Status and Plight of the Searun Cutthroat Trout

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1. Introduction

The Endangered Species Committee of the American Fisheries Society recently identified all Washington, Oregon, and California populations of searun cutthroat trout, the anadromous form of the coastal cutthroat trout, *Oncorhynchus clarki clarki*, as being at some level of risk of extinction (Nehlsen et al., 1991). Here we focus on these at risk populations, listing reasons for their decline as set forth by the AFS Committee. We then review the life history, ecology, and genetic population structure of the subspecies, and from this identify gaps in our knowledge that will have to be filled if these populations are to be preserved.

2. Populations at Risk and Reasons for Declines

The status of anadromous populations of coastal cutthroat trout was surveyed in the continental U. S. by the AFS Endangered Species Committee (Nehlsen et al., 1991). As Figure 1 shows, California, Oregon and Washington comprise nearly one-third of the subspecies' historic range. The Committee reached the conclusion that all native naturally spawning populations within this area are at some level of risk, either on the threshold of endangered, on the threshold of threatened, or are species of special concern due to low numbers or special environmental sensitivities. Reasons given by the Committee for the declines in population numbers are:

1. Present or threatened destruction, modification, or curtailment of habitat or range due to logging in forests, urban and rural development, or mainstem passage. Logging as well as urban and rural development has been intense throughout the surveyed area in recent years.
2. Over-harvest in recreational fishing.
3. Negative interactions with hatchery stocks and/or introduced species. These include searun cutthroat trout of hatchery origin and other salmonids such as coho salmon and steelhead.

3. Historic Range and Life Cycle

The historic range of *O. c. clarki* (Fig. 2) extends from the Eel River, California to Gore Point, Kenai Peninsula, Alaska (Behnke, 1979, 1988), a range that corresponds remarkably closely with the Pacific coast rainforest belt defined by Waring and Franklin (1979).

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Searun cutthroat trout populations comprise one of four principal life history forms found within this range (Trotter, 1989), the others being:

- Fluvial-Adfluvial: river-dwelling populations that migrate to small tributaries for spawning and rearing.
- Lacustrine: lake-dwelling populations that migrate to tributaries for spawning and rearing.
- Fluvial: populations that dwell in headwater reaches; may disperse locally but do not migrate.

Anadromous populations favor streams with small to moderate drainage area (watersheds up to 130 km^2) with an abundance of low-gradient channels (Hartman and Gill, 1968).

Details of the searun cutthroat trout life cycle have been published by Pauley et al. (1989) and Trotter (1989), and are illustrated in Figure 3. In the following summary, we have highlighted several areas where vital information is lacking.

Spawning: Spawning takes place in early spring (late January, February, and early March in Oregon, Washington and California) in upper reaches of small tributaries (0.10.3 m^3/sec. summer low flows) in low-gradient riffles and the shallow downstream ends of pools.

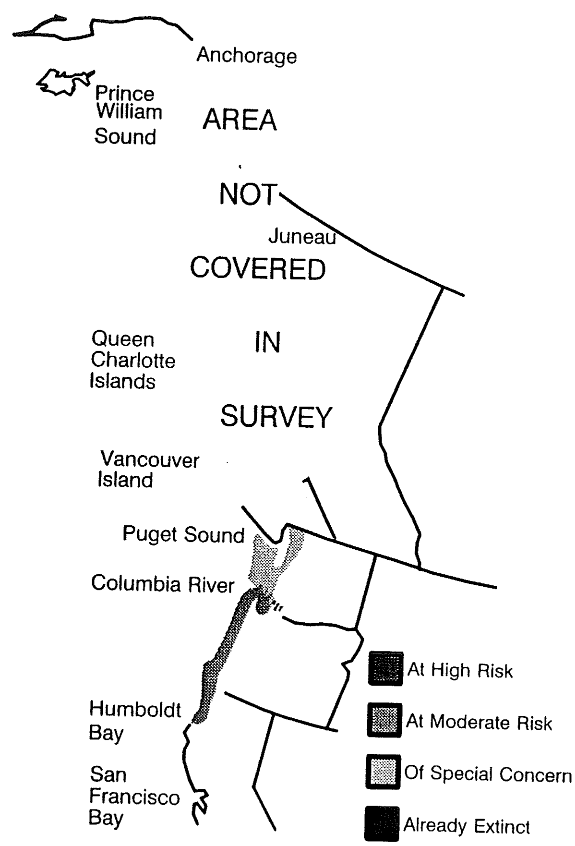

Figure 1. Distribution of searun cutthroat trout populations currently at risk of extenction in California, Oregon, and Washington (from Nehlsen et al., 1991).

Females typically spawn for the first time at age four. Searun cutthroat trout withstand the rigors of spawning rather well, and repeat spawning in subsequent years is common.

Egg incubation: Egg incubation requires 6 to 7 weeks and the alevins generally remain in the gravel about two weeks after hatching. Peak emergence usually occurs in mid-April but may be later in the northern portions of the range. Post-emergent fry move quickly into channel margins and backwaters for the first few weeks of their freeswimming lives.

Juvenile rearing in streams: Juvenile searun cutthroat trout prefer pools, but when other salmonids are present, the juvenile cutthroat trout move into low gradient riffles early in their first summer, then into pools as growth progresses. There is evidence of negative interactions with juvenile coho salmon and steelhead during this phase of searun cutthroat trout life history (Hartman and Gill, 1968; Glova, 1984, 1986; Bisson et al., 1988) which may limit searun cutthroat trout population size.

Populations exhibit variability during juvenile rearing. It has been suggested that this is an adaptation to the type of saltwater environment the young fish will be entering upon smoltification (Johnston, 1981). Where the fish enter relatively sheltered saltwater areas,

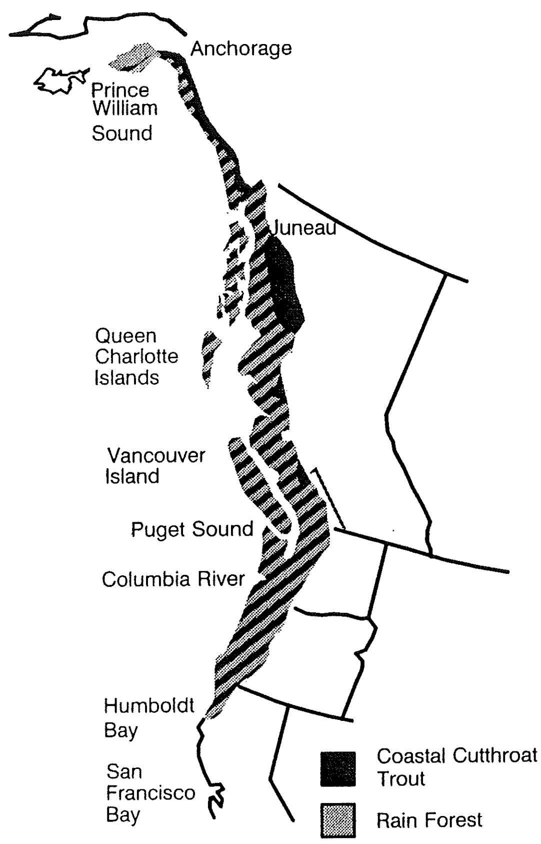

Figure 2. Native range of coastal cutthroat trout and its correspondence with the Pacific coast coniferous rainforest (from Behnke, 1979, 1988; and Waring and Franklin, 1979).

juveniles typically rear in the stream for two years. In areas where the young fish migrate directly into the open ocean, juvenile rearing extends for three years or more.

Smoltification: Peak outmigration occurs in mid-May in Washington, Oregon and California.

Saltwater Foraging: Fish stay close inshore, close to home streams, and limit their time in salt water to 5 to 8 months. Little else is known about saltwater movements and ecology.

Overwintering in Fresh Water: Searun cutthroat trout return from saltwater in late summer, fall, or winter. Not all of the returning fish will be ready to spawn the following spring, so the return to freshwater for these fish is truly an overwintering migration. Little if anything is known about the requirements of the fish during the overwintering state. Fish that overwinter but do not spawn, along with any adults that have survived spawning, return to saltwater in the spring.

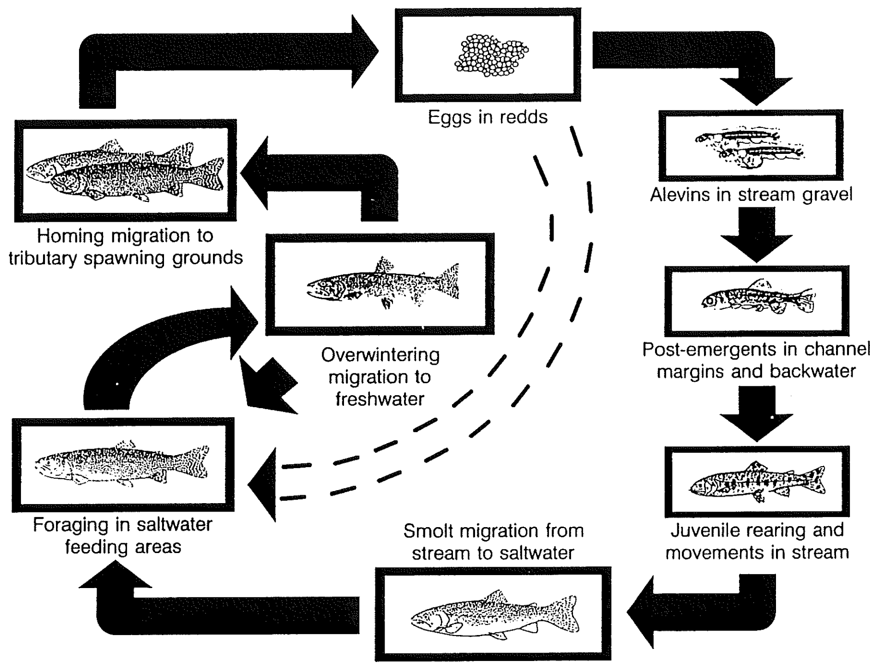

Figure 3. Life cycle stages of searun cutthroat trout.

4. Amount and Distribution of Genetic Diversity

Information about the genetic composition of anadromous coastal cutthroat trout populations is available from only a small part of the subspecies range. Campton (1981) and Campton and Utter (1987) used protein electrophoresis to examine populations from northern and southern Hood Canal and north Puget Sound, Washington, and Tipping (1982) examined populations from the upper Cowlitz River, Washington (Fig. 4). Although the sampled populations were generally similar electrophoretically, variation was found to be apportioned among the four locales, suggesting that gene flow between these locales is restricted. Thus, populations from north Hood Canal, south Hood Canal, and north Puget Sound appear to represent distinct stocks, as does the Cowlitz River stock.

If the pattern of genetic variation found in these studies is reflected across the entire subspecies range, then the total subspecies gene pool could be composed of literally hundreds of genetically distinct breeding units.

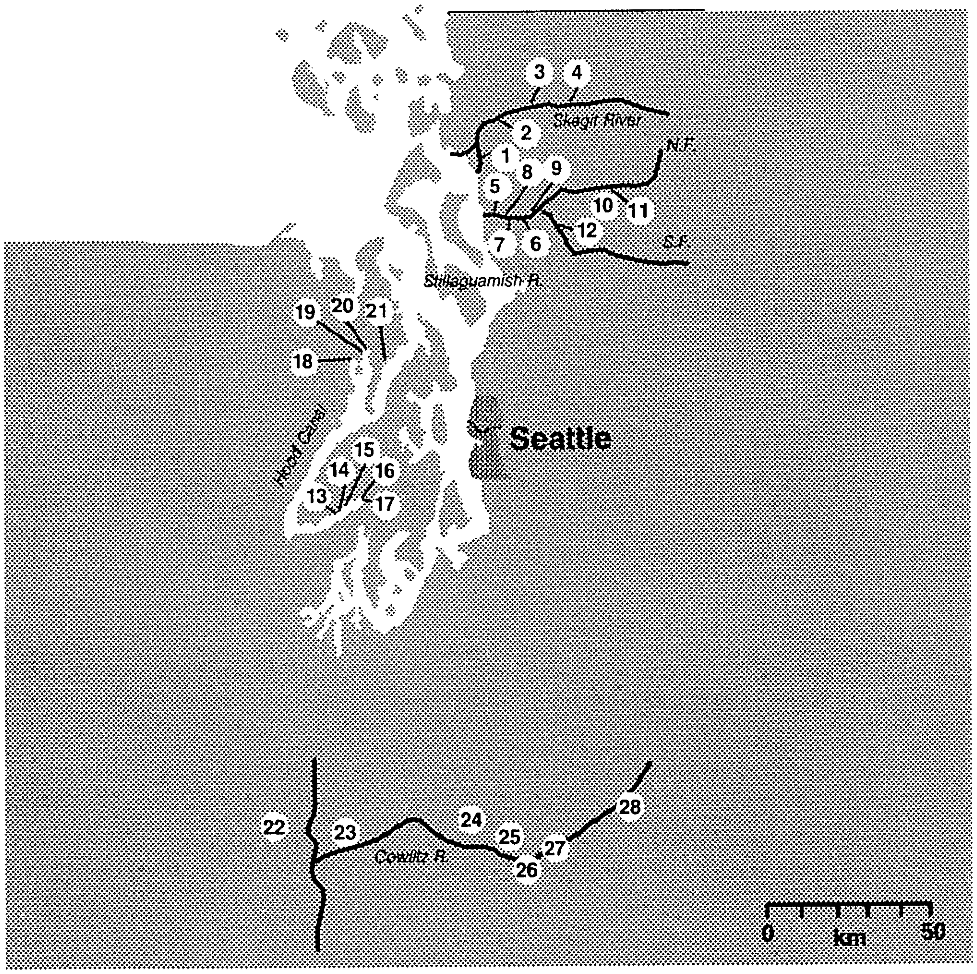

Figure 4. Distribution of some genetically distinct stocks of searun cutthroat trout in western Washington. Populations from sites 1-12 represent the northern Puget Sound stock; populations from sites 13-17 represent the southern Hood Canal stock; populations from sites 18-21 represent the northern Hood Canal stock; and populations from sites 22-28 represent the Cowlitz River stock (from Campton, 1981; Tipping, 1982; and Campton and Utter, 1987).

5. Key Research Needs

We suggest that further study is needed in the following key areas if populations at risk are to be preserved.

5.1. Freshwater Life History and Environmental Requirements

Although no other species of Pacific salmon appears to be as closely associated with the Pacific coastal rainforest as coastal cutthroat trout, there is still much to be learned about which environmental factors limit the production of anadromous populations. Cutthroat trout are known to heavily utilize stream habitat created by large coniferous woody debris (Bustard and Narver, 1975; June, 1981), and populations are known to be depressed by land use practices that result in losses of large woody debris and associated habitat (Lestelle and Cederholm, 1984; Hall et al., 1987). Yet other studies have documented shortterm increases in cutthroat trout populations after partial or complete removal of riparian trees (Murphy and Hall, 1981; Murphy et al., 1981; Bisson and Sedell, 1984). These increases have been shown to be related to increased food availability associated with elevated invertebrate production following forest canopy removal. Apparently complex interactions exist between the quality of physical habitat in streams and the abundance of prey, and our understanding of these interactions has still not reached the point that permits accurate forecasting of the outcome of environmental disturbances in forested watersheds on cutthroat trout populations (Hicks et al., 1991).

5.2. Limitation of Cutthroat Trout Populations Due to Interactions with Coho Salmon and Steelhead at the Juvenile Life History Stage

Studies carried out in British Columbia both in aquaria and in streams, have shown that juvenile coho salmon displace juvenile cutthroat trout from pools (Glova, 1984, 1986, 1987), and steelhead juveniles dominate juvenile cutthroat trout in riffles (Hartman and Gill, 1968). Juvenile coho and juvenile steelhead appear to be innately more aggressive than juvenile cutthroat trout, but there are also morphological differences between juveniles of the three species which confer performance advantage to juvenile coho over juvenile cutthroat trout in pools, and to juvenile steelhead over juvenile cutthroat trout in riffles (Bisson et al., 1988).

Since both riffles and pools are used by juvenile cutthroat trout, especially during that critical first summer of freshwater rearing, we suggest that competition for available habitat may limit cutthroat trout population size in streams where these species occur sympatrically. Measurements of juvenile salmonid biomass and density made over several years in a variety of habitat types in southwest Washington streams support this suggestion (Fig. 5).

When the pressures of competition for rearing space are removed, juvenile cutthroat trout densities may rebound. In one southwest Washington stream where juvenile coho are normally prevalent, a poor return of adult coho in the fall of 1989, followed by a scouring flood event that occurred in the winter of 1989-1990 after the few returning adult coho had spawned, nearly eliminated the 1990 coho year class. In the absence of young-of-the-year coho, juvenile cutthroat trout densities increased dramatically (Fig. 6).

This evidence is largely circumstantial, however. What is needed is a well-planned field study of juvenile interactions to confirm or reject the hypothesis that populations of anadromous cutthroat trout are controlled by exclusionary interactions at this life history stage. The results of this research would have an important management implication, particularly for salmon enhancement and supplementation programs. It has been the practice of fisheries managers in all three coastal states to stock hatchery coho or steelhead fry in rearing tributaries without actual knowledge of the numbers of natural fry present, or the potentially negative impacts of these releases on natural populations of other species such as coastal cutthroat trout. These practices would have to be curtailed if they were shown to be having severely adverse impacts on at-risk anadromous cutthroat trout populations.

5.3. Saltwater Movements and Ecology

This is an area that has never been systematically studied. Pearcy et al. (1990) recently reported on the distribution and biology of juvenile cutthroat trout in coastal waters off Oregon

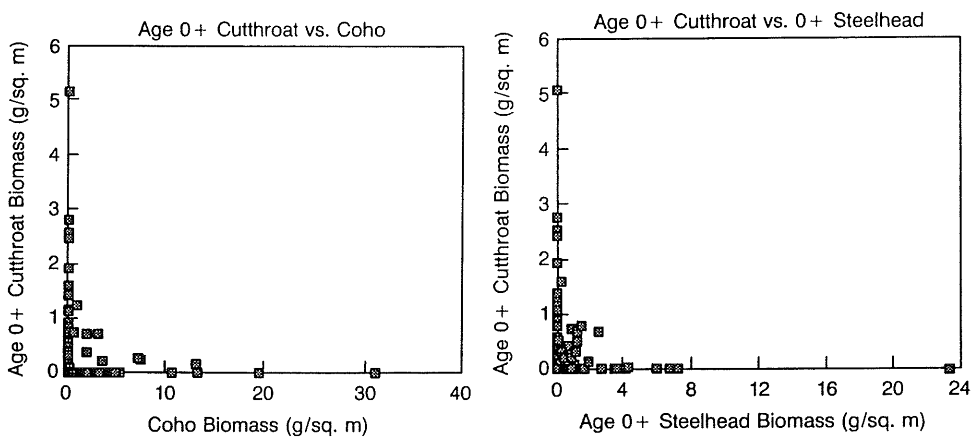

Figure 5. Relationship between the biomass of underyearling coastal cutthroat trout and underyearling coho salmon (left graph) and steelhead (right graph) in small streams in western Washington (data from B.R. Fransen and P.A. Bisson, unpublished).

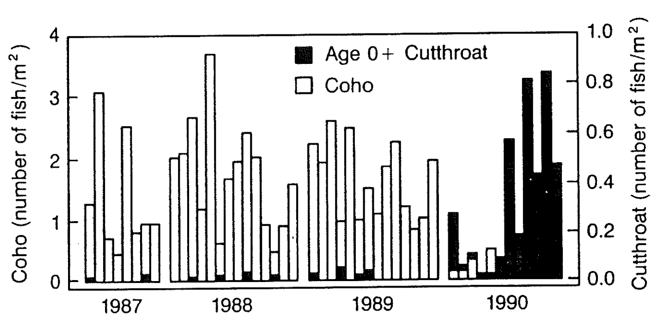

Figure 6. Increase in the summer abundance of underyearling coastal cutthroat trout in Huckleberry Creek, a tributary of the Deschutes River, Washington, after the absence of successful coho salmon spawning during the 1989-90 winter. Each bar represents the density of fish in an individual pool or riffle.

and Washington, but theirs was a compilation of data taken incidentally while pursuing other objectives.

5.4. Overwintering Ecology

Overwintering ecology is another area that has rarely been studied. The overwintering ecology of juvenile cutthroat presmolts has been investigated (Bustard and Narver, 1975; Sedell et al., 1984, Hartman and Brown, 1987) but not fish which have returned to overwinter after a period in saltwater.

5.5. Genetic Variation among Stocks

In addition to life history and ecological considerations, management plans for preserving *O. c. clarki* populations require detailed knowledge about how genetic variation is apportioned across the subspecies range, i.e., how many genetically significant breeding units exist, and how are they distributed geographically. This information is critical to establish population recovery programs. Emphasis should be placed on methods for obtaining genetic information that do not require sacrificing specimens, particularly in populations seriously at risk of extinction.

6. Summary

Wild native stocks of searun cutthroat trout are declining throughout the area surveyed by the AFS Endangered Species Committee. Information needed about the ecology, life history, and genetic population structure of anadromous *O. c. clarki* in order to form rational plans for preserving the declining stocks includes:

- A better understanding of Pacific coast rainforest ecosystem components that influence cutthroat trout production.
- Potential sensitivity of anadromous cutthroat trout populations to exclusion by coho and steelhead at the juvenile life history stage.
- Saltwater movements and ecology, and also freshwater overwintering requirements of both juveniles and prespawning adults.
- More complete information from across the subspecies historic range about the level and distribution of genetic diversity.

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