

*Life History and Management of
Paiute Cutthroat Trout in the White Mountains,
Mono County, California*

Darrell M. Wong

California Department of Fish and Game
Bishop, California 93514

Abstract. Since its introduction into the originally fishless Cottonwood Creek basin in 1946, the Paiute Cutthroat Trout [*Oncorhynchus clarki seleniris* (Snyder)] population has experienced periods of angler harvest and full protection. Life history studies conducted in 1973 and 1974 in the North Fork of Cottonwood Creek revealed that most of the estimated 500 fish present were one to three years of age. Disease was the major cause of adult mortality; sediment deposition in redds was the major cause of egg and alevin mortality for this spring-spawning species and is the major factor limiting trout production. Food is abundant for Paiute Cutthroat Trout, which are opportunistic feeders. These fish form stable linear dominance hierarchies and may remain in small areas of a stream for extended periods. Transplantation of fish to a vacant stream section resulted in fish remaining in their new area; the natural repopulation of vacant stream was very slow. Available life-history information has been utilized in developing management strategies to increase population densities and to expand the range of the Paiute Cutthroat Trout in the White Mountains as part of a joint Recovery Plan for this federally listed threatened species.

INTRODUCTION

The Paiute Cutthroat Trout [*Oncorhynchus clarki seleniris* (Snyder), formerly placed in the genus *Salmo*] is an inland form of cutthroat trout closely related to the Lahontan Cutthroat Trout [*Oncorhynchus clarki henshawi* (Gill and Jordan)] native to pluvial Lake Lahontan of the Great Basin. The Paiute Cutthroat Trout evolved in a small upstream area of Silver King Creek, Alpine County, a tributary to the Carson River. The subspecies has always occurred in small numbers due to its limited range above a barrier falls. Although several transplants of this fish have been made, one of the most successful has been to the North Fork of Cottonwood Creek in the White Mountains of California. After the introduction of Paiute Cutthroat Trout into originally fishless Cottonwood Creek in 1946, an inadvertent stocking of rainbow trout [*Oncorhynchus mykiss gairdneri* (Richardson)] in Silver King Creek in 1949 placed the genetic integrity of that population in jeopardy. The Cottonwood Creek population currently represents one of the two largest populations of these rare fish; following planned recovery efforts Cottonwood Creek will constitute the largest population of this subspecies.

The limited number of Paiute Cutthroat Trout and their vulnerability to hybridization and angling harvest resulted in their being listed as an endangered species by the Secretary of the Interior in 1973 and afforded the subspecies further protection from unnatural disturbances; the taxon was delisted to federally threatened status in 1976 where it remains at present. Biological studies were conducted in 1973 and 1974 on the North Fork Cottonwood Creek population to determine life-history requirements that might aid in the recovery of the subspecies. Due to the endangered status of the taxon, information on the biology of the population was obtained while causing as little disruption to the population as possible. Diana [1975] and Wong [1975] report the basic life-history information known to date. This paper summarizes the available information on the North Fork population and describes recent and future planned management activities.

ENVIRONMENTAL DESCRIPTION

The North Fork of Cottonwood Creek is located in an isolated area of the White Mountains, 27 km (~16 mi) east of Bishop, California. The North Fork has as its main water source

several springs at an elevation of 3,096 m (~10,250 ft). The stream drops 312 m (~1,000 ft) in a distance of 5.3 km (~3 mi) to a barrier falls delimiting the lower extremity of the Paiute Cutthroat Trout population. During the summers of 1973 and 1974, the stream had a mean discharge of 0.8 cfs and was characterized by mean maximum and minimum daily water temperatures of 14° C and 4° C, respectively. Water quality, particularly total hardness (as calcium carbonate), magnesium concentration, and pH (8.2 to 8.6), is indicative of groundwater seepage through the carbonate-rich Reed Dolomite. Due to the dry, cold climate, the North Fork experiences only modest spring flushing flows; most freshets occur as the result of summer thunderstorm events. Livestock use in the drainage has resulted in some adverse impacts to North Fork riparian areas and degraded streambank stability. Recreational use in the basin is light; the North Fork has been closed to angling since 1964 to afford full protection to the trout population. The remainder of the Cottonwood Basin is open to angling for introduced Rainbow Trout [*Onchorhynchus mykiss gairdneri* (Richardson)] and Brook Trout [*Salvelinus fontinalis* (Mitchill)].

STUDY RESULTS

Population Size and Distribution

Population size and distribution were determined from two separate electroshocking surveys. In 1973 Paiute Cutthroat Trout were present in only 2 km (1.2 mi) of the 5 km (3 mi) available in the North Fork as a result of past management activities and fish behavior. After detecting what appeared to be hybridized Paiute Cutthroat Trout in the lower reaches of the North Fork, Department of Fish and Game personnel chemically treated the lower portion of the stream to remove all fish in 1970. The observed distribution in 1973 reflected the results of the treatment and the general lack of movement of remaining fish into downstream areas. Utilizing actual counts of fish captured during the surveys, electroshocking efficiency determined by two mark-recapture experiments and a depletion experiment resulted in a population estimate of 397 to 704 adults and juveniles. It is most likely that the North Fork population approached 500 fish.

Genetic Integrity

The physical characteristics of individuals, including anomalies and number of body spots, were noted during the

electroshocking surveys. These data disclosed that portions of the population located downstream from a previously unknown barrier falls exhibited greater numbers of body spots (up to 13) than from members above the barrier. These were likely remnants of the population not removed during the 1970 chemical treatment. Spotting is a common indication of hybridization with Rainbow Trout, with which most cutthroat trout will hybridize readily. While the incidence of spotting was not great in the "lower" population, it did cause concern for the genetic purity of this subpopulation.

Age and Growth

The age distribution of fish was determined primarily from length-frequency distributions utilizing data from summer and fall electroshocking surveys. Scale annuli back-calculations were in general agreement with length-frequency data.

The majority of the population consists of fish from one to three years old. Although only 3.8 percent of the population survives past the third year, a few may survive to five or six years of age. The age-length data were fitted to various regression models; the most appropriate model for fish ten months or older (assuming a January 1 birthdate) was a straight line of the form: $FL=4.5A-10.43$, where FL is fork length in mm and A is age in months.

Growth is nearly isometric. The growth rate is relatively rapid in young fish and decreases at greater ages. Paiute Cutthroat Trout fry experienced relatively constant growth in captivity for approximately 39 days after emergence from the gravel during the first week of August. The mean length of the 1973 year class was 63 mm in July 1974.

Causes of Mortality

Predators of adult fish are almost nonexistent in the study area. Due to a fishing closure on the stream since 1964, angling mortality is assumed to be nearly zero. Most adult mortality was observed to be the result of secondary infections following physical trauma incurred during the spawning season. Predation by American Dipper (*Cinclus mexicanus*) probably accounts for some egg mortality; and dippers, water shrews (*Sorex palustris*), and some aquatic insects probably prey on young fish. Cannibalism likely occurs, but its extent is unknown. Sediment deposition in redds, resulting in suffo-

cation of eggs and alevins, is likely the major limiting factor to trout production.

Reproductive Biology

Paiute Cutthroat Trout pair and exhibit various forms of courtship behavior prior to spawning. Aggressive behavior towards other fish occurs at spawning sites, which are located in areas with preferred depths, substrate, and water velocity, which are generally found at the tails of pools. Redd building and spawning acts are similar to those of other salmonids. The fish probably spawn first in their third year and most likely spawn annually thereafter. The majority of spawning occurs in the spring, with a peak occurring in April and May.

Food and Feeding

Paiute Cutthroat Trout are generally opportunistic feeders. Fish over 100 mm in length utilized a variety of aquatic and terrestrial food items, while smaller fish fed exclusively on dipteran larvae and baetid naiads. Food availability does not appear to limit trout production and is ample enough to support a much larger fish population. A diverse biota exists in the North Fork of Cottonwood Creek with individuals of Ephemeroptera, Plecoptera, Trichoptera, and Diptera constituting the majority of the benthic fauna.

Fish Behavior

Visual observation, mark-recapture experiments, and traps were utilized to determine fish movement and behavior. All methods revealed a very limited movement of Paiute Trout. The marking experiment disclosed that after three months 78 percent of marked fish were still within the original area of capture. In 45 days of trap operation, only one fish was captured moving upstream naturally; no fish were found that moved beyond the two ends of the main populated area.

Visual observations were utilized to determine local movements and social structures. During prolonged observations of large pools over two summers, no fish were ever seen leaving the pool where they normally resided. Observations disclosed that adults established partial territories along major currents based on stable linear dominance hierarchies.

Transplantation and Repopulation

During transplantation and repopulation studies, 21 fish were removed from an area between two traps (0.2 km or 600 ft apart) and planted in an unpopulated area 2.5 km (1.5 mi) downstream from the removal area also located between two traps (0.2 km or 600 ft apart). The traps were removed two weeks later, and no fish had attempted to move from the transplant area during that time. After 63 days both areas were rechecked by electrofishing. Fifteen fish were recaptured in the transplant area, and the six transplanted fish that were not recaptured were all small fish that were likely missed by electroshocking. Only two fish had moved into the vacated area upstream. This indicated that the fish may be successfully transplanted to vacant stream areas, and the normal rate of repopulation of vacant stream is very slow.

Extrinsic Environmental Factors

Organic and inorganic sediments are deposited in the North Fork as a result of abundant streamside vegetation and infrequent high precipitation. A combination of relatively high sediment volume and lack of flushing flows result in the infiltration of gravel interstices by sediments, contributing to egg and alevin mortality.

Three beaver dams were present at the beginning of the study, increasing to 15 dams by 1974. Beaver impoundments may indirectly limit trout production by destroying spawning areas as a result of siltation and can result in increases in bedload downstream when dams are abandoned, fall into disrepair, and are eventually breached.

MANAGEMENT STRATEGIES

The Paiute Cutthroat Trout recovery effort is directed by the U.S. Fish and Wildlife Service Recovery Plan, Department of Fish and Game Management Plan, the Inyo National Forest Land Management Plan, and Inyo Forest draft Paiute Cutthroat Trout Habitat Management Plan. All these plans call for increased protection and habitat enhancement for the North Fork population to optimize trout density and to expand the range of the Paiute Cutthroat Trout throughout the rest of Cottonwood Creek currently occupied by Brook Trout and

Rainbow Trout. Recent activities have been focused on implementation of these objectives.

Based upon observations made in 1973 regarding the incidence of body spotting in the population, samples of fish from above and below the upper barrier falls were removed in 1980 for electrophoretic analysis. Results disclosed that the "lower" population contained an allele which indicated Rainbow Trout introgression. The "upper" population contained no such allele and had avoided introgression, likely resulting from the illegal introduction of Rainbow Trout above the lower fish barrier with fish from downstream areas in the early 1960's. As a result, the North Fork downstream from the upper barrier was chemically treated in 1981 and 1982 to remove all introgressed fish; the stream was detoxified at the lower barrier to eliminate impacts to downstream fisheries. From 1983 through 1986, 30 to 40 adult trout were removed from the upstream population and transplanted to lower areas of the stream. These fish have survived and reproduced well, as anticipated based on previous studies. In 1987 and 1988 additional fish were moved by the Department to unoccupied downstream areas. As of June 1989 pure Paiute Cutthroat Trout were present throughout the desirable habitats in the North Fork. Within two to three years, trout densities should be near maximum.

In order to maximize trout densities in the North Fork in a timely manner, an experiment began in 1985 to enhance spawning sites. Subsequent inspections indicated that the gravel areas which had been cleaned of fine-grained sediments were preferred by adults for spawning. Since that time California State funding has been made available to the Inyo National Forest to continue enhancement activities. Annual inspections of the 100-plus sites enhanced to date and visual fish counts indicate that spawners are selecting the cleaner gravels; the enhanced egg and alevin survival and recruitment has resulted in a trout population that likely numbers over 1,000 adults and juveniles.

Beginning in the early 1980's, a beaver eradication program has been implemented to remove the few beavers in the North Fork. At present no active dams are present. In addition, California State funding has been utilized by the Inyo National Forest to conduct watershed restoration and stabilization work throughout the North Fork. The combination of introduction of clean gravels combined with a reduction in fine sediment

input will aid in maximizing trout recruitment. The development of an Allotment Management Plan for the livestock allotment in the Cottonwood Basin is planned by the Inyo National Forest in 1989/90. Implementation of Forest-Wide Standards and Guidelines in this plan should alleviate any livestock-caused adverse impacts to riparian habitats through better livestock management and result in enhanced fish and wildlife habitat throughout the Cottonwood basin.

As final implementation of the Recovery Plan, fish from the North Fork population will be used to restock approximately 25 km (15 mi) of Cottonwood Creek, from which introduced trout will be removed by chemical treatment. This became imminently feasible after several barrier falls up to 8 m in height were discovered on Cottonwood Creek near Fish Lake Valley, which will maintain the isolation of the Paiute Cutthroat Trout population from downstream trout. Following the adequate repopulation of Cottonwood Creek with Paiute Cutthroat Trout, it is expected that limited angling could occur so that the public can observe and enjoy this California native, while the North Fork would remain closed to angling and remain a very well protected refuge. It is very likely that numbers of fish from the Cottonwood basin will be utilized to repopulate the waters of Silver King Creek following chemical treatment and barrier construction to remove introgressed fish and maintain genetic isolation, respectively. Following the recovery of the subspecies in its native waters, it would likely be delisted and finally removed from the Federal list of threatened and endangered species. This California native would then continue to be protected while being managed, so California anglers and observers of nature can appreciate it for its unique and beautiful characteristics.

REFERENCES

- Curtis, B., Survival of transplanted Piute Trout, *Calif. Fish and Game*, 25(1), 46-47, 1939.
- Diana, J. and D. Wong, Studies on the Paiute Cutthroat Trout in the North Fork of Cottonwood Creek, White Mountains, California, *Cal-Neva Wildlife Transactions* 1975, 128-131, 1975.
- Diana, J., The movement and distribution of Paiute Cutthroat Trout, *Salmo clarkii seleniris* Snyder, in the North Fork of Cottonwood Creek, Mono County, White Mountains, California, M.S. thesis, 98 pp., California State University, Long Beach, 1975.
- McAfee, W. R., Piute Cutthroat Trout, in *Inland Fisheries Management*, edited by A. Calhoun, pp. 231-233, State of California,

- Department of Fish and Game, 1966.
- Snyder, J. O., Description of *Salmo seleniris*, a new California trout, *Proc. Calif. Acad. Sci.*, 20(11), 471-472, 1933.
- Vestal, E.H., A new transplant of the Paiute Trout (*Salmo clarkii seleniris*) from Silver King Creek, Alpine County, California, *Calif. Fish and Game*, 33(2), 89-95, 1947.
- Wong, D. M., Aspects of the life history of the Paiute Cutthroat Trout, *Salmo clarkii seleniris* Snyder, in North Fork Cottonwood Creek, Mono County, California, with notes on behavior in a stream aquarium, M.S. thesis, 178 pp., California State University, Long Beach, 1975.