Chapter 4

Bonneville Cutthroat Trout

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Introduction

"In this little stream, the trout are more abundant than we have yet seen them. One of our *sober* men took, this afternoon, upward of thirty pounds. These fish would probably average fifteen or sixteen inches in length, and weigh three-quarters of a pound; occasionally, however, a much larger one is seen." This passage from the journal of John Townsend, a trader delivering goods to mountain fur trappers (Townsend, in Trotter and Bisson 1988), describes the Bear River in Wyoming and refers to the native Bonneville cutthroat trout. Historically, the Bonneville cutthroat trout occurred throughout the Pleistocene Lake Bonneville basin, which included portions of Idaho, Nevada, Utah, and Wyoming. The desiccation of Lake Bonneville into the smaller Great Salt Lake and the fragmentation of other stream and lake habitats may have led to three slightly differentiated groups of Bonneville cutthroat trout from the Bear River basin (which includes Bear Lake), the Bonneville basin proper, and the Snake Valley (Behnke 1992). Genetic evidence lends at least partial support to this interpretation; fish from the southern portion of the range can be recognized unequivocally, but northern fish from the Bear River basin share some genetic characteristics with Yellowstone cutthroat trout that suggest a relatively recent separation between these subspecies (Shiozawa and Evans 1994). By 1988, human activities had further reduced the range of Bonneville cutthroat trout to 302 km of streams and 28,293 ha of lakes (Duff 1988).

Habitat for the Bonneville cutthroat trout is widely distributed and variable. It ranges from high-elevation (3,500 m mean sea level) streams with coniferous and deciduous riparian trees to low-elevation (1,000 m mean sea level) streams in sage-steppe grasslands containing herbaceous riparian zones. Bonneville cutthroat trout have adapted to a broad spectrum of conditions throughout their range. Winters are extremely cold with abundant snowfall. Streams are often ice-covered during the winter and may have formations of instream ice that reduce trout habitat. Spring brings runoff from snowpack in the mountains, followed by low flows during July, August, and September. Lethal and sublethal temperatures may be common throughout the range.

Life History Characteristics

Bonneville cutthroat trout typically spawn during the spring and early summer months at higher elevations (Behnke 1980,1992). In Wyoming, fish usually spawn at lower elevations first, then progress upstream to higher elevations as waters warm (Binns 1981). May et al. (1978) reported Bonneville cutthroat trout spawning in Birch Creek, Utah, in May and June. Fish from Bear Lake, Idaho-Utah, spawned from late April to June (Nielson and Lentsch 1988). Resident fish in St. Charles Creek, Idaho, a tributary to Bear Lake, spawned in April and May (Kershner, pers. obs.). In Lake Alice, Wyoming, fish were predicted to spawn from late May until mid-June (Binns 1981). Spawning temperatures may range from 4 to 10°C (May et al. 1978; L. Jacobson, Payette National Forest, unpubl. data). In Birch Creek, male Bonneville cutthroat trout sexually matured at age 2 and females matured at age 3 (May et al. 1978). A reservoir population of mixed stocks of fish, partly derived from Birch Creek, displayed a similar pattern of age at maturity (D. Hepworth, Utah Division of Wildlife Resources, unpubl. data). Fish appeared sexually mature at age 3 in St. Charles Creek (Kershner, pers. obs.). In Bear Lake, adults normally begin maturing at age 5 but may not spawn until age 10 (Nielson and Lentsch 1988). The average age of spawning fish is 6.8 years (range, age 4 to age 11). Repeat spawners make up less than 4% of the total run.

Fecundity is typically 1,800–2,000 eggs per kilogram of body weight (Behnke 1992). In Birch Creek, a 147-mm female produced 99 eggs, a 158-mm female produced 60 eggs, and a 176-mm female produced 176 eggs (May et al. 1978), whereas three females ranging from 124 to 248 mm averaged 165 eggs in Raymond Creek, Wyoming (Binns 1981). There is little other information on the fecundity of stream-resident Bonneville cutthroat trout. Fecundity of females in Lake Alice averaged 474 eggs/female (Binns 1981) and in Manning Meadow Reservoir, Utah averaged 994 eggs/female (D. Hepworth, Utah Division of Wildlife Resources, unpubl. data). Incubation times of eggs for naturally spawned Bonneville cutthroat trout are not well-known, but are probably similar to Yellowstone cutthroat trout, which average 310 degree-days (the sum of mean daily temperatures above 0°C) for incubation (Gresswell and Varley 1988). For hatchery-incubated eggs from Manning Meadow Reservoir, degree-days to hatching varied from 329 to 345 (D. Hepworth, Utah Division of Wildlife Resources, unpubl. data).

Fry typically emerge in mid- to late summer, depending on spawning times. Once emerged, fry are poor swimmers and typically migrate laterally to stream margins (Moore and Gregory 1988b). Adfluvial Bonneville cutthroat trout spend 1 or 2 years in streams before migrating to the lake (Nielson and Lentsch 1988; L. Jacobson, Payette National Forest, unpubl. data). It is unknown what proportion of 1- to 2-year migrants is within the population. In 1989, many young-of-the-year Bonneville cutthroat trout emigrated from lower St. Charles Creek to Bear Lake (L. Jacobson, Payette National Forest, unpubl. data).

Growth of resident fish is highly dependent on stream productivity. Since existing populations of resident Bonneville cutthroat trout are limited to smaller, headwater drainages, growth rates tend to be much slower than in lacustrine environments. For example, in Birch Creek, age 1 fish were 84 mm, age 2 fish 119 mm, age 3 fish 158 mm, and age 4 fish 197 mm (May et al. 1978). Growth in two Wyoming streams was faster, and age 4 fish averaged 282–320 mm (Binns 1981). These rates are probably typical for Bonneville cutthroat trout in small streams. In contrast, mature Bonneville cutthroat trout in Bear Lake grow to an average size of 560 mm and 2 kg (Nielson and Lentsch 1988). Age 2 individuals constitute 50% of the fish in Bear Lake, and older fish make up less than 35% of the population. Stocking of young fish, however, may be influencing age structure and growth; between 160,000 and 1,000,000 age 1 fish from 125 to 200 mm have been introduced annually (Nielson and Lentsch 1988).

Likewise, growth in large rivers was probably faster than in streams. Yarrow (1874) reported fish up to 650 mm and 7 kg from the Timpanogos (Provo) River, Utah, but these may have been adfluvial fish from Utah Lake.

Habitat Relations

Habitat relations for Bonneville cutthroat trout are presumed to be similar to those of other cutthroat trout subspecies and other nonanadromous trout. Specific habitats are apparently used for spawning, juvenile rearing, and adult rearing. In addition, these requirements may vary by season. Binns (1981) calculated habitat values for Bonneville cutthroat trout in Wyoming streams using the Habitat Quality Index, but this is a generic model for many trout species and uses cover, bank stability, water velocity, maximum summer stream temperature, stream width, late summer streamflow, annual streamflow variation, nitrate nitrogen, and substrate to classify trout habitat. Most data specific to Bonneville cutthroat trout are anecdotal or unpublished.

In St. Charles Creek, adfluvial Bonneville cutthroat trout typically spawned in pool tails in the lower one-third of the stream, which was characterized by channel gradients less than 1%, high sinuosity, and sorted substrates with a high percentage of fine sediment. Redds typically contained a high percentage of fine sand (less than 1 mm), as well as gravel or cobble (8–100 mm) (Jacobson and Kershner, unpubl. data). Body size was proportional to the size of gravel excavated in the stream.

Resident Bonneville cutthroat trout spawned in higher gradient reaches of St. Charles Creek. Similar patterns have been observed in Salt and Coal creeks, Wyoming (N.A. Binns, Wyoming Game and Fish Department, pers. commun.). Characteristics of these reaches included gradients of 1.5 to 3.5%, low sinuosity, and sequences of steps and pools. Resident spawners were opportunistic, using small pockets of gravel in pools and riffles. These spawning areas generally contained large sand and small gravel (1–16 mm).

Habitat requirements for young Bonneville cutthroat trout are poorly reported in the literature. Other authors, however, have described the location and habitat of cutthroat trout fry (Moore and Gregory 1988a,b; Bozek and Rahel 1991). Moore and Gregory (1988b) reported that coastal cutthroat trout fry used lateral stream habitats associated with complex cover. When they artificially increased cover complexity (Moore and Gregory 1988a) the numbers of fry increased. Bozek and Rahel (1991) found somewhat different results for young-of-the-year Colorado River cutthroat trout. In steep headwater streams, cutthroat trout fry used small backwater pools and upstream dam pools where velocities were low. In lower-gradient streams, fry were also found in backwaters and dam pools, as well as low-velocity areas of lateral scour pools. The authors also found fry in larger habitat units where slow water was interspersed with fast water. A key to habitat use was the proximity of these habitats to redds.

In St. Charles Creek, juvenile cutthroat trout used different channel units depending on the characteristics at the reach scale (L. Jacobson, Payette National Forest, unpubl. data). In all reaches the majority of age 0 and age 1 trout were primarily found in complex pool habitats in summer, fall, and winter. Age 1 trout used habitats associated with wood, e.g., rootwads and woody debris. Run habitat was heavily used in the low-gradient reach by age 1 cutthroat trout in summer.

Adult habitat may limit populations of resident trout in most streams (Behnke 1992). Fluvial habitat for adult Bonneville cutthroat trout is primarily related to the amount and type of cover available and the depth of water. Cover for adult Bonneville cutthroat trout is primarily in deeper pools associated with undercut banks and vegetative cover. It is likely that beaver ponds play an important role as both summer and winter holding habitat for adults (Binns 1981; Remmick et al. 1993). In St. Charles Creek, pools and runs were important habitat features for adult Bonneville cutthroat trout during all seasons and in all stream reaches (L. Jacobson, Payette National Forest, unpubl. data). Riffles were important habitats for adults during summer in low-gradient reaches and during winter in high-gradient reaches.

Most studies on the habitat relations of lacustrine Bonneville cutthroat trout have been conducted in Bear Lake. There, Bonneville cutthroat trout typically inhabit the littoral and pelagic zones during most of the year (Nielson and Lentsch 1988). During the winter, fish were located from 2 to 25 m deep (Wurtsbaugh and Hawkins 1990). In June, trout were found in the littoral zone and at the metalimnetic intercept with the bottom. In August and October trout less than 250 mm were concentrated at the metalimnetic intercept with the bottom (10–20 m) whereas larger fish were evenly distributed in the metalimnion and profundal zone (15–35 m). Temperature appears to be the major influence on the distribution of Bonneville cutthroat trout in Bear Lake.

Biotic Interactions

In many parts of their range, Bonneville cutthroat trout evolved with june sucker, Utah sucker, mountain sucker, leatherside chub, Utah chub, redside shiner, least chub, longnose dace, speckled dace, Bonneville mottled sculpin, and mountain whitefish (Sigler and Miller 1963). In Bear Lake, Bonneville cutthroat trout evolved with Bear Lake whitefish, Bonneville whitefish, Bear Lake cisco (all restricted to Bear Lake), and Bear Lake sculpin.

Interactions between Bonneville cutthroat trout and these fish vary. Suckers, sculpins, and minnows probably provide forage after Bonneville cutthroat trout attain sufficient size to switch from invertebrates to larger prey. Occasionally, sculpins prey on Bonneville cutthroat trout eggs and fry (Sigler and Miller 1963), but sculpins appear to be a minor predator. Many of these fishes feed on insects during part or all of their life history. Since Bonneville cutthroat trout are insectivorous, especially in streams (May et al. 1978), there may be competition for food. It is likely that as the range of Bonneville cutthroat trout has shrunk to the smaller, headwater tributaries, this phase of competition lasts longer in their life history. This is particularly true where Bonneville cutthroat trout co-exist with mountain whitefish.

There has been almost no information published on non-piscine predators. Anecdotal accounts from St. Charles Creek indicate that birds prey on young Bonneville cutthroat trout when they are migrating to the lake (L. Jacobson, Payette National Forest, pers. commun.).

Both terrestrial and aquatic invertebrates appear to be important food items for stream-dwelling Bonneville cutthroat trout (May et al. 1978; Binns 1981). Their diet was diverse during summer in Birch Creek, but consisted primarily of terrestrial insects in late summer and early fall in Trout Creek, Utah (May et a1. 1978). Dipterans and debris were the dominant food items for immature trout and terrestrial insects were the dominant prey for mature individuals.

In Bear Lake, the diets of Bonneville cutthroat trout shift as they grow. Trout less than 250 mm primarily ate aquatic and terrestrial insects (Wurtsbaugh and Hawkins 1990). Of the aquatic insects, over 90% were chironomid pupae. As summer progressed, terrestrial insects became the dominant food item. Ninety-two percent of the diet during August was ants. For intermediate-sized fish (250–350 mm), diets consisted mostly of Bear Lake sculpin during the winter and spring, and fish, aquatic chironomids, and terrestrial insects during summer and fall. Ants and homopterans were the most frequent terrestrial insects in the diet, and chironomid pupae were the most frequent aquatic prey. At 225 mm, fish became piscivorous, and until the fish reached 300 mm they primarily preyed on Bear Lake sculpin. After Bonneville cutthroat trout exceeded 300 mm they switched to other fish prey items. Trout longer than 350 mm relied almost exclusively on a fish diet and preferred Bear Lake cisco during the winter.

A variety of diseases and parasites are found in waters containing Bonneville cutthroat trout. Infectious pancreatic necrosis and infectious hematopoietic necrosis have historically been found in waters throughout Utah but have not been recently observed (R. Goede, Utah Division of Wildlife Resource, pers. commun.). Recently, whirling disease was introduced into the Little Bear River, Utah. Though this disease is currently localized, there is a possibility that it may spread throughout the Bear River system. The parasites plestophera and epitheliocystis have been found in the Bear River system and may affect Bonneville cutthroat trout. The bacterial diseases furunculosis and bacterial kidney disease are also found within the system. There is no literature that directly assesses the effect of diseases on Bonneville cutthroat trout.

Reasons for Concern

Prior to European settlement of the Great Basin, Bonneville cutthroat trout were well distributed throughout the historical Bonneville Basin (Behnke 1992) but by the early 1950's it was believed that the Bonneville cutthroat trout was extinct (Cope 1955). Though it is unknown how many lakes contained Bonneville cutthroat trout prior to nonnative fish stocking, fewer than 5% of the thousands of kilometers of stream habitats once occupied by Bonneville cutthroat trout are currently known to be inhabited. Large river systems like the Bear River and Sevier River probably had connected networks of streams enabling Bonneville cutthroat trout to move freely from headwater streams to mainstem rivers. Bonneville cutthroat trout may have used these sections differently during their life history. For example, fish probably spawned and reared in the smaller tributary streams, then migrated to the larger streams. Given the historical documentation of larger fish in the mainstem Bear and Provo rivers it appears this pattern was likely (Suckley 1874). Today, this access to mainstem rivers is largely nonexistent owing to physical barriers from irrigation, power, and agricultural diversions. Except for the Smiths Fork and Thomas Fork Bear River enclave of Bonneville cutthroat trout, there is little connectivity left within their former range. Furthermore, many fragmented stream habitats within the former range have declined in quality (Binns 1981; Duff 1988; Behnke 1992; Fallau 1992; Remmick et al. 1993; Scully 1993). Recovery strategies have often proposed erecting barriers within a drainage, further isolating Bonneville cutthroat trout populations. Though this may have negative connotations for connectivity, managers have often used these barriers to inhibit hybridization and reduce competition with nonnative salmonids.

Causes of the Decline

Nonnative species have been widely introduced throughout the former range of Bonneville cutthroat trout. These introductions began in the late nineteenth century and have continued (Behnke 1992). Probably the most significant introduction has been the planting of other salmonids. Rainbow trout have been widely introduced throughout the West and pose many problems to native cutthroat trout (Duff 1988). Foremost among these problems is hybridization between the two species; this may cause the loss of coadapted gene complexes within certain Bonneville cutthroat trout populations that enabled these fish to survive catastrophic events such as prolonged drought and associated high water temperatures. In addition, the characteristic phenotype of pure Bonneville cutthroat trout is no longer expressed. Similarly, Bonneville cutthroat trout suffer from hybridization with other subspecies of cutthroat trout. The Yellowstone cutthroat trout has been cultured successfully and is frequently stocked throughout the West (Behnke 1992), including many waters that historically contained Bonneville cutthroat trout.

Competition with nonnative salmonids is also believed to have resulted in the decline of cutthroat trout throughout the western United States (Behnke 1992). In Wyoming, Bonneville cutthroat trout have decreased in four streams (Raymond Creek, Smiths Fork River, Hobble Creek, and Coal Creek) containing brook trout, brown trout, or both (Remmick et al. 1993). These species are thought to replace the native fish through competition or predation, but these explanations have not been confirmed (Fausch 1988,1989; Griffith 1988).

Moyle and Vondracek (1985) speculated that introduced brown and rainbow trout may compete with the endemic Lahontan cutthroat in Martis Creek, California. They believed that once other species were introduced it was unlikely that cutthroat trout would regain the original space. In Bear Lake, rainbow trout and lake trout were introduced during the early twentieth century. Nielson and Lentsch (1988) speculated that a gradual decline in Bonneville cutthroat trout in the lake was due to competitive effects.

The abundance and quality of the stream and lake habitat once available to Bonneville cutthroat trout have declined (Binns 1981; Duff 1988; Behnke 1992). The primary causes of habitat loss have been water diversion, degradation of riparian habitats from grazing, road building, mining, and timber harvest. Probably the greatest single cause of habitat loss has been the diversion of streamflows. Diversions have fragmented stream habitats and disconnected tributary streams from mainstem rivers. These diversions reduce streamflow, preventing migration and creating thermal barriers. Many unscreened diversions attract migrating fish into the diversion canals and these fish are lost during irrigation. In St. Charles Creek, diversion during incubation caused a dewatering of 80% of the Bonneville cutthroat trout redds in the stream (Kershner, pers. obs.). I estimated that diversion flows reduced the survival of over 90% of the young Bonneville cutthroat trout in the 1989 year class.

Grazing has been shown to negatively influence stream habitats and stream communities (Keller and Burnham 1982; Platts and Nelson 1985). Poor grazing practices cause stream bank degradation by eliminating or reducing riparian vegetation, physically damaging streambanks, and promoting active erosion. Final results are often a loss of pool habitat, reduced cover, increased water temperature, and substrates that are poorly suited for spawning and food production (Duff 1988; Platts 1991). In Preuss, Dry, and Giraffe creeks, Idaho, habitat features in grazed sections were compared with those in ungrazed sections. Bank stability, the percentage of undercut banks, the width:depth ratio, and the percentage of fine sediment indicated poor habitat quality compared with the ranges of values found in ungrazed streams; trout populations in grazed streams declined from 1980 to 1992 (Fallau 1992). Biologists on the Bridger-Teton National Forest have surveyed grazed streams in the Thomas Fork Bear River drainage and found that streambank stability was below the desired condition set in forest planning documents (Nelson 1993). Dufour (1992) concluded that grazing along Sugar Pine Creek, Utah, contributed to poor habitat quality. Streams in this area are believed to contain Bonneville cutthroat trout.

Road building may affect Bonneville cutthroat trout populations in two ways. First, during construction sediment is generated that may reach streams during runoff. Native surface roads are particularly susceptible to short-term and long-term erosion from road surfaces and drainage ditches. During surveys of Preuss, Dry, and Giraffe creeks I observed numerous road crossings where fine sediment entered the streams. The second influence is the blockage of Bonneville cutthroat trout migration in streams by poorly designed and placed culverts. In streams throughout Idaho, Utah, and Wyoming I have found numerous culverts that would hinder upstream passage of trout. By preventing upstream migration, culverts effectively isolate small populations. This may have a significant effect on the genetic health of these populations.

Logging has been reported to significantly affect salmonids. Though logging practices probably influenced the quality of habitat in the historical range, there is little evidence of logging effects in the current range. Historical effects included railroad tie driving in the headwater streams of the Bear River. I have observed channels that are still affected by this practice and this may serve as a constraint to some populations of Bonneville cutthroat trout.

Historically, mining severely affected streams in the West (Nelson et al. 1991). Currently, there are few reported mining effects on the remaining populations of Bonneville cutthroat trout, with the possible exception of Hendry's Creek, Nevada (Haskins 1993).

Angling has been shown to depress populations of cutthroat trout (Behnke 1992). Cutthroat trout may be more susceptible to angling pressure than are other salmonids, which could cause a decline in populations that are heavily fished. There are few studies that report the angling effects on Bonneville cutthroat trout. Binns (1981) reported that Bonneville cutthroat trout were "fairly easy to catch," but variation in catchability was noted. In Bear Lake, vulnerability to harvest was highest during the winter (Nielson and Lentsch 1988), probably because of increased angler access.

Current Management

Currently the Bonneville cutthroat trout is listed as a Category 2 species, though recently it has been both petitioned for listing as threatened and proposed for de-listing (D. Hepworth, Utah Division of Wildlife Resources, pers. commun.). The USDA Forest Service, Region 4, has placed the Bonneville cutthroat trout on the sensitive species list and has categorized it as a species of special concern. Similarly, the Bonneville cutthroat trout is listed as a game fish and a sensitive fish species by the Nevada Board of Wildlife Commissioners, as a sensitive species in Wyoming, and as a species of special concern in Utah.

Several existing conservation plans are being used to guide the management of Bonneville cutthroat trout. Idaho is developing special management guidelines for Bonneville cutthroat trout and has signed a statewide conservation agreement with the Forest Service that will address future management of Bonneville cutthroat trout. Nevada has developed a species conservation plan that guides the protection and enhancement of Bonneville cutthroat trout. Utah has recently developed a draft plan that reviews the status of all native cutthroat trout within the state and proposes recommendations for their management, and is developing a conservation agreement with the U.S. Fish and Wildlife Service. Wyoming has a draft 5-year plan that reviews the status of habitats and populations and highlights needed management and research. Many National Forests have developed special standards and guidelines for managing Bonneville cutthroat trout habitat.

State agencies have restricted angling to protect Bonneville cutthroat trout. Idaho and Utah have closed tributaries of Bear Lake to angling during spawning, and Idaho and Wyoming have imposed regulations to reduce harvest in tributaries of the Bear River containing Bonneville cutthroat trout. Also, Bonneville cutthroat trout have been introduced into the Snake Valley of Nevada by the Nevada Division of Wildlife (Haskins 1993). This subspecies has been introduced into Strawberry Reservoir and other waters by the Utah Division of Wildlife Resources (Nielson and Lentsch 1988), and habitats have been protected and enhanced in many waters throughout its range (D. Hepworth, Utah Division of Wildlife Resources, pers. commun.). Also, the genetic purity of many populations has been assessed (Loudenslager and Gall 1980; Leary et al. 1987; Shiozawa et al. 1993; Shiozawa and Evans 1994).

Research Needs

There is currently very little life history information on stream-resident Bonneville cutthroat trout. The most comprehensive studies (May et al. 1978; Binns 1981) examined some life history information, but spawning, fry rearing, and adult rearing requirements have been neglected. There is better information on lacustrine forms, but their juvenile phase in streams is poorly understood.

Habitat relations are also largely speculative, especially in streams. The best information on habitat relations comes from Binns (1981,1986) and Jacobson (unpubl. data), and though the latter documentation details habitat relations for all life stages by season, it represents a sample of one stream. Given the distribution of the current populations, more information on habitat requirements is needed.

The decline of native cutthroat trout after introductions of nonnative fishes has been well documented, but there is no conclusive explanation for this decline, e.g., competition has been hypothesized but never demonstrated. Studies that examine competition and other interactions between nonnative salmonids and Bonneville cutthroat trout should be initiated.

The knowledge of the distribution of this subspecies is spotty. We need a full assessment of the historical and current range to accurately document the decline of Bonneville cutthroat trout. In addition, we need to establish the population trends. And given the existing small populations and fragmented habitats, we need to learn how to design effective reserves for Bonneville cutthroat trout.

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