Lahontan Cutthroat Trout (*Oncorhynchus clarki henshawi*)
Data: Lahontan Cutthroat Trout Recovery Plan, 1995; LCT Status Update, 2006
Partners: CA, NV, OR, FWS, FS, BLM, Pyramid Lake Paiute Tribe

Status of the Lahontan Cutthroat Trout:
The Lahontan cutthroat trout (LCT, *Oncorhynchus clarki henshawi*) is endemic to the hydrographic Lahontan basin of northeastern California, southwestern Oregon and northern Nevada (Figure 1). One of approximately 14 allopatrically distributed subspecies of cutthroat trout (*O. clarki*). LCT was listed as an Endangered Species by the U.S. Fish and Wildlife Service on October 13, 1970 (35 FR 16047 16048), and down-listed and reclassified as Threatened (40 FR 29863 29864) in 1975 to facilitate management and allow regulated angling.

Behnke (1992) proposed that the Lahontan subspecies be split further into separate Lahontan and Humboldt (*O. Clarki* subsp.) subspecies, which would better reflect the lacustrine and fluvial life histories of these fish and be consistent with morphological differences (Humboldt fish have fewer gill rakers and tend to have fewer scales in the lateral series and above the lateral line). Currently, there is no formal recognition of the Humboldt subspecies. However, based upon morphological, genetic, and ecological differences, Lahontan cutthroat populations have been divided into three Distinct Population Segments (DPS) by the USFWS for recovery activities: Western (Truckee, Carson, and Walker rivers); Eastern (Humboldt River); and Northwestern (Quinn River/Black Rock Desert) DPS. The Recovery Plan for LCT was approved on January 30, 1995 (Coffin and Cowan 1995), but no critical habitat has been designated.

Sport fishing status of the LCT:
Lahontan cutthroat trout, though listed as threatened, can be harvested under a special 4(d) rule under the endangered species act that allows the states to permit angling. Consequently, LCT have played an important part of the recreational fishing in Nevada, California and Oregon for the past 30 years. They are raised at State, Tribal and Federal Hatcheries both for recovery and recreational fishing purposes. There are also numerous other lakes and streams in the historic drainages that are stocked with Lahontan cutthroat trout from the Heenan Lake broodstock established from Independence Lake LCT. In Nevada, numerous LCT waters are open to fishing and are very popular, including the Truckee River, Pyramid Lake, and Walker Lake populations. In order to protect the integrity of fishable populations, special fishing restrictions are in place in some waters. Fishable populations are also supported by hatchery stockings. The sportsfish status of LCT has improved angler support for LCT reintroduction and management.

Current Range of the Lahontan Cutthroat:
Lahontan cutthroat trout have been extirpated from > 90% of historical habitat in the 20th and 21st centuries (Dunham et al. 1997; Dunham et al. 2003). LCT native to the Western Basin DPS are most imperiled as few extant populations persist in these watersheds. In the Truckee River basin alone there are only two naturally reproducing endemic stream populations and a single

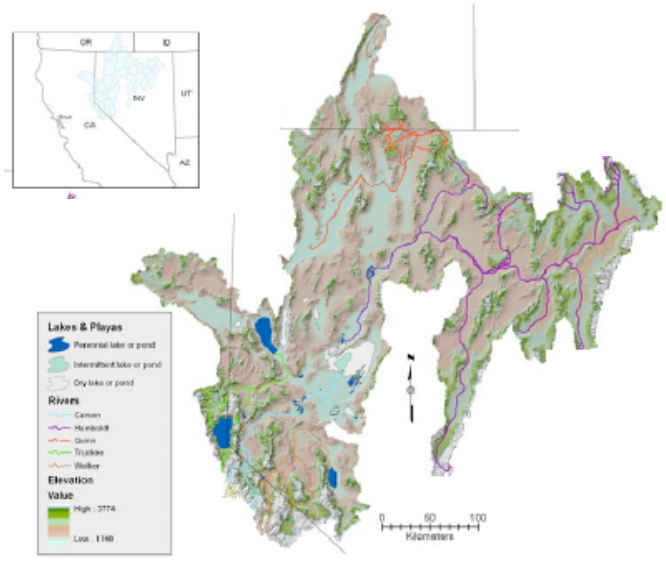

Figure 1. Physiographic Lahontan basin (map created by Robert Elson, GIS specialist, BRRC, University of Nevada, Reno).

naturally reproducing native lake population (Independence Lake). The Carson River has five remaining extant native fluvial populations, where the Walker Lake LCT population and all Walker basin fluvial populations were effectively extirpated in the early 20th century. All fluvial populations in Walker Basin today (five streams) are derived from one small pure population, By-Day Creek.

The Western Lahontan basin retains remnants of pluvial Lake Lahontan (Pyramid and Walker lakes). Although the three major river basins that contain LCT in the Western Lahontan basin (Carson Walker and Truckee rivers) were never inundated by pluvial lake, these streams originate in the eastern Sierra Nevada and drain into lacustrine habitats that are remnants of the ancient lake. The east and west forks of Walker River flow into Walker Lake. Lake Tahoe is the source for the Truckee River, which flows into Pyramid Lake. Walker and Pyramid are terminal lakes supporting highly alkaline and nitrogen-limited ecosystems. The stream drainages flowing into these lakes historically provided spawning habitat and undoubtedly formed networked ecosystems that supported all life stages prior to water diversions and introduction of non-native fishes in the 20th century.

The majority of naturally sustaining fluvial LCT populations are found in the Humboldt River watershed. The Humboldt River is a large main stem river that connected 1000's of kilometers of stream habitat pre-European settlement of the Lahontan basin. Historically, fluvial LCT populations were interconnected at various temporal and spatial scales facilitating wide-ranging movement. Although water still flows into the main stem Humboldt River from ancillary drainages, water diversions have largely isolated LCT within headwater reaches in either single streams or small groups of tributaries.

Currently only 15% of the streams in the Quinn River drainage are occupied by Lahontan cutthroat trout, and most of these habitats are isolated headwater reaches above barriers. Streams in the McDermitt Creek drainage remain interconnected, but non-native salmonids threaten the integrity of this LCT population network (Peacock and Kirchoff 2004). The Quinn River basin was inundated by pluvial Lake Lahontan and in the post-lake period, this system had as many as 46 streams occupied by LCT, where only 11 extant populations remain (Coffin and Cowan 1995). Summit Lake, north of the Black Rock Desert, was formed by a landslide approximately 12,500 years ago and was subsequently isolated, along with associated streams, from the rest of the western basin drainages. Summit Lake and Mahogany Creek which drains into the lake maintain a naturally reproducing LCT fishery.

The Coyote Lakes basin, north of the Quinn River, in Oregon, contains Coyote Lake, a small ephemeral lake, and the Willow and Whitehorse stream systems. Though now physically separated from the Quinn River basin, the Coyote Lake and Quinn River populations were possibly connected during the Pleistocene.

Habitat requirements of the LCT: Lahontan cutthroat trout, like other trout species, are found in a wide variety of cold-water habitats including large terminal alkaline lakes, oligotrophic alpine lakes, slow meandering low-gradient rivers, moderate gradient montane rivers, and small headwater tributary stream. Generally, Lahontan cutthroat trout occur in cold ($<20^0$C) flowing water with available cover, velocity breaks, well-vegetated and stable stream banks, and relatively silt free, rocky substrate in riffle-run areas. However, they have demonstrated a tolerance for higher water temperatures for short periods of time.

Historically, Lahontan cutthroat trout were found in large interconnected stream and/or stream and lake ecosystems. Demographic and genetic data reveal a complex population dynamic for the few remaining interconnected stream systems (Ray et al. 2000; Neville et al. 2006). Long term

occupancy of these stream networks was historically achieved via movement of fish among discrete populations and re-colonization of extirpated habitat facilitated by interconnected waterways (Neville et al. 2006).

Lacustrine Lahontan cutthroat trout populations have adapted to a wide variety of lake habitats from small alpine lakes to large desert waters. Unlike most freshwater fish species, native lacustrine strains of LCT have adapted to alkalinity and total dissolved solid levels as high as 3,000 mg/L and 16,000 mg/L, respectively. This ability to tolerate high alkalinity prompted introductions of Lahontan cutthroat trout into saline-alkaline lakes in Nevada, Oregon, and Washington for recreational purposes. LCT have been reintroduced into Walker Lake, Nevada, where they were extirpated in the early 20th century due to water diversions which prevented access to spawning habitat. In the last several decades over allocated water rights have largely eliminated inflow from the Walker River and produced unnaturally high levels of alkalinity in the lake. LCT have been reintroduced into Walker, Pyramid, and the Tahoe Basin and are currently maintained by hatchery propagation.

Obstacles, Concerns and Threats to improving the status of the LCT:

The severe decline in range and numbers of Lahontan cutthroat trout is primarily attributable to dam and diversion structures in the Western DPS, habitat fragmentation and degradation throughout the species ranger and the introduction of non-native trout species. Other impacts include water diversion of rivers and streams, degradation of riparian habitat by overgrazing of domestic livestock. All of these threats represent significant impediments to recovery of naturally sustaining, networked populations.

Habitat Degradation Concerns:

Major impacts to LCT habitat include: 1) Reduction and alteration of stream discharge; 2) alteration of stream channels and morphology; 3) degradation of water quality; and 4) reduction of lake levels and concentrated chemical components in natural lakes. Concentration of livestock in the riparian area causes alteration of riparian areas, loss of undercut banks and other cover, exposed stream channels, increased silt loads, wider and shallower streams which ultimately causes elevated water temperatures during the summer, and colder temperatures during the winter. Lacustrine habitat has been altered by construction of dams and diversions, pollution, reduced spawning flows, desiccation of lakes, and drought and water withdrawal.

Non-native Fish Concerns:

Non-native rainbow, brook, and brown trout have become established in all the basins inhabited by LCT, causing the loss of many LCT populations. Additionally, kokanee salmon and lake trout are established in Lake Tahoe. Fluvial LCT populations have been displaced by competition and predation from introduced brown and brook trout, and from hybridization with rainbow trout. Non-native fish stocking for recreational fishing has been reduced in many areas important for recovery but this practice continues in other areas and slows recovery progress.

Population Viability Concerns:

Habitat loss and fragmentation have become serious extinction threats for species globally (for recent reviews see Green 2003 and Reed 2004). Isolation and small population size increase vulnerability to local extirpation through demographic stochasticity in the short term, and genetic stochasticity in the long term (Lande 1998; Frankham and Brook 2004; Munzbergova 2006). Loss of genetic variability through the process of random genetic drift can reduce the ability of natural populations to adaptively respond to

changing environmental conditions. In the case of wide-ranging species the aim is often to identify genetically distinct groups of populations whose genetic differences reflect local adaptive differences (Waples 1998; Solorzano et al. 2004; Ficetola and De Bernardi 2005). The genetic challenge to recovery of imperiled species is to preserve enough variation to (1) facilitate adaptive responses to changing environments and (2) maintain evolutionary potential.

Role of metapopulations in LCT recovery:

Metapopulations, defined as groups of small, discrete, but interacting populations, are primarily characterized by an extinction and colonization dynamic (Hanski and Gilpin 1997; Hanksi 1999). A major assumption of metapopulation theory is one of independent population dynamics such that extinction and colonization probabilities are uncorrelated among subpopulations. Long-term persistence of the assemblage is achieved through the juxtaposition of interconnectedness and independence with extinction risk spread across the landscape As with other inland cutthroat trout subspecies, LCT populations persisted historically in large, interconnected aquatic ecosystems that were either lacustrine habitats with tributary streams or large stream networks consisting of a main stem river and smaller tributary streams. Research on this subspecies has shown that persistence of local populations is strongly tied to landscape connectivity and local habitat (patch) size (Dunham et al. 1997, 2003; Neville et al. 2006).

Opportunities for improvement of the status of Lahontan Cutthroat Trout:

Conservation measures implemented to improve the status of Lahontan cutthroat trout have fallen into several major categories including:

- Fish population analyses and manipulations (genetic evaluations, extensive population surveys, fish transplants and fish stockings)
- Watershed management planning;
- Habitat analyses and manipulations (habitat inventory, habitat improvement activities; changes in grazing practices, and riparian fencing and enclosures)
- Land exchanges to secure important LCT habitat;
- Development of fishery management plans and fishing regulation and season closures;
    - Reduce or eliminate stocking of non-native trout in recovery waters

LCT Population Surveys, genetic analyses, and fish population manipulation:

Key actions will include:

Maintain genetic diversity of extant LCT populations by securing existing populations and expanding occupied habitat.
Conduct standardized population surveys and implement a genetic monitoring program to assess the effectiveness of habitat improvements projects on population size and maintenance of genetic diversity.
Reduce impacts of non-native salmonids by reducing or eliminating reproducing populations these species and stop artificial stocking of non-native in recovery areas.
Review and update fishery management and production plans on a prescribed schedule to incorporate current science.

Development of Watershed-based Fishery Management Plans

Key Actions will include:

Develop cooperative management plans to manage major watersheds focusing on reducing degradation of riparian, stream and lake ecosystems leading to improved water temperature profiles, and manage for LCT for recreational fishing.
Develop cooperative management plans to remove movement barriers and provide interconnected habitats.
Assess the impact of climatic changes and drought or other catastrophic events like

forest fires on the recovery of LCT

LCT Habitat Manipulations:
Restoration of LCT habitat will have to address habitat and water quality and quantity issues. Restoration of a natural hydrograph, in seasonal variation if not in historic volume, is key to the restoration and maintenance of riparian habitat and channel function. Current efforts to manage LCT have been directed toward improving in-stream and riparian conditions, addressing land use practices conditions and restoring limited stream fragments.

Key actions will include:

Secure and improve riparian and in-stream habitat for the restoration of LCT fluvial populations.
Identify critical stream and riparian zone habitats for cooperative management projects and recovery of LCT
Restore and enhance water flow, including restoring the natural hydrograph, not necessarily historic volumes, in key habitats
Address public and private land management practices to improve watersheds habitats for LCT and reduce livestock and agricultural impacts
Monitor and evaluate natural catastrophe impacts like fire and drought

Lahontan Cutthroat Management related to public use and supplemental stocking

Key actions will include:

Revise current management plans to clarify the role of hatchery produced fish conservation and recreational fishing. Use of broodstock eggs to establish self-sustaining populations of LCT in the Western DPS
LCT strains native to each DPS should be used for DPS specific recovery activities.
Manage sportfishing to preclude adverse angling impacts on LCT through the use of special fishing regulations and use of LCT for recreational fishing in place of non-natives

Highest Priority Actions for LCT by major watershed:

1) Western Lahontan basin comprised of the Truckee, Carson, and Walker river sub-basins:

Preventing further losses of genetic variation of extant populations and suitable habitat and restoration of historically occupied habitat should be of the highest priority. Pilot Peak LCT have the strongest phylogenetic relationship to historical, museum preserved LCT of known Lake-Tahoe-Truckee basin origin prior to extirpation in the 1940s. This strain has high levels of heterozgosity and allelic richness and retains the genetic signature of their source population. As such this strain likely retains any adaptations
specific to lacustrine life history and represents the best chance for recreating native networked populations within the Lake Tahoe-Truckee River and Walker River watersheds in Western basin DPS. Investigation of this strains performance is now ongoing in all three basins.

2) Northwestern Lahontan basin comprised of Quinn River, Black Rock Desert, and Coyote Lake sub-basins:

Preventing further losses of genetic variation should be of the highest priority. These populations should be monitored to assess additional losses of genetic variation in the short term as well as increases in population size and emergence of population genetic structure with increases in habitat quantity and quality in the long term.

3) Humboldt River basin:

Long-term recovery activities of LCT populations in the Eastern basin DPS should involve habitat recovery – in terms of both habitat quality and

interconnectedness in order to facilitate emergence of the historic population dynamic in these watersheds.

Completed projects

1.
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