take into account when assessing the status of the least chub is the condition and degree of "naturalness" of the habitats where the populations currently occur. With the exception of Clear Lake, all of the current, wild, extant populations of least chub are in natural spring systems, with little human augmentation (save the occasional small drop structure, outflow control devices, etc.). The problem is that very few natural systems like these exist outside of those six sites currently occupied by wild chub populations. In the course of their survey efforts, the UDWR has investigated over 100 sites for potential refuge population establishment. Yet the majority of the sites chosen for refuges are human-created ponds and/or require some form of augmentation ranging from providing supplementary water to dredging to outflow control structures, etc. The concern is not so much whether this is a desirable situation, but rather that it simply reflects the rather stark reality that this is the "best we've got left" to house new populations of least chub. Large, connected and relatively unimpacted spring/marsh complexes such as those that currently exist in Snake Valley are simply not available in very many places. This makes the conservation of least chub and its habitat in this locale even more imperative, and the looming threat of Snake Valley water withdrawal even more insidious.

Another facet to account for in summarizing this species' status, is not only to consider the past 5 –10 years of progress made towards least chub recovery since the USFWS original proposal to list as endangered in 1995 and the adoption of the 1998 LCAS, but to look ahead to the next 5-10 years to come. Apparently, neither the authors of the LCAS nor the USFWS (in its decision to withdraw its listing proposal in 1999) considered at the time the potential impact to Snake Valley least chub of the withdrawal of up to 25,000 acre feet of water per year from the Snake Valley aquifer (potentially as soon as eight years from now). It's true that the precise amount of water to be withdrawn at this time is not known, nor is it known at this time what the precise impacts of this withdrawal will be on spring discharge rates. But the possibility of many, if not most springs in the valley being significantly reduced in size or drying up completely is not outside of the realm of possibility, especially if one considers the impacts to springs of ground water pumping in other deep carbonate aquifers in the Great Basin. There certainly is a possibility of catastrophic results of this project in Snake Valley…and thus catastrophic impacts to Snake Valley populations of least chub. In summary, the question is not only whether the LCAS has led to improvements of the status of the species as a whole; rather the question is whether the improvements made in the status of the species in the Wasatch Front and Sevier GMUs are so great that they can "make up for" the potential future loss of all wild populations in the West Desert GMU. This worst-case scenario must be considered.

There are many laudable goals in the LCAS that have yet to be carried out. However, in considering the adequacy of the LCAS, the Fish and Wildlife Service must note that under the Endangered Species Act, the agency is not to consider planned and future management actions when determining whether a species meets the requirements of a threatened or endangered species, but instead only the current management and status of the species. In numerous cases, the Fish and Wildlife has been forced by judicial action to reverse decisions not to list species because they relied on promised management actions, including decisions over the Barton Spring's salamander, Queen Charlotte goshawk, jaguar, Alexander Archipelago wolf and coho salmon. This is not merely a legalistic technicality. There is good reason for considering only current management and status. States, Federal agencies and private interests can easily promise to protect and recover species in order to avoid or delay a listing that they consider potentially controversial.

E. OTHER STATE AND FEDERAL AGENCIES

The Bureau of Reclamation, the Utah Reclamation Mitigation and Conservation Commission, and the Central Utah Water Conservancy District are all signers of the LCAS. While they participate in LCCT meetings, the bulk of the conservation actions taken on behalf of the least chub are driven and carried out by other signers to the LCAS (principally UDWR).

F. PRIVATE LANDS

There are currently no known populations of least chub that exist solely on private lands. For example, while it is believed that the majority of least chub occupied habitat in Mills Valley is on the UDWR-owned Meadows Wildlife Management Area (WMA), least chub are also known to exist on private lands outside of the WMA. UDWR is uncertain how many adjacent spring and marsh sites in Mills Valley house least chub, as it is rare that UDWR is allowed access to monitor on the adjacent private lands. What probably can be assumed is that any least chub occupied habitat outside of the WMA is currently significantly impacted by livestock grazing.

Part of the Leland Harris population site contains Private land as well. Miller spring, which is considered part of the Leland Harris population site, is on private land. The monitoring efforts that have been conducted in recent years have been unsuccessful at capturing any least chub in this spring/pond (personal communication, Mike Mills UDWR Central Region, September 2006). Miller spring is considered to be very good least chub habitat, partly because there is an agreement with the landowner regarding the grazing system, and this also entails a fence around the main springhead and associated pond at Miller spring. Because of this, UDWR reintroduced Leland Harris least chub stock back into Miller spring in 2005. The UDWR is trying to definitively determine whether the transplant was successful, though informal visits to the spring in 2006 seems to point to successful breeding in Miller Spring.

G. TRIBAL LANDS

Currently, there are no populations of least chub on tribal lands, although there was historically and tribal lands may have a role in recovering the species in the future. The Confederated Tribes of the Goshute Reservation is a signer on the LCAS and this petition.

H. SUMMARY, INADEQUACY OF EXISTING REGULATIONS

In a recent legal decision, District Judge David Bury found that state, Tribal, and local programs, regardless of their value or efficacy, were not adequate substitutes for Federal protection under the Endangered Species Act (*Center for Biological Diversity v. Gale Norton, CV 01-409 TUC DCB* [Jan. 13, 2003]). Doremus and Pagel (2001) also found that State, local, and private laws and regulations were of substantially less effectiveness at conservation of imperiled species and concluded that “background law generally does not protect species against either of these two primary threats (habitat degradation and exotic species).

Least chub has experienced dramatic population and distribution declines throughout its range. This species has been extirpated from the majority of historic habitats where it once existed and currently persists in only a few isolated spring complexes along the Wasatch Front, the Sevier River basin and in Snake Valley in the Utah West Desert. Many of the extant populations are small and fragmented due to water diversions and urban development. The main threats to the least chub populations include increased urbanization, current and future water development, livestock impacts, and predation and competition impacts from introduced nonnative species. The inadequacy of existing regulations are partly to blame for the decline of this species. This includes the inadequacy of the LCAS, which from its adoption in 1998 to the present, does not have a whole lot to show for its efforts (in the last eight years exhaustive surveys of the historic habitat of least chub have only produced one new wild population , and refuge populations have only increased by one).

Recovery of the least chub will require a holistic approach to watershed management and the continuation of strong efforts of the Least Chub Conservation Team to conserve existing wild populations and introduce new populations into the most natural and suitable habitat available. The effort required to make significant strides in least chub conservation and recovery will require listing of the species as Threatened or Endangered under the Endangered Species Act, especially if withdrawal of Snake Valley ground water leads to reduced spring discharges in the Valley.

VIII. REQUEST FOR CRITICAL HABITAT DESIGNATION

Petitioners request the designation of critical habitat for the least chub concurrent with its listing. Because of the critical status of the species and the need for restoration throughout large portions of its historic range, critical habitat should encompass all potential, suitable and occupied habitat within the historic range of the species in Utah's part of the Great Basin.

Sincerely,

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