Sea-Run Cutthroat Trout: Biology, Management, and Future Conservation
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The Role of Special Angling Regulations in Management of Coastal Cutthroat Trout

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Abstract.—Sea-run coastal cutthroat trout are vulnerable to overharvest by sport angling, and special angling regulations have often been proposed to maintain or rebuild naturally reproducing populations. These regulations include creel (number) limits, size limits, terminal-gear specifications, and season-length restrictions used either singly, or in combination, to reduce harvest. In most portions of the current range of the subspecies, harvest is governed by general angling regulations, but restrictions that are specific to sea-run cutthroat trout have been implemented in some areas. For numerous fishes (including several subspecies of cutthroat trout), size limits, in conjunction with a reduced creel limit, have been successful in reducing negative effects of overharvest, provided that (1) size structure of the population (both current and historical) and size distribution of angler-captured fish are monitored closely, and (2) mortality associated with hooking and handling is minimal. If a substantial proportion of anglers fish with bait, regulations that require the release of some fish may require a bait exclusion. Because coastal cutthroat trout have developed diverse life-histories, including complex migratory patterns, sportfishing regulations designed to limit harvest must provide protection for all life stages. Information concerning biological parameters such as (1) size and age at maturity, (2) growth rates, (3) age and length structure, (4) migratory behavior, and (5) exploitation and natural mortality rates greatly increases the probability that specific angling regulations will meet management objectives. Although harvest reduction is only one part of an integrated management program, evidence suggests that special regulations should probably be incorporated in efforts to maintain or rebuild populations of coastal cutthroat trout.

As the popularity of trout fishing continues to grow, there is an increased need to monitor and regulate sport fisheries for wild trout. For fishery managers, this means preventing declines in abundance and, in some cases, enhancing trout populations. This task is difficult, particularly considering the concomitant trend of decreasing habitat quality and quantity. Special angling regulations, such as creel (number) limits, size limits, seasonal restrictions, and terminal-gear specifications, can play an important role in maintaining and rebuilding trout populations by substantially reducing sportfishing harvest (Gresswell 1990). Other than habitat restoration, angling regulations may be the only tool fishery managers have to maintain wild populations of trout.

In order to adapt to a variety of marine and freshwater habitats, coastal cutthroat trout have developed diverse life histories with complex migratory patterns (Johnston 1982; Trotter 1989; Northcote 1997). It is the only subspecies of cutthroat trout with an anadromous life-history type (Behnke 1992), and there are four different life stages when anadromous coastal cutthroat trout are susceptible to sport angling, including (1) instream migrating non-smolting parr, (2) subadults returning to freshwater (not necessarily to a natal stream), (3) fish feeding in salt water, and (4) sexually mature adults returning to freshwater streams to spawn (Johnston 1982; Wright 1992). Additionally, adults, subadults, and juveniles are all vulnerable to harvest in fresh water during overwintering periods. Consequently, for angling regulations to be effective for this subspecies, fish must be protected during all life-history stages.

Special regulations have been used to reduce harvest and restore population structure for numerous species throughout the USA and Canada (Novinger 1984; Barnhart and Roelofs 1987; Brousseau and Armstrong 1987). Management goals have not always been met, however (Hunt 1977; Graff 1987; Austen and Orth 1988), and the importance of considering agency philosophy, fish species, environmental conditions, and angler compliance in the formulation and application of special regulations is receiving increased emphasis (Gresswell 1990; Wright 1992; Goeman et al. 1995). Furthermore, population size-structure and susceptibility to angling can influence selection of regulations that focus harvest on specific portions of a population (Clark et al. 1981; Dunning et al. 1982; Power and Power 1996).

Cutthroat trout are among the salmonids most vulnerable to capture by angling. In 1981, Yellowstone cutthroat trout in a catch-and-release-only section of the Yellowstone River (Yellowstone National Park) were captured an average of 9.7 times each during the 108-d angling season (Schill et al. 1986). During a 12-month period, a single tagged cutthroat trout was captured and released 13 times by anglers in Rattlesnake Creek, Montana (Wilson et al. 1987). Using four tributaries that were closed to angling as controls, Thurow and Bjornn (1978) concluded that angler harvest was an important factor limiting the density of westslope cutthroat trout in areas open to angling. MacPhee (1966) reported that westslope cutthroat trout were about twice as easy to catch as brook trout. Mortality estimates for stream populations of coastal cutthroat trout in Oregon suggested that the effects of angling were

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significant (Giger 1972).

Although high catchability may be a desirable trait to anglers, it has led to overharvest in virtually all subspecies of potamodromous cutthroat trout (Bjornn and Johnson 1978; Gresswell 1988). Subsequent implementation of special regulations has been successful in sustaining and rebuilding numerous potamodromous populations across the historic range of this native trout in the western USA (Bjornn and Johnson 1978; Gresswell 1988; Gresswell 1995), but there are few examples in the published literature pertaining to anadromous (sea-run) coastal cutthroat trout. The purpose of this paper is to summarize current regulations for sea-run cutthroat trout throughout the current range and identify special regulations that may be effective in the protection and restoration of this complex subspecies of cutthroat trout.

Review of Regulations for Sea-run Cutthroat Trout

The responsibility of maintaining sea-run cutthroat trout populations in their native range falls under several management jurisdictions, each of which uses a variety of angling regulations. A review of the West Coast angling regulations revealed the following generalizations: (1) there are few regulations specific to sea-run cutthroat trout; (2) angling regulations for sea-run cutthroat trout generally fall under the category of general trout regulations; and (3) sea-run cutthroat trout are typically secondary beneficiaries of angling regulations aimed at protecting rainbow trout/steelhead populations. The allowable harvest in each of the states and provinces has declined dramatically over the last several years as harvest regulations have become incrementally more restrictive. With some exceptions, the creel limit for sea-run cutthroat trout across the native range of the subspecies is now two, with further restrictions applied through size limits, season closures, mandatory release of wild fish, and catch-and-release-only. We have summarized the current (1997) angling regulations in each of the jurisdictions below.

California

The harvest of sea-run cutthroat trout in California is managed under the general fishing regulations that combine aggregate creel limits (any combination of two trout or salmon/day) with season closures. Although the general regulations are designed to protect juvenile and adult salmon and steelhead, sea-run cutthroat trout populations also receive protection under these regulations. Interest in the conservation and management of sea-run cutthroat trout in California has increased in recent years, and a workshop on sea-run coastal cutthroat trout was recently held in northern California (Eric Gerstung, California Department of Fish and Game, personal communication). In 1996, the aggregate creel limit for trout and salmon was reduced from 5 to 2 fish/day (year-round) in most California waters containing sea-run cutthroat trout. A regulation specifically for sea-run cutthroat trout was established in 1992 for Stone Lagoon; the daily creel limit is 2 trout over 16 inches (40 cm), and only artificial lures with barbless hooks are permitted. Further reductions in harvest of sea-run cutthroat trout may be required to maintain angler satisfaction, especially for larger fish in heavily fished waters (Gerstung 1997).

Oregon

Size limits and seasonal closures have been used for many years in Oregon to restrict the harvest of wild trout. New angling regulations for coastal cutthroat trout were recently adopted by the Oregon Fish and Wildlife Commission and became effective January 1, 1997 (R. Hooton, Oregon Department of Fish and Wildlife, personal communication). These regulations are designed to protect sea-run cutthroat trout populations by reducing the harvest of wild trout throughout the range of the subspecies in western Oregon. Specific regulations for sea-run cutthroat trout are grouped into three geographical zones or management areas: coastal streams, mainstem Columbia River, and Columbia River tributaries. Coastal streams have a season closure from November 1 through the fourth Saturday in May; during the remainder of the year, all sea-run cutthroat trout must be released (catch-and-release-only). The mainstem Columbia River is closed to angling for sea-run cutthroat trout during April and May in order to prevent harvest of outmigrating smolts. During the angling season, only fish with a clipped adipose fin (hatchery fish stocked by Washington Department of Fish and Wildlife) may be retained. In tributaries to the Columbia River that contain sea-run cutthroat trout, the creel limit is 2 trout over 8 inches (20 cm); angling in some localities in the area is restricted to catch-and-release only.

Washington

The biological objectives of current regulations in Washington are to (1) provide protection for juveniles and outmigrating smolts, and (2) allow most sea-run cutthroat trout to spawn at least once before being available for harvest (Leider 1997). To achieve these objectives, fishery managers in Washington have implemented season closures, minimum-size limits, daily creel limits, and catch-and-release regulations (Leider 1997). Protection for juveniles and smolts is currently provided under the statewide general fishing season closure (closed November through May) and a daily creel limit of 2 trout over 8 inches (20 cm) in small streams only. Adult populations in all other areas are protected under a daily creel limit that permits the harvest of 2 fish over 14 inches (35 cm). In areas where hatchery sea-run cutthroat trout are stocked, regulations restrict the harvest to hatchery cutthroat trout (fin marked) only; all wild cutthroat trout (unmarked) must be released immediately.

Currently there are no restrictions on the use of bait for sea-run cutthroat trout in the state of Washington. Although results of hooking mortality studies with potamodromous fishes suggest that the use of bait causes significantly higher mortality than the use of artificial lures or flies (Wydoski 1977; Taylor and White 1992), results from similar studies on anadromous species suggest that mortality rates vary with species, life stage, and environment. For example, hooking mortality for sea-run cutthroat trout caught with worm-baited hooks was about 6–8% in the Samish River (Jim Johnston, WDFW, personal communication), about 40–58% on the Snohomish and Stillaguamish rivers (Pauley and Thomas 1993), and about 35% in a second study on the Stillaguamish River (Johnson and Cooper 1993). Mortality of chinook and coho salmon following capture and release by anglers using sportfishing gear was 30% and 14%, respectively, during the first year of ocean life (Gjernes et al. 1993). Wertheimer (1988) estimated that total hooking mortality of chinook salmon released by commercial trollers (marine) was 25.7% for those < 26 inches (66 cm) and 23.5% for fish of all sizes. In freshwater, four experiments using radiotelemetry to assess the 5-d hooking mortality rate of chinook salmon in the Kenai River yielded an average of only 7.6% (Bendock and Alexandersdottir 1993).

British Columbia

In British Columbia, angling regulations for sea-run cutthroat trout are based on local stock status, human demographics (heavy populated south and lightly populated north), and land development. Since the 1960s, allowable harvest of wild sea-run cutthroat trout has been reduced from 12 fish/day to no retention of wild fish (i.e., not fin clipped), except in undeveloped northern areas (Central Mainland Coast, Skeena, and Queen Charlotte Islands). Although harvest of sea-run cutthroat trout is usually restricted under the general provincial trout regulations that incorporate a combination of creel limits, size restrictions, and season closures, in some areas regulations are specific for sea-run cutthroat trout. Under the provincial trout regulations, an aggregate daily harvest of 4–6 fish is permitted; however, a minimum-size limit of 12 inches (30 cm) in most British Columbia streams that support sea-run cutthroat trout (to protect juvenile trout) effectively reduces the daily quota of sea-run cutthroat trout to 1 or 2 (depending upon specific locations). In more developed areas such as Vancouver Island and the lower mainland (where some stocks are now extinct), all cutthroat trout caught in streams between October and May must be released. In order to reduce hooking mortality, bait is prohibited from May through November. In the ocean, sea-run cutthroat trout are protected by federal regulations that, dependent on geographic area, either ban retention of wild fish or restrict retention to 2 fish (only 1 wild fish) over 12 inches (30 cm) and only one over 20 inches (50 cm). The 12-inch minimum size limit is designed to protect juveniles and smolts, and the upper size limit of 20 inches protects older, highly fecund adults.

Alaska

In 1994, new trout regulations that combined creel limits, size limits, and bait restrictions were adopted in southeastern Alaska. A 12-inch (30-cm) minimum-size limit for trout was implemented throughout the area to 1) provide protection for juvenile steelhead and cutthroat trout before they emigrate to the ocean, and 2) protect cutthroat trout until the majority can spawn at least once. A larger size limit (14-inch or 35-cm minimum size) was adopted for areas with developed access and/or intensive fisheries; under this more restrictive limit all cutthroat trout should have at least one opportunity to spawn. A 22-inch (56-cm) maximum-size limit (fish greater than this size cannot be harvested) was implemented to protect returning adult steelhead, but because coastal cutthroat trout rarely reach that size, their harvest is not affected. To reduce hooking mortality of cutthroat trout, a 10-month bait ban (November 16 through September 14) was initiated in freshwater systems.

In the northernmost portions of the range of coastal cutthroat trout (Prince William Sound and North Gulf Coast area of Alaska), general creel limits allow harvest of two cutthroat trout per day (no size limit); a few local areas have a higher creel limit (5 fish /day; only 1 of which may exceed 10 inches (25 cm). A specific regulation for sea-run cutthroat trout that prohibits bait was adopted in this northern region to protect these fish during spawning periods (April 15–June 14), when they are most vulnerable to angling.

Potential Effects of Special Angling Regulations

Review of effects resulting from the application of special regulations suggests that although special regulations have been used successfully to protect and rebuild fisheries in many regions of the USA, they are not without limitations (Behnke 1978; Gresswell 1990; Dean and Wright 1992). For instance, it appears that for special regulations to be successful, hooking mortality must be low and the probability of recapture must be high (Quinn 1989). If natural mortality is compensatory, desired changes in population structure may not occur (Shetter and Alexander 1967). Unless angler harvest comprises a major portion of total mortality, reductions in angler harvest will be ineffective. Where fish growth is limited by environmental conditions, it may not be possible to achieve large sizes even in the absence of angling (Clark and Alexander 1985; Quinn et al. 1994). Consequently, even when a fish population is protected from overharvest, arbitrary size targets or success rates may not be attainable in the associated sport fishery. Species (or even segments of a population) that are not vulnerable to angling may not provide the quality angling experiences, even at high densities. Unequal susceptibility to angling is especially important for mixed-species (-stock) fisheries (Clark and Alexander 1985; Chapman 1990; Dwyer 1990).

Effects of special regulations vary with species, communities, and specific habitats. Although some generalization is possible at the species level, response to particular regulations may be substantially modified by the presence of sympatric species (Clark and Alexander 1985). Furthermore, waters with similar biological assemblages may differ in habitat variables that influence growth, mortality, and distribution. It is becoming increasingly apparent that the ecological and management context for each specific area where special regulations are being considered must be examined thoroughly. Agency and angler objectives should be concordant with the target species and site-specific environment.

Anadromous forms, such as the sea-run cutthroat trout, present further complications to the application of special regulations. Regulations that are meant to promote persistence for anadromous populations must be effective over a much greater temporal and spacial range than those for potamodromous populations, even within the same species. Movement to and from the ocean can occur numerous times during the life of individual coastal cutthroat trout (Johnston 1982; Northcote 1997), and these movements can encompass a substantial portion of an individual drainage, extending from headwaters to estuary. Vulnerability to specific terminal gear can change with life-history stage, time of year, and current location. It is necessary to differentiate specific stocks of sea-run cutthroat trout that are to be protected and to define the migratory distribution of each stock. Identification of critical habitat and information about the sport fishery is also crucial to successful implementation of regulations.

Knowledge of the size and age structure of the target population is important for the initial development of special regulations (Serns 1978; Dean and Wright 1992; Hoff 1995). To be effective, size limits must protect a significant portion of mature adult fish. Protection can be achieved in some cases by focusing harvest on the segment of the catchable population that has not become fully recruited to the fishery (maximum-size or slot-size limits). This strategy will provide a means to limit the total potential harvest; however, occasionally, the size of fish available for harvest will not be acceptable (too small) to anglers. Simulation modeling can be useful for determining the potential biological outcomes of regulation options (Schneider 1978; Clark et al. 1981; Luecke et al. 1994), but monitoring after regulations have been implemented is critical (Goeman et al. 1995). In cases where angler harvest has historically affected population structure, a subsequent reduction in mortality of older and larger fish may result in major changes in size distribution of the catch, and readjustments of size limits may be necessary. Dean and Wright (1992) have developed a monitoring methodology for black bass that incorporates a graphical approach for assessing size limits. This technique provides criteria for selecting specific regulation type (minimum- or slot-length limit) and appropriate sizes for protection.

Public support and angler compliance are additional factors that are essential to the success of special regulations (Wright 1992; Goeman et al. 1995). Some estimates of angler compliance have been documented (Dunning and Hadley 1978; Paragamian 1984), and Gigliotti and Taylor (1990) used a simulation model to evaluate the effects of illegal harvest on the effectiveness of a minimum-size limit and catch-and-release-only. Angler preferences are fundamental considerations in the formulation of any new regulation (Renyard and Hilborn 1986), but concomitantly, it is important to recognize the complexities of values among anglers and the general public (Gresswell and Liss 1995). Because management responsibility extends beyond immediate constituencies to future generations of anglers and nonanglers alike, all regulations should have a sound ecological basis; educating the public about management options and their biological consequences becomes a major necessity.

Although many of the generalizations and recommendations resulting from this review are not novel, it is regretfully apparent that they continued to be ignored. In many cases, an attitude of denial exists that prevents change (Wright 1992; Orr and Ehrenfeld 1995). Proposed changes to angling regulations, including those for sea-run cutthroat trout, can evoke strong emotional responses from the public (Wright 1992).

There is increasing pressure for fishery managers to inform the public of resource problems, generate support for general management goals, and integrate diverse values and opinions for the development of appropriate management actions (Barber and Taylor 1990; Gresswell and Liss 1995). The necessity of a broad information base and a strong public-education program has become increasingly apparent. In the context of adaptive management (Walters 1986), monitoring programs for evaluating the effects of specific regulations should be used to determine the need for future adjustments. Simply proclaiming success or failure of a particular special regulation is not sufficient. Efforts to identify interacting factors that are related to site-specific effects are critical to the development of general principles to guide implementation of special regulations for protecting and rebuilding fish populations.

We emphasize that limiting harvest by the use of special regulations is simply one part of an integrated fishery management program. Where aquatic habitats have been severely degraded by land-management activities or where biological assemblages have been disrupted by the introduction of nonnative species, other direct management actions may be required. Even in pristine areas, low productivity may limit the effectiveness of special regulations (Nehring and Anderson 1985; Quinn et al. 1994). These few examples underscore the necessity of developing realistic management goals and objectives that are concordant with the other components of the aquatic systems under consideration. It is apparent, however, that coastal cutthroat trout are highly susceptible to capture by anglers, and although angler harvest may not be the direct cause of population decline, special regulations should probably be incorporated in any integrated effort to maintain or rebuild populations of anadromous or potamodromous populations of this diverse subspecies of cutthroat trout.

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