BEFORE THE SECRETARY OF INTERIOR

PETITION TO LIST THE LEAST CHUB (*Iotichthys phlegethontis*) AS A THREATENED OR ENDANGERED SPECIES UNDER THE ENDANGERED SPECIES ACT

Least chub (USFWS 2021, p. 1, credit: Esther J. Stokes)

September 30, 2021
CENTER FOR BIOLOGICAL DIVERSITY

September 30, 2021

NOTICE OF PETITION

The Honorable Deb Haaland
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Dear Secretary Haaland,

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b); section 553(e) of the Administrative Procedure Act (APA), 5 U.S.C. § 553(e); and 50 C.F.R. § 424.14(a), the Center for Biological Diversity and Krista Kemppinen hereby petition the Secretary of the Interior, through the U.S. Fish and Wildlife Service ("FWS" or "Service"), to protect the least chub (*Iotichthys phlegethontis*) as a threatened or endangered species. FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on FWS. Specifically, the Service must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." Id.

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.

The Center for Biological Diversity ("Center") is a non-profit, public interest environmental organization dedicated to the protection of native species and their habitats through science, policy, and environmental law. The Center has more than 1.7 million members and online activists throughout the United States. The Center and its members

are concerned with the conservation of endangered species and the effective implementation of the Endangered Species Act.

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TABLE OF CONTENTS

I. INTRODUCTION

The least chub (*Iotichthys phlegethontis*) is a rare, imperiled species of minnow, endemic to Utah and restricted to Utah's part of the ancient Bonneville Basin.

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 7 wild populations along the Wasatch Front, the Sevier River basin and the Utah West Desert. Many of the extant populations are small and fragmented. In addition, there are 12 to 14 least chub refuge populations, primarily in the northern portion of the Bonneville Basin. The main threats to the least chub populations are water withdrawal and diversion, nonnative fish and invasive plants, drought and climate change, stochastic disturbance and population isolation, oil and gas development, urban development, livestock grazing and the cumulative the effects of various threats.

Of great concern for this species are the planned water withdrawals from Pine Valley (Basin 255), as well as Wah Wah Valley (Basin 256) and Hamlin Valley (Basin 254), to support human population growth in Cedar City, Iron County, Southern Utah. Cedar City is seeking rights to build a pipeline to withdraw up to ~15,000 acre-feet a year of groundwater from Pine Valley, and is subsequently planning to withdraw water from Wah Wah and Hamlin Valleys. These three valleys are hydrologically connected to Snake Valley (Basin 254) and the Sevier Desert Basin (Basin 287), which contain four of the remaining seven wild populations of least chubs. The best science available so far tells us that the proposed groundwater withdrawal in Pine, Wah Wah and Hamlin Valleys could potentially cause significant drawdown of the Snake Valley and Sevier Desert Basin water tables, 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 the least 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

Utah's Bonneville Basin encompasses the area that was covered by ancient Lake Bonneville (Figure 1) and which is now located within the Great Basin physiographic province of North America. The entire Great Basin province is geologically distinct due to its characteristically parallel north-south mountain ranges separated by broad, alluviated desert basins and valleys (Christiansen 1951 as cited in Bailey et al. 2005, p. 16). In Utah, prominent features of the ranges' steep gravelly slopes are benches and other shore features of Lake Bonneville. At the base of the mountains and in the valley floors are numerous springs and several aquatic species that have maintained an existence as relict populations in these springs. These species include the least chub, Columbia spotted frog (*Rana luteiventris*), and several species of mollusks. However, these species' populations are rare and decreasing in some areas. Other unique species of the Bonneville Basin, such as *Rhinichthys osculus relictus*, a speckled dace subspecies, have become extinct due to these aquatic environments' rapid degradation primarily caused by water development and/or agricultural practices (Bailey et al. 2005, p. 16 and Bick 1966 and Hubbs et al. 1974 cited therein).

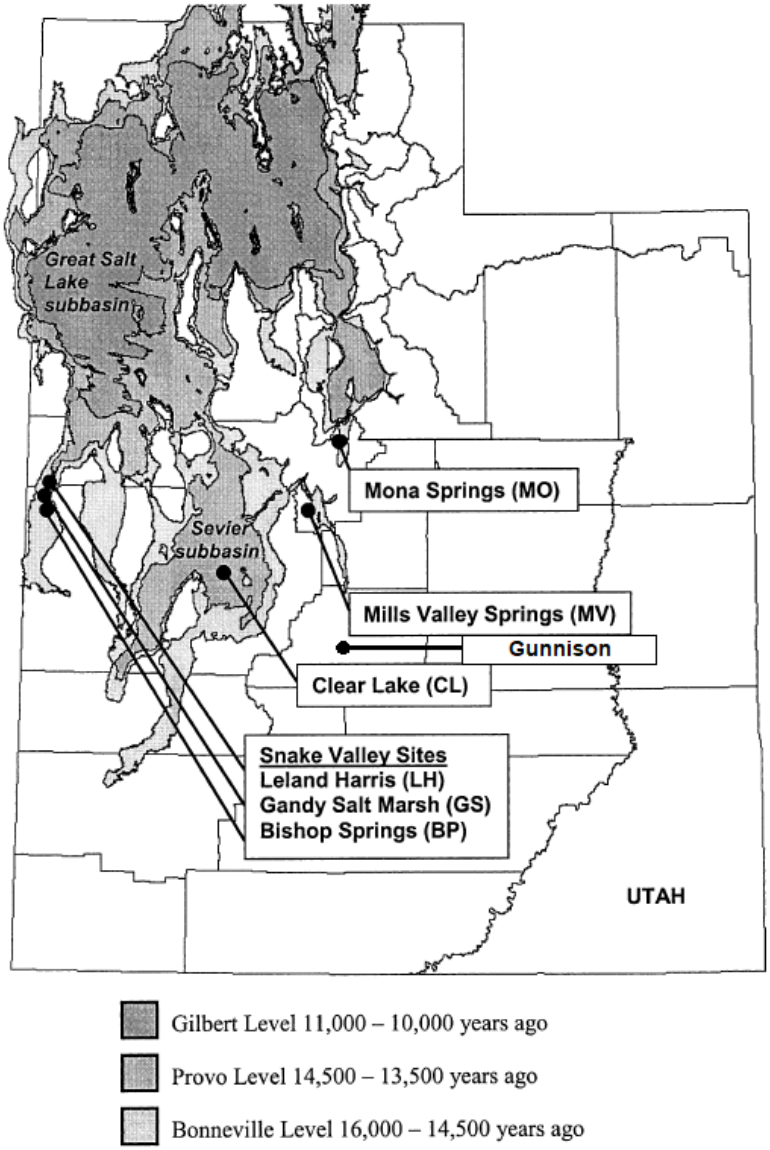

Figure 1. Current distribution of wild least chub populations. Adapted from Mock and Bjerregaard, 2007 (p, 143). The location of the Gunnison population within Sanpete County is approximate.

B. DESCRIPTION

The least chub is a small monotypic minnow (Figure 2) that swims in rather dense, well-ordered schools (Bailey et al. 2005, p. 19). 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 as cited in Bailey et al. 2005, p. 19).

The colorful least chub has a gold stripe along its blue sides and white-to-yellow fins. The color of males is olive-green above, steel blue on the sides, with a golden stripe behind the upper end of the gill opening. The fins are lemon-amber and paired fins sometimes are bright golden-amber. The color of females and young is pale olive above, silvery on the sides, with watery-white fins. Their eyes are silvery with only a little gold coloration, rather than gold as in the males (*Id.*).

Figure 2. Adult least chub. *Photo by Mark Belk, Brigham Young University* (taken from Bailey et al. 2005, p. 19).

C. TAXONOMY

As described in Bailey et al. 2005 (p. 19), the least chub is a minnow of the family Cyprinidae and is the sole representative of the genus *Iotichthys.* The authors state,

> *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

Least chub mature at one year (Bailey et al. 2005, p. 20). Spawning takes place in the spring when water temperatures reach 16ºC (Sigler and Sigler 1987 as cited in Bailey et al. 2005, p. 19-20). Peak spawning activity occurs in May but the reproductive season lasts from April to August, and potentially longer depending on environmental

conditions. Based on field studies, changes in photoperiod or light intensity, rather than increasing water temperature, trigger the onset of egg development and spawning (Bailey et al. 2005, p. 20).

Least chub are polyandrous broadcast spawners over vegetation, mostly algae (*Id.*). The demersal eggs are adhesive to the vegetation, with fertilized eggs hatching in about two days at a water temperature of 22ºC (Crawford 1979 as cited in Bailey et al. 2005, p. 20). Least chub are partial and intermittent spawners, with females producing only a few eggs at a time but releasing eggs over an extended period. The number of eggs produced may range from about 300 to 2700 (Crawford 1979 and Sigler and Sigler 1987 as cited in Bailey et al. 2005, p. 20).

Field studies have shown that least chub reproduce in marshes when temperature, alkalinity, pH, and conductivity are at a maximum. Spawning does not, however, occur in springs, with the fish moving back into the springs after the spawning period. The least chub's unique reproductive strategies allow it to successfully reproduce in the strongly fluctuating environment of the spring/marsh complexes (Hickman 1989 as cited in Bailey et al. 2005, p. 20).

Least chub were believed to be short lived, until studies showed longevity to be up to 6 years (Mills et. al. 2004a, p. 411; Bailey et al. 2005, p. 19). The least chub is the smallest cyprinid in Utah, with a maximum size of just 76 mm total length (TL; Sigler and Sigler 1996 as cited in Thompson et al. 2015, p. 548). In laboratory studies, specific growth rates of 2.06 to 3.38%/day have been recorded (Wagner et al. 2005, p. 17). Mills et al. 2004a (p. 409-412) 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 believed to be opportunistic feeders, with diets that are related to the abundance or availability of food items during different seasons and from different types of habitat. This species commonly eats algae, diatomaceous material, and midge adults, larvae, and pupae. Other food items include copepods, ostracods, and other available invertebrates (Crist and Holden, 1980, Lamarra 1982, Sigler and Sigler, 1987 and Hickman 1989 as cited in Bailey et al. 2005, p. 20). The diet of 121 least chub collected from various areas consisted of around 50% insects, 30% crustaceans, and 20% algae. Less algae was consumed during the winter and spring months (Workman et al. 1979 as cited in Bailey et al. 2005, p. 20). The least chub is a valuable natural predator of mosquito larvae (Sigler and Sigler, 1987 as cited in Bailey et al. 2005, p. 20), although the latter is likely only consumed on a seasonal basis (Bailey et al. 2005, p. 20).

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 the aforementioned Columbia spotted frog which is a Species of Greatest Conservation Need in Utah (Utah Wildlife Action Plan Joint Team 2015, p. 14), the California floater (*Anodota californiensis*) which is listed as Critically Imperiled in the state of Nevada, the Toquerville springsnail (*Pyrgulopsis kolobensis*) which is listed as Vulnerable in Nevada (Nevada Division of Natural Heritage, 2021), and the Ute Ladies'-tresses orchid (*Spiranthese diluvialis*), a federally threatened wetland plant. 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 effect on least chub populations.

G. HABITAT REQUIREMENTS

Historically, least chub were found in a variety of habitat types in different environments, including both lotic and lentic (Lamarra 1982, Sigler and Sigler 1987 and Sigler and Miller 1963 as cited in Bailey et al. 2005, p. 20).

Least chub is a generalist and for many water quality parameters, has broad tolerance limits, allowing it to exist in the severe environment of the springs and marshes in Snake Valley of Utah's West Desert (Lamarra 1982 as cited in Bailey et al. 2005, p. 20). 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, p. 21). Marshes with least chub typically have higher temperatures, conductivity, pH and dissolved oxygen than springs containing least chub (Hickman 1989 as cited in Bailey et al. 2005, p. 20). Marsh habitats with least chub also exhibit wide diurnal fluctuations in dissolved oxygen due to higher daytime primary productivity. During the day, marsh temperatures can fluctuate between 15º and 32ºC (59º- 90ºF; Crist and Holden 1980 as cited in Bailey et al. 2005, p. 20). In occupied least chub habitats, surface water temperature has been reported to range between 10º and 29ºC, dissolved oxygen between 0.1 and 9.8 mg/L, and pH between 7.3 to 8.9 (Fridell et al. 1999, p. 4, 5). Least chub move back and forth between different habitat types, especially between springs and marshes, due to seasonal water quality changes in marsh and stream habitat (Crist and Holden 1980 as cited in Bailey et al. 2005, p. 20-21).

While substrate type appears to be insignificant, the presence of aquatic vegetation is a key habitat component for least chub (Crist and Holden 1980 as cited in Bailey et al. 2005, p. 21). Least chub are very adept at diving into bottom vegetation or retreating rapidly into rushes when disturbed (Bailey et al 2005, p. 19). Submerged vegetation is also an important habitat for eggs and larvae, providing the necessary oxygen and food (Crist and Holden 1980 as cited in Bailey et al. 2005, p. 20). Typical least chub habitat features a variety of herbaceous emergent, floating, and submergent vegetation. Most commonly found vegetation 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 that occur in Snake Valley populations' habitats include: saltgrass (*Distichilis spicata*), Elodea (*Elodia*), pondweed (*Xanthium spinosum* and *X. strumarium*), giant reed (*Phragmites*) and sandbar willow (*Salix* sp.) (Bailey et al. 2005, p. 21).

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. The species formerly occupied a variety of habitats including rivers, streams, springs, ponds, marshes and swamps (Sigler and Miller 1963 as cited in Bailey et al. 2005, p. 17). It was historically found in streams near Salt Lake City, in freshwater ponds, swamps and tributaries around the Great Salt Lake, in Utah Lake, in and around the Provo River, Beaver River, Parowan Creek, and Clear Creek, in tributaries of Sevier Lake, and in springs in Snake Valley and in Utah Valley (Sigler and Sigler 1987 as cited in Bailey et al. 2005, p. 17).

Least chub were first recorded by Dr. H.C. Yarrow and H.W. Henshaw in 1872 in Beaver River, Utah (Cope and Yarrow 1875 as cited in Bailey et al. 2005, p. 17). They found the species to be abundant in the areas where they made their collections. In 1889, least chub were collected by D. S. Jordan in the Provo River drainage, where they found the species to be 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 as cited in Bailey et al. 2005, p. 17). Least chub were subsequently found in tributaries of Great Salt Lake and Sevier Lake and were excessively common in ponds and warm pools (Jordan and Evermann 1896 as cited in Bailey et al. 2005, p.17). In the early 1900's, the distribution of least chub included the Beaver River, Parowan Creek and Clear Creek. The least chub was also found in the Provo River and freshwater ponds around the Great Salt Lake (V.M.Tanner 1936 as cited in Bailey et al. 2005, p. 17)

Least chub were additionally previously collected from the northeastern edge of the Bonneville Basin in Salt Lake and Davis counties. The Michigan Museum of Zoology contains specimens dating back to 1871 and 1933, from a small brook outside of Salt Lake City. Least chub were also collected in 1953 from Big Cottonwood Creek, in Salt Lake County, and near Centerville in 1964 and in Farmington Bay, Davis County, in 1965 (Pendleton and Smart, 1954 and Hickman 1989 as cited in Bailey et al. 2005, p. 17).

The abundance of least chub was declining by the 1940's and 1950's. By 1979, there were only 11 known populations (Holden et al. 1974, in Hickman 1989, and Workman et al. 1979, as cited in USFWS and UDWR 2014, p. 7). The only least chub populations located by Workman et al. 1979 were from Snake Valley including the Gandy Marsh complex, Leland Harris Spring complex, Callao Spring complex, Twin Springs and in

Redden Springs. Least chub were absent from the lower reaches of the Ogden River, Big and Little Cottonwood Creeks, Provo River, and from numerous springs and ponds in Juab, Millard and Tooele counties. The sites surveyed by Workman et al. in 1977 were also surveyed by Osmundson 1985 but this time least chub were only found in the Gandy Salt Marsh complex and Leland Harris Spring complex. Least chub were however found in Miller and Central Spring. The Callao springs were surveyed again by Shirley 1989 but no least chub were collected, while Rosenfeld found in 1984 that least chub chub in Redden Springs were not very abundant (Hickman 1989 as cited in Bailey et al. 2005, p. 17-18). Later surveys confirmed the extirpation of least chub from the Callao springs on the Bangley ranch and the Redden Springs complex (Crist 1990 as cited in Bailey et al. 2005, p. 18).

By 2007, a majority of the known natural populations extant in 1979 were extirpated and the known distribution of least chub consisted of 6 populations (USFWS and UDWR 2014, p. 7); Gandy Marsh, Bishop Springs and Leland Harris Springs in Snake Valley in northwestern Utah, Mills Valley in the Sevier drainage below Yuba Reservoir, the Mona Springs Complex in the Utah Lake drainage, and Clear Lake within the Sevier Desert Basin (Bailey et al. 2005, p. 18-19). The status of the Mona Springs population in 2007 was functionally extirpated (USFWS 2010, p. 35400).

B. CURRENTLY KNOWN, EXTANT, WILD POPULATIONS

Currently, there are only seven known, wild, extant populations of least chub, including the six that were extant (or functionally extirpated) in 2007. A seventh population (Gunnison) was discovered by the Utah Division of Wildlife Resources (UDWR) along the San Pitch River in 2016 (UDWR 2017, p. 27). These geographically separated populations are distributed across Genetic Management Units (GMU) delineated according to genetics information that showed population similarities in these areas. These units include West Desert GMU, Sevier GMU, and Wasatch Front GMU (Mock and Miller 2005 as cited in USFWS 2014a, p. 51043).

1 Mona Springs Population

This population is located in the southeastern portion of the Great Salt Lake sub-basin, on the eastern border of ancient Lake Bonneville, near the highly-urbanized Wasatch Front (USFWS and UDWR 2014, p. 7). It is found in the Utah Lake hydrologic subunit. Significantly, this is the only known wild population of least chub in the Wasatch Front GMU (Bailey et al. 2005, p. 30).

The Mona Springs population was discovered in 1995 (Mock and Miller 2003 as cited in USFWS and UDWR 2014, p. 8). Habitat near Mona Springs was originally privately owned, but 84 ha (208 ac) of land has been acquired by the Utah Reclamation and Mitigation Commission ("Mitigation Commission") since 1998 (USFWS, 2014a, p. 51045). The Mitigation Commission is a federal agency tasked with funding and implementing mitigation projects associated with the Central Utah Project, a federal

water project authorized in 1956, to develop Utah's allotment of the Colorado River. The Mitigation Commission was signatory to the 1998 and 2005 least chub candidate conservation agreements (CCAs) (USFWS 2014a, p. 51045) (see section VII. D. for more details).

The main threats to the Mona Springs population are nonnative species, particularly western mosquitofish, and unsuitable habitat (UDWR 2017, p. 34). Least chub at Mona have been negatively impacted by mosquitofish since the 1990s (UDWR 2015, p. II-1).

The Mona Springs population was considered to be functionally extirpated as early as 2007 and as recently as 2014 (USFWS 2010, p. 35400; Graham and Dittmer, 2019, p. 5). Only four least chub were collected at the Mona Springs site in 2008, 13 in 2009, three in 2010, five in 2011 and nine in 2012 surveys (USFWS and UDWR 2014, p. 9). Efforts to control nonnative species between ca. 1998 and 2008 were unsuccessful (Jones and Mellon, 2009, p. I-7). In 2012, UDWR installed fish barriers, and in 2013 a record number of juveniles were collected, documenting successful recruitment for the first time in many years (USFWS 2014a, p. 51045-51046). However, in 2014, the number of juveniles captured per trap declined sharply, down to a level similar to those obtained during monitoring surveys conducted from 1995 to 2012. There was therefore a substantial decline in least chub abundance at Mona Springs during the summer of 2014 (UDWR 2015, p. II-12).

In 2016, relative abundance was the third highest on record but as in 2013, the observed relative abundance was due to sampling after the stocking of least chub previously in the year (UDWR 2017, p. 36). Least chub were present at 14 out of 17 sampled monitoring sites. The number of least chub collected was 1,380, comprising 45% of the fish assemblage and captured at a rate of 15.86 least chub per trap. Western mosquitofish was the second most abundant species, representing 30% of the fish assemblage (UDWR 2017, p. 32) – somewhat lower than in 2015. Least chub were also collected from the only site without nonnative fishes (site 8), compared to 1 chub in the 4 years prior. The site habitat was enhanced in 2016 (UDWR 2017, p. 36). Average total least chub length was 40.5 mm TL, with a range of 24 to 65 mm TL. The proportion of juveniles (i.e. individuals < 35 mm TL) was 13% (UDWR 2017, p. 32). Overall, efforts to increase and further establish the least chub population at Mona Springs through stocking and extensive nonnative removal efforts have only seemed to have a temporary effect (*Ibid*, p. 37).

In 2018, least chub represented less than 2% of all fish species at Mona Springs (Graham and Dittmer, 2019, p. 8). The Mona Springs population was not surveyed in FY2020 (*Ibid*, p. 21), but was described as having declined in UDWR 2020 (p. 1).

Livestock grazing at Mona Springs was removed in 2005, and habitat enhancement projects to deepen the springs and remove Russian olive (*Elaeagnus angustifolia*) and other nonnative vegetation were started in 2011 (USFWS 2014a, p. 51045). However, it is indicated in Graham and Dittmer, 2019 (p. 8) (albeit with reference to the Mona population of the Columbia Spotted Frog), that there is livestock damage in Mona, as

well as water depletions, and residential development. The human population in Juab County increased by 85% from 1980 to 2010 (USFWS 2014b, p. 51) and at the time of publication of USFWS 2014a, there was a housing development within 1km (0.6 mi) of the least chub site (USFWS 2014a, p. 51050-51051). The rate of human population growth in Mona is currently positive (University of Utah, 2019, p. 3). As indicated in USFWS 2010, although much of Mona Springs habitat areas have been purchased and protected by the Mitigation Commission for the purposes of conserving least chub and spotted frog populations (USFWS 2010, p. 35404), negative impacts can still occur. Additional human development may lead to water diversion, 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. Urban stormwater runoff, or changing hydrological sediment regimes due to sedimentation from construction activities can furthermore lead to pollution (USFWS 2010, p. 35404).

2. Mills Valley Population

The Mills Valley population is one of three populations known in the Sevier GMU (USFWS 2014a, p. 51043; Graham and Dittmer 2019, p. 24). Historically, water in the Sevier River Basin flowed into pluvial Sevier Lake, but is now mostly diverted for agricultural purposes. The Mills Valley population was discovered in 1998 and is located at a relatively undeveloped site in the Lower Sevier River hydrologic subunit. The site consists of a wetland with numerous spring heads throughout the complex (Bailey et al. 2005, p. 31; USFWS and UDWR 2014, p. 7-8).

Almost 80% of the occupied habitat at Mills Valley is under private ownership, with the remaining 20% owned by UDWR as the Mills Meadow Wildlife Management Area (WMA) (LCCT 2014 as cited in USFWS, 2014a, p. 51046). Livestock grazing on the UDWR WMA by adjacent landowners was initially allowed in exchange for UDWR and public access to UDWR property (USFWS, 2014a, p. 51046). However, private landowner grazing rights were subsequently purchased back. The UDWR is also encouraging landowners to take part in the programmatic candidate conservation agreement with assurances (CCAA) to ameliorate their current grazing management strategies (Id.)

Least chub that were captured and measured during distributional surveys in 2014 averaged 34.5 mm TL. In annual monitoring surveys of that same year, 83.6% of the fish captured were least chub but western mosquitofish had become well-established at two of the four monitoring sites (UDWR 2015, p. II-11). In 2019, both western mosquitofish and green sunfish were captured but reproduction (i.e. presence of individuals less than 35 mm TL) was again observed. Catch rates of least chub were below average. There is no clear catch rate trend for the past 10 years of monitoring data or for the period dating back to the first surveys in 2004 (Graham and Dittmer, 2019, p. 22, 27). However, chubs are currently restricted to primarily one site, which is the only one without nonnative fish since 2013 (*Ibid*, p. 23).

Threats to this population include:

- **Nonnative species**. Nonnative species were considered to be a minimal threat at the time of the 2014 of the 12-Month Finding on the Petition To List Least Chub as an Endangered or Threatened Species (USFWS 2014a, p. 51057). Nonnative species had invaded the least chub habitat and become widespread in prior years but in 2009 made up less than 1% of the fish community. To mitigate against potential reinvasions, the 2014 CCA amendment required the drafting of a nonnative fish management plan by the spring of 2015 to address this threat (USFWS 2014a, p. 51057-51058), and nonnative removal efforts have indeed been conducted since (UDWR 2017, p. 29). However, nonnative fishes were discovered again in 2013, and as discussed above, only one site remains devoid of such fish since then (Graham and Dittmer, 2019, p. 23).

- **Livestock grazing**. Eighty percent of the least chub site is privately owned but, in general, only springs on the eastern edge of the wetland complex (ca. 50% of privately owned lands) have been significantly impacted by grazing in the past. In 2012, targeting of habitat restoration efforts and a shifting of grazing patterns to previously impacted private lands, led to an improvement in habitat quality and no additional accumulation of sediment from grazing at restored sites. The UDWR has also agreed to encourage private landowners to enroll in the programmatic CCAA to further minimize the remaining livestock impacts at Mills Valley (USFWS 2014a, p. 51049). This level of management cannot, however, protect against all impacts and grazing therefore remains a threat.

- **Potential for peat mining in the area.** In 2003, the State of Utah, Division of Oil and Gas Mining (UDOGM) gave a Mills Valley landowner a permit for conducting peat mining on their private land. A testing hole was dug although no further mining occurred. This permit is now inactive and the operation has been abandoned. Although past peat mining activities have been unsuccessful in Mills Valley (USFWS 2014a, p. 51050), there is no guarantee that viable projects will not be initiated in the future.

- **Potential oil and gas exploration**. Oil and gas leases have been sold by the Bureau of Land Management (BLM) in Mills Valley, and seismic lines constructed to ascertain whether commercially viable deposits of oil and/or gas are there (personal communication, Mark Pierce, Fillmore BLM office, August 2006). Given this history and the fact that the commercial viability of a deposit can change, there is the possibility that drilling will occur in the future.

3. Clear Lake Population

Clear Lake is the second population known in the Sevier GMU (USFWS 2014a, p. 51043), discovered in 2003 by UDWR at the Clear Lake Wildlife Management Area (WMA), in Millard County (Hines et al. 2008 as cited in USFWS and UDWR 2014, p. 8), in the Lower Beaver hydrologic subunit, and the Sevier Desert hydrologic basin (Basin 287) (Bailey et al. 2005, p. 31). The reserve includes a shallow reservoir and diked ponds fed by springs from adjacent Spring Lake (USFWS and UDWR 2014, p. 8). Clear Lake WMA is under UDWR ownership and management, and UDWR also owns the water right to the site (USFWS 2014a, p. 51046).

In 2015, least chub (n = 558) made up 67.6% of fish captured throughout Clear Lake. Ponds 2, 3, and 4 all had dry areas, pond 6 was completely dry, and Pond 4 had only one small pool below a culvert outflow. The north side of Pond 3 was also dry (UDWR 2017, p. 59). Annual drying in the outer ponds of Clear Lake was already occurring in 2007 (Jones and Mellon 2009, p. II-2) and now occurs consistently, and has resulted in decreased habitat quality and limited least chub distribution (UDWR 2017, p. 62).

In 2019, least chub were captured at two sites to monitor size class structure. Least chub comprised 20.8 % of the fish captured, with other fish including Utah chub and common carp (*Cyprinus carpio*). Least chub captured within seine hauls ranged from 16 mm to 37 mm, with almost all individuals less than 35 mm in total length (Graham and Dittmer, 2019, p. 11). Overall, the population was reported to be declining with water flow at Clear Lake (Graham and Dittmer 2019, p. 11).

In addition to reduced water availability, the Clear Lake population is also threatened by invasive species. Considerable numbers of common carp were removed from the Lake between 2003 and 2013, where they impacted vegetated habitat (USFWS 2014a, p. 51046). In 2013, small, targeted rotenone treatments were used to remove more than 928 adult common carp. In February 2015, there was another targeted treatment in the same area, with 160 adult carp removed. Continued removal is necessary for reducing carp numbers and preventing repopulation. However, the effectiveness of the rotenone treatment is contingent on large numbers of carp regularly congregating in small areas (UDWR 2017, p. 62).

The Clear Lake WMA is protected from livestock grazing as a result of UDWR management policies that followed the establishment of the WMA (USFWS 2014a, p.51048-51049).

4. Gunnison Population

Gunnison is the third and final population of least chub found in the Sevier GMU. It was discovered by the UDWR in 2016, in a 190m seepage channel below Gunnison Dam, located ca. 10 miles northeast of the town of Gunnison, in Sanpete County, in the San Pitch Subunit. Least chub are also encountered in some pools below where the ditch

empties into the San Pitch River. The land is owned by the Gunnison Irrigation Company (Graham and Dittmer, 2019, p. 24; Utah Department of Natural Resources 2021, p. 1).

Since 2016, chubs have been found annually in the seep and portions of the river, and approximately 70% of the fish collected have been juveniles. The fish are therefore reproducing (*Id*.). In 2018, however, around 500 chubs were stranded in a pool below the seepage channel and had to be transferred to the seep. The latter constitutes the only reliable water in the area due to water from the San Pitch River channel often being diverted (*Id*.). Much of the river dries up during periods of extreme drought, and even during normal conditions (*Ibid*, p. 2). In 2019, catch rates were below average at Gunnison for the period dating back to the first (2017) surveys but the relatively high catch rates in 2018 greatly skewed the average due to the hundreds of chubs that were stranded in the isolated pool that year (Graham and Dittmer, 2019, p. 22). The number of least chub captured in 2019 was 64, while the number of captured fathead minnows and green sunfish was 443 and 7 respectively (*Ibid*, p. 25).

In addition to fluctuating river flow, there are Russian olive and tamarisk (*Tamarix ssp.*) trees growing densely along the seep and which are negatively impacting water quantity and quality in the seep and river downstream (Utah Department of Natural Resources 2021, p. 1). Olive trees lining the seepage channel are discharging large quantities of leaf litter into what is often a limited amount of water. Russian olive fixes nitrogen and its leaf litter therefore contains high levels of this element. Nitrogen can degrade water quality and cause the harmful proliferation of algae in excessive amounts (*Ibid*, p. 4).

There is also excess submerged vegetation and woody debris in the channel. Overabundant vegetation covering the channel bottom may impact available habitat. Moreover, it may hinder translocation of chubs to refuge sites (*Ibid*, p. 2). Both chub translocation efforts to refugia (to preserve the genetic stock of this population) and removal of nonnative fish such as green sunfish (*Lepomis cyanellus*) and fathead minnows (*Pimephales promelas*) are hampered by the presence of Russian olive and tamarisk trees (*Ibid*, p. 1). UDWR is proposing to remove some of the nonnative vegetation to improve the status of the Gunnison least chub population (*Ibid*, entire).

5. Snake Valley Populations

The Snake Valley Hydrologic Subunit (Basin 254) of the West Desert GMU is located between the Deep Creek Mountains and the Confusion Range (Bailey et al. 2005, p. 29). The remaining three wild populations of least chub are found here: Leland Harris (including Miller Spring), Bishop Springs, and Gandy Marsh. These populations are genetically similar, very close in proximity to each other and occur within the same groundwater basin (USFWS 2014a, p. 51043; USFWS and UDWR 2014, p. 12). They include large complex spring and wetland systems consisting of multiple springheads (LCCT 2014, p. 9).

Leland Harris Spring Complex Population

The Leland Harris Spring complex is located north of the Juab/Miller County line and least chub were first collected from this site by R.R. Miller in 1970 (Sigler and Sigler 1987 as cited in USFWS 2010, p. 35401). The site is made up of 12 to 15 springheads that feed a playa wetland. Habitat fluctuates seasonally fluctuates in size (USFWS 2010, p. 35401). Least chub occupied habitat is 50% privately owned, 40% UDWR lands and about 10% owned by the BLM (USFWS 2014a, p. 51046).

Miller Spring, another spring complex in the area, consists of "a diked upper spring pool (Poplar Spring) that drains into a channel that meanders through the wetland, receiving discharge from a few smaller peripheral springs along the way" (UDWR 2015, p. II-15). Least chub have been observed in the meandering channel in the past. The channel receives seasonal flow from the Leland Harris Spring Complex to the south but the channel usually dries up through most of summer and early fall, greatly restricting downstream movement of least chub. In 2013, least chub were transferred from drying ephemeral pools at the Leland Harris Spring to Poplar Spring, where they had not previously been observed. Based on 2014 surveys, the least chub in Poplar Spring were established and reproducing, and may provide a source of colonists for the downstream wetland at Miller Spring (UDWR 2015, p. II-15). The latter spring and its surrounding wetlands (approximately 20.2 ha (50 ac)) are under private ownership but managed under a grazing plan developed by the UDWR and the private landowner (USFWS 2014a, p. 51046).

Least chub have been persistently found at the Leland Harris Spring complex since monitoring began in 1993 (USFWS 2010, p. 35401). Least chub were present at all monitoring sites (2, 6, 7 and 11) surveyed in 2016. Least chub (n=1,298) represented 78% of the fish assemblage and the average capture rate was 44.8 least chub per trap (UDWR 2017, p. 31). The number of least chub per trap was considerably lower in 2016 than in 2015 but average compared to the past 12 years. The reason for the decline is unclear (*Ibid*, p. 35). The average catch rate at annual monitoring sites was above average in 2019. There is no clear catch rate trend for the past 10 years of monitoring data or for the period dating back to the first surveys in 2004 (Graham and Dittmer, 2019, p. 22, 28). However, relative to 2014 when the last distributional survey was conducted, several sites in 2019 had dried up or become too shallow for trap deployment. Overall, abundance had substantially decreased at a number of sites from 2014 to 2019, including instances of no detection where abundance was relatively high (*Id*.).

The Leland Harris least chub population is threatened by dewatering. Based on recent studies, there is a strong link between groundwater level and surface water habitat of least chub in the Leland Harris area (Grover 2016 as cited in UDWR 2017, p. 36; Grover, 2019, entire). Habitat used by this species and in particular shallow water habitats used for spawning could be destroyed by reduced groundwater. Maintaining adequate groundwater levels is therefore critical (UDWR 2017, p. 36).

The complex is currently free of nonnative species and "all efforts to prevent the spread of invasive species into this area should be utilized" (*Id.*). Russian olive trees were

growing at Leland Harris and Miller Spring in 2019 (Graham and Dittmer 2019, p 23). At the time of publication of USFWS 2014a, only 28% of the Leland Harris site had no livestock grazing, although the remainder of the area was either managed under a grazing management plan or managed for grazing (USFWS 2014a, p. 51049).

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). Today, most of the land in Snake Valley west of the least chub populations is under active oil and gas leases (see section IV. C).

Gandy Salt Marsh Population

Gandy Salt Marsh is located south of the Millard/Juab County line and the Leland Harris Spring Complex (USFWS 2010, p. 35401). Least chub were first collected from Gandy Marsh in 1942 by C.L., L.C., and E.L. Hubbs (Sigler and Miller 1963 as cited in USFWS 2010, p. 35401). The site is south of the Millard/Juab County line and the Leland Harris Spring Complex, and measures about 6.4 km (4 mi) north to south, and 3.2 km (2 mi) east to west. The complex includes a large playa wetland fed by 52 small springheads or ponds on ca 1,295 hectares (ha) (3,200 acres (ac)) (USFWS 2010, p. 35401).

Seventy percent of the land in Gandy Marsh is owned by the BLM, 29% is private lands and 1% is owned by the State and Institutional Trust Lands Administration (SITLA). There is also an Area of Critical Environmental Concern (ACEC) spanning 919 ha (2,270 ac) (USFWS 2014a, p. 51046). The ACEC includes most of the lake bed and habitats and is closed to oil and gas leasing to protect the least chub (*Id.*). However, oil and gas development further afield may still occur, potentially impacting the hydrology of the least chub habitat (see section IV. C). The ACEC is also fenced to exclude livestock. The landowner of the privately owned parcel voluntarily enclosed some springheads, leading to a significant reduction in the rate of livestock entrainment. When livestock become trapped in soft spring deposits, they can die, and as they decompose, pollute the springhead (USFWS 2014a, p. 51046).

The number of occupied sites within Gandy Marsh decreased by about 50% between ca. 1994 and 2010 (USFWS 2010, p. 35401). Manual restoration of degraded springheads at Gandy Marsh by removing of overgrown vegetation, silt, and mud to provide habitat for least chub was started by UDWR in 2006. Restoration work took place at 30 sites between 2006 and 2017, and least chub have since been trapped at 21 out of the 30 (70%) restored sites (Graham and Dittmer, 2019, p. 10-11). In 2016, least chub were captured in 10 of the 52 (19.2%) distribution monitoring sites and comprised half of the fish captured. The distribution of least chub was similar than in 2013 (UDWR 2017, p. 59). In October 2017, prescribed burns were used to increase open water and improve the movement of fish between habitats within exclosures. Subsequent monitoring indicated the burns were successful. However, continued habitat restoration activities, invasive plant control and monitoring of least chub and vegetation to the controlled burn at the Gandy Marsh exclosures are recommended (Graham and Dittmer, 2019, p. 11).

In 2019, least chub were captured at 13 of 52 (25%) sites and comprised about two thirds of the fish captured (Graham and Dittmer, 2019, p. 10). The size of the fish ranged between 28 and 46 mm, with 85.2% being young (*Ibid*, p. 11). The population appears to be stable overall (Graham and Dittmer 2019, p. 11; UDWR 2020, p. 1).

Bishop Spring Complex Population

The Bishop Spring Complex is located south and very near Gandy Salt Marsh. Least chub were first documented at this site in 1942 (Hickman 1989 as cited in USFWS 2010, p. 35401). Bishop Springs has large springs containing least chub, including Central Spring and Twin Springs (Hines et al. 2008 as cited in USFWS 2010, p. 35401). BLM owns 50% of the land at Bishop Springs, SITLA 40% and 10% is under private ownership. Foote Reservoir and Bishop Twin Springs provide most of the perennial water to the complex. In 2006, a CCAA was established to purchase privately owned water rights for Foote Reservoir and Bishop Twin Springs (USFWS 2014a, p. 51046). A single property owner previously had water rights to Foote Reservoir reservoir for agricultural purposes. When the landowner exercised these water rights, up to two thirds of the wetland complex would become dewatered, causing the mortality of thousands of least chub as well as impacts to Columbia spotted frog (Utah Wildlife Action Plan Joint Team 2015, p. 110). In 2008, a permit for permanent change of use was obtained, leading to a seasonal instream flow that helps maintain water levels at Bishop Springs Complex and protect the least chub (USFWS 2014a, p. 51046). However, as noted in USFW 2010 (p. 35412), this level of land management may not adequately protect the site from the indirect loss of water caused by future large-scale groundwater pumping.

There was a significant decline in the percentage of sampling sites containing least chub between 2003 and 2014 based on annual monitoring data (UDWR 2015, p. III-14, figure 4). In 2014, least chub were captured in only 6 out of 42 (14.3%) distribution monitoring sites at Bishop Springs but the distribution within sampled sites was similar than in previous years, if not slightly expanded (UDWR 2015, p. III-3). Least chub captured at one site for size monitoring ranged from 20 mm to 55 mm, with less than 8% being young-of-year (*Ibid*, p. III-3). In 2019, 89.9% were young-of-year, ranging from 13 to 45 mm (Graham and Dittmer, 2019, p. 11). The Bishop Springs population appears to be stable overall (Graham and Dittmer 2019, p. 11; UDWR 2020, p. 1). However, distribution monitoring post-2014 had not yet been conducted by December 2019 (UDWR 2017, p. 63; Graham and Dittmer, 2019, p. 12).

In addition to the threat of groundwater pumping, invasive Russian olive and purple loosestrife (*Lythrum salicaria*) are intruding into Bishop Springs, and controlling these species is a priority. In 2012, Russian olive were removed from Foote Spring and its outflow over 28 acres. In 2014, roughly 11 acres of Russian olive were removed from the Twin Springs area, and approximately 200 purple loosestrife plants from the Foote Spring outflow channel. Spraying with Garlon 3A was conducted to reduce and control regrowth in 2014, 2015 and 2016 (UDWR 2015, p. III-4; UDWR 2017, p. 61).

Other habitat-based threats to the Bishop Springs population include oil and gas (see above) and livestock grazing. There is currently fencing around the accessible springs but are livestock are not excluded completely from the site (USFWS 2014a, p. 51046, 51049; UDWR 2015, p. III-4).

Nonnative fish are a potential threat to the Bishop Springs least chub population due to a history of nonnative fish introductions and removals at the site. Indeed, Bishop Springs was historical least chub habitat until introductions of nonnative common carp and largemouth bass (*Micropterus salmoides*) extirpated the species. In August 2010, UDWR attempted a reintroduction but largemouth bass were again introduced, leading to the demise of the least chub. Largemouth bass were mechanically removed between 2010 and 2014 and the least chub was reintroduced again in 2014 (UDWR 2015, p. III-4).

With the above threats already acting on the least chub populations, proposed groundwater pumping from the adjacent Pine, Wah-Wah and Hamlin Valley aquifers to support human population growth in Cedar City, Utah, may be particularly insidious. The proposed withdrawals could impact groundwater levels in Snake Valley and the Sevier Desert Basin, and thus the freshwater habitats supplied with groundwater where least chub occur. More discussion on this groundwater pumping project and its impact can be found below, in section IV. E.

C. INTRODUCED POPULATIONS

Establishing additional least chub populations has been a goal of the Least Chub Conservation Team (LCCT) since it was established in 1998 (see section VII. D. for more details). Introduced populations can provide secure genetic refuges to protect against catastrophic loss, mitigate current and future threats affecting natural populations, and provide a source for reestablishing naturally occurring populations or establishing new populations (USFWS 2014a, p. 51043). The LCCT set a goal of establishing three introduced populations in each of the three GMUs, with the introduced populations providing a genetic representation of each of the six (now seven) wild populations (*Ibid*, p. 51044).

At the time of publication of USFWS 2014a, approximately 30 introductions had been attempted by the UDWR since 1979, to new locations within the least chub's historical range. Pre-2008 introductions were, however, not highly successful or lacked sufficient monitoring to determine success. Since 2008, additional monitoring data has become available and specific criteria needed for success have been developed, such as suitable water quality and two seasons of documented recruitment. An introduction site is, however, not excluded from consideration even if it has some level of livestock grazing or nonnative species presence (*Ibid*, p. 51043-51044).

From 2014 to 2019, the number of refuge populations increased from 10 to 14 (USFWS 2014a, p. 51044; Graham and Dittmer, 2019, p. 18, 27), but the current number may be closer to 12 (see below). There have also been two extirpations despite the overall small increase in the number of refuge populations. Indeed, the Fitzgerald WMA (Atherly

reservoir) population established in 2006 was extirpated due to drying caused by drought conditions and upstream diversions of Faust Creek (UDWR 2015, p. II-3, II-17). The hundreds of common carp observed at the site in 2014 (*Ibid*, p. II-13) may have also been a contributing factor. The Off Spring refuge population established in 2015 was extirpated due to winterkill (LCCT 2017).

In 2013, there were also two introduction sites (Lucin Pond and Sparks Spring) (UDWR 2014, p. I-5, I-6) that were subsequently extirpated as "experimental" (i.e. not meeting the refuge criteria) populations in 2014 (UDWR 2015, p. I-1; UDWR 2017, p. 6). Another introduction site (Baker Spring) existing in 2013/2014 (UDWR 2014, p. I-7; UDWR 2015, p. I-3) was upgraded to an experimental population in 2016, after least chub were documented for the first time after stocking (UDWR 2017, p. 9-10). The current status of Baker Spring is unknown as no monitoring data for this site is presented in the latest statewide monitoring report (Graham and Dittmer, 2019, entire).

Other introduction sites (West Locomotive, Teal and Bar M Springs) existing in 2013/2014 (UDWR 2014, p. I-1; UDWR 2015, p. I-3) were classified as "range expansion" as opposed to experimental populations at the time of publication of UDWR 2017, because least chub were yet to be captured post-stocking (UDWR 2017, p. 9-10). However, their current status is unknown for the same reason as for Baker Spring. As of 2021, efforts to translocate a proportion of the Gunnison population to refugia seem to have begun but are being hampered by the growth of invasive vegetation (Utah Department of Natural Resources 2021, p. 1).

Below we provide a brief description of the extant 14 refuge (including Escalante and Pilot Spring) and 1 experimental and 3 range expansion populations, and their status.

1. Refuge populations

Red Knolls Pond. Least chub were introduced into this semi-natural BLM site, from Bishop Springs, in 2005. Successful recruitment was observed 2005-2009 and 2011-2012, suggesting reproduction was occurring (LCCT 2004, p. 8; USFWS and UDWR 2014, p. 9). Young-of-the-year (YOY) were also observed in 2010, and from 2013-2016, and in 2019. However, none were observed in 2017 and 2018, and %YOY was only 1 in 2011 and 2012 (Graham and Dittmer, 2019, p. 20). No other species were recorded at the site in 2015 (UDWR 2017, p. 15).

Keg Springs. Least chub were released into this semi-natural site, from Gandy Marsh, in 2009 (LCCT 2014, p. 8). There was grazing, although fenced and managed, at the site at the time of publication of USFWS 2014a (p. 51044). Young-of-the-year were observed from 2010 to 2019, although %YOY was only measured through to 2018. Percent YOY in 2018 was 57 but it was less than 7 in 2015-2017 (LCCT 2014, p. 8; UDWR 2017, p. 7; Graham and Dittmer, 2019, p. 20) and catch per unit effort (CPUE) was also low in 2015. Vegetation may have been crowding out least chub and causing water

quality/temperature issues (UDWR 2017, p.7, 11). No other species were observed in 2015 (*Ibid*, p. 15).

Pilot Spring. Least chub from Leland Harris were introduced into this semi-natural BLM land site in 2008. Least chub were detected from 2009 to 2012. Although recruitment was limited in 2009, juvenile least chub comprised 50 percent or more of the samples in 2010, 2011, and 2012. The BLM dredged the pond in 2010 and water levels took about two years to recover (USFWS and UDWR 2014, p. 10; LCCT 2014, p. 8). There was grazing at the site, although fenced and managed, at the time of publication of USFWS 2014a (p. 51044), and presumably UDWR 2017 due to the reported presence of a grazing permittee (UDWR 2017, p. I-3). In 2014, 15% of least chub captured were age-0 or young of the year, and the CPUE was 19.8 fish/trap hour (UDWR 2015, p. I-4). In 2015, CPUE was low (1.4 fish/trap hour) and only about 3% of least chub were age=0. The target number of 100 captured was not met. No other species were recorded at Pilot Spring in 2015 (UDWR 2017, p. 15). Encroaching vegetation due to the exclusion of grazing (presumably via fencing) may have been crowding out least chub and causing water quality/temperature issues. In 2016, low numbers of fish were produced, including age-0 numbers (*Ibid*, p. 11, 13). From 2017 to 2019, CPUE varied between <1 and 3 fish/trap hour and %YOY varied between 16 and 46 (Graham and Dittmer, 2019, p. 19). At the time of publication of Graham and Dittmer, 2019, Pilot Spring was the only refuge for the Leland Harris population (p. 19, 24). UDWR has since indicated that the Leland Harris population does not have a refuge population (UDWR 2020, p. 1) which means that the Pilot Spring population may be extirpated.

Rosebud Top Pond. Least chub from Mills Valley were introduced to this semi-natural site in 2008. Least chub were observed annually from 2009-2012 and recruitment to the population was apparent (USFWS and UDWR 2014, p. 9; LCCT 2014, p. 8). In 2014, more than 68% of least chub captured were age-0 fish. CPUE was only 1.98 fish/trap hour, significantly lower than the 274-3540 fish/trap during the three years prior (UDWR 2015, p. I-4). However, this relatively low CPUE may have been caused by later than normal sampling, with least chub retreating into cattails to avoid predation by sterile rainbow trout (*Oncorhynchus mykiss*) in the pond as they move vertically in response to temperature changes (UDWR 2015, p. I-8). In 2015-2016, age-0 fish were present and CPUE was higher, albeit still lower than in the three years prior to 2014 (UDWR 2017, p. 6-7). From 2017-2019, CPUE varied between 24 and 500 fish/trap hour and %YOY between 28 and 98 (Graham and Dittmer, 2019, p. 19).

Cluster Springs. Least chub from Mills Valley were introduced into this natural site on BLM land in 2008 (LCCT 2014, p. 8; USFWS and UDWR 2014, p. 10). Least chub were present in 2009 and 2010 and recruitment to the population was apparent. In 2014, 7% of the least chub captured were age-0 fish and CPUE was the lowest on record at 0.29 fish/trap hour, with prior estimates ranging between 17.7 and 606 fish/trap hour (UDWR 2015, p. I-4, I-5). In 2015, CPUE was again relatively low at 6 fish/trap hour (UDWR 2017, p. 8). Cluster Springs is fenced from grazing activities and overgrown vegetation may have been crowding out least chub and causing water quality/temperature issues. Submerged aquatic vegetation was removed from ~40% of the ponded area on August 31

2016 (*Ibid*, p. 11). From 2016-2019, CPUE ranged between 12 and 42 fish/trap hour (Graham and Dittmer, 2019, p. 19). Continued dredging of encroaching submerged vegetation out of Cluster Springs is required annually (*Id.*).

Pond SE of Pilot. Least chub from Mills Valley were introduced into this semi-natural site on BLM land in 2008 (LCCT 2014, p. 8; USFWS and UDWR 2014, p. 10). There was (managed) grazing at the site at the time of publication of USFWS 2014a (p. 51044) and presumably also UDWR 2017 due to the reported presence of a grazing permittee (see below) (UDWR 2017, p. I-3). Successful recruitment was documented from 2009 to 2012 (USFWS and UDWR 2014, p. 10). The site was classified as a refuge population in 2013. In 2014, 5.5% of fish captured were age-0 and the majority of the fish were also adults in the previous 5 years of monitoring. CPUE was at a record low, at 1 fish/trap hour (UDWR 2015, p. I-4). In 2015, CPUE was even lower and no recruitment was documented (UDWR 2017, p. 3, 7). Encroaching vegetation due to the exclusion of grazing (presumably via fencing) may have been crowding out least chub and causing water quality/temperature issues (*Ibid*, p. 11, 13). In 2016, CPUE was 1.61 fish/trap hour and 52% of fish captured were age-0 (*Ibid*, p. 7). In 2017 and 2018, %YOY was 0 and in 2019, it was 1. Dredging is required to remove fully encroached cattails and provide additional open water habitat (Graham and Dittmer 2019, p. 19).

Escalante Elementary. Least chub from Mona Springs were introduced on the property of the Escalante Elementary School in Salt Lake City, in 2006. Their presence was observed from 2009 to 2012, with recruitment to the population also apparent (USFWS and UDWR 2014, p. 10; USFWS 2014a, p. 51051). In 2014, the Escalante population was characterised as stable, with steady juvenile recruitment and high adult survival (UDWR 2015, p. II-3). In 2015, the catch rate was 53.6 least chub per trap but only 1% of individuals were juvenile (UDWR 2017, p. 30-31). In 2016, the catch rate was 33.9 least chub per trap and 41% of individuals were juvenile (*Ibid*, p. 32). In 2019, the catch rate was 60 least chub per trap and the proportion of juveniles was 17% (Graham and Dittmer 2019, p. 27). However, the refuge has been plagued by difficulties maintaining water levels due to operational issues. The school district decided not to finance the repairs for the latest issues while UDWR made its support contingent on the issues being repaired by the school. The population will be considered extant while it continues to be maintained by the school teachers (*Ibid*, p. 22).

Upper Garden Creek Pond. Least chub from Mona Springs were introduced into this semi-natural site in 2011, after the introduced population in the Lower Garden Creek Pond was lost in 2010 due to reduced water flows in the lower end of the drainage. Successful recruitment was observed in 2012. In 2014, CPUE was high at 77.4 fish/trap hour but only 1% of least chub were age-0 (LCCT 2014, p. 8; USFWS and UDWR 2014, p. 11; UDWR 2015, p. I-3). The site was not monitored in 2015 or 2019 due to time constraints. In 2016 and 2018, %YOY was 2 and CPUE was 27.3 and 166 fish/trap hour respectively. No recruitment (% YOY = 0) was observed in 2017 (UDWR 2017, p. 6; Graham and Dittmer 2019, p. 19).

Tooele Army Depot South (formerly Deseret Chemical Depot). Least chub from Mona Springs were introduced into this man-made site in 2011 (USFWS and UDWR 2014, p. 11; LCCT 2014, p. 8). High overwinter survival and very strong juvenile recruitment were observed during 2012-2013. The population grew exponentially between 2011 and 2014, reaching a CPUE of 168 least chub per trap hour (UDWR 2015, p. II-13). Juveniles comprised 43.4% of the least chub measured (*Ibid*, p. II-14). In 2015, the catch rate at the northeast pond of the Tooele Army Depot South site was 86.75 least chub per trap and 6% of measured individuals were juvenile. The catch rate at the southwest pond was 31.3 least chub per trap and 16% of measured individuals were juvenile (UDWR 2017, p. 31). In 2016, no juveniles were collected at the northeast pond and only one was captured in the southwest pond. However, abundance at the Tooele Army Depot South site was higher relative to 2015 and the relative low number of juveniles could be due to some young of the year having just recruited to the adult population (*Ibid*, p. 36). In 2019, the catch rate at the northeast pond was 303 least chub per trap and 43% were young chubs. At the southwest pond, the catch rate was 172 least chub per trap and 3% were young chubs (Graham and Dittmer 2019, p. 27).

Stokes nature center. Least chub were introduced to this natural site, from Mills Valley, in 2008 (USFWS and UDWR 2014, p. 10; LCCT 2014, p. 8). The site was elevated to the status of refuge population in 2014 as a result of its viable population and enrollment in a conservation easement (UDWR 2015, p. I-1). CPUE in 2014 was 55.1 fish/trap hour and approximately 77% of the least chub were age-0 fish (*Ibid*, p. I-5). In 2015 and 2016, approximately 33 and 39% of least chub were age-0 fish, while CPUE was 2.23 fish/trap hour and 1.91 fish/trap hour (UDWR 2017, p. 8). CPUE increased and %YOY was the same or higher in subsequent years, except for 2019, which was not sampled due to time constraints (Graham and Dittmer 2019, p. 19).

Chambers Spring. Least chub were introduced to this natural site, from Mills Valley, in 2008 (USFWS and UDWR 2014, p. 10; LCCT 2014, p. 8). The site is listed as an experimental population in UDWR 2017 (p. 15) and as a refuge population in Graham and Dittmer 2019 (p. 19), suggesting it was recently upgraded to this status. However, the population was not sampled in 2019 due to time constraints and CPUE was low from 2016 through 2018, at <1 least chub/trap hour (Graham and Dittmer 2019, p. 19).

Willow Pond. Least chub were introduced to this site, from Clear Lake, in 2007 (USFWS and UDWR 2014, p. 9). Willow pond was reclassified from refuge to experimental population in 2013 due a wildfire which caused flooding and subsequently siltation at the site (UDWR 2015, p. I-1). The least chub remaining were salvaged from the pond and transferred to Fisheries Experiment Station (*Ibid*, p. I-5). Recruitment was observed at the site in 2014, 2015 and 2016, and Willow Pond was re-classified as a refuge population in 2016 (UDWR 2015, p. I-1; UDWR 2017, p. 3). In 2017 and 2018, CPUE was 182 and 132 least chub/trap hour and %YOY was 12 and 19. In 2019, the Willow pond was only assessed visually and young of the year were confirmed to be present (Graham and Dittmer 2019, p. 19).

Jail Pond. Least chub were introduced to this man-made site, from Mona Springs, in 2015 (UDWR 2017, p. 29). In 2015, least chub were captured at a catch rate of 4.4 least chub per trap (June) and 1.4 least chub per trap (November). The proportion of juveniles was approximately 3 and 4% (UDWR 2017, p. 31). In 2016, least chub were captured at a catch rate of 89.4 least chub per trap (June) and 25 least chub per trap (October). Not enough individuals were measured in June to determine size structure but approximately 76% of measured individuals in October were juveniles (*Ibid*, p. 33). In 2019, the catch rate (August) was 110 least chub per trap and 84% of fish were young (Graham and Dittmer 2019, p. 27).

Big Springs. Least chub were introduced to this natural site, from Mona Springs, in 2013 and monitored for the first time in 2014 (LCCT 2014, p. 8; UDWR 2015, II-3). Least chub were locally abundant and reproducing in an upper pond and in the lower channel of the spring system (*Ibid*, p. II-16). In 2015 and 2016, multiple age classes were again observed in this refuge population, and more chubs were stocked into the site in 2016 (UDWR 2017, p. 27). The catch rate in 2015 was 3.2 least chub per trap and the proportion of juveniles was 35%, indicating a lower relative abundance but greater recruitment compared to 2014 (*Ibid*, p. 31, 25). In 2016, the catch rate was 1.57 least chub per trap and the proportion of juveniles was 9% (*Ibid*, p. 33). Compared to 2015, both recruitment and the relative abundance were therefore lower (*Ibid*, p. 36). In 2019, the survey was expanded to the lower portion of the complex, leading to the discovery of more least chub and evidence of reproduction (Graham and Dittmer 2019, p. 22). The catch rate at the Big Springs site was <1 least chub/trap and the proportion of young fish, 50% (*Ibid*, p. 27).

2. Experimental populations

Baker Spring. Least chub were introduced to this site, from Gandy Salt Marsh, in 2013. No least chub were captured in 2014 (UDWR 2015, p. I-6). However, there were other species present, including common carp (Ibid, p. I-12). Least chub were captured for the first time in 2016, resulting in Baker Spring being upgraded to an experimental site (UDWR 2017, p. 9-10).

3. Range expansion populations

Teal Spring. Least chub were introduced into this site, from Clear Lake, in 2012. No least chub were detected during the first year of monitoring in 2014. However, there were other species present, including common carp (UDWR 2015, p. I-7, I-12). No least chub were similarly captured in 2015 or 2016 surveys, but mosquitofish were present, including schools in the thousands in 2016 (UDWR 2017, p.10).

Bar M Spring. Least chub were introduced into this site, from Leland Harris, in 2013. No least chub were captured in 2014, 2015 or 2016, but other species including mosquitofish were captured (UDWR 2015, p. I-6; UDWR 2017, p. 10).

West locomotive springs. Least chub were introduced into this site, from Bishop Springs, in 2012. No least chub were captured in 2013 or 2014 (UDWR 2015, p. I-6). However, other fish species including mosquitofish and common carp were present in 2014 and 2015 (Ibid., p. I-12; UDWR 2017, p. 15). No least chub were captured in 2015 or 2016 (UDWR 2017, p. 9).

E. OCCURRENCE/POPULATION STATUS SUMMARY

The least chub is categorized by NatureServe as imperiled (NatureServe 2021a). The imperiled rank is assigned by NatureServe when there is a high risk of extinction (or extirpation in the jurisdiction under consideration) due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors (NatureServe 2021b). The least chub is also designated as a sensitive species in Utah as it "suffers from a reduced distribution, substantial current threats under present management, and potential future threats" (UDWR 2020, p 3).

A majority of the wild populations that existed historically have been extirpated, with the remaining 7 populations either declining or in a precarious state. Table 1 summarizes the status of each individual population, including the main site-specific threats. The following main threats also apply to all least chub populations and are described in more detail in section IV: prolonged drought and climate change, stochastic disturbance and population isolation, and the cumulative effects of various threats.

In addition to the wild populations, there are 12 to 14 refuge populations. The exact number of populations is unknown as one of the refuge population (Escalante) was no longer being maintained by UDWR in 2019, and another (Pilot Spring) was extant at the time of publication of Graham and Dittmer 2019 but seemingly extirpated thereafter. The total number of refuge populations also does not reflect the number of failed attempts to establish or maintain populations, which is much higher.

Among the existing refuge populations, no recruitment was observed at Pond SE Pilot in 2015, 2017 or 2018, at Red Knolls Pond in 2017 or 2018 and at Upper Garden Creek Pond in 2017. Nonnative fish are known from one site (Rosebud Top Pond), although as noted in Thompson et al. 2015 (p. 554) the invasion or illegal introduction of nonnative fish into extant and introduced populations is a constant threat, with the remote locations of most introduced populations likely providing some level of protection. Livestock grazing is known from 4 sites (Cluster Springs, Pilot Spring SE, Keg Spring and Pilot Spring), albeit fenced and/or managed (USFWS 2014a, p. 51044; UDWR 2017, p. 11, 13). Encroaching vegetation has also been identified as an issue at the latter 4 sites, seemingly driven at least in part by a reduction in grazing pressure.

In addition to the refuge populations, there were 1 experimental (least chub documented post-stocking but not meeting refuge population criteria) and 3 range expansion populations (no least chub documented post-stocking) as of 2016. Efforts to translocate a proportion of the Gunnison population to refugia seem to also be ongoing. The refuge

and range expansion populations' current status is unknown but nonnative fish have been detected at all 3 range expansion sites in recent surveys. Two experimental populations (Lucin Pond and Sparks Spring) were extirpated in 2014.

Table 1. Summary of least chub status and main site-specific threats by wild population.

Population	**Status**	**Details**	**Threats**
Mona Springs	Declining	Population considered to be functionally extirpated in 2010 and 2014 and despite temporary improvements has been declining	nonnative fish, livestock grazing, urban development, water depletions
Clear Lake	Declining*	Population reported to be declining with water flow at the site. The outer ponds tend to dry up annually.	Nonnative fish, reduced water availability/groundwater extraction
Mills Valley	Stable but with a reduced distribution	Population seemingly stable based on catch rates but primarily now restricted to the only site devoid of nonnative fish	Nonnative fish, livestock grazing, peat mining, oil and gas development
Gunnison	Unknown but in danger of being extirpated during dry years	Population discovered recently with only 3 years of monitoring data available. However, habitat is highly degraded and subject to fluctuating water availability	Nonnative fish, invasive plants, water diversion
Bishop Springs	Stable but recent distribution data is unavailable	Population reported to be stable but no recent distribution monitoring data and prior data indicated decline over the time in the percentage of sampling sites containing least chub	Invasive plants, nonnative fish, livestock grazing, oil and gas development, groundwater extraction
Gandy Marsh	Stable	Population reported to be stable	Invasive plants, livestock grazing, oil and gas

			development, groundwater extraction
Leland Harris Complex	Stable but water levels declining at multiple sites	Population seemingly stable based on catch rates. However, several sites have dried up or become too shallow to monitor in the past 5 years.	Livestock grazing, invasive plants, oil and gas development, reduced water availability/groundwater extraction

*The Clear Lake population was characterized as declining with water flow, as opposed to stable, in the latest statewide monitoring report of December 2019 (Graham and Dittmer 2019, 11), and as stable in Utah's species status assessment of April 2020. The basis for either determination is unclear but we deem the first one to be more likely given prior recent observations of habitat drying.

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

Habitat loss and degradation have been identified as major causes of least chub populations and distribution declines (Holden et al.1974, Hickman 1989 and Crist 1990 as identified in Bailey et al. 2005, p. 21). 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, p. 29, 31). The major threat now is water withdrawal and diversion, and this threat is compounded by the effects of the other threats, including invasive plants.

A. LIVESTOCK GRAZING

Historic livestock grazing impacted Mills Valley, Gandy Salt Marsh, Leland Harris Spring Complex and Bishop Springs (USFWS 2010, p. 35403), and grazing impacts were continuing to occur on an intermittent basis at the time of publication of USFWS 2010 (p. 35409).

It was also indicated in LCCT 2014 (p. 16) that "although efforts to control and minimize damage are ongoing, livestock grazing occurs on a portion of habitat at most wild least chub sites. A few instances of localized extensive livestock grazing-related damage have occurred in the last couple of years, and livestock grazing on private lands where least chub occur remains partially unregulated".

Livestock grazing is reported to have been removed from Mona Springs in 2005 (USFWS 2014a, p. 51045), but as described in section III. B. 1, there still seems to be livestock damage at the site. At the time of publication of USFWS 2014a, efforts were ongoing to reduce (but not eliminate) grazing impacts in Mills Valley, Bishop Springs,

Gandy Marsh and Leland Harris. Fenced and/or managed grazing is known from four of the refuge population sites (USFWS 2014a, p. 51044; UDWR 2017, p. 11, 13).

The most effective way of avoiding grazing impacts is to remove livestock from least chub sites. Conservation measures that can reduce grazing impacts include decreasing the number of animals, the duration of grazing impacts near least chub habitat or shifting the timing of grazing activities to periods when impacts to least chub are minimized. However, the following impacts may still occur to some degree with either one of these measures: least chub habitat degradation caused by bank destabilization, vegetation removal, and eutrophication of least chub habitat by waste inputs (USFWS and UDWR 2014, p. 18). Negative impacts can also occur when cattle fences are not maintained: "The grazing exclosure fence at Pilot Spring was in disrepair (two horizontal fence poles were down allowing an access gap for cattle) and minimal grazing did occur within the fenced area during the summer of 2013" (UDWR 2015, p. I-4).

As discussed above, livestock grazing can impact least chub habitats in multiple ways: livestock congregating around springs eat and trample plants, compact local soils and collapse banks. Input of organic waste to springs increases the concentration of nutrients and some of these (e.g. nitrogen compounds) can become harmful to fish. Entrapment of domestic livestock in soft spring deposits may also occur, leading to death and decomposition, which pollutes the water (Taylor et al. 1989 and Stevens and Meretsky 2008 as cited in USFWS 2014a, p. 51048). Other reports linking livestock trampling and grazing with fish habitat degradation (e.g. water quality, vegetation type and habitat morphology) in springs and streams include: Duff 1977, May and Somes 1981, Taylor *et al*. 1989 and Fleischner 1994 as cited in Bailey et al. 2005, p. 21. As noted in Fleischner 1994 (p. 635-636), livestock grazing can change water chemistry and temperature, leading to entirely new aquatic ecosystems.

B. INVASIVE PLANTS

Least chub at the Gunnison population site are threatened by tamarisk and Russian olive, nonnative phreatophytes known for their high water usage, and which are growing densely along the chub habitat (Utah Department of Natural Resources 2021, p. 1). Excess submerged vegetation and woody debris can also limit the amount of habitat available and nitrogen-rich leaf litter can cause excessive (and harmful) growth of algae (*Ibid*, p. 2, 3). The presence of dense vegetation furthermore hampers efforts to remove nonnative fish from the habitat and collect least chub for transfer to refugia (*Ibid*, p. 1).

Russian olive trees were regenerating at Leland Harris and Miller Spring in 2019 (Graham and Dittmer, 2019), and both Russian olive and purple loosestrife, an invasive herbaceous plant capable of dominating wetlands and displacing native vegetation (Mal et al. 1997 as cited in UDWR 2015, p. II-6), also threaten least chub at Bishop Springs (UDWR 2017, p. 61). Purple loosestrife is also potential threat to least chub habitat at Gandy Marsh (UDWR 2017, p. 61), which additionally has a vegetation density problem due to overgrown vegetation in grazing exclosures (Graham and Dittmer, 2019, p. 10-11).

C. MINING, INCLUDING OIL AND GAS LEASING AND EXPLORATION

Peat mining can permanently alter the hydrology and habitat complexity of Mills Valley, making it unsuitable for least chubs (Bailey et al. 2005, p. 31). In 2003, a landowner was given a permit from UDOGM to conduct peat mining on their land. One test hole was dug but the operation was subsequently abandoned and the permit ceased to be active by 2010 (USFWS 2010, p. 35404; USFWS 2014a, p. 51050). USFWS has also indicated that it is unaware of any additional private or commercial peat operation activities or permits at Mills Valley or any other natural or introduced least chub populations prior to or since USFWS 2010 (USFWS 2014a, p. 51050). However, there is no guarantee new peat mining permits will not be acquired in the future, and new projects initiated should these become economically viable or profitable.

Oil and gas leases have been sold within the watershed areas of most of the naturally occurring populations. In BLM's February, 2006 lease sale multiple parcels were sold north and west of Miller Spring, part of the Leland Harris population site. 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 promised to avoid spring and marsh habitat within those seismic lines (personal communication, Mark Pierce, BLM Fillmore Office, August 2006). Most of Snake Valley west of the least chub populations is under actively held oil and gas leases, per data from BLM's LR2000 system displayed in a Wilderness Society mapping portal (see Figure 3 below). These leases could be developed at any time, and their proximity to the least chub's habitat means any impacts to the aquifer from development could pose a threat to the fish.

Roads and well pads can impact local drainages and surface hydrology and enhance erosion and sedimentation. Accidental spills can lead to hydrocarbon products getting released into ground and surface waters. Contaminants accumulating in floodplains can cause lethal or sublethal impacts. Vehicles, including drilling rigs and recording trucks can also cause vegetation and soil compaction and spread exotic plant species (USFWS 2010, p. 35403).

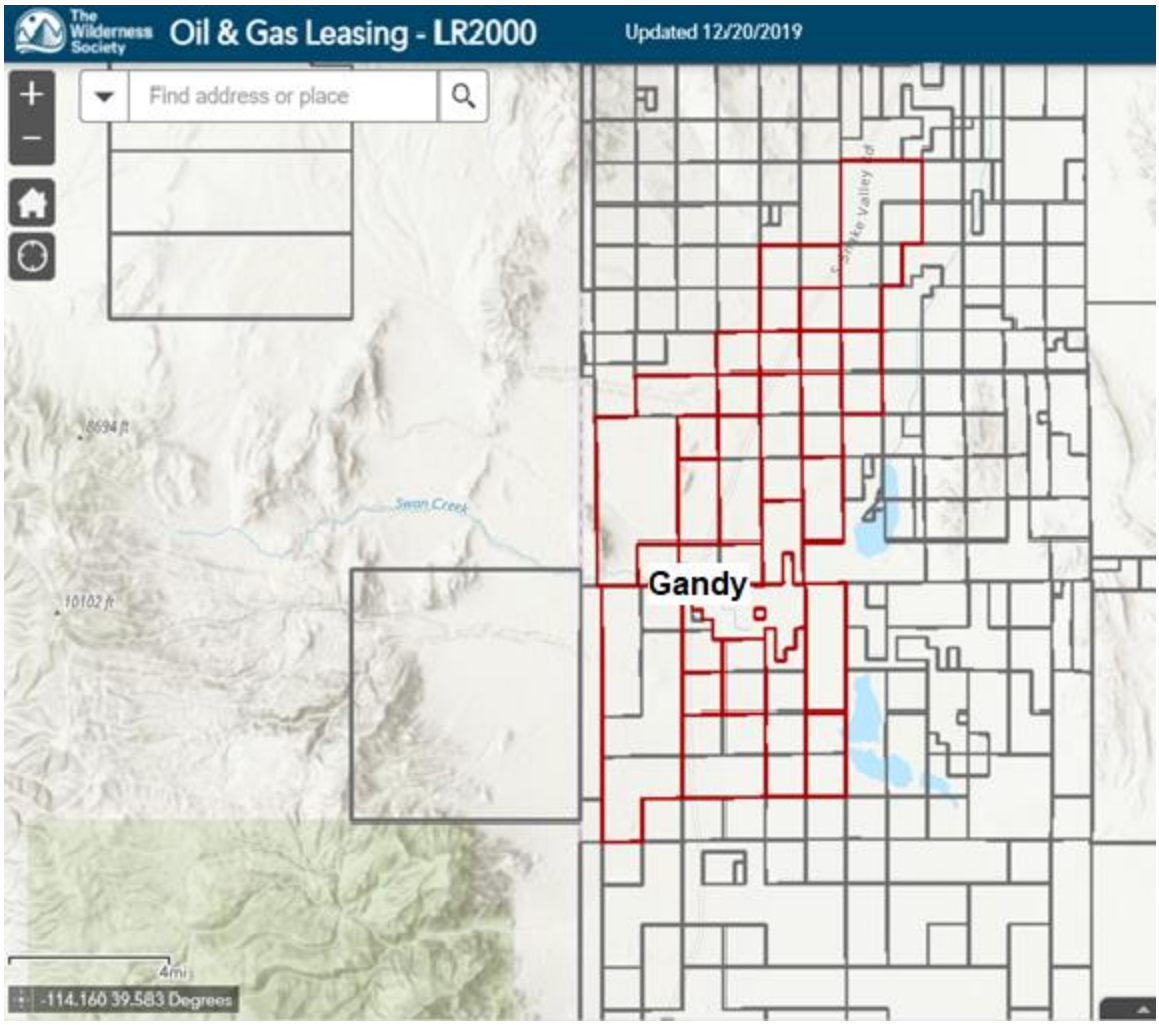

Figure 3. Oil and gas leasing. Active oil leases (depicted in red) north and south of the town of Gandy, UT. The water bodies depicted east of Gandy are in the general vicinity of the Leland Harris Spring Complex, Gandy Salt Marsh, and Bishop Springs Complex populations of least chub. (Grey outlines depict expired leases.). Source: The Wilderness Society 2019.

D. URBAN DEVELOPMENT

Least chub habitats and populations across the species' range have been lost due to historical development. Residential development and water development projects have destroyed historical habitats and potential least chub reintroduction sites in many urbanized and agricultural areas. Along the Wasatch Front, development and urban encroachment eliminated most springs, streams and wetlands, either functionally or completely (USFWS 2014a, p. 51050).

Least chub habitats can be affected by urban and suburban development in a number of ways; (1) hydrology and sediment regime changes; (2) inputs from polluting human

activities (contaminants, fertilizers, and pesticides); (3) nonnative plants and animals introductions; (4) springheads, stream banks, floodplains and wetland habitats alterations due to increased diversions of surface flows and connected groundwater (*Id.*).

As discussed above, the town of Mona is currently experiencing positive growth and at the time of publication of USFWS 2014a, there was a housing development about 0.6 (1 km) away from the least chub site (USFWS 2014a, p. 51050-51051). The introduced population site of Escalante Elementary is also near an urban interface, with ponds located on the property of the Escalante Elementary school in Salt Lake City. Two additional introduced sites are near the Wasatch Front, albeit more than 8 km (5 mi) away from development and with the closest developed site closed to additional development. Habitat degradation due to suburban or urban development has so far not been observed at these introduced sites (USFWS 2014a, p. 51051).

E. WATER WITHDRAWAL AND DIVERSION

Water levels are important to the life history of least chub (Lamarra 1981 and Crist and Holden 1990 as cited in Bailey et al. 2005, p. 22). Smaller habitats support fewer individuals due to the reduced availability of population resources. Least chub also live in patchily distributed desert aquatic systems and reduced water depth may isolate areas that connect hydrologically at higher water levels. Springhead habitats offer least chub stable environmental conditions (e.g. temperature and oxygen levels) for refugia and overwintering while marsh areas offer vegetation for feeding and spawning. Maintaining hydrologic connections between these two types of habitats allows the least chub to access the full range of their ecological requirements (USFWS 2010, p. 35404). Maintenance of water levels and discharge volumes is also critical in preserving natural sediment transport processes, thereby maintaining underwater habitat configurations and reducing aquatic vegetation encroachment into sensitive spring areas. Reductions in water may moreover change the chemical and physical properties of aquatic habitats: temperatures may rise, dissolved oxygen may decrease, and the concentration of pollutants may increase. These changes in habitat conditions may impact least chub life history processes beyond the state at which the species can survive. The maximum growth rate for least chub aged less than 1 year would occur at 22.3 °C (72.1 °F). Temperature deviations have the potential to negatively impact growth and affect survival rates (*Ibid*, p. 35405).

Groundwater pumping that causes aquifer levels to drop can result in springs drying out, even if the amount of groundwater stored in the aquifer is still very large (Parker et. al, 2021, p. 2). Springs that are at the highest elevation relative to the potentiometric surface of an aquifer may be the first to show impacts from drawdown (Partner Engineering and Science, Inc., 2020, p. 8). Notably, when aquifers have been depleted from unsustainable groundwater extraction, causing springs to dry up, spring-dwelling and groundwater-dependent species have gone extinct (Parker et. al, 2021, p. 2).

Figure 4 conceptualizes how springs may be affected by groundwater pumping, with the potential for impact ultimately depending on the proximity of the pumping, the hydraulic

characteristics of the aquifer and the magnitude and duration of pumping (Nye County, 2004, p. 23). Prior to pumping (A), the flow from recharge areas over the mountains balance the discharge areas along the valley axis or out of the basin via underflow and springs occur where the water table intercepts the land surface. With the onset and continuation of pumping (B-E), water levels are lowered around the pump, causing a hydraulic gradient that induces radial flow towards the pump. A cone of depression develops around the pump and grows until the recharge rates are in balance with the pumping rate. The drawdown may intercept water that would otherwise be discharged at springs (*Ibid*, p. 25), but also potential groundwater that supports baseflow in streams or the streamflow itself.

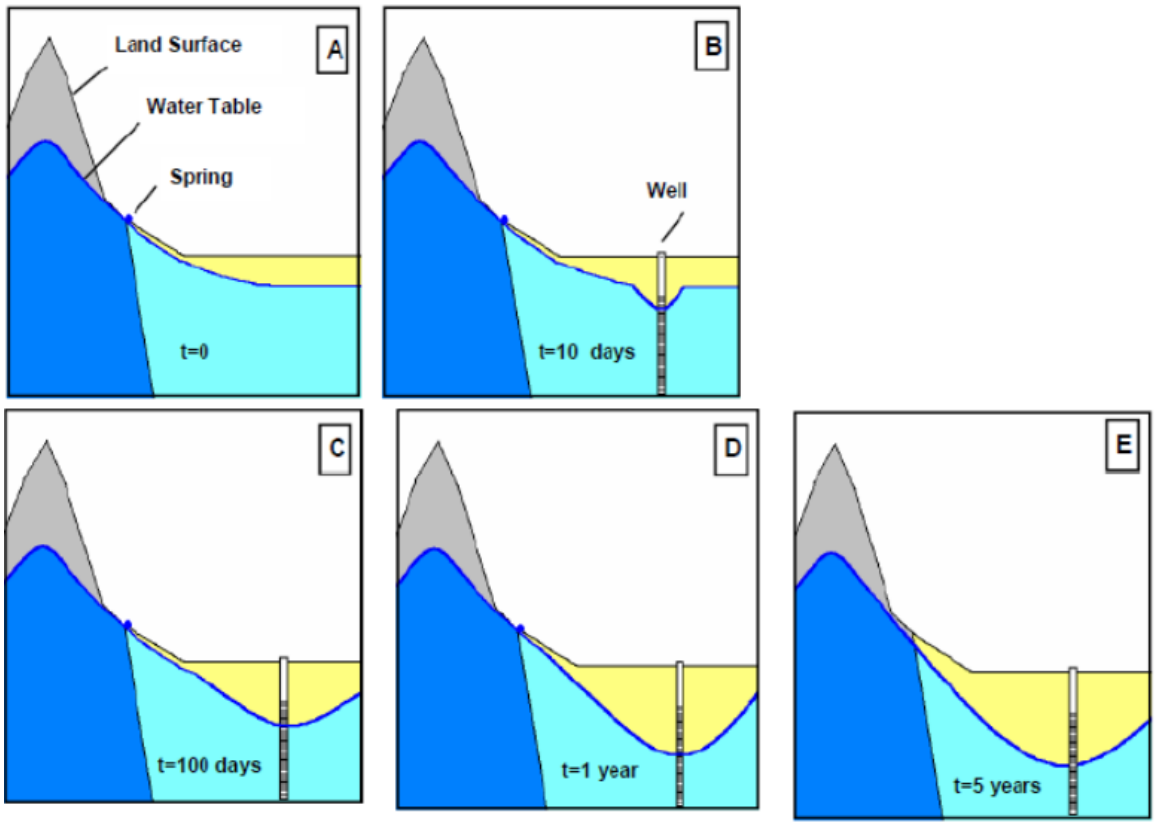

Figure 4. Potential effects of groundwater withdrawals on spring discharge rates: (A) Natural hydrologic system is in balance; (B) Water levels are lowered in the vicinity of the production wells; (C) The area of decline expands outward from the pumping well or wells; (D) Wells' area of influence approaches the edges of the valley-fill aquifer or the geologic structure controlling the spring and discharge rates may begin to decline; (E) Effects may expand beyond the valley-fill aquifer and eliminate the natural discharge of springs. Adapted from Nye County, 2004, p. 25.

Reduced habitat quality and quantity may cause overlap with other species' niches, resulting in more hybrid introgression, interspecific competition, and predation. Reduced spring flow decreases opportunities for habitat niche partitioning and therefore the ability

of multiple species to coexist. Native species are particularly vulnerable to extirpation in smaller habitats shared with introduced species (USFWS 2010, p. 35405).

Decreasing habitat size can also alter the individual success of least chub. Fish species tend to decrease their maximum size in response to reductions in habitat size and there is an exponential decrease in reproductive output with decreasing fish size. A reduction in spring volume may also lead to reduced longevity and consequently fewer reproductive seasons (*Id.*).

Water levels in pools containing least chub that are spring-fed (i.e. most of the habitat currently occupied by wild least chub populations) are dependent on stable, functioning aquifers that enable water tables near to surface to allow for consistent rates of spring discharge. Water development, especially groundwater pumping, could significantly lower the water table, possibly drying up or lowering the water level in springs and marshes populated by least chub. Groundwater withdrawal is the primary threat of habitat loss and degradation to the remaining natural populations of least chub (UDWR 2020, p. 2).

Current pumping in Snake Valley for agriculture is causing groundwater levels to decline (UGS 2014, p. 2). Declines vary based on proximity to agricultural pumping and seasonally based on irrigation use, but a monitoring well far from any pumping was found to have 2.2 inches per year of decline, which can be considered the background level of drawdown (*Id.*). This background level of drawdown is likely partially due to climate change and also partially due to the long-term aridification of the climate since the Pleistocene. Further drawdown of at least 1-2 inches per year due to pumping is occurring (*Id.*). This level of drawdown alone is concerning, implying several cumulative feet of groundwater decline, which cannot help but impact surface water resources. While any changes in discharge in springs inhabited by the least chub have not been attributed to agricultural pumping at this time, it remains a possibility that such pumping is currently or in the future will impact the chub. For instance, there is a center pivot within half a mile of Foote Reservoir/Bishop Springs.

While the exact amount of current pumping in Snake Valley is not tracked and is unknown, there are approximately 51,000 acre-feet per year of groundwater rights issued by the states of Utah and Nevada in Snake Valley, 93% of which are for irrigation (SNWA as cited in USFWS 2014b, p. 24).

Agricultural pumping combined with drought has impacted several springs in Snake Valley. These includes Knoll Spring near Eskdale and springs in Callao, on private property. Least chub historically occurred at all of these sites. Needle Point Spring, in Southern Snake Valley, did not historically contain least chub but monitoring information suggests the water level dropped to levels not seen in 40 years in 2001 due to groundwater pumping nearby. The spring was developed and used for watering livestock and horses over the past several decades. The 2001 groundwater decline was likely caused by increased irrigation in Hamlin Valley, approximately 3.2 km (2 mi) west, and not the decreased precipitation (USFWS 2010, p. 35406).

Declining groundwater levels, but particularly in proximity to agricultural pumping, suggest that water is being permanently removed from storage in the Snake Valley aquifer already (USFWS 2014b, p. 41). If current conditions continue, spring declines and concomitant declines in available habitat for the least chub can be expected. An increase in pumping in the broader hydrographic region, as for the Pine Valley project described below, could accelerate the loss of water from aquifer storage, increasing the amount of surface water resources which are captured as the basin moves toward a new equilibrium (*Id.).*

The Mills Valley least chub site does not have groundwater development immediately proximal to the habitat, but it is down the Sevier River basin from the Central Sevier Valley groundwater development area, and as such groundwater pumping may be affecting the habitat for the least chub there (USFWS 2014b, p. 8). As of 2012, 28,000 acre-feet of groundwater was pumped annually from the Central Sevier Valley area (*Id.*). While the area has been closed to new appropriations by the Utah Division of Water Rights, pumping within existing appropriations has increased steadily in recent decades and may pose a threat to the least chub.

At Clear Lake, annual drying in the outer ponds tends to occur consistently and has resulted in decreased habitat quality and limited least chub distribution (UDWR 2015, p. III-4). There is significant pumping in the Sevier Desert Basin of which Clear Lake is a part, however modeling is not clear that such pumping affects discharge and water levels at Clear Lake (USFWS 2014b, p. 10). In Bishop Springs, some areas were previously de-watered, with the situation now improved due to a water rights purchase and agreements with the water rights owner at Foote Spring (UDWR 2015, p. III-4).

At the Gunnison population site, the San Pitch River frequently dries up due to water diversion and most of the flow comes from a seepage channel below Gunnison dam, which is in turn limited in amount by the presence of nonnative vegetation (Utah Department of Natural Resources 2021, p. 1-2).

Least chub habitat along the Wasatch Front has been altered by several water development activities, including irrigation practices. Most springs have been significantly impacted by diversion, capping and pumping activities (Bailey et al. 2005, p. 22). These activities have resulted in the extirpation of all wild populations of least chub from the Wasatch Front, except Mona Springs. However, the least chub population at the Mona Springs site is declining and may eventually be extirpated due to a variety of threats (UDWR 2020, p. 1).

The least chub stronghold is in the Snake Valley. However, there is a very high probability of future groundwater withdrawal in the Valley, and if left unmanaged would significantly impact least chub populations by reducing seasonally available nursery habitat (UDWR 2020, p. 2), as well as potentially the amount of shelter, feeding and overwintering habitat.

There exist several examples of spring-dependent fish species other than the least chub that have been extirpated (or been driven extinct) by groundwater pumping. Pahrump

Ranch killifish (*Empetrichthys latos pahrump*) and Raycraft Ranch poolfish (*E. l. concavus*) both went extinct due to desiccation of their native springs from groundwater pumping and modification of springheads. The Pahrump poolfish (*E. latos latos*) was in turn extirpated from its native habitat due to desiccation of springs caused by groundwater pumping for irrigation. Now only refugium populations exist on public lands (Nevada Wildlife Action Plan, 2012, p. 42). Groundwater pumping is also a major threat to the endangered Owens tui chub. It is largely caused by agricultural irrigation and municipal demands in the Owens Basin. Most of the large Owens Valley floor springs have been eliminated by unregulated groundwater use. Without enhanced regulation, groundwater pumping could reduce or even halt water input to existing isolated springs and headwater springs of streams in the Owens Basin. This would in turn cause a further reduction or loss of the already extremely limited aquatic habitat occupied by Owens tui chub (California Department of Fish and Wildlife, 2021, p. 12-13). Other examples of spring-dependent fish species threatened by groundwater pumping include the Clover Valley speckled dace (*Rhinichthys osculus oligoporus*) and Independence Valley speckled dace (*R. o. lethoporus*) (Nevada Wildlife Action Plan, 2012, p. 13, 23).

The Pine Valley Water Supply Project

The most significant threat to the Snake Valley least chub populations is future water withdrawals from the Pine Valley aquifer, and adjacent aquifers, that are currently proposed to support human population growth in Cedar City, Iron County. The agency charged with supplying water to Cedar City, the Central Iron County Water Conservancy District (CICWCD) has proposed a project to supply water for urban growth near Cedar City by pumping it from remote basins in the West Desert. Such pumping could reduce spring flow or dry up least chub habitat altogether in Snake Valley and in the Sevier Desert Basin, posing a dire risk to the species.

CICWCD has proposed the Pine Valley Water Supply Project, which would pump 15,000 acre-feet of water annually from Pine Valley in the West Desert of Utah, and siphon it through 65 miles of pipeline to fuel suburban development in Cedar City, Utah (CICWCD, 2020, p. 6). The project would have 15 pumping stations across Pine Valley, use eight existing monitoring wells, and would include a 200MW solar facility to provide power for the project.

The Pine Valley Water Supply Project is part of a much larger Iron County Water Project, which includes additional proposed pumping and pipelines from Wah-Wah and Hamlin Valleys. CICWCD has water rights of 11,000 acre-feet per year in Wah-Wah Valley, and has applied for an additional 10,000 acre-feet per year in Hamlin Valley (Zdon and Osborne, 2021, p. 1). Taken together, this 36,000 acre-feet of water would be a dramatic increase in groundwater utilization in the West Desert of Utah, and could have significant impacts on the groundwater flow system and surface expression of groundwater across the Great Salt Lake Desert Flow System and associated groundwater basins including Snake Valley and the Sevier Desert Basin (*Id.*, p. 10-11).

As outlined in this petition, four of the last remaining wild populations of least chub are in Snake Valley (the stronghold), and the Sevier Desert Basin at Clear Lake. Snake Valley is part of the Great Salt Lake Desert Flow System, which extends from the southern part of the West Desert in Pine, Wah-Wah, and Hamlin Valleys, through Snake Valley, Tule Valley, and the Fish Springs area, to the terminal sink of the Great Salt Lake Desert (Zdon and Osborne, 2021, p. 3). The Sevier Desert Basin also receives interbasin from flow these basins, and in turn contributes interbasin flow down gradient to Tule Valley, Fish Springs and beyond (*Id.*, p. 4). This vast interconnected flow system means that some amount of recharge in the down-gradient basins comes from interbasin flow from the up-gradient basins. Thus, groundwater pumping in up-gradient basins can be expected to impact down-gradient basins by creating a cone of depression, which will then potentially reverse interbasin flow regimes, either slowing down or ceasing down-gradient interbasin flow or actually inducing reverse interbasin flow toward the cone of depression. In either event, the result will be declining groundwater levels in down-gradient basins. Indeed, groundwater pumping is the "primary risk" to springs in the Great Salt Lake Desert Flow System (*Id.*, p. 2).

At 15,000 acre-feet, the proposed pumping in Pine Valley is already more than the U.S.G.S. estimated perennial yield of 11,000 acre-feet (Zdon and Osborne, 2021, p. 8). This implies that the pumping will be removing water from storage – the very definition of groundwater mining and a situation which will result in declines in the aquifer. These declines could result in interbasin flow out of Pine Valley decreasing toward zero (*Id.*), thus impacting down-gradient aquifers including those in Snake Valley and the Sevier Desert Basin. Beyond simply decreasing the interbasin flow out of Pine Valley, however, significant groundwater withdrawals from storage could actually induce interbasin flow from down-gradient basins, in particular Snake Valley (*Id.*). The full extent of this capture could take decades or centuries to occur, as drawdown signals can permeate slowly through interconnected aquifer systems, which can take literally millenia to come into a new equilibrium (Bredehoeft & Durbin, 2009, p. 8).

On July 15, 2020, the Bureau of Land Management published a Notice of Intent to Prepare an Environmental Impact Statement (EIS) for the Pine Valley Water Supply Project, initiating a 30-day scoping period. The project includes development of the fifteen production wells, feeder pipelines, access roads, above-ground power distribution lines, a solar field, a large underground storage tank, and a main buried pipeline (BLM, 2021a, p. 42915). The project already has its state water rights, so federal approval for the right-of-way is the last step before permitting is complete.

As of September 30, 2021, the Draft EIS for this project has not yet been published in the Federal Register. As such, the exact nature of the analysis in the EIS has not been finalized. Materials released to the public by BLM during the scoping period give us only hints. Perhaps somewhat ominously with regards to the scope of analysis of the EIS, when BLM discussed springsnails, they said that springs in Pine Valley would be surveyed and monitored for springsnails (BLM, 2021b, p. 3). This is concerning, because it is so well known and documented that impacts to springs would occur well beyond the bounds of Pine Valley. If BLM limits the analysis of impacts to groundwater dependent

species to just those in Pine Valley, the least chub is put at risk because BLM would fail to analyze potential impacts of the project on the fish.

Additionally, the publicly available materials from the scoping period hint that the project will ultimately be subject to a monitoring and mitigation plan to detect and respond to impacts to groundwater dependent ecosystems (BLM 2021b, p. 6). BLM states,

> *Groundwater drawdown can be predicted, but impacts would not be fully understood until pumping commences and data is gathered over a period of years. Drawdown would be monitored at existing monitoring wells and at a set of sentinel wells at the edges of Pine Valley to make sure the predictions are accurate. The BLM would address groundwater impacts through an adaptive management plan that would detail how the project would respond to pumping effects.*

Detection of impacts of pumping in large aquifer systems has been described as "problematic" and elusive (Bredehoeft, 2011, p. 7). Water travels slowly and paradoxically through aquifer systems, and it may be that adaptive management techniques are not enough to mitigate detected impacts. Additionally, aquifers in the desert recharge very slowly - on the scale of an order of magnitude more slowly than water discharges (*Id.,* p. 6). BLM's adaptive management techniques cannot speed up the rate at which the aquifer would recharge, should unacceptable levels of drawdown occur. And indeed, it could be thousands of years before the hydrologic system in these basins reaches a new equilibrium after a large loss in storage volume (Bredehoeft & Durbin, 2009, p. 8).

To summarize the potential impacts of the Pine Valley Water Supply Project on the springs which support the least chub in Snake Valley, in an analysis of existing data and modeling by Zdon and Osborne (2021) (see attachment A), they conclude, "Induced underflow from Snake Valley to Pine Valley caused by the Pine Valley Project would serve as a new stress on the Snake Valley groundwater system and would come at the expense of spring discharge and evaporation," (p. 4). Further, and specific to the issue at hand, they state, "Distant springs such as those in Snake Valley that support Least Chub and/or Fish Spring National Wildlife Refuge could be affected by changes in hydraulic gradients and gradient directions caused by Pine Valley Project pumping," (p. 10). Additionally, Zdon and Osborne find drawdown in the Sevier Desert Basin (Basin 287) (p. 5).

Southern Nevada Water Authority's Groundwater Development Project

For over three decades, the Southern Nevada Water Authority (SNWA), water purveyor for the Las Vegas Valley, pursued a similar pipeline project, intended to pump water from rural basins and pipe it to Las Vegas. One of the basins targeted by this project was in Snake Valley. The project proposed pumping 25,000 to 30,000 acre feet per year, though SNWA actually applied for over 50,000 acre feet of water rights with the State Engineer. This project was the source of significant controversy due to the widespread

environmental and social impacts which would have been borne by the natural and human communities of eastern Nevada and the West Desert of Utah. This project was also part of the basis for the previous petition for the least chub (Center for Biological Diversity 2007, p. 1).

Per the Lincoln County Conservation, Recreation, and Development Act of 2004, prior to any interbasin transfer out of a groundwater basin located in both Utah and Nevada (such as Snake Valley), an agreement must be reached between the two states regarding the division of water resources in the basin (LCCT 2014, p. 17). No agreement has ever been reached between Utah and Nevada regarding pumping in Snake Valley, and subsequent to the Lincoln County bill's passage, SNWA began pursuing the pipeline plan without specifically including Snake Valley in its plans.

On May 21, 2020, the SNWA Board of Directors voted to terminate the water rights applications for the project, terminate the National Environmental Policy Act (NEPA) environmental impact statement, remove the project from their long-term plans, and indefinitely defer further action. The project is no longer active, and is not an immediate threat to the least chub.

However, SNWA still owns several ranching operations in Spring Valley, adjacent to Snake Valley. These ranches hold water rights to tens of thousands of acre feet of water. Should those ranches, or other water rights in Spring Valley, be one day developed for a future pipeline plan, it could cause impacts to groundwater in 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 delivers additional ground water to, Snake Valley (Harrill et al. 1988, entire).

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

A. PREDATION, COMPETITION, AND DISEASE

Hickman (1989 as cited in Bailey et al. 2005, p. 22) considered the introduction and presence of nonnative species to be a constant threat to least chub. Few if any least chub have remained in spring complexes where nonnative fishes have been introduced. Introduced game fishes such as largemouth bass, rainbow trout, common carp, and brook trout (*Salvelinus fontinalis*) prey on least chub and have been regularly stocked into least chub habitat (Workman *et al*. 1979, Sigler and Sigler 1987, Osmundson 1985 and Crist 1990 as cited in Bailey et al. 2005, p. 22). In addition to game fish, nonnative mosquitofish, rainwater killifish (*Lucania parva*), and plains killifish (*Fundulus zebrinis*) have been introduced and these have similar diets to the least chub and are considered potential competitors. Mosquitofish also prey aggressively on eggs and young (Meffe 1985, Sigler and Sigler 1987 as cited in Bailey et al. 2005, p. 22; Mills et al 2004b, p. 713).

Currently, nonnative fishes are co-occurring with least chub in all natural populations outside of the Snake Valley and western mosquitofish likely constitutes the most significant threat (UDWR 2020, p. 2). This species is found in Mona Springs (Graham and Dittmer, 2019, p. 8) and Mills Valley (*Ibid*, p. 22). Other nonnative fish species at Mona Springs include fathead minnow, plains killifish and rainwater killifish (*Ibid*, p. 8), while green sunfish is found in Mills Valley (*Ibid*, p. 22). There are also green sunfish and fathead minnow at the Gunnison population site (*Id.*) and nonnative carp at Clear Lake (*Ibid*, 2019, p. 11). Nonnative fish introductions as well as removals have occurred at the Bishop Springs population site (UDWR 2017, p. 62). As discussed above, common carp may have contributed to the recent extirpation of the Fitzgerald WMA population.

Potential predators on least chub in addition to fish include frogs, ducks, gulls, herons, and egrets (Osmundson 1985 and Sigler and Sigler 1987 as cited in Bailey et al. 2005, p. 22). Predation from these sources would not negatively affect healthy populations of least chub under normal conditions. However, the effects of predation from the above combined sources, when populations are depressed by other factors, could further deplete already fragile populations (Bailey et al. 2005, p. 22).

Disease and parasitism are unlikely to currently be major factors affecting least chub. During 1977-78, the parasite blackspot (*Neascus cuticola*) was present at the Leland Harris Spring Complex site but all least chub were robust and in good condition (Workman et al. 1979, pp. 2, 103–107 as cited in USFWS 2014a, p. 51058). The parasite was also identified in least chub at the Bishop Springs site by Wheeler et al. 2004, p. 5 (as cited in USFWS 2014a, p. 51058) but there was no evidence of negative impacts at the time of publication of USFWS 2014a (p. 51058). In 2006, eight different parasites were detected on least chub from the Leland Harris Spring Complex subject to disease-check regimen. However, there is again a lack of evidence of negative impacts on the chub (USFWS, 2010, p. 35411). Finally, at the time of publication of USFWS 2010, the exotic snail *Melanoides Tuberculata* was reported to be present at Bishop Springs and Clear Lake sites, and it was hypothesized that it may be found at other sites in the future. Nonetheless, there was no information linking this snail species to parasites that are detrimental to the least chub (*Id.*).

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

Hybridization usually occurs in disturbed environments. Habitat alteration and degradation can eliminate reproductive isolator mechanisms and thereby cause overlaps of reproductive niches and breakdowns in behavior due to overcrowding. Hybridization

of least chub with Utah chub and speckled dace was documented in the 1970s at five locations. However, least chub no longer occur at three of the five locations and there was no new evidence of hybridization at other locations by 2010 (USFWS 2010, p. 35413-35414). In 2014, USFWS concluded again that hybridization is not a threat to the least chub (p. 51061), and hybridization is not discussed in UDWR 2015, 2017 or Graham and Dittmer, 2019 (entire).

D. MOSQUITO ABATEMENT PROGRAMS

Another potential threat to the least chub is mosquito-control spraying programs. Per USFWS 2010 (p. 35412), there is no prohibition on the spraying of least chub habitat to control for mosquitoes. This practice could reduce least chub prey items and negatively impact potential reintroduction sites. The Mills Valley and Leland Harris Springs Complex least chub populations are located in Juab County and the BLM rejected a request by the county to implement a mosquito-control spraying program in BLM administered marsh and spring areas. However, this does not mean that spraying cannot occur on private land. Although the effect of the chemical toxins on the least chub is not yet known, including through consumption of sprayed mosquito larvae, it is possible that spraying in abatement districts is having an effect on least chub populations at the individual or population level (USFWS 2010, p. 35412).

E. STOCHASTIC DISTURBANCE AND POPULATION ISOLATION

Extant least chub are found in populations that are small and isolated compared to the once-expansive historical populations of Lake Bonneville (USFWS 2010, p. 35414). There is no habitat connectivity among the Gunnison, Clear Lake, Mills Valley and Mona Springs populations, and the west desert populations are similarly disconnected except when water levels are exceptionally high (*Id.*). Decreases in population size and increased isolation can lead to a loss of genetic diversity, which in turn can reduce fitness and increase mortality. The loss of genetic diversity can to an extent be reduced through the maintenance of existing refuge populations. However, as discussed above, attempts to establish refuges for least chub have had highly variable results, and more refuge populations are needed.

Both wild and introduced populations are vulnerable to environmentally stochastic events such as drought (see next section), floods and fire. At the time of writing of USFWS 2010, one introduced population had been eliminated by flooding of the Great Salt Lake (USFWS 2010, p. 35414). In 2011, overland sheet flow from the Sevier River likely resulted in the colonization of least chub habitat by mosquitofish (USFWS 2014, p. 51057; UDWR 2015, p. II-15, II-16). In 2013, a wildfire caused flooding and subsequent siltation in Willow pond, which was consequently reclassified from a refuge to an experimental population (UDWR 2015, p. I-1, I-8). Willow pond was re-upgraded to refuge status in 2016 and additional fish were also stocked that same year for the purposes of bolstering the genetics of the fish in the event that the quick die off after the fire resulted in genetic reduction (UDWR 2017, p. 3, 11-12). However, this

environmental disturbance event was particularly significant in that Willow pond was and is the only refuge population replicating the population at Clear Lake (USFWS 2014, p. 51044; Graham and Dittmer 2019, p. 19, 24), which has been declining with decreasing water levels.

F. DROUGHT AND CLIMATE CHANGE

The impacts of prolonged drought conditions could exacerbate the effects of all the other threats to least chub described in this petition, and especially water withdrawals.

There are primary and secondary effects to groundwater resources from prolonged droughts. A decrease in precipitation means less aquifer recharge, while decreased surface-water resources generally means more groundwater withdrawal and more requests for water-well construction permits. Water development usually takes priority over aquatic habitats when the availability of water is limited by climatic conditions (USFWS 2014a, p. 51056).

Least chub habitat can be impacted by drought in the following ways: reduction in habitat carrying capacity; lack of connectivity leading to isolation of habitats and resources; alteration of habitat physical and chemical properties, such as temperature, oxygen, and pollutants; vegetation changes; hybridization, competition, and predation due to niche overlap; and reduced size and reproductive output. Loss of springs in the Snake Valley, including those on the Bagley and Garland Ranches, has occurred due to the cumulative impact of drought and water development for irrigation (*Id.*). To help the least chub be resilient or adapt to drought, the LCCT intends to locate the areas with limited connectivity due to prolonged drought (or climate change) and prioritize these areas for restoration or habitat modification so that habitat corridors remain open for least chub (LCCT 2014, p. 22; USFWS 2014a, p. 51062). However, drought conditions are still a potential threat when coupled with water diversions and withdrawals (e.g. the Gunnison population), which have similar impacts on the least chub, or when considering the projected changes in drought due to climate change (see next).

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). Since 1850, global air temperatures have increased by ~1°C (1.8F) (Masson-Delmotte et al. 2018 as cited in Utah Department of Public Safety 2019, p. 286) and continental regions such as Utah have generally warmed more than the global average (Utah Department of Public Safety 2019, p. 286). The average annual temperature in Utah has increased by ~1.5°C (2.7F) since 1900 (Frankson et al. 2017, p. 1).

Future warming in Utah is also expected to exceed the global average, with the consequences of this warming including fewer frost days, longer growing seasons, and more heat waves. Annual mean temperature in Utah is projected to increase by about 4.5°C (8F) by the end of the century (USFWS 2014a, p. 51062), with more recent warming projections of 1.7-2.2°C (3-4F) by 2050 for Logan, Salt Lake City and St

George (Utah Department of Public Safety 2019, p. 288). Due to increasing temperatures, soils are expected to dry more rapidly, likely resulting in reduced inundation duration and depth in some years. Utah is also likely to experience more frequent heavy precipitation events, interspersed with more prolonged dry spells or drought conditions which, as described above, are a potential stressor to the least chub. Based on precipitation models, there will be less snowpack, a threat of more severe and prolonged episodic drought and less precipitation across all of Utah, although there is some uncertainty in the precipitation trends (USFWS 2014a, p. 51062).

At a more local level, the Great Salt Lake Basin will be impacted by declining mountain snowpack and the resulting runoff, although the timing and extent of these changes is uncertain. Drought conditions and higher evaporation rates could likely lead to lower groundwater levels, reduced spring flows and decreased least chub pool habitat size and depth. The least chub is dependent on small, ephemeral spring fed wetlands for a significant part of its life history, and under climate change, this habitat will likely be reduced and restricted to spring heads. The severity of climate change is therefore an important factor in determining whether or not the species is able to persist. Moreover, the least chub is restricted throughout its range by dispersal barriers and cannot retreat to additional habitats or easily recolonize areas following extirpations (*Id.*).

There are several factors that may mitigate some of the negative effects of climate change such as aforementioned plans to maintain habitat corridors if these become closed off during warming periods. Other factors include the presence of introduced sites over a relatively large geographic range, allowing for heterogeneity and redundancy. Some introduced and natural population sites also have established water rights which helps guarantee a continued water source for least chub habitats. However, water rights are still typically subject to changing yearly runoff or precipitation amounts (USFWS 2014a, p. 51062-51063).

G. CUMULATIVE EFFECTS

Cumulative effects can occur whenever and where-ever more than one stress is acting on a population at the same time. There are multiple cumulative effects that currently are, or will be in the near future, a threat to the least chub.

One example of a cumulative effect would be the impact of groundwater withdrawal and water diversions. Loss of habitat due to decreasing water levels may force least chub into close spawning proximity with other species (e.g. Utah chub), which coupled with the least chub's extended spawning period could lead to hybridization (USFWS 2010, p. 35413). In addition to hybridization, invasion of least chub habitat by nonnative fish may lead to increased predation or heavy interspecific competition, which the least chub is unlikely to be able to withstand (Crawford 1979, p. 73, Mills et al. 2004b, p. 713).

Other examples of cumulative effects would include a population site that is experiencing both water pollution and increased numbers of nonnative fish, 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.

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, p. 242; Deacon et al. 1979, p. 5). In 1980, the U.S. Fish and Wildlife Service 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 (USFWS 1982, p. 50520). After preparation of a 1989 status report, the Service reclassified least chub as a Category 1 Candidate Species (USFWS 1989, p. 556).

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 (USFWS 1995, entire). At the time of the issuing of the Federal Register notice, the least chub was only known to exist in five locations in Snake Valley. Moreover, at that time least chub had not been collected outside of Snake Valley since 1965 (*Ibid*, p. 50519 and Hickman 1989 as cited therein), 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 (USFWS 1995, p. 50519). 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) (*Ibid*, p. 50520-50522).

Subsequent to the proposed listing by the USFWS, a technical team was formed by the UDWR and the Least Chub Conservation Agreement and Strategy (LCCAS, 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, p. 8-10) 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 (USFWS 1999, p. 41062).

One June 25, 2007 the Service received a petition from the Center for Biological Diversity, Confederated Tribes of the Goshute Reservation, Great Basin Chapter of Trout Unlimited, and Utah Chapter for the Sierra Club requesting that the least chub be listed as threatened under the Act and that critical habitat be designated for it. Their 90-day finding concluded the petition presented substantial information indicating that listing may be warranted. Their subsequent 12-month finding identified least chub as a species for which listing as endangered or threatened was warranted but was precluded due to higher priority listing decisions, and the least chub was assigned a listing priority number of 7. Following the candidate finding, the Service completed annual candidate notices of review in 2010, 2011, 2012 and 2013, with each maintaining the species as a candidate with a listing priority number of 7. Due to a 2011 multidistrict litigation settlement between the Service and the petitioners, a proposed listing rule or a withdrawal of the 12-month was required by September 30, 2014 (USFWS 2014a, p. 51042-51043). On August 26, 2014, the Service concluded that listing was not warranted and removed the least chub from their list of candidates under the ESA (*Id.*).

At the time of publication of USFWS 2014a, the least chub was classified in the State of Utah Wildlife Action Plan as a Tier 1 Sensitive Species. This status "includes federally listed species and species for which a conservation agreement was completed and implemented" but is not a regulatory mechanism (USFWS 2014a, p. 51059). In the 2015 edition of the State of Utah Wildlife Action Plan, the least chub is classified as a Species of Greatest Conservation Need, a designation intended to prioritize conservation efforts and which takes into account the likelihood of an Endangered Species Act listing, the consequences of such a listing, and the State's ability to influence a listing decision (Utah Wildlife Action Plan Joint Team 2015, p. 11). Due to its status as the subject of an active conservation agreement, however, the least chub also still qualifies for inclusion on the Utah Sensitive Species List (*Ibid*, p. 229; UDWR 2020, p. 3).

Least chub are additionally considered ''prohibited'' species under the Utah Collection Importation and Possession of Zoological Animals Rule (Utah Code 657–3), which makes it illegal to collect or possess least chub. Yet, while regulatory protection from unauthorized collection and take (USFWS 2014a, p. 51059) helps prevent against these types of losses in the future, over-utilization for commercial, recreational or other purposes is currently not a main threat. Lastly, the least chub is designated as a sensitive species by the BLM in Utah. However, as will be described in more detail in the next section, the protection measures associated with this designation do not adequately protect the least chub from the threat of extinction.

VII. INADEQUACY OF EXISTING REGULATIONS

Analyzing recovery and delisting of endangered and threatened species, Doremus and Pagel (2001, p. 1260) 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 LCCAS 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 LCCAS signers, the USFWS withdrew the listing proposal in 1999. Unfortunately, even with the good intentions of the LCCT, it is clear that the least chub is still imperiled today. The species still only exists in the wild in about half a dozen locations, is subject to multiple threats, and the establishment of refuge populations has had (and continues to have) highly variable results.

The Fish and Wildlife Service has no specific authority at present to take actions for the recovery of the least chub. Least chub are 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.

In 1990, Department of the Interior (DOI) agencies protested water rights applications in Spring and Snake Valleys due partly to potential impacts to water-dependent natural resources. In 2006, a stipulated agreement was reached between the DOI agencies and SNWA for the Spring Valley water rights applications, and the protests were withdrawn by the agencies (USFWS, 2014a, p. 51053). The Spring Valley Stipulated Agreement requires hydrological and biological monitoring, and management and mitigation of unreasonable adverse effects to federal resources caused by SNWA groundwater pumping in Spring Valley (USFWS 2014a, p. 51053, 51060).

B. BUREAU OF LAND MANAGEMENT

Least chub are found on BLM land at all three wild population sites in Snake Valley (Gandy Marsh, Bishop Springs and Leland Harris) (USFWS 2014a, p. 51059), and in five introduced sites (Red Knolls Pond, Keg Spring, Pilot Spring, Pilot Spring SE and Cluster Spring) (UDWR 2017, p. 15).

The Snake Valley populations occur within the Fillmore BLM area and the majority of BLM land in the Fillmore Field Office was open to oil and gas leasing at the time of publication of USFWS 2010 (p. 35403). Based on the recent BLM data discussed above, active oil and gas leases currently exist for most of Snake Valley west of the least chub populations. However, only the Gandy Salt Marsh population area is closed to leasing by BLM (USFWS 2010, p. 35403; USFWS 2014a, p. 51060).

Fenced and/or managed grazing is known from all but one of the refuge populations on BLM lands (Cluster Springs, Pilot Spring and Pond SE of Pilot), which means that there is the potential for some level of grazing impact. At the Bishop Springs Complex, South Twin Spring has been severely impacted by livestock grazing, and at the time of writing of USFWS 2014a, BLM was planning to install, in 2014 and 2015, a fence structure and water gap to improve bank stabilization and reduce sediment deposition (USFWS 2014a, p. 51049). As discussed above, the exclosure at Twin Springs has been expanded to include the majority of South Twin Spring with a water gap left for livestock access (UDWR 2015, p. III-4).

The main Federal regulatory mechanisms protecting the least chub and its habitat in addition to the stipulated agreement for Spring Valley described in the previous section, include section 404 of the Clean Water Act (33 U.S.C. 1251 et seq.), the Federal Land Policy and Management Act (43 U.S.C. 1701 et seq.) and the National Environmental Policy Act (42 U.S.C. 4231 et seq.). Several Executive Orders (E.O. 11990 for wetlands, E.O. 11988 for floodplains, and E.O. 13112 for invasive species) additionally provide guidance and incentives for Federal land management agencies to manage for habitat characteristics essential for least chub conservation (USFWS 2014a, p. 51060).

Section 404 of the Clean Water Act is administered by the U.S. Army Corps of Engineers and is therefore described in the next section.

The Federal Land Policy and Management Act (FLPMA) is the primary Federal law governing most land uses on administered by the BLM within the least chub range. Per Section 102(a)(8), wildlife and fish resources are among the uses for which BLM lands are to be managed. Regulations pursuant to FLPMA address protection of wildlife habitat on BLM land. Cumulatively, BLM regulations allow formal recognition by the agency of sensitive species, such as the least chub, for special management and protection and inclusion into BLM land management plans (USFWS 2014a, p. 51060). Per the policy in BLM Manual 6840—Special Status Species Management (BLM Manual 6840 as cited in USFWS 2014a, p. 51060): *Consistent with the principles of multiple use and in compliance with existing laws, the BLM shall designate sensitive species and implement species management plans to conserve these species and their habitats and shall ensure that discretionary actions authorized, funded, or carried out by the BLM would not result in significant decreases in the overall range-wide species population and their habitats.*

The BLM Manual 1613—Areas of Critical Environmental Concern (BLM Manual 1613 as cited in USFWS 2014a, p. 51060) allows designation of critical areas for protecting

fish and wildlife resources and natural processes and systems, such as Gandy Marsh. As described above, the latter is closed to oil and gas leasing by BLM in accordance with the House Resource Management Plan (RMP), with the ACEC designation also providing additional protection for least chub. The RMP is BLM's land use decision-making document that provides guidance on management decisions for the area such as issuance of grazing permits and oil and gas leasing. The RMP specific to the Snake Valley populations should be updated in ~2024 to 2029, with any change to the management direction subject to public comment. The management policy and direction for BLM's continued involvement in the 2014 CCA amendment and its LCCT membership is also established in the BLM manual 6840. The BLM has also committed to the continued management and protection of least chub and its habitat on BLM lands through the 2014 CCA amendment. Specific protections for the least chub have been implemented through the ACEC designation and the RMP grazing management (USFWS 2014a, p. 51060).

Finally, there is a provision in NEPA that allows the Service to participate in updates to BLM's RMPs. However, the BLM does not have to accept the Service's NEPA recommendations; maintaining or enhancing least chub habitat may be considered together with other agency priorities (*Id.*).

C. U.S. ARMY CORPS OF ENGINEERS

Least chub occur in wetlands, and section 404 of the Clean Water Act regulates fill in wetlands that meet certain jurisdictional requirements. Fill activities meeting those requirements require a section 404 permit. The US Fish and Wildlife Service can review review permit applications and give recommendations to avoid and minimize impacts and implement measures to conserve fish and wildlife resources, including the least chub. However, whether or not Service recommendations are incorporated into section 404 permits is at the discretion of the U.S. Army Corps of Engineers. In addition, not all activities that occur in wetlands involve fill and not all wetlands are ''jurisdictional.'' (USFWS 2014a, p. 51060).

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

Five of the seven wild least chub populations occur either entirely or partially on state-owned land. UDWR owns the Clear Lake WMA and part of the Mills Valley and Leland Harris Spring Complex sites. Part of the Gandy Marsh and the Bishop Springs sites are in turn owned by SITLA (USFWS 2014a, p. 51059). Up until recently, there were several refuge populations on land owned by the state; the now extirpated Fitzgerald WMA and Off Spring populations were owned by UDWR, while the Escalante Elementary School population, which UDWR recently decided not to maintain anymore, is on land owned by local government. Only the Upper Garden Creek Pond population remains on state-owned land (Utah State Parks) and maintained by UDWR. The four experimental/range expansion sites are on state-owned land (Locomotive Springs Wildlife Management Area) (UDWR 2017, p. 3, 15).

The state of Utah has no substantial laws or regulations to protect the least chub. As discussed in section VI, least chub are ‘‘prohibited’’ species under the Utah Collection Importation and Possession of Zoological Animals Rule, and classified as Tier 1 Sensitive Species in the State of Utah Wildlife Action Plan. However, neither adequately addresses the main threats to the species.

Under the authority of 657–16 of the Utah Code and the 2003 Policy for Fish Stocking and Transfer Procedures, the stocking of mosquitofish and other nonnative fishes into aquatic habitats is not allowed without appropriate documentation and certification. All stocking actions must align with ongoing recovery and conservation actions for the least chub. While this policy regulates primary mode of mosquitofish introduction in least chub sites (USFWS 2014a, p. 51059), mosquitofish and/or other nonnative fish species are still a threat to least chub populations at Mona Springs, Mills Valley, Gunnison, Clear Lake and Bishop Springs. Moreover, as discussed above, common carp may have contributed to the recent extirpation of the introduced population of least chubs at Fitzgerald WMA.

The State of Utah operates under the 2008 Utah Aquatic Invasive Species Interdiction Act (Aquatic Invasive Species Act), per title 23, chapter 27 of the Utah Code (and Rule 657–60), developed to prevent aquatic invasive species movement during fish transfer operations. Under the Aquatic Invasive Species Act, UDWR requires a control plan that includes notification and evaluation of water sources where fish transfers are considered, inspections of fish health, and completion of an updated hazard analysis and critical control point plan. While the Aquatic Invasive Species Act can help reduce the probability of additional aquatic invasive species such as mussels and snails being introduced to least chub habitats (USFWS 2014a, p. 51059), it does not protect against the existing threat posed by nonnative fish.

Regulatory mechanisms pertaining to historical groundwater withdrawal are implemented through the Utah State Engineer through the Utah Division of Water Rights. Groundwater withdrawal in the Snake Valley for future municipal development is subject to both federal legislation known as the Lincoln County Conservation Recreation and Development Act (LCCRDA) and Utah Code 73–3, 73–4 (USFWS 2014a, p. 51059). However, these regulatory processes cannot adequately protect least chub habitat from the threat of large scale groundwater pumping.

LCCRDA has stated that (LCCT 2014, p. 17):

Prior to any transbasin diversion from ground-water basins located within both the State of Nevada and the State of Utah, the State of Nevada and the State of Utah shall reach an agreement regarding the division of water resources of those interstate ground-water flow system(s) from which water will be diverted and used by the project. The agreement shall allow for the maximum sustainable beneficial use of the water resources and protect existing water rights.

As discussed above, no agreement between Utah and Nevada has so far been signed, and therefore it is expected that no transbasin groundwater diversions will occur until after an agreement is met. However, diversions can still occur within the state, in both Utah and Nevada, and within Snake Valley. UDWR as well as USFWS and BLM have agreed to continue to petition and formally protest new water rights applications infringing on USFWS, UDWR, and BLM water rights and their lands that contain least chub (LCCT 2014, p. 17).

Least Chub Conservation Agreement and Strategy

The Conservation Agreement and Strategy for the Least Chub is a candidate conservation agreement developed in 1998 by the Least Chub Conservation Team comprised of the FWS, UDWR, BLM, Bureau of Reclamation (BOR), the Mitigation Commission, Confederated Tribes of the Goshute Reservation, and the Central Utah Water Conservancy District (CUWCD). The LCCAS was subsequently updated and revised in 2005, and amended in 2014 (USFWS 2014a, p. 51042), with the majority of the conservation actions proposed for implementation falling under UDWR (LCCT 2014, p. 18-22).

The aim of the CCA is to ensure the species' long-term survival within its historical range and to assist in the development of rangewide conservation efforts. Its objectives include eliminating or significantly reducing threats to the least chub and its habitat, to the greatest extent possible, and ensuring the continued existence of the species by restoring and maintaining a minimum number of least chub populations throughout its historical range (USFWS 2014a, p. 51042).

At the time of publication of USFWS 2014a, implementation of the CCA had led to the discovery of the Mills Valley and Clear Lake populations, acquisition and protection of occupied habitat, fencing of sensitive habitat to reduce grazing, grazing removal at select sites, an agreement with the mosquito abatement districts to limit western mosquitofish introduction and use, least chub introductions into unoccupied suitable habitat, development of memoranda of understanding (MOUs) with grazing operators on private lands, restoration of occupied habitat, and monitoring of groundwater near natural populations (USFWS 2014a, p. 51042). Conservation actions taken since USFWS 2014a include (but are not limited to): additional fencing to protect against grazing impacts, dredging of least chub habitat, invasive plant and nonnative fish removals, stocking of least chub at introduction sites and population monitoring. Attempts have also been made to secure the Gunnison population, discovered in 2016 during surveys of Southern Leatherside Chub (UDWR 2017, p. 27). Furthermore, studies have been conducted investigating the relationship between groundwater levels and least chub surface water habitat (Grover, 2016 as cited in UDWR 2017, p. 36; Grover, 2019, entire).

Despite successes, there have also been many failures. As discussed above, UDWR attempted approximately 30 introductions between 1979 and 2014 but only 10 were considered successful in 2014 (UDWR 2014a, p. 51043). An example of a failed refuge

is Walter Spring in the Fish Spring National Wildlife refuge, which was extirpated by western mosquitofish. Other examples include Deadman Springs (also located within the Wildlife refuge) and Antelope Island pond (USFWS 2010, p. 35410). From 2014 to present, the number of refuge populations increased by 4 if including the refuge population which was no longer being maintained by UDWR in 2019 (Escalante) and the refuge population extant in 2019 but seemingly now extirpated (Pilot Spring). Despite the small overall increase in the number of refuge populations, there were also two confirmed refuge population extirpations. The CCA objective of at least one introduced population per distinct wild population source (LCCT 2014, p. 3) has not been met due to the apparent extirpation of the Leland Harris refuge population (Pilot Spring) and the lack of an established refuge population for the wild Gunnison population.

As described in USFWS 2010, LCCAS is unable to protect the least chub from the primary threat of habitat loss caused by groundwater development, and is limited in its ability to protect the species from the threat of nonnative fish introduction (USFWS 2010, p. 35409). Nonnative species have been a constant problem for the Mona Springs least chub population (UDWR 2017, p. 34), are currently a threat to multiple other populations, and may have contributed to the extirpation of the Fitzgerald WMA introduced population.

Another limitation of the LCCAS is its ability to manage livestock grazing on private and SITLA lands (USFWS 2010, p. 35409), and probably also conduct monitoring on said lands.

A final parameter worth measuring is the UDWR funding for the implementation of conservation actions under the Conservation Agreement. The amount available in 2005 was only $35,700, and expenditures were anticipated to stay around that level from 2014 through to 2018 at the time of publication of the 2014 CCA Amendment (LCCT 2014, p. 25). UDWR also decided not to partake in the rehabilitation of the Escalante Elementary School refuge after problems at the site that were not being financed externally, and the survival of the population currently relies on efforts by teachers at the school (Graham and Dittmer 2019, p. 22). Lack of time to survey all known least chub populations is also mentioned in recent statewide monitoring reports (UDWR 2017, p. 6; Graham and Dittmer, 2019, p. 9).

E. OTHER STATE AND FEDERAL AGENCIES

The BOR, the CUWCD, the Mitigation Commission and SNWA are all signers of the LCCAS. However, the signers' responsibilities vary significantly and more significant conservation efforts are needed. The BOR funded fish nonnative removal projects over some years at the Mona Spring Complex (LCCT 2014, p. 15). The Mitigation Commission purchased the Mona Springs site for the protection of the least chub and the Columbia Spotted Frog (USFWS and UDWR 2014, p. 8-9; USFWS 2014a, p. 51045). Grazing was removed in 2005 and habitat enhancement projects to deepen the Spring and remove nonnative vegetation began in 2011 (USFWS 2014a, p. 51045). However,

unsuitable habitat and nonnative fish, especially western mosquitofish, have constantly plagued the Mona Spring population (UDWR 2017, p. 34).

SNWA is a signatory to the amendment but "is committed to avoiding and/or mitigating impacts on least chub from groundwater withdrawal *within the constraints of SNWA policy and authority* [emphasis added]" (LCCT 2014, p. 17). SNWA has been involved in a groundwater level monitoring effort through a cooperative funding agreement (*Id.*). It is not unclear what actions have been taken by CUWCD.

At the time of publication of LCCT 2014, funding for the implementation of conservation actions under the Conservation Agreement had predominantly been provided by the BLM, UDWR and FWS, with the Mitigation Commission contributing $22,300 and $4,700 in 2005 and 2007 respectively. No future expenditures are anticipated by the Mitigation Commission (LCCT 2014, p. 25).

F. PRIVATE LANDS

Most of the wild least chub populations exist partly on private lands. Approximately 80% of Mills Valley is privately owned, and although livestock impacts have been reduced through conservation measures and UDWR has agreed to encourage private landowners to enroll in the programmatic CCAA, the proportion of private lands that has suffered significant grazing impacts in the past is around 50% (USFWS 2014a, p. 51049). Approximately half of the habitat at Leland Harris is on private land. Miller Springs (located in the complex) are managed according to a grazing plan developed by the UDWR and the private landowner. However, least chub are not regularly monitored at the Spring (*Ibid*, p. 51046). Almost 30% of Gandy Marsh is privately owned. The landowner has voluntarily enclosed about 50% of the springheads, resulting in a reduction in livestock entrainment (*Ibid*, p. 51046, 51049). Around 10% of Bishop Springs is privately owned. In 2006, UDWR and the Service entered into a CCA with the landowner to obtain water rights for Foote Reservoir and Bishop Twin Springs, and in 2008, UDWR acquired a permit for permanent change of use, allowing a seasonal instream flow (*Ibid*, p. 51046). However, as noted in USFWS 2010 (p. 35412) this level of land management cannot protect against possible nonnative fish invasion and may inadequately protect the site from water losses caused by future large-scale groundwater pumping. UDWR has agreed to encourage private landowners at Leland, Gandy and Bishop to enroll in the CCAA (LCCT 2014, p. 18).

At the newly discovered wild Gunnison population site, chubs are found in a seep below Gunnison Dam, in some nearby pools and portion of the San Pitch River (Utah Department of Natural Resources 2021, p. 1). The seep is often the only reliable water in the area and occurs on private land. Although the irrigation company that owns the land seems supportive of a proposed UDWR vegetation removal project (*Ibid*, p. 1, 3), the least chub faces major threats from water diversion.

Over 40% of least chub refuge populations occur on private land, including Rosebud Top Pond, Stokes Nature Center, Willow Pond, Escalante Elementary School, Big Spring and

Chamber Spring (USFWS and UDWR 2014, p. 20; UDWR 2017, p. 15). A MOU exists for Rosebud Top Pond and Willow Pond (UDWR 2017, p. 15) and Stokes Nature Center is enrolled in a conservation easement with the UDWR (*Ibid*, p. 4). At Big Spring, LCCT is recommending activities in coordination with the private landowner that may enhance habitat in the lower portion of the site and prevent intrusion by nonnative fish from downstream (Graham and Dittmer, 2019, p. 23).

G. TRIBAL LANDS

Currently, there are no populations of least chub on tribal lands, although there were historically. The Confederated Tribes of the Goshute Reservation is a signer on the LCCAS.

H. SUMMARY, INADEQUACY OF EXISTING REGULATIONS

In the lawsuit *Center for Biological Diversity v. Gale Norton, CV 01-409 TUC DCB* [Jan. 13, 2003] (entire), 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. Doremus and Pagel (2001, p. 1261) 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 natural populations currently persist at only about a handful of sites along the Wasatch Front, in the Sevier River basin and in Snake Valley in the Utah West Desert.

The least chub faces major threats including current and future water developments, nonnative fish, invasive plants, drought and climate change, stochastic disturbance and population isolation, livestock grazing, urban development, oil and gas development, and the cumulative impacts of these threats. The inadequacy of existing regulations are partly to blame for the decline of this species.

Recovery of the least chub will require a holistic approach to watershed management and the continuation of strong efforts of the LCCT to conserve existing wild and refuge populations and create new refuge populations to provide redundancy and resiliency to all naturally occurring least chub populations (USFWS 2014a, p. 51043).

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 Pine, Wah Wah and Hamlin Valleys

groundwater leads to reduced spring discharges in Snake Valley and the Sevier Desert Basin, impacting a majority of extant wild populations.

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.

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