COLDWATER FISH MANAGEMENT

Robert Behnke, Colorado Cooperative Fishery Unit

Presented to the fourth annual short course in game and fish management, February 28, 1968, Colorado State University, Fort Collins, Colorado.

For this presentation, "Coldwater fish management", is essentially restricted to trout management.

Because of diverse philosophies and management methods involved in maintaining trout fisheries, three categories will be discussed: (1) Put and take trout fishing using catchable hatchery trout; (2) Wild trout and "quality" fishing; and (3) Unique fisheries, emphasizing the restoration of native species and subspecies and rare fishes.

(1) PUT AND TAKE TROUT FISHERY

The role of the trout hatchery and the use of hatchery trout is one of the major problems inherent in the fishery management program of states with trout waters. On the positive side, modern technology, improved diets, and highly selected strains of trout have enormously increased the efficiency and lowered the cost of producing catchable-sized trout. The other side of the coin reveals the gross inequality of the distribution of costs among the license buyers in states with large scale catchable programs. Detailed studies make clear that, in general, no more than 5% of the license buyers taken home 50% of the catchable trout caught. When 70-80% of a state's license fee monies are used to maintain such a program, it is obvious that the majority of fishermen are being short changed. Perhaps, a more insidious result of attempting to fulfill the insatiable demands of "welfare troutism" or "socialized creel insurance", is the committment of a conservation department's resources and talent to such an extent that their primary task - that of preserving and improving the quality of the environment and of natural fisheries is neglected. This leads to a decline in the quality of the department itself. Better students avoid employment and any competence and enthusiasm originally present is eroded away by the unchallenging task of fish distribution. Such a department may then be staffed with uninspired "time servers."

The complexities of the problem of "cost sharing" a catchable program is directly related to the magnitude of the program. A state with very limited amount of trout water may simply invoke a pay-as-you-go policy where only those fishermen utilizing the catchable trout pay for the program. In states where the catchable program is vast and deeply imbedded in the psyche of the fishermen, the problem can get out of hand. There is a solution, however, to the ever increasing demands for more trout. It is possible to provide, essentially, an unlimited supply of trout while removing the most onerous part of the burden of supplying these trout from the public conservation agency. Particularly in areas of dense population, certain waters can be managed with an admission fee used to purchase trout from private hatcheries. This type of fishing has been successful in southern California and many municipal and private irrigation reservoirs have been opened to the public when income is available to buy trout, police the area, and even make a profit. A variety of combinations of public and private stocking may be envisioned, but the main aim of a catchable trout program of the future, must be a more equitable distribution of costs among license buyers and a clear statement of the primary goals of the fishery section of a conservation agency; i.e. the protection and improvement of the aquatic environment.

(2) WILD TROUT MANAGEMENT

The term wild trout is used for naturally propagated fish and those stocked as fingerlings and grown in a natural environment. It is understood that in heavily fished waters, wild trout alone cannot supply enough fish to maintain a reasonable catch per hour statistic. In these situations, special regulations on tackle and catch can be used in some areas (quality fishing) and supplementary plantings with catchable trout can be used in others. Thus, there may not be a clear-cut separation of sections 1 and 2 of this discussion.

The emphasis of a wild trout fishery, however, is to preserve and create conditions most favorable for propagation, growth, and survival of natural trout populations. The most economical return to the fisherman in terms of numbers, poundage, and enjoyment, from a hatchery program is the stocking of fingerling trout in lakes having favorable conditions for growth and survival but lacking natural spawning areas. Much research is needed on species and "strains" of trout, on when to stock, and at what size and density to stock, and possibilities of influencing the food chain for optimum production, to more fully utilize the potential of our waters.

Stocking of fingerling trout in waters with adequate natural reproduction is a wasteful practice because the natural mortality rate, as determined by the environment, will allow only a certain number of individuals to survive to the adult stage.

(3) UNIQUE FISHERIES

Remote, isolated waters can be managed to perpetuate rare and endangered forms of fish. For example, several subspecies of cutthroat trout recognized from the western United States are on the verge of extinction due to competition, hybridization, and water use policies. Conservation agencies have a duty to perpetuate these diverse genotypes of our biological heritage. The main problem is to locate and recognize the dwindling remnant populations of our native trouts. Once the true native trout has been found, a watershed can be selected where the unique form may flourish without danger of hybridization or competition. Many waters now containing only stunted brook trout could be reclaimed and a unique fishery established.

No special regulations would be needed in most areas because limited access would control fishing pressure. The esthetic value of each rare trout to the sportsman, understanding the situation, would be many times that of an ordinary fish.

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presented to
Western Division American
Fisheries Society.
July 9, 1968
Reno, Nevada.

RARE AND ENDANGERED SPECIES:

The Native Trouts of Western North America

Robert J. Behnke
Colorado Cooperative Fishery Unit
Colorado State University
Fort Collins, Colorado 80521

The great diversity, phenotypic plasticity, and lack of reproductive isolation among "species" of the native trouts in the genus *Salmo* of western North America, impose complex problems for placing them in taxonomic categories. No definition of a species or subspecies will adequately arrange these trouts into a classification reflecting natural relationships. Some distinct and rare forms have never been named. The difficulties of recognizing the influence of hybridization in suspected genetically pure native populations adds to the problem of placing a rare or endangered label on many of the remaining native trout populations.

As a starting point, two relatively well differentiated evolutionary lines are apparent: the rainbow series, *Salmo gairdneri*; and the cutthroat series, *S. clarki*. The rainbow trout, native to the Pacific Coast from northern Mexico to Alaska, has been intensively propagated for 90 years. Introductions of rainbow trout into interior waters where only the cutthroat trout is native, and subsequent hybridization between the two, has been a major factor in the decline of populations of native interior cutthroat trout.

The cutthroat series can be considered as two distinct trouts. The coastal cutthroat, *S.c. clarki*, found in coastal waters from northern California to southern Alaska, is the only cutthroat known to coexist with the rainbow without mass hybridization. The coastal cutthroat is not rare or endangered. The interior cutthroat consists of several sub groups inhabiting parts of the upper Columbia and Missouri river systems, the South Saskatchewan, the Colorado, Rio Grande, South Platte, and Arkansas drainages and the Great Basin. These are often recognized as subspecies.

The most numerous instances of rare and endangered trouts are found with the interior cutthroats.

The Lahontan cutthroat trout, *S.c. henshawi*, attains the largest size and is the most differentiated of the interior cutthroats, typically possessing 4-6 or more gill rakers. The Lahontan cutthroat illustrates a practical purpose why rare and endangered genotypes should be perpetuated and illustrates some of the subtle considerations involved in determining rare or endangered status. A trout called the Lahontan cutthroat is widely propagated from eggs taken from a stock in Heenan Lake, California. With such extensive hatchery propagation and wide distribution into many waters of California and Nevada, it might be surmised that the Lahontan cutthroat is not rare or endangered. However, the facts of the case reveal that the Heenan Lake trout is only a good counterfeit of the real article. The origin of the Heenan Lake stock was Blue Lake, California, originally a barren lake, but stocked with Lahontan cutthroat from the Carson River in 1864. Later, rainbow trout were introduced twice and hybridization occurred. Although the Heenan Lake cutthroat has proved superior to the rainbow when stocked in Pyramid Lake, Nevada, they do not approach the size once attained by the native Pyramid Lake cutthroat trout. The latter were exterminated by the removal of water from the Truckee River, the only spawning tributary to Pyramid Lake. The point that I want to stress is that evolution by natural selection has produced some highly adapted genotypes for specific environmental conditions. The recognition and utilization of these specialized genotypes could be of immense importance for fish management programs. Slight genetic changes can produce major behavioral and physiological differences, while the morphology of the population remains essentially unchanged. Thus, all the genetic diversity present in the disjunct populations of a widely distributed subspecies such as *S.c. henshawi* should be preserved for possible future use. Pure populations of *S.c. henshawi* are certainly rare.

Headwater tributaries of the Humboldt River drainage in the Lahontan basin of eastern Nevada, has a slightly differentiated version of the Lahontan cutthroat. The Humboldt cutthroat will eventually be named as a new subspecies. This trout seems highly adapted to conditions of eastern Nevada and frequently is found in reservoirs where hatchery introductions will not persist.

The cutthroat trout most widely distributed in western states as "native" trout had its origins mainly from Yellowstone Lake, Wyoming. Pure populations of the true native cutthroat trout of the Bonneville basin, the Colorado, Rio Grande, South Platte, and Arkansas River systems are indeed rare.

The "golden trout complex" is a term I use to denote an evolutionary line distinct from both rainbow and cutthroat trouts. At present, I provisionally include the California golden trout, *S. aguabonita*, the Mexican golden trout, *S. chrysogaster*, the Gila trout, *S. gilae*, and the Apache trout (at present without a scientific name) in this group. These trouts represent relict populations of a group once widespread, probably associated with the lower Colorado River basin during Plio-Pleistocene times.

The relationships of yet another group of uncertain affinities are now under study. This distinctive red banded form with golden hues possesses characteristics of all three of the above mentioned groups; the rainbow, cutthroat, and golden trouts. During a field trip made this summer specimens were collected from tributaries to the McCloud and Pit rivers and Goose Lake in northern California, from the upper Klamath basin in Oregon, as well as from the following desiccating basins in Oregon: Fort Rock, Chewaucan, Warner Lakes, Catlow Valley, and the Harney-Malheur drainages. This unique trout is now found in only a few headwater streams of each basin. Dr. Ray Simon, Leader of the Oregon Cooperative Fishery Unit, obtained material for chromosome preparations of these trout. Hopefully, an authoritative statement regarding the systematics of this trout will be available by 1969.

Talk presented to Annual meeting of the American Fisheries Society, Sept. 1968 Tuscon, Arizona

MANAGEMENT IMPLICATIONS OF INTER AND INTRASPECIFIC VARIABILITY

Robert Behnke
Assistant Unit Leader
Colorado Cooperative Fishery Unit

Selection is the driving force responsible for changes in population gene pools. In nature this is an exceedingly slow, but a marvelously efficient process. Under domestication, rapid selection can produce changes in growth rate, food conversion, disease resistance, spawning time, age at maturity, and behavior. These genetic changes, however, "unadapt" the population for the rigors of the natural environment, much like the DDT resistant genotype of the fruit fly which is quickly replaced when DDT is removed from the environment.

The important question is how to fit the right genotype to a specific situation. When the function of a trout strain is to yield the most trout in the least time for the least money, and these trout are expected to be quickly removed by fishermen in a put and take fishery - the inbred hatchery strains of rainbow can't be surpassed. This, however, is more the province of the fish culturist. The great challenge of fishery research and management is to utilize pre-adapted inter- and intra-specific variability to maximize the potential of a sport fishery. Often, within a species, strikingly different results can be obtained, for example, Kamloops rainbows compared with hatchery rainbows when stocked in large lakes with minnows and suckers present. The genetic variability known to exist in *Salmo*, *Oncorhynchus*, *Salvelinus*, and *Coregonus* has hardly been exploited in fish management work in North America. Within a species complex such as *Salvelinus alpinus*, there are planktonic, benthonic, predaceous, lacustrine, fluviatile, and anadromus forms with very different life histories.

Particularly in large man-made lakes, the establishment of the best species (or intraspecies) composition can mean the difference between a poor, but expensive to maintain, fishery or a high quality show piece.

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A comprehensive bibliography pertaining to introductions of salmonid fishes and their genetic variability was compiled under my supervision by Mr. Howard Druckenmuller. This information source is available in the Coop. Units Library.

SYMPATRIC SIBLING SPECIES OF SALMONID FISHES WITH INFERENCES FOR FISHERIES MANAGEMENT

Seminar, Department of Zoology, University of Wyoming
February 22, 1973

Robert J. Behnke
Division of Research, U.S. Bureau of Sport Fisheries and Wildlife
Department of Fishery and Wildlife Biology
Colorado State University

The currently accepted criteria for defining species emphasizing reproductive isolation has some serious limitations for the taxonomy of the family Salmonidae, where strong, innate, reproductive homing behavior may allow genetic segregation between two or more morphologically similar populations with only slight genetic differentiation.

Although the coexistence of closely related populations of salmonid fishes is a prime cause for taxonomic confusion and disagreement, this phenomenon suggests some innovative applications for fisheries management. In order for two or more populations to coexist in the same environment in nature, there must be some degree of ecological segregation to avoid direct competition. It then can be assumed that two or more coexisting populations will exploit the resources more effectively and produce more total biomass than either or any one could alone.

Examples in the literature exploring the nature of ecological segregation between coexisting salmonid fishes are limited to natural situations where the populations have been coexisting for thousands of years and the behavioral mechanisms for coexistence are probably incorporated into the genotypes.

The pertinent question for fisheries management application is: Can two closely related groups (for example, races or subspecies of a species) without genetic programming for coexistence in their evolutionary history, be introduced together and initiate ecological segregation?

Results from a study of two populations of cutthroat trout introduced in a small Colorado lake is enlightening. Their behavior is interpreted as an example of interactive segregation, whereby behavior patterns expressed in allopatry are modified in sympatry to avoid direct competition and allow coexistence. This, in turn, resulted in a striking difference in angling vulnerability between the two populations.