Updated Goals and Objectives for the Conservation of Lahontan Cutthroat Trout (*Oncorhynchus clarkii henshawi*)

Endorsed by: Lahontan Cutthroat Trout Management Oversight Group

Prepared by: Lahontan Cutthroat Trout Coordinating Committee

May 29, 2019

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Vision of Recovery

This vision of recovery for Lahontan cutthroat trout (LCT) provides context for updating the goals and objectives provided within the original 1995 LCT Recovery Plan. The updated goals and objectives presented below inform the conservation actions needed in the future to achieve and maintain recovery for LCT, within an adaptive framework, and are based on the conservation biology principles of Representation, Redundancy, and Resiliency:

> **Representation:** Conserve the genetic and behavioral (*i.e.,* variable life-history strategies/characteristics) diversity of LCT by ensuring that it is present within the variety of ecological and geographic settings throughout its historical range; and
>
> **Redundancy:** Guarantee that an adequate number and distribution of LCT populations are present throughout its historical range so that catastrophic events do not diminish the adaptive capacity of LCT; and
>
> **Resiliency:** Ensure that each LCT population used to meet the updated objectives contains an adequate number of individuals that are distributed throughout sufficient habitat so that they are able to withstand stochastic, population-level events over time.

This vision, along with the resulting goals and objectives are designed to recover LCT, while also providing the public with sustainable ecological and recreational benefits. To ensure this vision is realized, all LCT conservation partners will need to work closely together, and effectively engage appropriate stakeholders, while continually applying the best available science in an adaptive process. The adaptive process requires continual scientific inquiry and adherence to the guidance presented in this document, including the development of genetics management and monitoring plans. Although recovery is the ultimate goal of this process, it is recognized that due to the multiple-use landscape where LCT occur, LCT will likely remain a conservation-reliant species in several portions of its range.

Purpose

The purpose of this document is to provide clarity for LCT conservation actions to allow a more efficient and effective approach to the recovery of this species. This document uses the best available science to update goals and objectives for the conservation of LCT. When these updated objectives have been met, LCT recovery populations will be sufficiently redundant and resilient throughout the variety of ecological and geographic settings within its historical range to safeguard its genetic and behavioral legacy. Therefore, achieving these updated objectives would provide LCT with the adaptive capacity necessary to persist through time, resulting in the ability to delist this species as it would no longer be threatened with endangerment.

The LCT Management Oversight Group endorsed this document as the unified approach to conserve LCT on May 29, 2019, with a unanimous vote of 13-0.

INTRODUCTION AND BACKGROUND

Lahontan cutthroat trout (LCT; *Oncorhynchus clarkii henshawi*) evolved within the geographically isolated Lahontan Basin, which historically contained a large Pleistocene-era lake known as Lake Lahontan. This lake ebbed and flowed for several million years, reaching its high stand approximately 650 thousand years before present and covered most of northwestern Nevada at that time (Reheis *et al.* 2002). Starting about 13,500 years ago, ancient Lake Lahontan began to desiccate, decreasing in elevation due to a warming trend in this region that is still continuing today (Thompson *et al.* 1986; Benson & Thompson 1987). The large and interconnected ancient lake system became fragmented over time, resulting in a network of lakes and sinks within the basin fed by river and/or stream systems. LCT developed several life-history strategies and characteristics over this time to adapt to differences in the available stream, river, and/or lake habitats. In addition, some drainage basins became isolated, resulting in genetic and/or morphological differentiation of LCT populations over time. In 1800, it is believed that over 370,000 surface acres of lake (in 12 larger lake systems) and more than 7,400 miles of stream/river habitat was occupied or had the potential to be occupied by LCT (Gerstung 1986, US Fish and Wildlife Service (USFWS) 2009). However, starting in the mid 1800's, significant changes occurred across the landscape as settlement of the Lahontan Basin and northern California began. Over harvesting of LCT, mining, logging, pollution, water diversions, dams and reservoirs, and introduction of non-native trout species significantly reduced the amount and quality of habitat available and numbers of LCT. By the early 1900's, noticeable reductions in LCT numbers and populations had occurred (USFWS 1995); by the mid 1900's, LCT were extirpated from a majority of major drainage basins, and generally restricted to isolated headwater or small lake systems. The historical range of LCT is entirely within the Lahontan hydrographic basin (Figure 1), with the exception of Thousand-Virgin and the Alvord Lake subbasins, which were historically occupied by an evolutionarily-similar lineage of inland cutthroat trout, the Alvord cutthroat trout.

On October 13, 1970, LCT were federally listed as endangered under the Endangered Species Conservation Act of 1969 and reclassified as threatened under the Endangered Species Act (ESA) on July 16, 1975, to facilitate management and allow regulated angling (USFWS 1970, 1975). The combined impacts of non-native species introductions and management, habitat destruction, and habitat fragmentation over the last 170 years were the primary reasons LCT was listed and remains threatened today (USFWS 1975, 2009). There is no designated critical habitat for LCT.

Currently, LCT is documented to occur throughout its historical range with the exception of the Susan River basin. It is unknown when LCT were extirpated from the Susan River basin. Among the documented occurrences, 72 self-sustaining LCT populations currently exist in approximately 10.5 percent of historical habitat (752 stream miles and 1,394 surface acres); however, the majority of the existing populations are in smaller, isolated habitat fragments and/or have lower abundances due to poor habitat quality, and are likely not resilient in the long-term. Within the historical range of LCT, approximately 68.3 percent of historical stream and lake habitat (7,457 miles and 372,330 surface acres, respectively) are potentially suitable habitat for LCT today, including currently occupied habitats. This loss is due to climatic and anthropogenic factors over the last several hundred years that have resulted in either the complete loss of habitat or increased temperatures within habitats at lower elevations. Because of this reduction in habitat suitability across the historical range over time, self-sustaining LCT populations currently occupy approximately 15 percent of the potentially suitable habitat (see Updated Objectives for more information).

The range of LCT is currently divided into three geographic management units (GMUs; Figure 1): the Western (Truckee River, Carson River, and Walker River basins), Northwest (Coyote Lake and Quinn River basins, including Black Rock Desert/Summit Lake), and Humboldt (Humboldt River Basin, including the Reese and Little Humboldt rivers). In the Western GMU, due to the presence of large lake systems (*i.e.,* Tahoe, Pyramid, Walker) that are interconnected by hundreds of miles of lake, river, and stream habitats and different management agency jurisdictions, the GMU is further divided into Recovery Implementation Teams (RITs): Tahoe Basin and Truckee, Carson, and Walker River Basins RITs currently exist. The Northwest and Humboldt GMU teams and the Western GMU RITs are guided by a Management Oversight Group (MOG) and Coordinating Committee (CC) that together manage and coordinate LCT recovery efforts. The MOG was originally organized in 1998, and then restructured in 2017 to enable the development of the CC. The MOG and CC are made up of executive/senior and upper management/senior level technical staff, respectively, from the majority of agency and partner organizations involved in LCT recovery actions rangewide (Figure 2; also see Governance Structure of LCT Recovery).

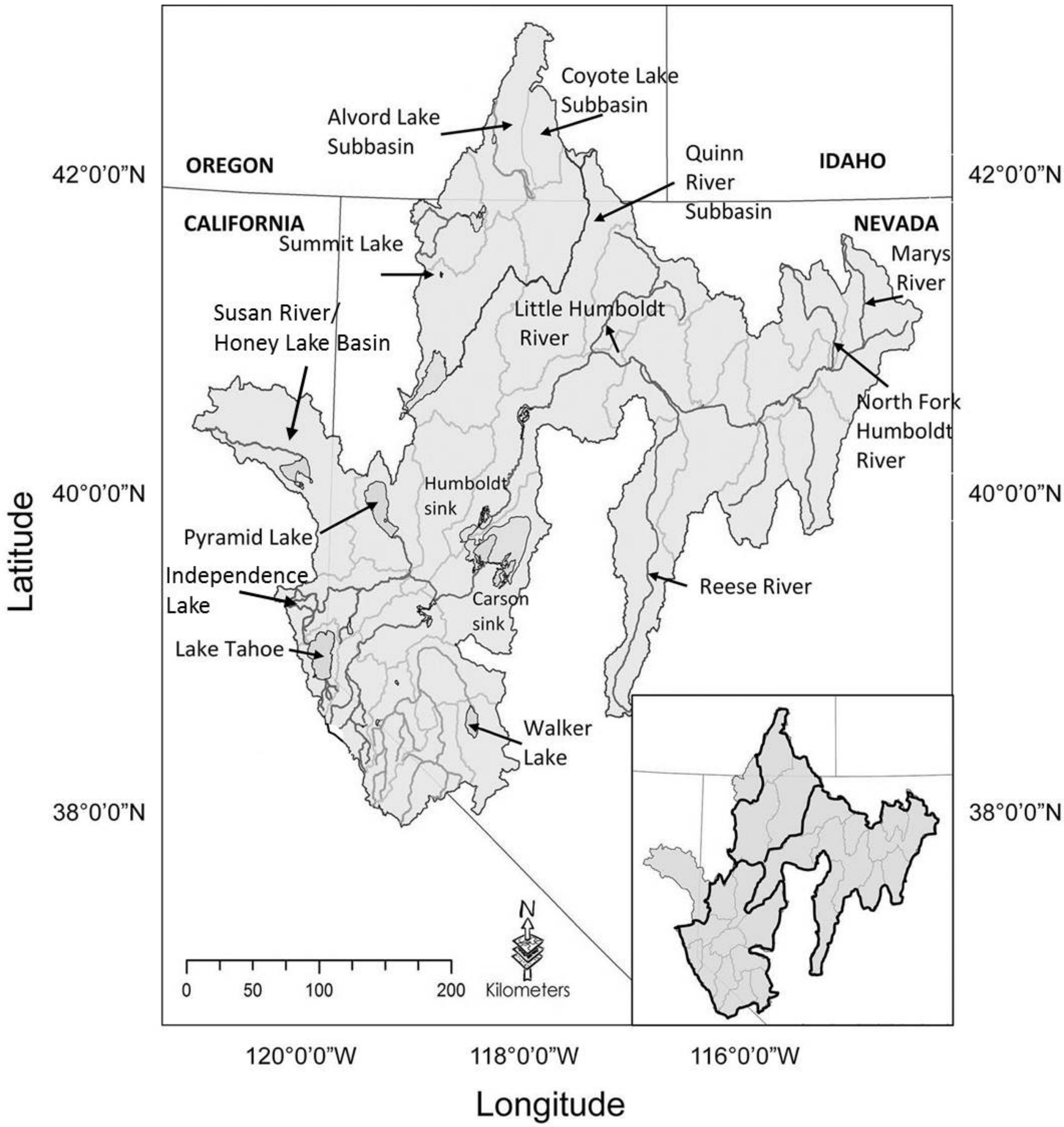
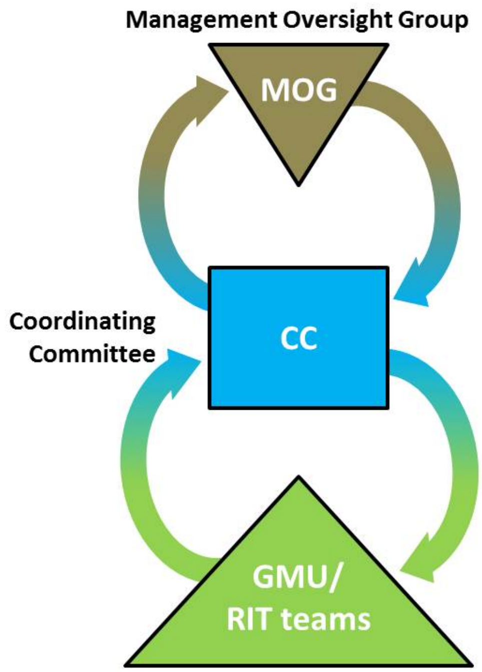


Figure 1. The Lahontan hydrographic basin of northern Nevada, northeastern California, and southwestern Oregon. Major rivers and lakes shown, with the inset depicting USFWS GMUs for LCT. Adapted from Peacock *et al*. 2018.



Northwest, Humboldt, and Western Geographic Management Unit (GMU) teams; the Western GMU is comprised of the Carson, Tahoe, Truckee, and Walker Recovery Implementation Teams (RITs).

Figure 2. A depiction of the LCT recovery partners' governance structure.

In 1995, the USFWS published the Recovery Plan for the Lahontan Cutthroat Trout (USFWS 1995). The plan outlined recovery objectives and criteria for delisting LCT rangewide (USFWS 1995, pg. 47–49), including protecting existing LCT populations, establishing new populations, determining how many populations are necessary to ensure persistence for the next 100 years, implementing research and analyses to validate the recovery objectives and to define additional objectives, and revising the plan as more information became available. In the more than 24 years since the recovery plan was signed, a substantial amount of research has been conducted on inland trout species conservation and persistence needs, as well as specific research on LCT. For example, the original plan did not require meta-population dynamics within populations, something that we now know is important for population resiliency. Instead, it focused on maintaining or establishing isolated, but viable/self-sustaining populations; the best available science now indicates that many of these isolated populations are not resilient in the long-term, especially when they exist in small systems and/or are not in climate-resilient habitats. In addition, many of the populations listed in the plan are actually part of a larger interconnected system, which artificially inflates population numbers and creates ambiguity.

This current effort attempts to create current and complete goals and objectives using best available science, while clarifying terms used in the 1995 Recovery Plan to reduce vagueness. For example, the 1995 Recovery Plan calls for the maintenance of over 140 "populations" when only 94 actually existed (Appendix Table A-1), in addition to the establishment of at least 13 additional viable fluvial populations. Of the 94 populations in existence in 1995, 30 have since been lost (Appendix Tables A-1 through A-3); of those 30 populations, 29 were in small, isolated habitat fragments

(Appendix Table A-1). A total of 63 "populations" were not described, or have been discovered or established since 1995; however, 37 of them are sustained *via* hatchery stocking, 16 are in small, isolated fluvial fragments, and 10 are additions to existing populations (Appendix Table A-2). Currently, at least 42 of the approximately 72 existing LCT populations within the historical range are present in small, isolated habitat fragments. Lastly, of the 33 "out-of-basin populations" described in the 1995 Recovery Plan, it is likely that only 25 currently exist, with 1 of them actually being within the historical range of LCT (Pete Hansen Creek) and the others remaining in relatively small, isolated creeks (Appendix Table A-4). Additionally, it is likely that there are previously undescribed "out-of-basin populations" that currently exist on the landscape. See the 5-year Review (USFWS 2009) for more detailed information regarding population changes between 1995 and 2008.

In addition, the 1995 Recovery Plan placed little emphasis on climatic or anthropogenic changes across the historical range of LCT nor did it address how that would impact population persistence. These updated goals and objectives display historical LCT habitat and potentially suitable LCT habitat (as of 2019) within LCT Management Unit-based maps, improving context and future recovery planning efforts (see maps in Updated Objectives section). Climate modelling data will be integrated into these maps to further advance the efficiency and effectiveness of LCT recovery efforts in the future and will be part of the next update. The 1995 Recovery Plan also did not focus on the importance of conserving the variable life-history strategies of LCT; for example, there were no requirements to establish additional lacustrine populations. Although the plan called for revisions to validate research regarding the viability needs of lacustrine populations and update the recovery objectives, it never occurred. Lastly, the original plan lacked adequate definitions for several key aspects of recovery. For example, the term "recovery population" was described as one that "has been established for five or more years and has three or more age classes of self-sustaining trout…" This document improves upon that definition and identifies tools that are currently available to validate the resiliency of a recovery population. In summary, this effort was completed to ensure that goals and objectives for the conservation of LCT are up-to-date, complete, supported by the best available science, and reside within a living document that contains a scheduled revision process (see The Adaptive Process section).

For more detailed information regarding LCT, please see the 2009 Status Review (USFWS 2009), the 1995 LCT Recovery Plan (USFWS 1995), and the Short-Term Action Plans (USFWS 2003a, USFWS 2003b).

Updated Goals and Objectives

Framework and Goals

The conservation biology principles of Representation, Redundancy, and Resiliency (3 R's) formed the framework for the development of the updated goals and objectives presented in this document. These principles are well-accepted by the scientific community because they are rooted in findings from ecological theory and empirical studies (Shaffer & Stein 2000, Wolf *et al.* 2015), and are aligned with guidance provided by the USFWS (USFWS 2016).

Representation refers to a species' adaptive capacity, or ability to adapt to a changing environment over time (USFWS 2016).

> <u>Goal 1 (Representation):</u> *Conserve the genetic and behavioral (i.e., variable life-history strategies/characteristics) diversity of LCT by ensuring that it is present within the variety of ecological and geographic settings throughout its historical range.*

For the purposes of this planning effort, the range of LCT has been divided into 10 Management Units (Figure 3), which are nested within the 3 GMUs presented in the 1995 Recovery Plan. Each Management Unit contains locally-adapted populations that possess some level of genetic differentiation and/or geographic isolation. In addition, each unit is currently managed by recovery partners differently due to the above-mentioned factors. By conserving all 10 Management Units, the entirety of the remaining genetic diversity of LCT can be preserved throughout the variety of geographic settings within its historical range. Conservation at this scale is necessary because it is likely that much of the genetic diversity of LCT has already been lost (see Introduction and Background); this was not the focus of the 1995 Recovery Plan, but is necessary to ensure the adaptive capacity of LCT is conserved. Also, it is important that LCT persist within the assortment of habitats it evolved in because the differences in the available habitats resulted in LCT evolving multiple life-history strategies and characteristics (some of which are likely genetically derived). The main life-history strategies of LCT are lacustrine (lake/adfluvial; see Glossary of Terms) and fluvial (stream/river). Furthermore, meta-population dynamics likely existed in each of the major watersheds, basins, and/or sub-basins, resulting in resident and migratory life-history characteristics that provided gene flow and increased resiliency. It is essential to recognize and conserve the variety of life-history strategies and characteristics (*i.e.,* behavioral variation) to further maximize the adaptive capacity of LCT and meet the above definition of representation.

Redundancy refers to a species' ability to withstand catastrophic events. In general, redundancy spreads the risk throughout a species range (USFWS 2016), ensuring that enough of the species' adaptive capacity is secured after catastrophic events occur within portions of its range.

> <u>Goal 2 (Redundancy)</u>: *Guarantee that an adequate number and distribution of LCT populations are present throughout its historical range so that catastrophic events do not diminish the adaptive capacity of LCT.*

Redundancy is first addressed at the unit-level because the 10 LCT Management Units described above encompass the entirety of the remaining genetic and behavioral diversity of LCT, and the units in total include the variety of ecological and geographic settings present within its historical range. Dividing the range into 10 Management Units and ensuring that each unit contains at least one population provides an initial level of redundancy for LCT rangewide as well (*e.g.,* spreading the risk throughout the range of the species). However, to fully meet the goal of redundancy, updated objectives were created to ensure: 1) redundant lacustrine populations, 2) redundant fluvial populations that display meta-population dynamics, and 3) additional within-unit redundant populations (when necessary) present throughout the majority of LCT's historical range. Several units will require more than two resilient populations within them to ensure redundancy because of several factors. First, fluvial populations, by nature, are more vulnerable than lacustrine populations to a variety of impacts; thus, units with only fluvial populations will need to have increased redundancy to better safeguard them against catastrophic events. Next, the habitats within several units are not as climate-resilient as others, therefore decreasing persistence probabilities of individual populations within those habitats. These units will require more and/or larger populations to better ensure persistence of the Management Unit into the foreseeable future.

Providing redundancy for every Management Unit may not be possible as the unit itself does not contain additional suitable habitat within it (*i.e.,* the Summit Unit). This could be addressed in the future by establishing and/or maintaining populations in habitats out-of-the-historical-range, within portions of the historical range that currently do not contain LCT (*e.g.,* Susan River area), or by increasing the resiliency of the existing population to an acceptable level. In addition, some units may not need additional within unit redundancy because another unit contains redundant populations that contain the same genetic and behavioral diversity (*i.e.,* Pyramid-Truckee and Tahoe Units). Currently, the goal is to maintain at least one meta-population within each relevant unit, basin, or major sub-basin with some additional level of redundancy, in combination with increasing the amount of recovery populations within lacustrine systems, which are currently underrepresented rangewide. The best available science will be used to validate how a certain set of populations throughout the range of LCT, and at the unit-level, meets the redundancy component of the 3 R's.

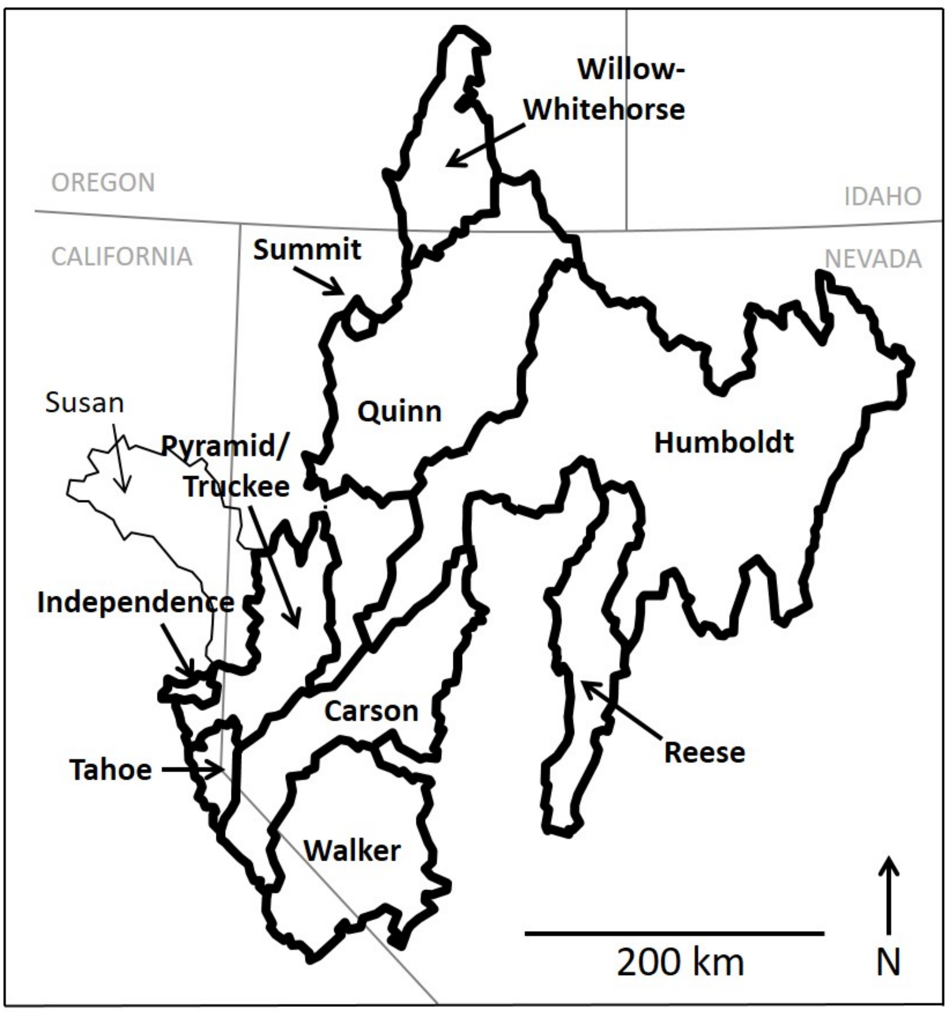


Figure 3. The LCT Management Unit designations overlaid within its historical range. Currently, the Susan Unit does not contain LCT and was not considered for the purposes of this update (see pg. 2).

Resiliency refers to a species' ability to withstand stochastic disturbances at the population level. In general, this requires a population to contain enough individuals throughout habitat(s) of sufficient area and quality to survive and reproduce in spite of typical environmental and demographic disturbances (USFWS 2016).

> Goal 3 (Resiliency): *Ensure that each LCT population used to meet updated objectives contains an adequate number of individuals that are distributed throughout sufficient habitat so that they are able to withstand stochastic, population-level events over time.*

The accumulated understanding of inland trout indicates that larger, more variable, and interconnected habitat fragments are essential to sustain enough individuals to be resilient (Nelson & Soulé 1987, Hilderbrand & Kershner 2000, Harig & Fausch 2002, Young *et al.* 2005). In addition, meta-population dynamics are an important component of salmonid population resiliency, allowing for movement throughout a variable and interconnected system based on environmental factors and gene flow (Rieman & Dumham 2000, Neville *et al.* 2006, Haak & Williams 2012). Thus, a population that exhibits meta-population dynamics (see Glossary of Terms) is more resilient than one that does not. Also, larger habitats tend to hold more individuals, likely making them more resilient, although this is a generalization that is dependent on habitat quality. Nonetheless, LCT populations can still be resilient without displaying meta-populations dynamics or inhabiting large habitat fragments, assuming that enough individuals are present throughout sufficient habitat. To validate whether or not a "recovery population" is in fact likely to persist through time, several PVA models and/or additional science-based tools are now available for LCT (Element 3 of a "recovery population"). Lastly, LCT populations will likely only be resilient in habitats that are maintained at, or on an upwards trend towards, a functioning ecological condition; this likely requires the presence of full to partial native aquatic assemblage and active/adaptive management of land uses. The desired elements of a resilient, recovery population are:

1) Genetically pure LCT; and
2) Multiple age-classes resulting from regular, natural reproductive events with recruitment; and
3) Enough individuals over time to produce a population trend that is in-line with the best available science regarding viable populations given climatic conditions.

The purpose of parameterizing a recovery population is only to provide a foundational benchmark for future recovery and conservation actions. However, achieving genetic purity within all LCT recovery populations will not be possible; in some cases, introgression may be present. In these specific cases, effectively managing the risk of hybridization to minimize it over time will be imperative. In addition, to improve LCT population resiliency, larger, more variable, and interconnected habitat fragments are required, as many of these populations will need to exhibit meta-population dynamics in order to meet the goal of representation and resiliency for LCT.

An assessment completed in 2008 indicated that more than 70 percent of the existing LCT populations rangewide were isolated within small habitat fragments containing relatively low abundances (USFWS 2009); although several larger populations have been established over the last decade, the majority of LCT populations are still isolated in small habitat fragments containing low abundances. Many of these smaller, isolated populations will not meet the recovery population benchmarks described above. Nevertheless, these populations are important for LCT recovery and conservation. In some portions of LCT's historical range, it may not be possible to connect existing isolated populations because anthropogenic impacts have physically disconnected systems or changes in hydrology and/or the climate have resulted in the loss of historical connections. However, science supporting assisted migration, commonly known as the "rescue effect," may provide insight into a possible conservation strategy. This strategy entails physically moving a few fish from one isolated population to another to increase that population's resiliency by assisting gene flow and has the potential to reduce the genetic effects of isolation and small population size (see Hendrick & Fredrickson 2010, Whiteley *et al.* 2015, Frankham 2015). Therefore, it may be possible to "connect" several small, isolated populations in this way, creating a set of populations that together function as a recovery population. Currently, efforts are underway to better understand how this strategy can be better integrated into future updates of this document, and to ensure that deleterious outcomes (*e.g.,* outbreeding depression) are unlikely to occur. These findings, among others (*e.g.,* pending rangewide genetic assessment, out-of-historical-range LCT population genetics), will be used to guide the development of a rangewide LCT Genetics Management Plan that will better conserve the genetic legacy of LCT into the future and protect important existing, isolated populations from genetic effects associated with isolation and small population size.

Updated Objectives

The framework and associated *goals* described above were used to develop the updated objectives described below. Each updated objective is quantifiable, addresses demographic and/or habitat needs of LCT, and is based on the best available science. The objectives were broken down into the same 10 LCT Management Units as the Updated Goals: Carson, Humboldt, Quinn, Reese, Summit, Walker, Willow-Whitehorse, Independence, Pyramid-Truckee, and Tahoe. Although populations of LCT in the Pyramid-Truckee and Tahoe units were not historically isolated geographically or genetically different, these units were separated due to different threats, management challenges, stakeholders, and partnerships (see *Truckee River Watershed Units* for more information). Updated objectives were not established within the Susan River basin for this update because it does not contain locally-adapted LCT populations or unique habitats that would significantly contribute to the representation or adaptive capacity of this species. However, some potentially suitable habitat does exist within higher-elevation areas of the Susan Unit; those habitats should be explored further in the future for opportunities to promote the long-term conservation of LCT.

As described in previous sections, the objectives within the 1995 Recovery Plan for LCT are outdated, inadequately defined and/or no longer relevant. First, relying solely on the number of populations does not adequately address recovery. The best available science now indicates that meta-population dynamics are essential to develop a highly resilient population and fully meet representation; this is especially important for fluvial populations. In addition, populations within smaller systems or habitat fragments are less resilient than populations within entire watersheds and thus will require additional levels of redundancy either within-unit or a watershed. This will require establishing and/or reconnecting populations within habitat fragments large and complex enough to ensure resiliency and allow for meta-population dynamics to occur. Next, the 1995 Recovery Plan did not set adequate objectives for conserving the lacustrine/adfluvial life-history strategy. Currently, only two lacustrine LCT recovery populations exist (Summit and Independence Lakes), both in isolated and relatively small systems. The updated objectives presented below result in the establishment of at least four additional lacustrine recovery populations, two of which within the largest lake systems in LCT's historical range (Pyramid and Tahoe). Moreover, except for the Summit Lake population (see Summit Unit description for more information), the updated objectives also provide sufficient levels of redundancy for each of the unique lacustrine forms either within or among units.

When the updated objectives are accomplished, a total of at least 40 resilient LCT recovery populations will be present across the species historical range. This will include:

- At least 6 lacustrine LCT recovery populations present within 5 of the 10 LCT Management Units, several of which are in known climate-resilient habitats; and
- At least 34 fluvial recovery populations present within 7 of the 10 LCT Units, with each unit containing at least 1 population that displays meta-population dynamics; and
- Meta-population dynamics present within at least 15 recovery populations spread throughout LCT's historical range.

The best available science will be used to ensure LCT populations are established in the most climate-resilient habitats present, as well as restoring watershed-level processes to reduce impacts to terminus lake systems unique to LCT's range and thus necessary for achieving representation and recovery. Existing, isolated LCT populations (at least 40 populations; see specific Unit Objectives and Appendix Tables A-1 through A-3 for more information) will be maintained until the pending LCT Genetics Management Plan is developed; this plan will provide guidance for the long-term management of those existing, isolated populations to increase long-term persistence probabilities. Next, the integration of a science-based monitoring program that allows LCT recovery partners to assess progress towards the updated objectives presented below is necessary; this will require the establishment of a unified monitoring approach (*i.e.,* LCT Monitoring Plan) for both LCT and the habitats it depends on. Lastly, it is also important to better understand the existing out-of-historical-range populations; thus, a thorough genetic assessment needs to be completed and integrated into the pending LCT Genetics Management Plan. This will require maintenance of all existing out-of-historical-range populations not specifically mentioned in this document until formal guidance can be compiled (Appendix Table A-4).

The maps presented in the Updated Objectives for each LCT Management Unit below depict the following:

- Historical habitat likely occupied by LCT in 1800 upon the arrival of western settlers (refer to USFWS 2009 for methodology used to create the historical map layer);
- Potentially suitable habitat that LCT does or likely could occupy today; and
- LCT occupied habitat.

The historical habitat layer was not designed to depict pre-history conditions. For the purposes of the LCT Management Unit-Specific Maps present below, the historical layer is a depiction of where LCT likely occurred prior to the large-scale settlement of the western United States (*circa* 1800). The potentially suitable habitat layer was created based on information commonly known (*i.e.,* Lake Winnemucca is dry) and results from Warren *et al.* (2014); effectively, many fluvial systems below 4,700 above mean sea level (amsl) are presumed not likely to contain suitable habitat for LCT due to lack of suitable habitat (*e.g.,* high water temperatures, lack of water, poor water quality). However, systems known to currently contain suitable habitat (*e.g.,* Walker River) for LCT below 4,700 amsl were mapped as suitable. The potentially suitable habitat layer was mapped on top of the historical habitat layer to provide context regarding available habitat for LCT in 2019 versus where LCT existed in 1800. However, habitat not suitable for LCT today can likely be restored and made suitable in the future (*i.e.*, Walker Lake) because the potentially suitable habitat layer is merely a snapshot of habitat conditions in 2019 and can change. It is also likely that some of the mapped potentially suitable habitat is not actually suitable for LCT today because of site-specific factors. This site-specific information will be incorporated during updates of this document as it becomes available. Lastly, not all mapped LCT occupied habitats contains self-sustaining LCT populations, as stocking maintains approximately 35 populations (see Appendix Table A-3). Although each map presented below contains some descriptive information for orientation, each system or population was not labelled (refer to USFWS 2009 for the location and population-specific information). Populations out-of-historical-range were not mapped in this effort; please refer to USFWS 2009 and Appendix Table A-4 for the locations of, and more information regarding, those populations.

Carson Unit (CU)

The CU (Figure 4) encompasses several 8-digit United States Geological Survey (USGS) hydrologic units, including the: Upper Carson (hydrologic unit code (HUC) 16050201), Middle Carson (HUC 16050202), and Carson Desert (HUC 16050203). Currently, several isolated LCT populations exist in the Upper Carson hydrologic unit; the Middle Carson and Carson Desert hydrologic units were historically occupied by LCT, but currently contain little suitable trout habitat due to mostly anthropogenic impacts (*i.e.,* barriers, water diversions, reservoirs, higher water temperatures). The Upper Carson hydrologic unit contains ample, high-quality fluvial habitats within the most climate-resilient region of LCT's range (Sierra Nevada Mountains). Achieving the objectives below would better guarantee redundant and resilient populations to safeguard CU genetics in a unique geographic and ecological setting, and contribute to the conservation of the fluvial life-history strategy. The updated objectives for LCT in the CU are:

- CU 1) Remove threats (*i.e.,* competition, predation, hybridization) associated with non-native trout species to allow for the formation and/or maintenance of CU LCT populations identified in CU objectives 3–4; and
- CU 2) Ensure all habitats required to meet CU objectives 3–4 function ecologically. In some cases, this may require restoration and/or management changes; and
- CU 3) Establish meta-population dynamics within at least 1 recovery population; and
- CU 4) Establish at least 2 additional recovery populations in the Upper Carson hydrologic unit, spatially separated from each other and the meta-population required by CU objective 3.

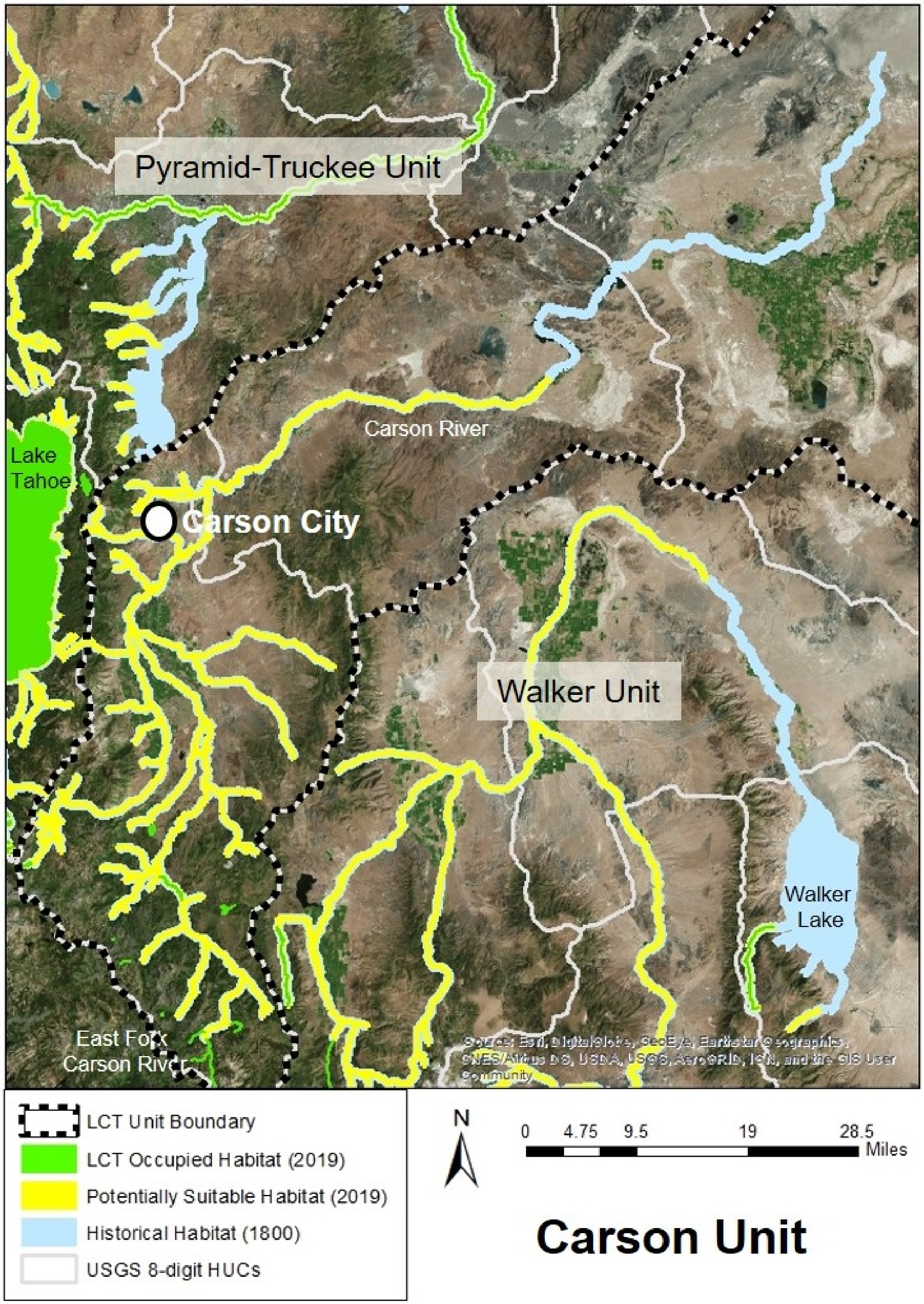


Figure 4. Occupied, potentially suitable, and historical habitat in the Carson Management Unit. Self-sustaining LCT populations are currently above natural barriers to upstream fish migration in the upper east fork of the Carson River.

Humboldt Unit (HU)

The HU (Figure 5) encompasses eight, 8-digit USGS hydrologic units, including: North Fork (HUC 16040102), Upper (HUC 16040101), South Fork (HUC 16040103), Middle (HUC 16040105), Lower (HUC 16040108), and Little (HUC 16040109) Humboldt, and Rock (HUC 16040106) and Pine (HUC 16040104). The Humboldt River drainage is very large (>16,000 square miles), contains many large and interconnected fluvial systems, and represents the easternmost portion of LCT's range. Some of the most climate-resilient fluvial habitats in Nevada are present in the HU (*i.e.,* Ruby Mountains). The Lower and Middle Humboldt, and Pine hydrologic units offer limited conservation potential due to mostly anthropogenic impacts (*i.e.,* barriers, water diversions, reservoirs, higher water temperatures) and lack locally-adapted HU LCT. North Fork, Upper, South Fork, and Little Humboldt, and Rock hydrologic units currently contain LCT populations, some of which exhibit meta-population dynamics and are resilient. Each of these hydrologic units contain locally-adapted fluvial LCT populations, thus it is important to achieve redundancy within each of the hydrologic units to ensure the genetic diversity within the HU is conserved. Collectively, LCT within the HU are genetically discrete from LCT found in other units. Meeting the objectives below would better safeguard HU genetics in a variety of unique geographic and ecological settings, and would further the conservation of the fluvial life-history strategy. The updated objectives for LCT in the HU include:

Unit Wide:

HU 1) Remove threats (*i.e.,* competition, predation, hybridization) associated with non-native trout species to allow for the formation and/or maintenance of HU LCT populations identified in HU objectives 3–13; and

HU 2) Ensure all habitats required to meet HU objectives 3–13 function ecologically. In some cases, this may require restoration and/or management changes; and

HU 3) Maintain existing, isolated populations that cannot individually meet the recovery population benchmarks provided in this document. Actively manage those populations based on guidance provided in the pending LCT Genetics Management Plan; and

Little Humboldt hydrologic unit:

HU 4) Maintain meta-population dynamics in 1, and establish meta-population dynamics in at least 1 additional, recovery population; and

HU 5) Establish at least 1 additional recovery population that is spatially separated from the meta-populations required by HU objective 4; and

North Fork Humboldt hydrologic unit:

HU 6) Establish meta-population dynamics in at least 1 recovery population; and

HU 7) Maintain (or establish if necessary) at least 1 additional recovery population that is spatially separated from the meta-population required by HU objective 6; and

Rock hydrologic unit:

HU 8) Maintain meta-population dynamics in at least 1 recovery population; and

HU 9) Maintain (or establish if necessary) at least 1 additional recovery population that is spatially separated from the meta-population required by HU objective 8; and

South Fork Humboldt hydrologic unit:

HU 10) Establish meta-population dynamics in at least 1 recovery population; and

HU 11) Maintain (or establish if necessary) at least 2 additional recovery populations that are spatially separated from each other and the meta-population required by HU objective 10; and

Upper Humboldt hydrologic unit:

HU 12) Maintain meta-population dynamics in 2, and establish meta-population dynamics in at least 1 additional, recovery population(s); and

HU 13) Maintain (or establish if necessary) at least 3 additional recovery populations that are spatially separated from each other and the meta-populations required by HU objective 12.

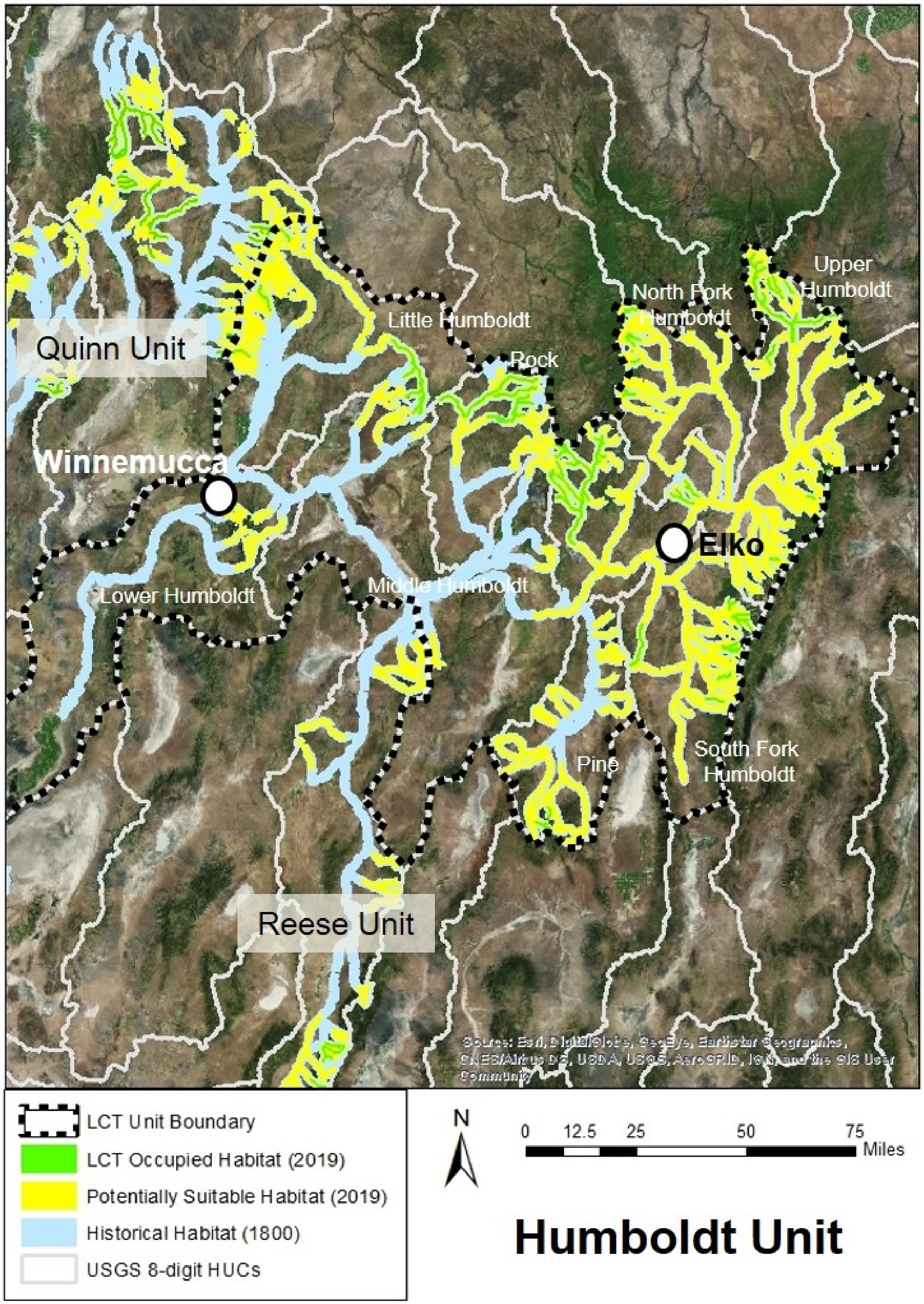


Figure 5. Occupied, potentially suitable, and historical habitat in the Humboldt Management Unit. Eight-digit USGS hydrologic units are labeled on this map to help orient due to large size scale of this unit.

Quinn Unit (QU)

The QU (Figure 6) includes the USGS Upper Quinn (HUC 16040201) and Lower Quinn (HUC 16040202) hydrologic units, but excludes the Summit Lake subbasin, which is geographically isolated from the Quinn River drainage. QU LCT are adapted to life within semi-arid fluvial systems and are genetically distinct from LCT found in other Management Units. This unit receives the lowest amount of precipitation compared to other LCT units and thus has fewer systems that can support larger, more resilient LCT populations. However, it contains several higher-elevation mountain ranges (*i.e.,* Montana, Santa Rosa) that have climate-resilient properties. The potential to reconnect and/or actively manage isolated LCT populations and reintroduce LCT into larger habitat fragments is present within the QU, albeit limited due to the arid, lower elevation nature of this unit. Achieving the objectives below would dramatically increase the probability that QU genetics are conserved in the unique geographic and ecological settings of the Quinn River Valley, and contributes to the conservation of the fluvial life-history strategy. The updated objectives for LCT in the QU are as follows:

- QU 1) Remove threats (*i.e.,* competition, predation, hybridization) associated with non-native trout species to allow for the formation and/or maintenance of QU LCT populations identified in QU objectives 3–5; and
- QU 2) Ensure all habitats required to meet QU objectives 3–5 function ecologically. In some cases, this may require restoration and/or management changes; and
- QU 3) Establish meta-population dynamics in at least 1 recovery population; and
- QU 4) Establish at least 2 additional recovery populations that are spatially separated from each other and the meta-population required by QU objective 3; and
- QU 5) Maintain existing (or establish new if necessary), isolated populations that cannot individually meet the recovery population benchmarks provided in this document. Actively manage those populations together based on guidance provided in the pending LCT Genetics Management Plan to result in at least 2 additional recovery populations.

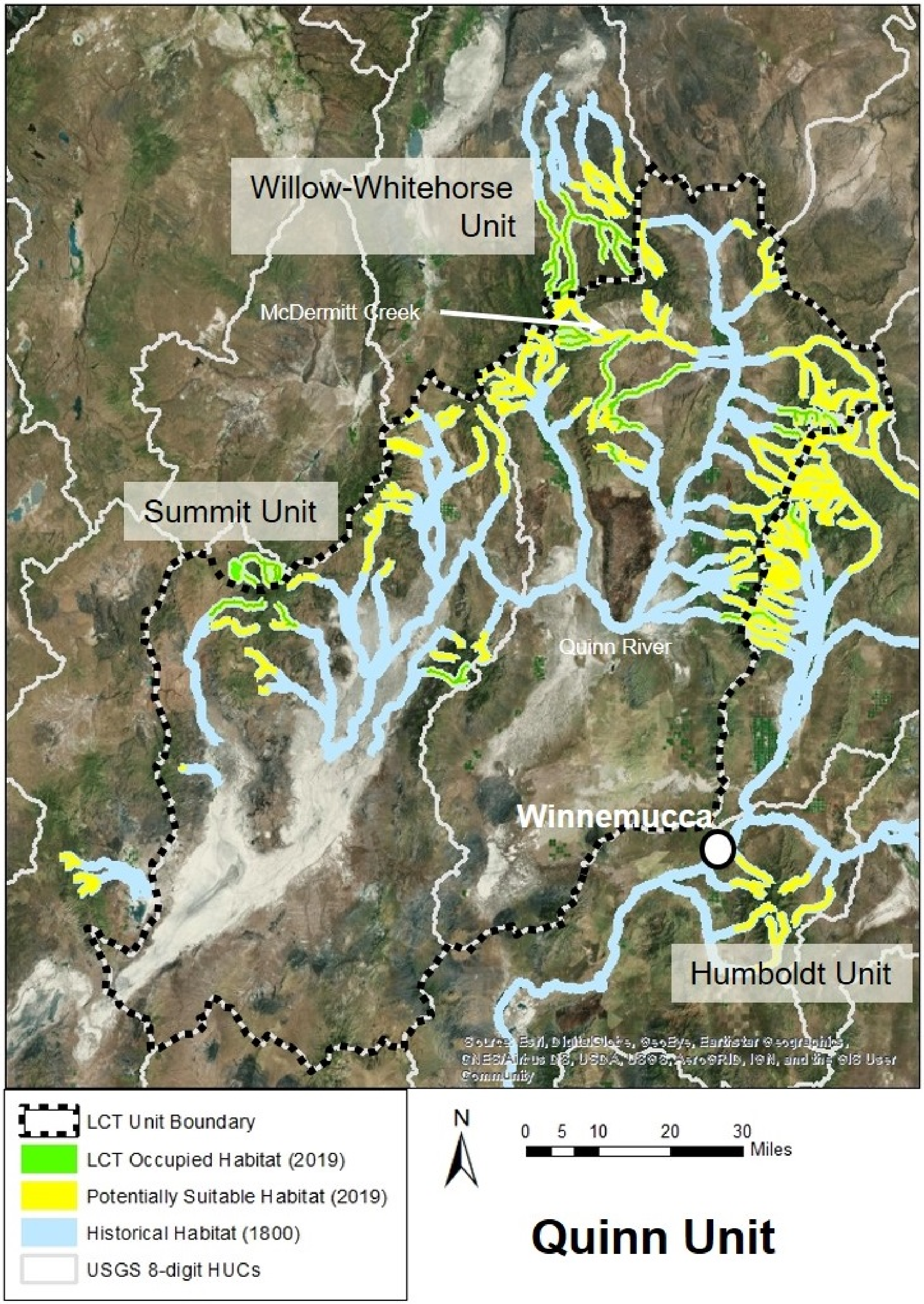


Figure 6. Occupied, potentially suitable, and historical habitat in the Quinn Management Unit. Numerous small, isolated LCT population exist in this unit, however, it is unlikely that many of them are resilient.

Reese Unit (RU)

The RU (Figure 7) is within the USGS Reese hydrologic unit (HUC 16040107). LCT populations present in this unit are genetically distinct from HU LCT populations, likely due to the distance to the confluence with the Humboldt River (>100 mi; Peacock *et al.* 2018). This unit contains many miles of fluvial habitats within a high-elevation, extensive, and climate-resilient mountain range. Currently, several isolated and one interconnected fluvial LCT populations exist in this unit. Existing plans to remove non-native trout from a larger system that has the potential to support a resilient LCT recovery population that may exhibit meta-population dynamics could lead to the completion of RU Objective 3. In addition, several isolated fluvial LCT populations exist on the east side of the Toiyabe Range; however, these populations are technically out of the historical range of LCT. Nonetheless, these out-of-historical-range populations were founded with original RU LCT and provide some level of redundancy for this unit. Achieving the objectives below would better guarantee redundant and resilient populations to safeguard RU genetics in the unique geographic and ecological settings present along the west side of the Toiyabe Range, and contributes to the conservation of the fluvial life-history strategy. The updated objectives for LCT in the RU are:

- RU 1) Remove threats (*i.e.,* competition, predation, hybridization) associated with non-native trout species to allow for the formation and/or maintenance of RU LCT populations identified in RU objectives 3–5; and
- RU 2) Ensure all habitats required to meet RU objectives 3–5 function ecologically. In some cases, this may require restoration and/or management changes; and
- RU 3) Establish meta-population dynamics in at least 1 recovery population; and
- RU 4) Maintain at least 1 additional recovery population that is spatially separated from the meta-population that is required by RU objective 3; and
- RU 5) Maintain existing, isolated populations (including the out-of-historical-range populations) that cannot individually meet the recovery population benchmarks provided in this document. Actively manage those populations together based on guidance provided in the pending LCT Genetics Management Plan to result in at least 1 additional recovery population.

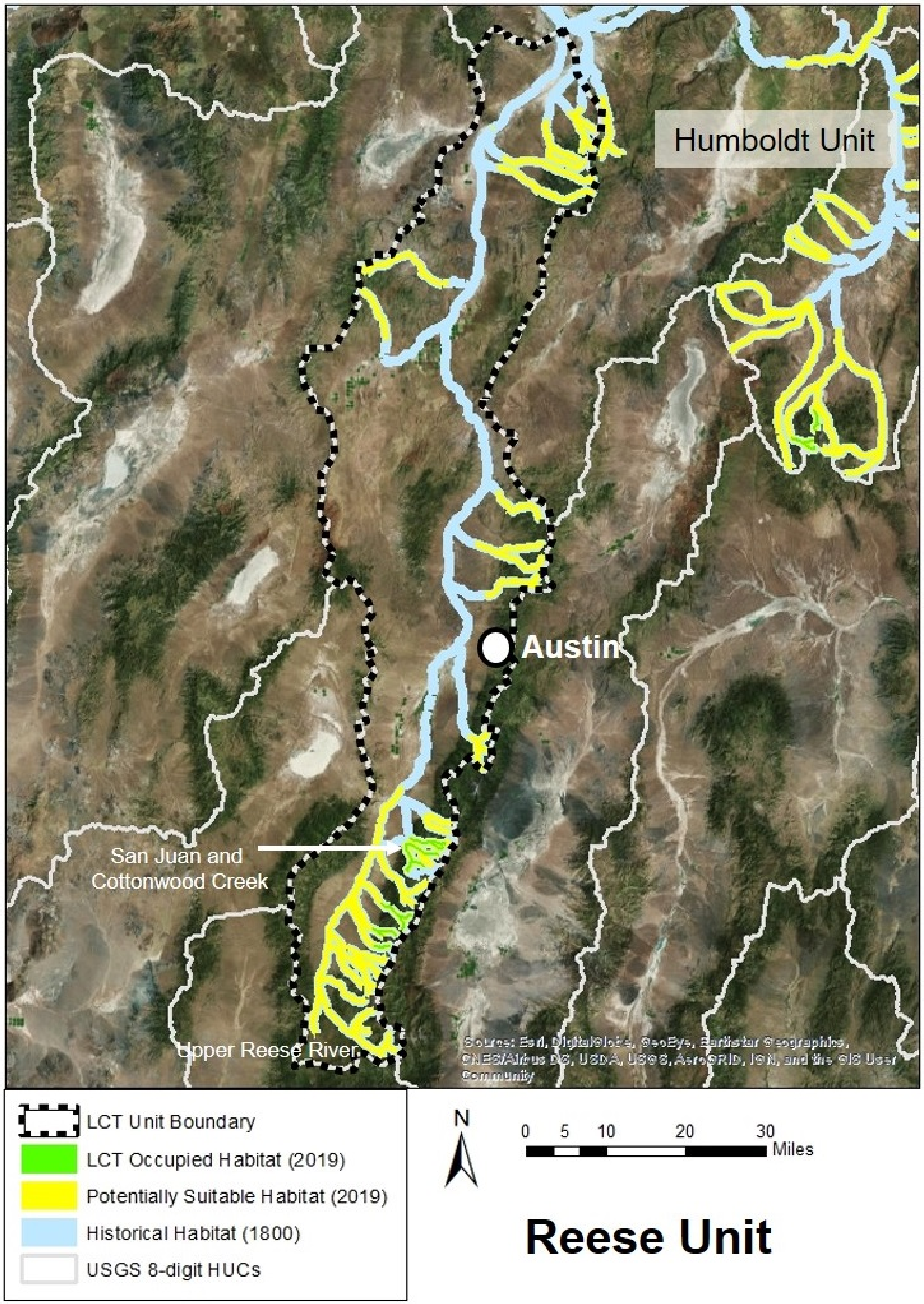


Figure 7. Occupied, potentially suitable, and historical habitat in the Reese Management Unit. Restoration and re-introduction plans to establish an LCT meta-population are scheduled to begin in 2020 in the Upper Reese River.

Summit Unit (SU)

The SU (Figure 8) is within the USGS Lower Quinn (HUC 16040202) hydrologic unit but is within a geographically isolated subbasin with a terminus lacustrine system (Summit Lake) fed by two tributary creeks, Mahogany and Snow. LCT in this system are genetically distinct from LCT in neighboring basins (Peacock *et al.* 2018) and are lacustrine/adfluvial. Thus, conserving this unit separately assists in achieving representation for LCT rangewide, as this system is unique geographically, ecologically, contains distinct genetic qualities, and contributes to preserving the lacustrine life-history strategy. Currently, an LCT recovery meta-population exists in Summit Lake and its tributaries; individuals from the lake enter Mahogany Creek annually to spawn and resident fluvial individuals are present in the creek system as well. Snow Creek is occupied by a small, likely isolated population of LCT, as it currently contains several barriers to fish movement. No other suitable LCT habitat exists within this subbasin; however, exploring out-of-historical-range habitats may provide future opportunities to establish a refuge population to better ensure the security of SU genetics. Lastly, improving connectivity from Snow Creek to Summit Lake would likely increase the resiliency of the population in Summit Lake. The updated objectives for LCT in the SU are as follows:

- SU 1) Manage and minimize threats from non-native species to improve the resiliency of the SU LCT recovery population; and
- SU 2) Ensure that all habitats that support the SU recovery population are managed to function ecologically. In some cases, this may require restoration and/or management changes; and
- SU 3) Continue management of the recovery meta-population within Summit Lake and its tributaries to improve resiliency.

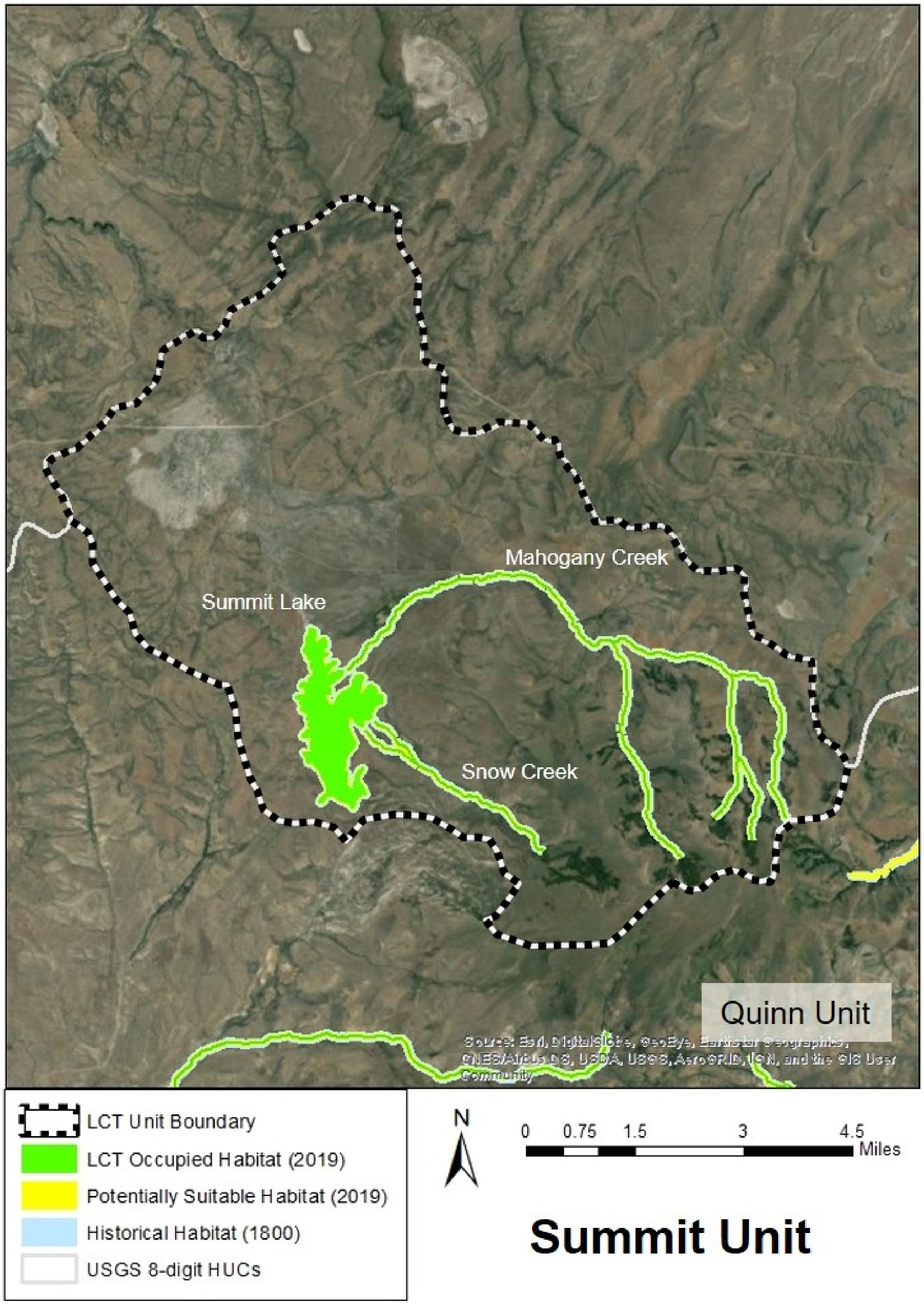


Figure 8. Occupied, potentially suitable, and historical habitat in the Summit Management Unit. There are likely portions of the southern tributary (Snow Creek) that are currently not occupied by LCT due to barriers to fish movement.

Walker Unit (WU)

The WU (Figure 9) covers several USGS hydrologic units, including the: East Walker (HUC 16050301), West Walker (HUC 16050302), Walker (HUC 16050303), and Walker Lake (HUC 16050304). Currently, several isolated fluvial LCT populations exist within the headwaters of the East and West Forks of the Walker River (in both the East and West Walker hydrologic units), and near Walker Lake. There is some potential that a few of these populations may meet the recovery population benchmarks established in this document. Although population trend data does not exist currently, habitat restoration and/or expansion projects are likely necessary to result in these existing populations meeting the recovery population benchmarks. The LCT populations found in the WU contain low-levels of genetic diversity and are different genetically from LCT found within other units. The genetic effects associated with small population size and isolation within one headwater stream (By-Day Creek), or possible early hydrologic disconnection from other LCT units, or a combination of both (Peacock *et al.* 2018) may account for the differences. Walker Lake (a unique desert terminus lake) and the associated fluvial and alpine lake habitats (much of which is in the climate-resilient Sierra Nevada Mountains) were very productive historically. Reestablishing a lacustrine population in this unit will require the continuation of extensive restoration efforts to improve habitat conditions within Walker Lake and the lower portion of Walker River. Safeguarding WU genetics by improving its redundancy and resiliency throughout the unit will further contribute to meeting the updated goals provided in this document. The updated objectives for LCT in the WU include:

- WU 1) Manage and minimize threats (*i.e.,* competition, predation) and hybridization risk from non-native trout species to allow for the formation and/or maintenance of WU LCT populations identified in WU objectives 2–5; and
- WU 2) Establish meta-population dynamics within at least 1 recovery population; and
- WU 3) Establish 3 additional recovery populations that are spatially separated from each other and the meta-population required by WU objectives 2; and
- WU 4) Ensure at least 1 of the 4 recovery populations required by WU objectives 3 or 4 is in a system with a lacustrine component; and
- WU 5) Maintain existing, isolated populations that cannot individually meet the recovery population benchmarks provided in this document. Actively manage those populations together based on guidance provided in the pending LCT Genetics Management Plan to result in at least 1 additional recovery population; and
- WU 6) Improve habitat conditions throughout the Walker River Basin, and water inflow to Walker Lake, to provide for the future opportunity to reintroduce a lacustrine LCT population into Walker Lake.

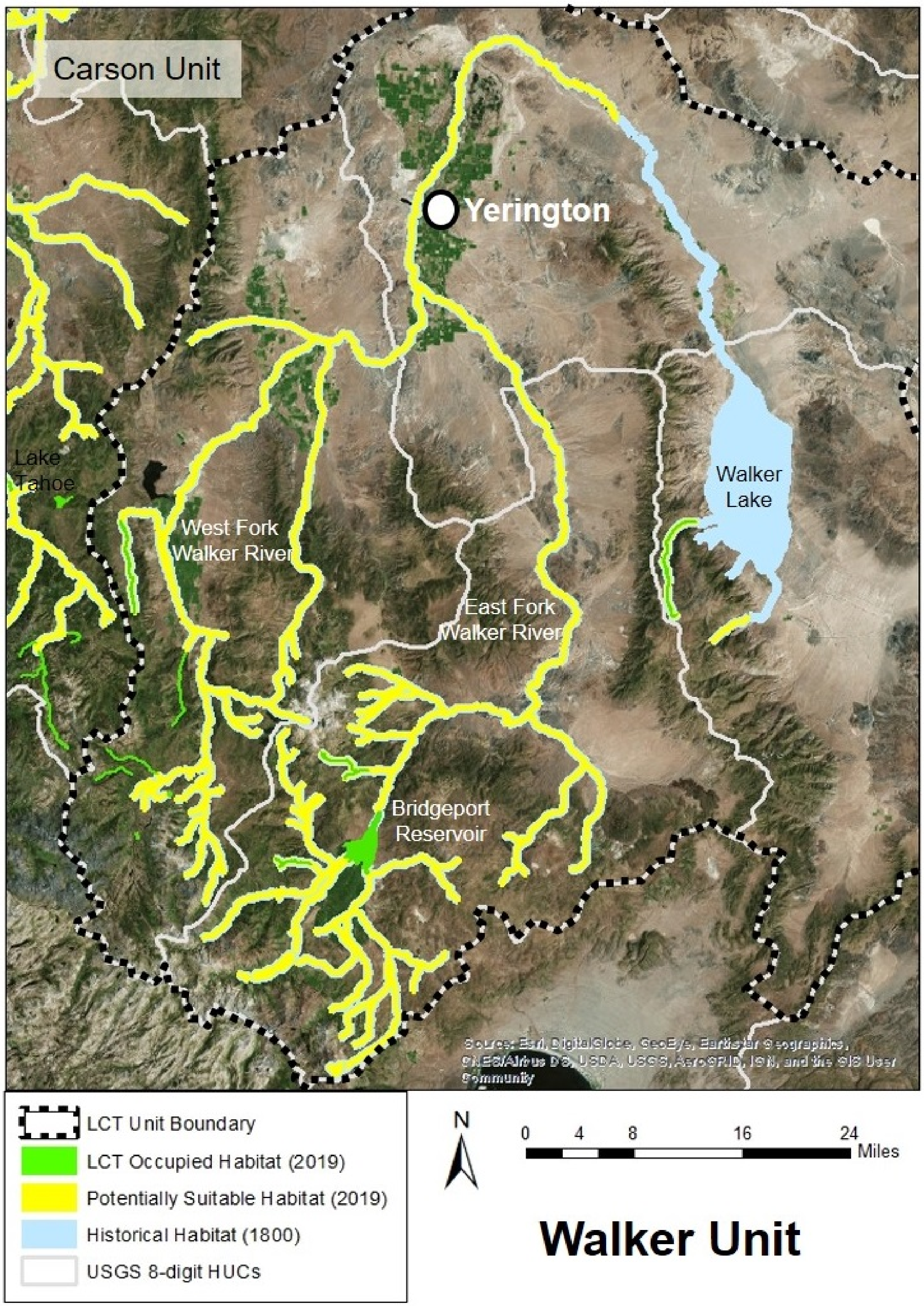


Figure 9. Occupied, potentially suitable, and historical habitat in the Walker Management Unit. Several small, isolated fluvial LCT populations exist in this unit, with some about natural barriers to upstream fish movement.

Willow-Whitehorse Unit (WWU)

The WWU (Figure 10) is within the Alvord Lake hydrologic unit (HUC 17120009). LCT are native to waters that flow into the Coyote Lake subbasin, with the Alvord cutthroat trout, a putatively extinct subspecies, existing within the remainder of this hydrologic unit (waters that historically flowed into Alvord Lake). This unit represents the northernmost portion of LCT's historical range. Currently, two LCT recovery populations exist in this unit, within separate but neighboring multi-order fluvial systems, Willow and Whitehorse Creeks. Eight, isolated LCT populations also exist in the headwater streams in the western portion of this unit but are technically outside of the historical range (Alvord Lake subbasin). Of the out-of-historical-range LCT populations, seven are within the climate-resilient Steens Mountains; these populations were founded with original WWU LCT and provide redundancy for this unit. Achieving the objectives below would better guarantee that this unit contains enough (*e.g.,* redundancy) resilient populations to conserve WWU genetics in this unique geographic and ecological setting and contributes to the conservation of the fluvial life-history strategy. The updated objectives for LCT in the WWU are:

- WWU 1) Remove threats (*i.e.,* competition, predation, hybridization) associated with non-native trout species to allow for the formation and/or maintenance of WWU LCT populations identified in WWU objectives 3–5; and
- WWU 2) Ensure all habitats required to meet WWU objectives 3–5 function ecologically. In some cases, this may require restoration and/or management changes; and
- WWU 3) Maintain meta-population dynamics in the Whitehorse Creek recovery population; and
- WWU 4) Maintain the recovery population within Willow Creek; and
- WWU 5) Maintain existing, isolated populations and the out-of-historical-range populations in the Steens Mountains, and actively manage them (adopting guidance from the pending LCT Genetics Management Plan) to increase long-term persistence probabilities for use in augmenting Willow and Whitehorse Creek recovery populations as needed.

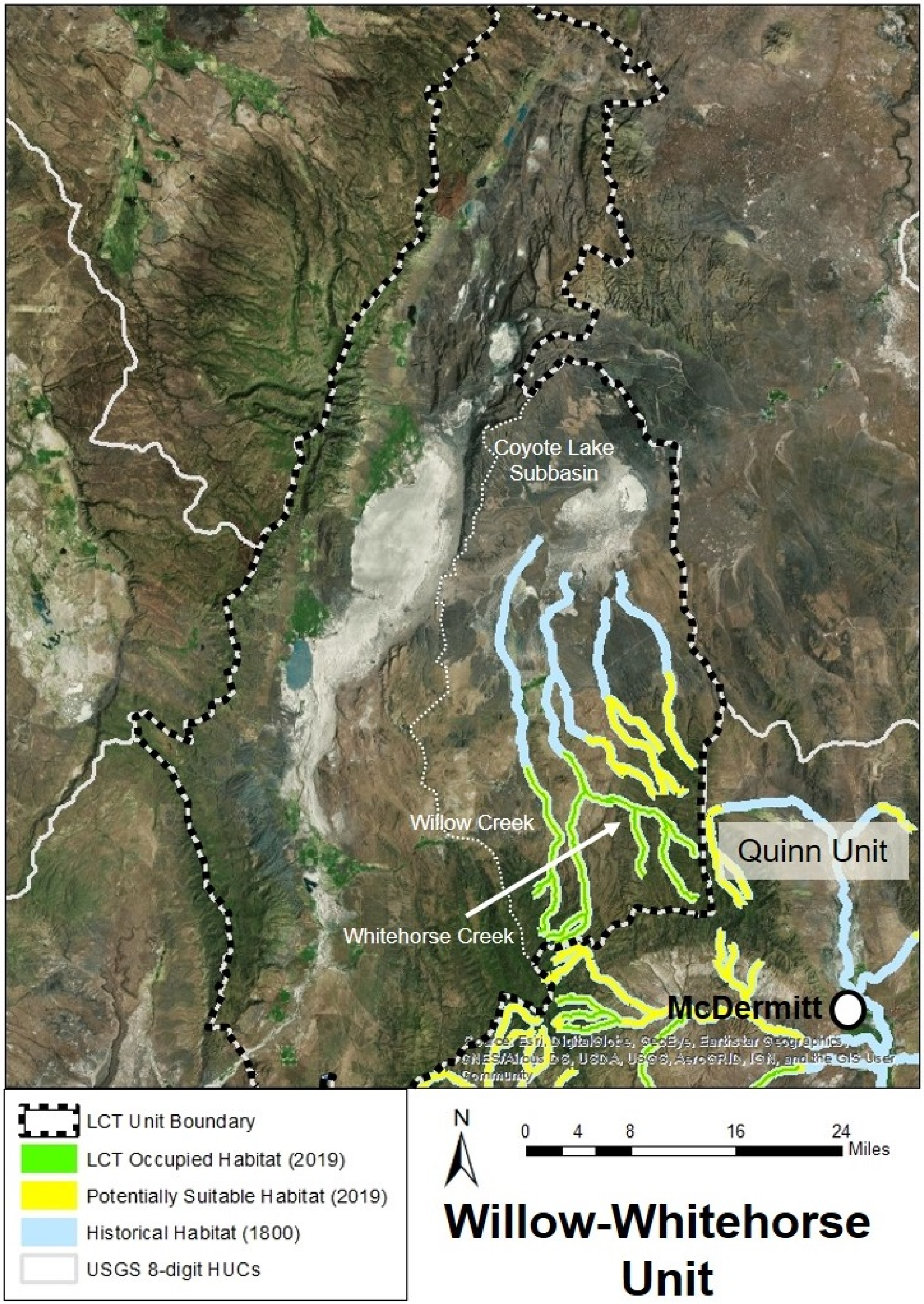


Figure 10. Occupied, potentially suitable, and historical habitat in the Willow-Whitehorse Management Unit (within the Coyote Lake subbasin in the Alvord Lake hydrologic unit depicted). The higher-quality habitat in this unit currently contains LCT recovery populations.

Truckee River Watershed Units

The Truckee River watershed is complex due to convoluted threats, recovery approaches, management challenges, stakeholders, and partnerships throughout the region. Therefore, the watershed was divided into three LCT units: Independence (Little Truckee River hydrologic unit), Pyramid-Truckee (Pyramid-Winnemucca Lakes and Truckee hydrologic units, excluding the Little Truckee River hydrologic unit) and Tahoe (Lake Tahoe hydrologic unit). Only two, extant genetic strains are native to this watershed, Independence and the Pilot Peak. Current genetic evidence suggests that the Independence strain is a remnant of the upper watershed (Little Truckee River), while the Pilot Peak strain is more closely related to fish historically present in the large lake systems (Lake Tahoe, Pyramid Lake) and their tributaries, which make up the remainder of the watershed (Peacock & Kirchoff 2007, Peacock *et al.* 2017). No other extant strains of LCT occurred naturally within this watershed prior to fishery management practices that began in the early 1900's. Therefore, recovery efforts should focus on using the appropriate strain in the appropriate unit(s), although this should not preclude additional scientific endeavors in the future to improve our ability to ensure persistence of LCT.

Independence Unit (IU)

The IU (Figure 11) is within the USGS Little Truckee River (HUC 1605010201) hydrologic unit, which is within the Truckee (HUC 16050102) hydrologic unit. IU LCT are lacustrine/adfluvial and are genetically distinct compared to other LCT historically or currently found within the Truckee hydrologic unit (Peacock *et al.* 2018). Currently, the IU LCT population annually migrates up Independence Creek to spawn, with resident fluvial individuals present in the creek as well. IU LCT are adapted to high-elevation, oligotrophic conditions. Independence Lake is the highest elevation lake to currently contain an LCT recovery population within its historical range. Outside of the Truckee hydrologic unit, IU LCT exist in Heenan Lake, California; this lake precludes natural spawning, thus LCT are spawned annually at an egg collection station and reared in captivity for recreational stocking in several other higher-elevation lakes both within and outside of the historical range of LCT. Several higher-elevation, climate-resilient systems have the potential to contain a recovery population and provide the necessary redundancy for IU LCT within the Little Truckee River hydrologic unit. Achieving the objectives below better guarantees that this unit contains enough populations to protect IU genetics in the unique geographic and ecological setting in this subbasin, and potentially contributes to the conservation of both the lacustrine and fluvial life-history strategies. The updated objectives for LCT within the IU are:

- IU 1) Remove threats (*i.e.,* competition, predation, hybridization) associated with non-native trout species to allow for the formation and/or maintenance of IU LCT populations identified in IU objectives 2–4; and
- IU 2) Maintain the recovery population within Independence Lake; and
- IU 3) Establish at least 1 additional recovery population within the Little Truckee River hydrologic unit that displays meta-population dynamics; and
- IU 4) Maintain the Heenan Lake population and actively manage it, in line with the pending LCT Genetics Management Plan, to increase long-term persistence probability and for use in augmenting the recovery populations within the IU as needed.

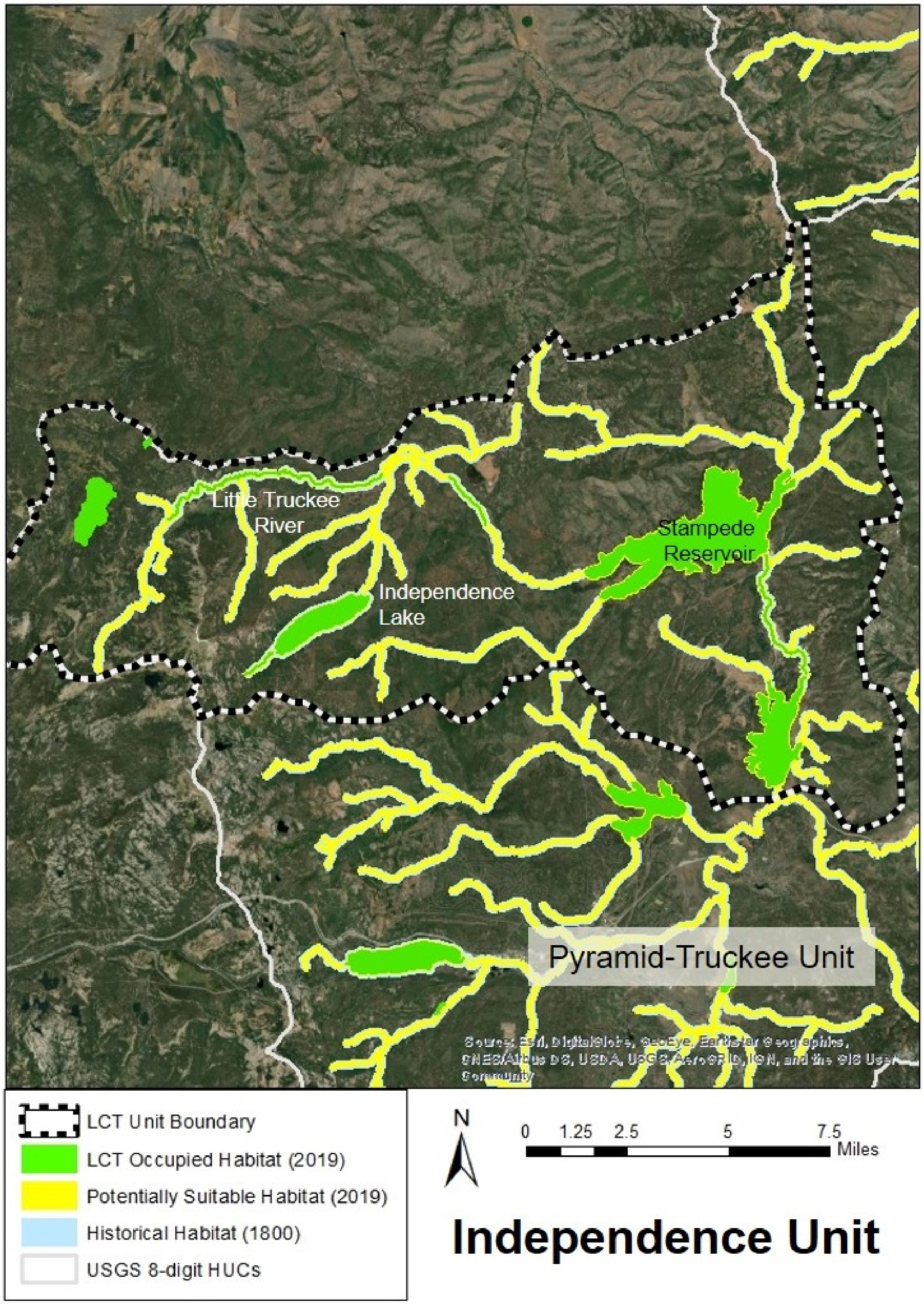


Figure 11. Occupied, potentially suitable, and historical habitat in the Independence Management Unit (Little Truckee River subbasin). Except for Independence Lake and Creek, occupied habitats are maintained by recreational stocking and do not contain self-sustaining populations.

Pyramid-Truckee Unit (PTU)

The PTU (Figure 12) is within the USGS Pyramid-Winnemucca Lakes (HUC 16050103) and Truckee (HUC 16050102) hydrologic units, but excludes the Little Truckee River (HUC 1605010201) hydrologic unit (*i.e.,* Independence Unit). Two strains of LCT currently exist in this unit, the Pyramid and the Pilot Peak. When the native Pyramid-Truckee-Tahoe LCT were extirpated from the system in the 1930's, it was thought that the original genetics were lost as well. As a result, the Pyramid Lake Paiute Tribe, working with the State and USFWS, used the best available science at the time to re-introduce lacustrine LCT in an effort to restore the species within Pyramid Lake and the lower Truckee River. After several decades, this resulted in the current Pyramid strain, which is a mix of genetics from SU, IU, and CU populations. In the late 1970's, fish within an out-of-historical-range stream in the Pilot Peak mountain range were phenotypically described as lacustrine; later, several different genetic analyses confirmed that these fish were in fact originally from the Pyramid-Truckee-Tahoe system (see Peacock *et al.* 2017). The Pilot Peak strain is lacustrine and exists in several lakes currently, with the largest population found within Pyramid Lake (the largest desert terminus lake within LCT's range); Pilot Peak fish from Pyramid Lake recently began making annual spawning runs up the Truckee River. Reestablishing a population that resides in Pyramid Lake and spawns annually in the Truckee River will require an increased understanding of the hybridization risk of LCT with non-native rainbow trout; managing and minimizing that risk through time to an acceptable level will be an ongoing, iterative process. Achieving the objectives below would contribute to safeguarding PTU genetics within this unique geographic and ecological setting, and contribute to the conservation of the lacustrine life-history strategy. The updated objectives for LCT in the PTU are:

- PTU 1) Manage and minimize threats (*i.e.,* competition, predation) and hybridization risk from non-native trout species to allow for the formation and/or maintenance of PTU LCT population identified in PTU objective 3; and
- PTU 2) Manage watershed connectivity and habitat in Truckee River by addressing fish passage barriers and improving inflow to Pyramid Lake to provide spawning, rearing, and residency opportunities; and
- PTU 3) Establish a recovery population in Pyramid Lake and the Truckee River.

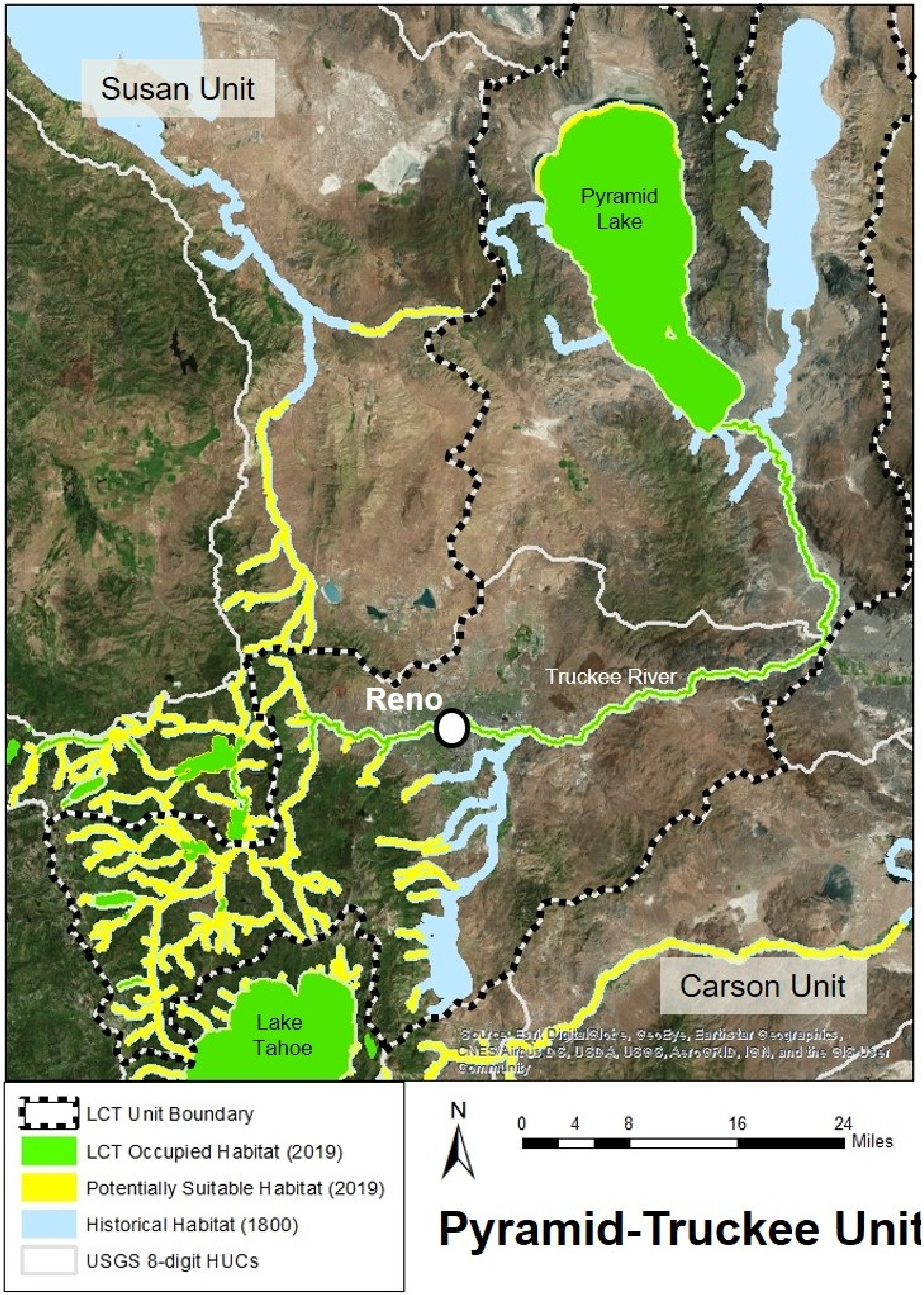


Figure 12. Occupied, potentially suitable, and historical habitat in the Pyramid-Truckee Management Unit. The majority of the occupied habitat in this unit is currently maintained by conservation and recreational stocking.

Tahoe Unit (TU)

The TU (Figure 13) includes the USGS Lake Tahoe (HUC 16050101) hydrologic unit. The TU contains some of the most climate-resilient habitat within LCT's historical range, including numerous permanent lakes. Several strains of LCT have been used within this basin for recovery or recreational purposes over the last 150 years. Currently, the Pilot Peak strain has been introduced to its historical habitat in Fallen Leaf Lake and has been spawning in Glen Alpine Creek since 2012. Several genetic analyses confirm that Pilot Peak LCT are the strain most genetically similar to the LCT historically found in Lake Tahoe (Peacock & Kirchoff 2007, Peacock *et al.* 2017). LCT originating from Macklin Creek were introduced above a barrier in Meiss Meadow starting in 1990; Meiss Meadow is part of an interconnected stream complex within the upper Truckee River. Currently, it is not clear exactly where Macklin Creek LCT, an out-of-historical-range population, originated from (Nielsen & Sage 2002; Peacock & Kirchoff 2007). Reestablishing population(s) that reside in Lake Tahoe and spawn annually in a subset of its tributary systems requires an increased understanding of the hybridization risk of LCT with non-native rainbow trout; managing and minimizing that risk through time to an acceptable level will be an ongoing, iterative process. Nevertheless, by achieving the objectives below, the lacustrine and fluvial life-history strategies and genetic diversity of TU LCT have increased probabilities of being conserved, further contributing to representation, redundancy, and resiliency of LCT. The updated objectives for LCT within the TU include:

- TU 1) Manage and minimize threats (*i.e.,* competition, predation) and hybridization risk from non-native trout species to allow for the formation and/or maintenance of TU LCT population identified in TU objectives 2 and 3; and
- TU 2) Establish multiple lacustrine recovery populations within the unit, including in Lake Tahoe; and
- TU 3) Continue management of the meta-population population within Upper Truckee River/Meiss Meadow and adopt guidance from the pending LCT Genetics Management Plan.

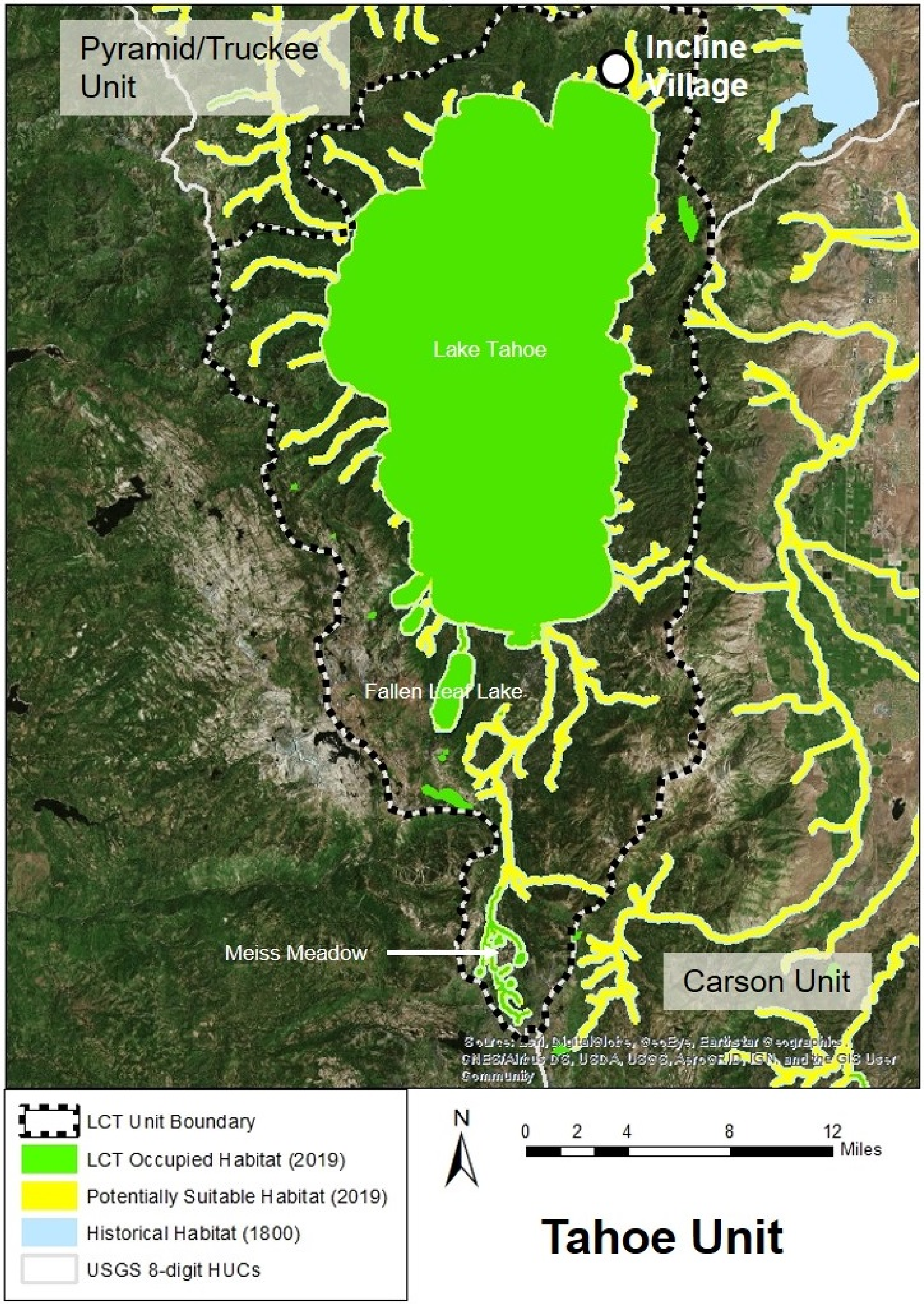


Figure 13. Occupied, potentially suitable, and historical habitat in the Tahoe Management Unit. The majority of occupied habitat in this unit is currently maintained by conservation and recreational stocking.

Conclusion

When these updated objectives have been met, LCT recovery populations will be sufficiently redundant and resilient throughout the variety of ecological and geographic settings within its historical range to safeguard its genetic and behavioral legacy. Therefore, achieving these updated objectives would provide LCT with the adaptive capacity necessary to persist through time, resulting in the ability to delist this species as it would no longer be threatened with endangerment. These objectives will achieve *Goal 1* (Representation) by resulting in: 1) the preservation of unique, locally-adapted population sets (*i.e.,* genetic diversity), 2) the preservation and expression of unique life-history strategies and characteristics (*i.e.,* behavioral diversity), and 3) the presence of LCT within the variety of ecological and geographic settings within its historical range. *Goal 2* (Redundancy) will be met because each unique genetic/behavioral population set will be redundant enough to better guarantee persistence through catastrophic events. Lastly, *Goal 3* (Resiliency) will be achieved because each population used to meet the benchmarks established in this document is resilient as validated by the best available science and in-line with the current understanding of inland trout population persistence needs.

To accomplish the updated goals and objectives for LCT presented in the document, several additional elements must be realized. First, enhancing public support for LCT recovery and conservation is paramount. Public support can be augmented through a variety of mechanisms, from improving stakeholder engagement practices to increasing recreational angling opportunities to improving interagency coordination and messaging. A recently developed Stakeholder Engagement Plan (Sundance *et al.* 2018) will help guide LCT recovery partners to better inform, engage, and collaborate with the public and key stakeholder groups. This plan offers recommendations for communication, messaging, and outreach methods to reach stakeholders and the public. Different regions of the LCT range require different strategies and/or approaches to communicate and engage with stakeholders effectively. Awareness of these differences will help LCT recovery partners be more effective when engaging the public to support LCT recovery efforts. Improved stakeholder engagement practices will likely lead to increased public support for LCT recovery efforts.

Secondly, conservation hatchery programs have the unique ability to both advance LCT recovery, while also providing economic and recreational benefits to the public. For example, a federally-operated conservation hatchery program in the Western GMU is currently providing a native, locally-adapted strain of LCT to its historical lacustrine habitats and their associated tributaries; this furthers recovery of LCT while also providing the public with recreational angling opportunities that boost local economies. In combination with LCT hatchery programs at tribal and state facilities, LCT production capabilities are further expanded and anglers, a significant constituency involved in or affected by LCT recovery efforts, have increased access to LCT. These increased angling opportunities provide the public with more positive experiences with LCT, enhancing public support for LCT recovery and conservation throughout the range of the species. Thus, expanding LCT propagation efforts, especially under a genetic conservation framework, would further increase recreational angling opportunities while simultaneously expanding the recovery capabilities for LCT. In addition, expanding LCT production capabilities would enhance local economies and continue amplifying public support for LCT recovery rangewide.

Lastly, the recovery partners have embraced the philosophy that achieving recovery of LCT will take collaboration and prioritization of recovery actions over the next decade with recovery implementation spanning multiple decades, and that active management of LCT will be required in perpetuity within portions of its range. To adequately incorporate these additional elements into LCT recovery implementation, the MOG/CC recognize the need to more efficiently and effectively manage and coordinate an adaptive and iterative process that will require increased interagency coordination and partnerships with a more diverse group of stakeholders.

GOVERNANCE STRUCTURE FOR LCT RECOVERY

There are several partners contributing to LCT recovery and conservation including tribes, state and federal agencies, and non-governmental organizations (Figure 2). The governance structure for these partners is organized into three tiers of oversight, planning, and implementation.

Management Oversight Group (MOG): The mission of the MOG is "to attain interagency and tribal cooperation for achieving recovery of LCT throughout its range and the removal of LCT from the ESA List of Threatened and Endangered Wildlife and Plants."

Currently, the signatory agencies and tribes include: Bureau of Land Management, USFWS, US Forest Service, US Army Corps of Engineers, US Geological Survey, US Bureau of Reclamation, California Department of Fish and Wildlife, Nevada Department of Wildlife, Oregon Department of Fish and Wildlife, Pyramid Lake Paiute Tribe, Summit Lake Paiute Tribe, Walker River Paiute Tribe, Washoe Tribe of Nevada and California, and the Tahoe Regional Planning Agency. Each MOG agency is represented by a designee at the executive or director-level.

The LCT MOG works in an advisory capacity to provide direction and guidance pertaining to whether recovery, management, and agency undertakings in or near LCT habitat are consistent with and necessary to achieve recovery. The LCT MOG also recommends measures to resolve management issues and concerns related to the implementation of LCT recovery planning efforts. Lastly, MOG representatives strive to improve intra-agency coordination as they are uniquely situated in a position to do so most effectively.

Coordinating Committee (CC): The CC includes manager-level representatives from each of the chartered agencies, tribes, and organizations. The CC is responsible for liaising between the MOG and the GMU/RIT teams in order to insure consistency in recovery and conservation goals and objectives range wide. The CC meets more frequently than the MOG and is thus best poised to enhance inter-agency coordination as members can commit more time and resources.

Geographic Management Units/Recovery Implementation Teams (GMU/RIT): The GMU/RIT teams contain field and technical staff from MOG signatory entities and additional researchers knowledgeable in the conservation of LCT; the GMU/RIT teams' purpose is to plan and implement on-the-ground recovery actions. In addition, these teams partake in much of the stakeholder engagement-related activities, as they are consistently scoping, planning, and implementing recovery and restoration projects.

The Adaptive Process

It is not expected that the updated goals and objectives (UGOs) developed for LCT in this document will change frequently or comprehensively over time. However, the future management of LCT needs to be informed by the best available science and accumulated management experience. Thus, every five years a review of these UGOs will be conducted. Key tasks of the review process will include: monitoring progress towards the goals and objectives outlined above, reviewing new scientific information, reviewing management experiences, and reviewing new estimates in climatic and hydrologic patterns and predictions. The UGOs document will be updated as necessary depending on the results of the review process. This adaptive approach could lead to the USFWS and CC updating recovery and conservation targets identified in this UGOs document to increase the effectiveness of LCT recovery efforts. The next review is expected to be initiated by the USFWS in cooperation with CC recovery partners in January 2025.

These updated goals and objectives are focused on achieving rangewide recovery of LCT to the point that the protections of the ESA are no longer necessary and the species can be delisted. All recovery partners recognize the need for long-term conservation of LCT and the habitats it depends on and are committed to codifying a long-term conservation strategy at the time of delisting.

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GLOSSARY

Assisted Migration is the physical movement of a small number of individual LCT from one system to another system in an effort to mimic historical connectivity of currently isolated populations. This strategy will be employed when two (or more) isolated LCT populations that were historically connected cannot be physically connected in the foreseeable future; theoretically, this would offset the well-understood genetic effects that occur within small, isolated populations over time and provide a means to manage two or more isolated LCT populations as one "recovery population". *However, research related to this specific type of management approach is lacking, so several GMU/RIT teams will dedicate resources to better understand it over the next decade (2018-2028); the goal is to publish the findings within peer-review scientific journals and use them to inform whether this approach is empirically valid.*

Demographics are the numerical characteristics of a population. They are typically used to understand how a species changes over time, and they can be expressed as numbers, rates, and/or trends (adapted from USFWS 2016).

Demographic Stochasticity refers to the variability in population growth rates arising from random differences among individuals in survival and reproduction within a season. This variability will occur even if all individuals have the same expected ability to survive and reproduce and if the expected rates of survival and reproduction don't change from one generation to the next. Even though it will occur in all populations, it is generally more important only in populations that are already fairly small (adapted from USFWS 2016).

Environmental Stochasticity is unpredictable spatiotemporal fluctuation in environmental conditions, often resulting from weather, disease, and/or predation or other factors external to the population. Environmental stochasticity influences the variability of birth and death rates and thus how population abundance fluctuates and affects the fate (*e.g.,* persistence or extirpation) of populations (adapted from USFWS 2016). For LCT, fluctuations in precipitation patterns are generally the most important and are normally positively correlated with population fluctuations.

Genetically pure LCT do not contained introgressed DNA from other species.

Historical Range of LCT is mostly within two major USGS Subregions (1604 and 1605) of the Great Basin Region. However, two additional Cataloging Units within two other Regions, 18080003 (Honey-Eagle Lakes) within the North Lahontan Subregion of the California Region and 17120009 (Alvord Lake) within the Oregon Closed Basins Subregion of the Pacific Northwest Region, are within the historical range of LCT as well.

Lacustrine is defined as "pertaining to or living in lakes or ponds" [https://www.fishbase.de/; FishBase ver. (06/2018)], and does not specifically pertain to a life-history strategy. Currently, self-sustaining "lacustrine" populations of LCT are adfluvial ("[A] life history strategy in which adult fish spawn and juveniles subsequently rear in streams but migrate to lakes for feeding as sub-adults and adults." [https://www.fishbase.de/; FishBase ver. (06/2018)]), as individuals of the populations remain in tributary systems into sub-adulthood or adulthood. However, we are unsure how future LCT populations will use stream/river systems associated with potential future recovery habitats, and thus the use of lacustrine in this document refers to an LCT population that relies on an adult population within a lake or lake system (*i.e.,* it may also be adfluvial).

Long-term Conservation Strategy refers to a plan that contains long-term strategies to improve the conservation of a species (or set of species), but is not necessarily tied to "recovery criteria" or USFWS Recovery Plans. Conservation Strategies are jointly developed, formalize agreements between Federal, State, Tribal, and/or Private entities that provide some degree of certainty that long-term conservation for a species, or set of species, will continue to occur. Generally, they contain an adaptive management framework, as well as identify the best available science, equipment, tools, and known approaches to improve the status of a species (or set of species). Lastly, the long-term conservation strategy for LCT will not be limited by current political, social, or budgetary constraints as it is designed to bring all stakeholders together to develop an ideal, potential long-term goal for LCT.

Meta-population dynamics refers to a population of LCT that meets the "recovery population" definition and exists within a larger network of variable and interconnected habitats. There are two types of LCT meta-populations, one with a lacustrine component that contains resident fluvial individuals and one that exists in interconnected fluvial habitats and contains both resident and migratory individuals.

Minimum Viable Population (MVP) is a lower bound on the population of a species, such that it can survive in the wild. This term is used in the fields of biology, ecology, and conservation biology. MVP estimates are the smallest possible size at which a biological population can exist without facing extinction from natural disasters or demographic, environmental, or genetic stochasticity (adapted from USFWS 2016).

Population Viability Analysis (PVA) refers to a mathematical demographics model that uses data related to species population dynamics to calculate extinction probabilities. There are many different types of PVAs, including simple to very complex models. In general, the more species- and/or habitat-specific data that are incorporated into the model, the more accurate the model and its predictions will be.

Recovery Population refers to a population of LCT that contains the desired elements of a resilient inland trout population. Those elements are: 1) genetically pure LCT; 2) Multiple age-classes resulting from regular, natural reproductive events with recruitment; 3) Enough individuals over time to produce a population trend that is in-line with the best available science regarding viable populations given climatic conditions; 4) a full to partial native aquatic assemblage; and 5) habitat within its historical range that is maintained at, or is on an upward trend towards, functioning ecologically. However, achieving genetic purity within all LCT recovery populations will likely not be possible; in some cases, introgression will be present. In these specific cases (as described within individual LCT Units), effectively managing the risk of hybridization to minimize it over time will be the goal.

APPENDIX: LCT POPULATIONS TABLES

Table A-1. Status and description of LCT populations required to be maintained for recovery by the 1995 LCT Recovery Plan. Includes LCT Unit designation, population name, occupancy status in 2019, updated objective, and population description for each population.

2019 LCT Management Unit	Required Maintenance Populations in 1995	Occupied in 2019?	Updated 2019 Objective	Population Description
Carson	East Fork Carson River	Yes	CU 3 or 4	Isolated Fluvial
Carson	Murray Canyon Creek	Yes	CU 3 or 4	Isolated Fluvial
Carson	Raymond Meadows Creek	Unknown	Potentially CU 4	Potential Isolated Fluvial
Carson	Poison Flat Creek	Yes	CU 3 or 4	Isolated Fluvial
Carson	Golden Canyon Creek	Yes	CU 3 or 4	Isolated Fluvial
Carson	Bull Lake	Unknown		Stocked Lacustrine
Humboldt/Little Humboldt	South Fork Little Humboldt River Secret Creek Sheep Creek Pole Creek	Yes, but it was 1 population	HU 4	Fluvial Meta-population
Humboldt/Little Humboldt	Indian Creek South Fork Indian Creek	Yes, but it was 1 population	HU 3	Isolated Fluvial
Humboldt/Little Humboldt	Abel Creek	Yes	HU 3, 4, or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Little Humboldt	Long Canyon Creek	Unknown	Potentially HU 3	Potential Isolated Fluvial
Humboldt/Little Humboldt	Lye Creek	No	Potentially HU 4 or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Little Humboldt	Mullinex Creek	No	Potentially HU 4 or 5	Potential Isolated Fluvial/Fluvial Recovery
Humboldt/Little Humboldt	Deep Creek	No	Potentially HU 4 or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Little Humboldt	Road Canyon Creek	No	Potentially HU 4 or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Little Humboldt	North Fork Little Humboldt River	No	Potentially HU 4 or 5	Potential Fluvial Recovery/Meta-population

2019 LCT Management Unit	Required Maintenance Populations in 1995	Occupied in 2019?	Updated 2019 Objective	Population Description
Humboldt/Little Humboldt	Dutch John Creek	No	Potentially HU 4 or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Little Humboldt	Round Corral Creek	No	Potentially HU 4 or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Lower	Rock Creek	Unknown	Potentially HU 3	Potential Isolated Fluvial
Humboldt/North Fork	North Fork Humboldt River	Yes, but it was 1 population	HU 6	Potential Fluvial Meta-population
	Cole Canyon Creek			
Humboldt/North Fork	California Creek	Yes	HU 3 or 7	Isolated Fluvial
Humboldt/North Fork	Foreman Creek	Yes	HU 3 or 7	Isolated Fluvial
Humboldt/North Fork	Gance Creek	Yes, but it was 1 population	HU 7	Fluvial Recovery
	Road Canyon Creek			
	Warm Creek			
Humboldt/North Fork	Mahala Creek	No	Potentially HU 7	Potential Isolated Fluvial
Humboldt/North Fork	Pie Creek	No	Potentially HU 7	Potential Isolated Fluvial
Humboldt/North Fork	Jim Creek	No	Potentially HU 7	Potential Isolated Fluvial
Humboldt/North Fork	Winters Creek	Unknown	Potentially HU 3	Potential Isolated Fluvial
Humboldt/North Fork	Dorsey Creek	No	Potentially HU 7	Potential Isolated Fluvial
Humboldt/Rock	Frazier Creek	Yes	HU 3 or 9	Potential Fluvial Recovery
Humboldt/Rock	Lewis Creek	Yes, but it was 1 population	HU 8	Potential Fluvial/adfluvial Meta-population
	Nelson Creek			
	Upper Willow Creek			
	Willow Creek Reservoir			
Humboldt/Rock	Upper Rock Creek	Yes	HU 3 or 9	Potential Fluvial Recovery
Humboldt/Rock	Toe Jam Creek	Yes	HU 3 or 9	Potential Fluvial Recovery
Humboldt/South Fork	Dixie Creek	Yes	HU 3 or 11	Potential Fluvial Recovery
Humboldt/South Fork	Lee Creek	Yes	HU 3	Isolated Fluvial
Humboldt/South Fork	Pearl Creek	Yes	HU 11	Fluvial Recovery
Humboldt/South Fork	Welch Creek	Yes	HU 3	Isolated Fluvial
Humboldt/South Fork	Carville Creek	No	Potentially HU 3	Potential Isolated Fluvial
Humboldt/South Fork	Cottonwood Creek	No	Potentially HU 3	Potential Isolated Fluvial

2019 LCT Management Unit	Required Maintenance Populations in 1995	Occupied in 2019?	Updated 2019 Objective	Population Description
Humboldt/South Fork	Mitchell Creek	No	Potentially HU 3	Potential Isolated Fluvial
Humboldt/South Fork	North Fork Mitchell Creek	No	Potentially HU 3	Potential Isolated Fluvial
Humboldt/South Fork	Green Mountain Creek North Fork Green Mountain Creek	Yes, but it was 1 population	HU 11	Potential Fluvial Recovery
Humboldt/South Fork	Mahogany Creek Segunda Creek Long Canyon Creek North Furlong Creek	Yes, but it was 1 population	HU 10 or 11	Potential Fluvial Recovery/Meta-population
Humboldt/South Fork	Rattlesnake Creek	No	Potentially HU 3	Potential Isolated Fluvial
Humboldt/South Fork	McCutcheon Creek	Unlikely	Potentially HU 3	Potential Isolated Fluvial
Humboldt/South Fork	Smith Creek Middle Fork Smith Creek North Fork Smith Creek Gennette Creek	Yes, but it was 1 population	HU 10 or 11	Potential Fluvial Recovery/Meta-population
Humboldt/Upper	Marys River Camp Draw Creek Chimney Creek East Fork Marys River Marys River Basin Creek West Fork Marys River Basin Creek GAWS Creek Williams Basin Creek T Creek Short Creek Cutt Creek	Yes, but it was 1 population	HU 12	Fluvial Meta-population
Humboldt/Upper	T Creek Anderson Creek	Yes, but it was 1 population	HU 3 or 13	Potential Fluvial Recovery

2019 LCT Management Unit	Required Maintenance Populations in 1995	Occupied in 2019?	Updated 2019 Objective	Population Description
	Draw Creek			
Humboldt/Upper	Hanks Creek Conners Creek	Yes, but it was 1 population	HU 3 or 13	Potential Fluvial Recovery
Humboldt/Upper	Wildcat Creek	Yes	HU 3	Isolated Fluvial
Humboldt/Upper	Fourth Boulder Creek	Yes	HU 12 or 13	Isolated Fluvial
Humboldt/Upper	Second Boulder Creek	Yes	HU 12 or 13	Isolated Fluvial
Humboldt/Upper	East Fork Sherman Creek	Yes	HU 13	Isolated Fluvial
Humboldt/Upper	Conrad Creek	No	Potentially HU 3	Potential Isolated Fluvial
Humboldt/Upper	North Fork Cold Creek	Yes	HU 12 or 13	Isolated Fluvial
Humboldt/Upper	Maggie Creek Beaver Creek Coyote Creek Little Jack Creek Toro Canyon Creek Williams Canyon Creek Little Beaver Creek	Yes, but it was 1 population	HU 12	Fluvial Meta-population
Independence	Independence Lake Independence Creek	Yes, but it was 1 population	IU 2	Lacustrine Recovery
Independence	Heenan Lake	Yes	IU 4	Managed Lacustrine
Independence	Heenan Creek	Yes	IU 4	Managed Fluvial
Pyramid/Truckee	Pole Creek	Yes	Pending LCT GMP	Isolated Fluvial
Pyramid/Truckee	Bronco Creek	No		Isolated Fluvial
Pyramid/Truckee	Hill Creek	No		Isolated Fluvial
Pyramid/Truckee	West Fork Gray Creek	No		Isolated Fluvial
Pyramid/Truckee	East Fork Martis Creek	No		Isolated Fluvial
Pyramid/Truckee	Pyramid Lake	Yes	PTU 3	Potential Lacustrine Recovery
Quinn	Upper Leonard Creek	No	Potentially QU 4 or 5	Potential Recovery Fluvial
Quinn	Sage Creek Line Canyon Creek	Yes, but it was 1 population	QU 3 or 5	Isolated Fluvial

2019 LCT Management Unit	Required Maintenance Populations in 1995	Occupied in 2019?	Updated 2019 Objective	Population Description
Quinn	Riser Creek	Yes	QU 3 or 5	Isolated Fluvial
Quinn	Indian Creek	Unknown	Potentially QU 3 or 5	Isolated Fluvial
Quinn	Washburn Creek	Yes	QU 5	Isolated Fluvial
Quinn	Crowley Creek	Yes	QU 5	Isolated Fluvial
Quinn	Eigthmile Creek	Yes	QU 5	Isolated Fluvial
Quinn	South Fork Flat Creek	No	Potentially QU 4 or 5	Potential Fluvial Recovery
Quinn	Rock Creek	No		Isolated Fluvial
Quinn	East Fork Quinn River	No	Potentially QU 3 or 4	Potential Fluvial Recovery/Meta-population
Quinn	Rebel Creek	No	Potentially QU 4 or 5	Potential Fluvial Recovery
Reese	Marysville Creek	Yes	RU 4 or 5	Potential Fluvial Recovery
Reese	Tierney Creek	No	Potentially RU 5	Potential Isolated Fluvial
Reese	Washington Creek	Yes	RU 4 or 5	Potential Fluvial Recovery
Reese	Crane Canyon Creek	Yes	RU 5	Isolated Fluvial
Reese	Stewart Creek North Fork Stewart Creek Middle Fork Stewart Creek	No; but it was 1 population	Potentially RU 5	Potential Fluvial Recovery
Reese	Cottonwood Creek	Yes	RU 4 or 5	Potential Fluvial Recovery
Reese	Mohawk Creek	Yes	RU 5	Isolated Fluvial
Summit	Summit Lake Mahogany Creek Summer Camp Creek	Yes, but it was 1 population	SU 3	Lacustrine/adfluvial Meta-population
Summit	Snow Creek	Yes	Potentially SU 3	Isolated Fluvial
Tahoe	Upper Truckee River (Meiss Meadow)	Yes	TU 3	Fluvial Recovery
Walker	By-Day Creek	Yes	WU 5	Isolated Fluvial
Walker	Murphy Creek	Yes	WU 5	Isolated Fluvial
Walker	Slinkard Creek	Yes	WU 3 or 5	Isolated Fluvial
Walker	Mill Creek	Yes	WU 3 or 5	Potential Fluvial Recovery

2019 LCT Management Unit	Required Maintenance Populations in 1995	Occupied in 2019?	Updated 2019 Objective	Population Description
Walker	Bodie Creek	No	Potentially WU 3	Potential Fluvial Recovery
Walker	Walker Lake	No	Potentially WU 3 or 4, and 6	Lacustrine Recovery
Willow-Whitehorse	Whitehorse Creek Little Whitehorse Creek Doolittle Creek Cottonwood Creek, Trib. to Whitehorse Little Whitehorse Creek. Trib. B Fifteen Mile Creek	Yes, but it was 1 population	WWU 3	Fluvial Meta-population
Willow-Whitehorse	Willow Creek Willow Creek, Trib. E	Yes, but it was 1 population	WWU 4	Fluvial Recovery
Willow-Whitehorse	Antelope Creek	Unknown	Potentially WWU 5	Potential Isolated Fluvial
Willow-Whitehorse	Twelve Mile Creek	No		Isolated Fluvial

Table A-2. Status and description of LCT populations discovered, not described, or established after the publication of the 1995 LCT Recovery Plan. LCT Unit designation, population name, updated objective, and population description for each population.

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
Carson	Red Lake		Stocked Lacustrine
Carson	Scotts lake		Stocked Lacustrine
Carson	Raymond Lake		Stocked Lacustrine
Carson	Indian Creek Reservoir		Stocked Lacustrine
Humboldt/Little Humboldt	First Creek	HU 4	S.F. Little Humboldt River Fluvial Meta-population
	Snowstorm Creek		
	Brush Creek		
Humboldt/North Fork	Peterson Creek	HU 6	North Fork Humboldt River Potential Fluvial Meta-population
	McAfee Creek		
	Dell Creek		
	Walker Creek		
Humboldt/North Fork	Pratt Creek	HU 3	Isolated Fluvial
Humboldt/Pine	Pete Hansen Creek	HU 3	Isolated Fluvial; "out-of-basin population" in 1995
Humboldt/Pine	Birch Creek	HU 3	Isolated Fluvial
Humboldt/Rock	Cow Creek	HU 8	Willow Creek Fluvial Meta-population
Humboldt/South Fork	South Fork Smith Creek	HU 11	Smith Creek Fluvial Recovery Population
Humboldt/South Fork	Verdi Lake		Stocked Lacustrine
Humboldt/South Fork	Hidden Lakes		Stocked Lacustrine
Humboldt/South Fork	Griswold Lake		Stocked Lacustrine
Humboldt/South Fork	Seitz Lake		Stocked Lacustrine
Humboldt/Upper	Lone Mountain Creek	HU 12	Maggie Creek Fluvial Meta-population
	Jack Creek		
Humboldt/Upper	Currant Creek	HU 12	Marys River Fluvial Meta-population
Humboldt/Upper	lower T Creek	HU 12	Divided 1995 T Creek into lower and upper
Humboldt/Upper	upper T Creek	HU 3 or 13	Divided 1995 T Creek into upper and lower
Humboldt/Upper	Sherman Creek	HU 13	EB Sherman Creek Potential Fluvial Recovery population
Humboldt/Upper	Jackstone Creek	HU 3	Isolated Fluvial
Humboldt/Upper	Greys Lake		Stocked Lacustrine
Humboldt/Upper	Smith Lake		Stocked Lacustrine
Humboldt/Upper	Boulder Lake		Stocked Lacustrine

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
Independence	Little Truckee River		Stocked Fluvial
Independence	Lake of the Woods		Stocked Lacustrine
Independence	Webber Lake		Stocked Lacustrine
Independence	Boca Reservoir		Stocked Lacustrine
Independence	Stampede Reservoir		Stocked Lacustrine
Pyramid/Truckee	Truckee River	PTU 3	Managed Fluvial
Pyramid/Truckee	Martis Creek Lake		Stocked Lacustrine
Pyramid/Truckee	Donner Lake		Stocked Lacustrine
Pyramid/Truckee	Cold Stream Ponds		Stocked Lacustrine
Pyramid/Truckee	Prosser Reservoir		Stocked Lacustrine
Quinn	Falls Canyon Creek	QU 4 or 5	Isolated Fluvial
Quinn	Andorno Creek	QU 5	Isolated Fluvial
Quinn	Threemile Creek	QU 5	Isolated Fluvial
Quinn	Colman Creek	QU 5	Isolated Fluvial
Quinn	Jackson Creek	QU 5	Isolated Fluvial
Quinn	Corral Canyon Creek	QU 3 or 5	Isolated Fluvial; connected to Line Canyon and Sage
Quinn	Pole Creek	QU 5	Isolated Fluvial
Quinn	North Fork Battle Creek	QU 5	Isolated Fluvial
Reese	San Juan Creek	RU 4 or 5	Potential Fluvial Recovery; connected to Cottonwood
Tahoe	Lost Lake		Stocked Lacustrine
Tahoe	Hidden Lake		Stocked Lacustrine
Tahoe	Eagle Lake		Stocked Lacustrine
Tahoe	Cascade Lake	Potentially TU 2	Potential Lacustrine Recovery
Tahoe	Fallen Leaf Lake	Potentially TU 2	Potential Lacustrine Recovery
Tahoe	Angora Lakes		Stocked Lacustrine
Tahoe	Sawmill Pond		Stocked Lacustrine
Tahoe	Lower Echo Lake		Stocked Lacustrine
Tahoe	Upper Echo Lake		Stocked Lacustrine
Tahoe	Marlette Lake		Stocked Lacustrine
Tahoe	Lake Tahoe	Potentially TU 2	Potential Lacustrine Recovery
Tahoe	Taylor Creek	Potentially TU 2	Fluvial connection between Fallen Leaf and Tahoe
Tahoe	Dardanelles Lake	TU 3	

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
	Round Lake		Upper Truckee River (Meiss Meadow) Fluvial/adfluvial Recovery Population
	Showers Lake		
	Martini Pond		
	Four Lakes		
	Meiss Lake		
Walker	Silver Creek	WU 3 or 5	Isolated Fluvial
Walker	Wolf Creek	WU 3 or 5	Isolated Fluvial
Walker	Cottonwood Creek	WU 5	Isolated Fluvial
Walker	Bridgeport Reservoir		Stocked Lacustrine
Walker	Roosevelt Lake		Stocked Lacustrine
Walker	Lane Lake		Stocked Lacustrine
Walker	Kirman Lake		Stocked Lacustrine

Table A-3. Status and description of all currently existing LCT populations. LCT Unit designation, population name, updated objective, and population description for each population.

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
Carson	East Fork Carson River	CU 3 or 4	Isolated Fluvial
Carson	Lower East Fork Carson River		Stocked Fluvial
Carson	Murray Canyon Creek	CU 3 or 4	Isolated Fluvial
Carson	Raymond Meadows Creek	Potentially CU 4	Potential Isolated Fluvial
Carson	Poison Flat Creek	CU 3 or 4	Isolated Fluvial
Carson	Golden Canyon Creek	CU 3 or 4	Isolated Fluvial
Carson	Bull Lake		Stocked Lacustrine
Carson	Red Lake		Stocked Lacustrine
Carson	Scotts Lake		Stocked Lacustrine
Carson	Raymond Lake		Stocked Lacustrine
Carson	Indian Creek Reservoir		Stocked Lacustrine
Humboldt/Little Humboldt	South Fork Little Humboldt River Secret Creek Sheep Creek Pole Creek First Creek Snowstorm Creek Brush Creek	HU 4	Fluvial Meta-population
Humboldt/Little Humboldt	Indian Creek South Fork Indian Creek	HU 3	Isolated Fluvial
Humboldt/Little Humboldt	Abel Creek	HU 3, 4, or 5	Potential Fluvial Recovery/Meta-population
Humboldt/Little Humboldt	Long Canyon Creek	Potentially HU 3	Potential Isolated Fluvial
Humboldt/North Fork	North Fork Humboldt River Cole Canyon Creek Peterson Creek McAfee Creek Dell Creek Walker Creek	HU 6	Potential Fluvial Meta-population
Humboldt/North Fork	California Creek	HU 3 or 7	Isolated Fluvial
Humboldt/North Fork	Foreman Creek	HU 3 or 7	Isolated Fluvial

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
Humboldt/North Fork	Gance Creek	HU 7	Fluvial Recovery
	Road Canyon Creek		
	Warm Creek		
Humboldt/North Fork	Pratt Creek	HU 3	Isolated Fluvial
Humboldt/North Fork	Winters Creek	Potentially HU 3	Potential Isolated Fluvial
Humboldt/Pine	Pete Hansen Creek	HU 3	Isolated Fluvial
Humboldt/Pine	Birch Creek	HU 3	Isolated Fluvial
Humboldt/Rock	Frazier Creek	HU 3 or 9	Potential Fluvial Recovery
Humboldt/Rock	Lewis Creek	HU 8	Potential Fluvial/adfluvial Meta-population
	Cow Creek		
	Nelson Creek		
	Upper Willow Creek		
	Willow Creek Reservoir		
Humboldt/Rock	Upper Rock Creek	HU 3 or 9	Potential Fluvial Recovery
Humboldt/Rock	Toe Jam Creek	HU 3 or 9	Potential Fluvial Recovery
Humboldt/South Fork	Dixie Creek	HU 3 or 11	Potential Fluvial Recovery
Humboldt/South Fork	Lee Creek	HU 3	Isolated Fluvial
Humboldt/South Fork	Pearl Creek	HU 11	Fluvial Recovery
Humboldt/South Fork	Welch Creek	HU 3	Isolated Fluvial
Humboldt/South Fork	Green Mountain Creek	HU 11	Potential Fluvial Recovery
	North Fork Green Mountain Creek		
Humboldt/South Fork	Mahogany Creek	HU 10 or 11	Potential Fluvial Recovery/Meta-population
	Segunda Creek		
	Long Canyon Creek		
	North Furlong Creek		
Humboldt/South Fork	McCutcheon Creek	Potentially HU 3	Potential Isolated Fluvial
Humboldt/South Fork	Smith Creek	HU 10 or 11	Potential Fluvial Recovery/Meta-population
	Middle Fork Smith Creek		
	North Fork Smith Creek		
	South Fork Smith Creek		
	Gennette Creek		
Humboldt/South Fork	Verdi Lake		Stocked Lacustrine

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
Humboldt/South Fork	Hidden Lakes		Stocked Lacustrine
Humboldt/South Fork	Griswold Lake		Stocked Lacustrine
Humboldt/South Fork	Seitz Lake		Stocked Lacustrine
Humboldt/Upper	Marys River Camp Draw Creek Chimney Creek East Fork Marys River Marys River Basin Creek West Fork Marys River Basin Creek GAWS Creek Williams Basin Creek Currant Creek lower T Creek Short Creek Cutt Creek	HU 12	Fluvial Meta-population
Humboldt/Upper	upper T Creek Anderson Creek Draw Creek	HU 3 or 13	Potential Fluvial Recovery
Humboldt/Upper	Hanks Creek Conners Creek	HU 3 or 13	Potential Fluvial Recovery
Humboldt/Upper	Wildcat Creek	HU 3	Isolated Fluvial
Humboldt/Upper	Fourth Boulder Creek	HU 12 or 13	Isolated Fluvial
Humboldt/Upper	Second Boulder Creek	HU 12 or 13	Isolated Fluvial
Humboldt/Upper	East Branch Sherman Creek Sherman Creek	HU 3 or 13	Isolated Fluvial
Humboldt/Upper	Jackstone Creek	HU 3	Isolated Fluvial
Humboldt/Upper	North Fork Cold Creek	HU 12 or 13	Isolated Fluvial
Humboldt/Upper	Maggie Creek Beaver Creek Coyote Creek Little Jack Creek	HU 12	Fluvial Meta-population

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
	Toro Canyon Creek		
	Williams Canyon Creek		
	Lone Mountain Creek		
	Jack Creek		
	Little Beaver Creek		
Humboldt/Upper	Greys Lake		Stocked Lacustrine
Humboldt/Upper	Smith Lake		Stocked Lacustrine
Humboldt/Upper	Boulder Lake		Stocked Lacustrine
Independence	Independence Lake	IU 2	Lacustrine Recovery
	Independence Creek		
Independence	Heenan Lake	IU 4	Managed Lacustrine
Independence	Heenan Creek	IU 4	Managed Fluvial
Independence	Little Truckee River		Stocked Fluvial
Independence	Lake of the Woods		Stocked Lacustrine
Independence	Webber Lake		Stocked Lacustrine
Independence	Boca Reservoir		Stocked Lacustrine
Independence	Stampede Reservoir		Stocked Lacustrine
Pyramid/Truckee	Prosser Reservoir		Stocked Lacustrine
Pyramid/Truckee	Pole Creek	Pending LCT GMP	Isolated Fluvial
Pyramid/Truckee	Pyramid Lake	PTU 3	Potential Lacustrine Recovery
Pyramid/Truckee	Truckee River	PTU 3	Managed Fluvial
Pyramid/Truckee	Martis Creek Lake		Stocked Lacustrine
Pyramid/Truckee	Donner Lake		Stocked Lacustrine
Pyramid/Truckee	Cold Stream Ponds		Stocked Lacustrine
Pyramid/Truckee	Prosser Reservoir		Stocked Lacustrine
Quinn	Sage Creek	QU 3 or 5	Isolated Fluvial
	Line Canyon Creek		
	Corral Canyon Creek		
Quinn	Riser Creek	QU 3 or 5	Isolated Fluvial
Quinn	Indian Creek	Potentially QU 3 or 5	Isolated Fluvial
Quinn	Washburn Creek	QU 5	Isolated Fluvial
Quinn	Crowley Creek	QU 5	Isolated Fluvial

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
Quinn	Eigthmile Creek	QU 5	Isolated Fluvial
Quinn	Falls Canyon Creek	QU 4 or 5	Isolated Fluvial
Quinn	Andorno Creek	QU 5	Isolated Fluvial
Quinn	Threemile Creek	QU 5	Isolated Fluvial
Quinn	Colman Creek	QU 5	Isolated Fluvial
Quinn	Jackson Creek	QU 5	Isolated Fluvial
Quinn	Pole Creek	QU 5	Isolated Fluvial
Quinn	North Fork Battle Creek	QU 5	Isolated Fluvial
Reese	Marysville Creek	RU 4 or 5	Potential Fluvial Recovery
Reese	Washington Creek	RU 4 or 5	Potential Fluvial Recovery
Reese	Crane Canyon Creek	RU 5	Isolated Fluvial
Reese	Cottonwood Creek	RU 4 or 5	Potential Fluvial Recovery
	San Juan Creek		
Reese	Mohawk Creek	RU 5	Isolated Fluvial
Summit	Summit Lake	SU 3	Lacustrine/adfluvial Meta-population
	Mahogany Creek		
	Summer Camp Creek		
Summit	Snow Creek	Potentially SU 3	Isolated Fluvial
Tahoe	Lost Lake		Stocked Lacustrine
Tahoe	Hidden Lake		Stocked Lacustrine
Tahoe	Eagle Lake		Stocked Lacustrine
Tahoe	Cascade Lake	Potentially TU 2	Potential Lacustrine Recovery
Tahoe	Fallen Leaf Lake	Potentially TU 2	Potential Lacustrine Recovery
Tahoe	Angora Lakes		Stocked Lacustrine
Tahoe	Sawmill Pond		Stocked Lacustrine
Tahoe	Lower Echo Lake		Stocked Lacustrine
Tahoe	Upper Echo Lake		Stocked Lacustrine
Tahoe	Marlette Lake		Stocked Lacustrine
Tahoe	Lake Tahoe	Potentially TU 2	Potential Lacustrine Recovery
Tahoe	Taylor Creek	Potentially TU 2	Fluvial connection between Fallen Leaf and Tahoe
Tahoe	Upper Truckee River (Meiss Meadow)	TU 3	Fluvial/adfluvial Recovery

LCT Management Unit	Population Name	Updated 2019 Objective	Population Description
	Dardanelles Lake		
	Round Lake		
	Showers Lake		
	Four Lake		
	Martini Pond		
	Meiss Lake		
Walker	By-Day Creek	WU 5	Isolated Fluvial
Walker	Murphy Creek	WU 5	Isolated Fluvial
Walker	Slinkard Creek	WU 3 or 5	Isolated Fluvial
Walker	Mill Creek	WU 3 or 5	Potential Fluvial Recovery
Walker	Silver Creek	WU 3 or 5	Isolated Fluvial
Walker	Wolf Creek	WU 3 or 5	Isolated Fluvial
Walker	Cottonwood Creek	WU 5	Isolated Fluvial
Walker	Bridgeport Reservoir		Stocked Lacustrine
Walker	Roosevelt Lake		Stocked Lacustrine
Walker	Lane Lake		Stocked Lacustrine
Walker	Kirman Lake		Stocked Lacustrine
Willow-Whitehorse	Whitehorse Creek	WWU 3	Fluvial Meta-population
	Little Whitehorse Creek		
	Doolittle Creek		
	Cottonwood Creek, Trib. to Whitehorse		
	Little Whitehorse Creek. Trib. B		
	Fifteen Mile Creek		
Willow-Whitehorse	Willow Creek	WWU 4	Fluvial Recovery
	Willow Creek, Trib. E		
Willow-Whitehorse	Antelope Creek	Potentially WWU 5	Potential Isolated Fluvial

Table A-4. Status and description of all out-of-historical-range LCT populations. Location, population name, occupancy status in 2019, and updated objective for each population.

Location	Population Name	Occupied in 2019?	Updated 2019 Objective
Toiyabe Range, NV	Decker Creek	Unlikely	Potentially RU 5
	Santa Fe Creek	Yes	RU 5
	Shoshone Creek	Yes	RU 5
Desatoya Range, NV	Edwards Creek	Yes; but interconnected populations	Maintain for pending LCT GMP
	Topia Creek		
	Big Den Creek	Unknown	Potentially maintain for pending LCT GMP
	Willow Creek	Yes	Maintain for pending LCT GMP
Snake Range, NV	West Fork Deer Creek	No	
Monitor Range, NV	Mosquito Creek	Unknown	Potentially maintain for pending LCT GMP
Toquima Range, NV	North Fork Pine Creek	Unknown	Potentially maintain for pending LCT GMP
Ruby Mountains, NV	South Fork Thompson Creek	Yes	Maintain for pending LCT GMP
Steens Mountains, OR	Little Alvord Creek	Yes	WWU 5
	Pike Creek	Yes	WWU 5
	Cottonwood Creek	Yes	WWU 5
	Little McCoy Creek	Yes	WWU 5
	Willow Creek	Yes	WWU 5
	Big Alvord Creek	Yes	WWU 5
	Mosquito Creek	Yes	WWU 5
Pueblo Mountains, OR	Van Horn Creek	Unlikely	Potentially maintain for pending LCT GMP
	Denio Creek	Yes	Maintain for pending LCT GMP
Yuba River, CA	Macklin Creek	Yes	Maintain for pending LCT GMP
	East Fork Creek	Yes	Maintain for pending LCT GMP
	East Fork Creek, Unknown trib.	Yes	Maintain for pending LCT GMP
Stanislaus River, CA	Disaster Creek	Yes	Maintain for pending LCT GMP
Mokelumne River, CA	Pacific/Marshall Creek	Yes	Maintain for pending LCT GMP
	Milk Ranch Creek	Yes	Maintain for pending LCT GMP
San Joaquin River, CA	West Fork Portuguese Creek	Yes	Maintain for pending LCT GMP
	Cow Creek	Yes	Maintain for pending LCT GMP
Owens River, CA	O'Harrel Creek	Yes	Maintain for pending LCT GMP
Pilot Peak Mountains, UT	Bettridge Creek	Yes	Maintain for pending LCT GMP
	Morrison (Donner) Creek	Yes	Maintain for pending LCT GMP

Location	Population Name	Occupied in 2019?	Updated 2019 Objective
UT	Spring Creek	Unknown	Potentially Maintain for pending LCT GMP
UT	Camp Creek Reservoir	Unknown	Potentially Maintain for pending LCT GMP