

SECTION I: FISHERIES MANAGEMENT IN ROCKY MOUNTAIN NATIONAL PARK: HISTORY, GOALS, AND ACCOMPLISHMENTS

Historic Management: The aquatic ecosystem of Rocky Mountain National Park (RMNP) consists of approximately 147 lakes (446 ha) and 702 km of stream. The waters are oligotrophic and are accordingly cold, clear, and limited in their ability to produce large annual increases in fish growth. Although annual fish growth is limited, the cold temperatures can extend the life span of lake fish to over 15 years. The growing season for riparian vegetation and aquatic invertebrates is also limited, and results in slow growth and recovery rates for terrestrial damage and impacts due to angler harvest.

Due to the cold water temperatures and barriers to fish migration it is probable that many of the waters within RMNP were originally fishless. However, the original distribution of fishes was not documented prior to 1923. As with most waters within Colorado, the stocking of native and non-native fish species to establish and maintain harvestable populations of trout in RMNP probably started in the late 1800s, and continued until 1968.

After the establishment of RMNP, a variety of species, including rainbow trout (RBT), brook trout (BKT), and “black spotted” trout (the term used for all subspecies of cutthroat trout at that time) were documented as established in lakes within the park by 1923. Fishless lakes, or lakes not “fully stocked” (as lakes that supported low fish biomass were called) were identified, and scheduled to be stocked with the “best variety” of fish. The best variety suitable for stocking were identified mainly as “black spotted” trout, BKT, and RBT. However, black bass were selected as the best variety for Cub Lake, and Atlantic salmon were recorded as stocked into Emerald Lake.

Following the establishment of fish hatcheries at Yellowstone National Park (YNP) and Estes Park, Yellowstone cutthroat trout (YCT) eggs were shipped from YNP to Estes Park where they were hatched and then stocked into RMNP waters. Up to 400,000 YCT fry were stocked annually through the 1940s, as part of the National Park Service (NPS) policy of stocking only “native fish.” Although the greenback cutthroat trout (GBC) and Colorado River cutthroat trout (CRC) were native to RMNP waters, the use of any subspecies of cutthroat trout appeared to meet this policy prior to 1969.

Many stocked YCT fry did not survive, especially in waters dominated BKT. By the end of the 1940s, the stocking of high numbers of YCT was abandoned, since the stocking contributed very little to lake and stream fisheries. However, in some locations, such as Lake Haiyaha, Dream Lake, and possibly Bench Lake, YCT evidently replaced BKT that were reported to be present prior to the stocking of YCT.

Guse and Wallis (1965), redefined management objectives for fisheries, and classified RMNP waters for management purposes. Park waters were divided into three classes, depending upon biological and recreational considerations, with stocking limited to Class III lakes only:

Class I - Waters Not Managed for Sport Fishing

Class II - Waters Managed for Fishing Based Upon Self Supporting Populations of Fish.

Class III - Waters Managed for Fishing Based Upon Populations of Fishes Supplemented by Periodic Stocking

Of the 147 lakes within RMNP, 16 lakes were determined to be Class III lakes, and scheduled for periodic stocking to maintain sport fish populations. During this period, stocking of fish was limited to cutthroat trout, but still not defined as any subspecies, with some lakes stocked with Snake River cutthroat trout and GBC hybrids.

Current Management: The current RMNP fisheries management objectives were established in 1969, when the stocking of all species of non-native and hybrids of native fish to maintain artificial fish populations was abandoned. Lakes not capable of maintaining reproducing fish populations were allowed to become fishless, and emphasis was placed on documenting the status of RMNP aquatic resources. Those waters capable of sustaining reproducing fish populations were to be considered for reintroduction of GBC, CRC, and other native fish species.

As of 1969, 56 of the park's 147 lakes contained fish populations maintained by natural reproduction or the stocking of trout. Without stocking, nine of the Class III waters proved to be recruiting fish populations and six reverted to their original fishless status (Table 1). The last Class III lake, Crystal Lake, is an experimental GBC population where recruitment has not yet been documented. Although the stocking of these alpine lakes provided recreational opportunities, the fish removed invertebrate life used by other species and increased visitor use of delicate high elevation habitats.

Rocky Mountain National Park and the U.S. Fish and Wildlife Service (FWS) and its predecessor organizations have long cooperated to manage the park fisheries. The FWS Colorado Fish and Wildlife Assistance Office and RMNP have cooperated since 1977 to protect and restore native fish populations, complete aquatic resource surveys, and monitor angling programs. Many fisheries projects were completed from 1977 to 1988, but fisheries work declined from 1988 to 1997 due to limited funding. In 1996, RMNP was authorized by Congress and the NPS Washington Headquarters to raise entrance fees as part of the Recreation Fee Demonstration Project. Eighty percent of the fees stay within the parks in which they were collected. Some of this money has funded new native trout restoration work and has allowed for a FWS fisheries technician to be stationed in the park since 1998.

The specific objectives of the RMNP aquatic management program over the last 30 years have included three key goals: 1) Protect and restore native fish populations and meet the requirements of the Endangered Species Act of 1973; 2) Complete surveys within RMNP to monitor the distribution, condition, and abundance of fish and aquatic habitat within RMNP; and 3) Allow angler use according to NPS policy, and within limits necessary to perpetuate fish populations and riparian

Table 1. Status of Class III Lakes, 2000.

Lake	Status
Chasm Lake	Fishless
Crystal Lake	Experimental GBC population, recruitment not documented
Dream Lake	Recruiting GBC restoration population
Emerald Lake	Fishless
Glass Lake	Recruiting GBC and BKT population
Lake Haiyaha	Recruiting YCT population
Lake Irene	Fishless
Lake of Clouds	Fishless
Little Crystal Lake	Fishless
Lost Lake	Recruiting GBC restoration population
Mills Lake	Recruiting RBT population
Lake Nokoni	Fishless
Odessa Lake	Recruiting GBC restoration population
Timber Lake	Recruiting CRC restoration population
Thunder Lake	Recruiting CUT and BKT population
Ypsilon Lake	Recruiting CRC population

vegetation.

Progress over the years is summarized below under the headings of these three goals.

Goal 1: Protect and restore native fish populations and meet the requirements of the Endangered Species Act

Greenback cutthroat trout (GBC) and Colorado River cutthroat trout (CRC) are the only trout native to RMNP. Conservation and restoration activities in the park have centered on these two native subspecies. Non-native cutthroat trout and RBT, previously stocked into RMNP waters, are capable of hybridizing with native trout. Due to this, taxonomic analysis of historic populations is necessary to determine purity. Management decisions on whether to conserve a population or to remove it and restore the area to a pure strain of native cutthroat trout are based on these analyses. Current taxonomic methods may not provide definitive conclusions, thus populations need to be reanalyzed periodically as techniques are refined. See Appendix III for further information on RMNP cutthroat trout taxonomy.

Greenback Cutthroat Trout: The historic range of the GBC is the mountains and foothills of Colorado east of the Continental Divide. Activities related to late 19th century development and especially introduction of non-native trout species, which hybridize and outcompete the native subspecies, caused drastic declines in GBC populations. At the time of the enactment of the Endangered Species Act in 1973, only two small historic populations of GBC were known to remain

within Colorado. These two historic populations represented 4.6 kilometers of stream and less than 2,000 fish. The GBC was initially listed as endangered, but downlisted to threatened in 1978 to facilitate recovery efforts.

Advancement in non-native fish removal techniques and the availability of large numbers of fish from captive broodstocks have allowed for several native trout restoration projects to be completed within RMNP. Pure or virtually pure GBC have been identified or introduced into 33 sites within the park (Table 2). Six of these sites are historic and 26 sites are sites restored to GBC through the removal of non-native fish, or stocking of pure GBC into fishless waters. Two sites are considered conservation populations, where the fish present are not pure, but they are good representatives of GBC and are worthy of conserving.

The most recent GBC restoration project was Dream Lake in 1996. Sites proposed for restoration in the near future are Lake Haiyaha, Poudre Lake/Cache la Poudre River/Chapin Creek, Hidden Valley Creek, and Mummy Pass Creek.

Five restoration sites are experimental introductions, where GBC were stocked into marginal habitats to determine the limits of GBC survival. Recruitment has not been documented in these sites. In addition to the sites listed in Table 2, good phenotypic GBC are present in The Loch, Glass Lake, and Sandbeach Creek.

See Section II for detailed information on management of greenback cutthroat trout populations.

Colorado River Cutthroat Trout: The Colorado River cutthroat trout's historic range included the western half of Colorado, the eastern half of Utah, southwestern Wyoming, and small parts of Arizona and New Mexico. By 1979, it was estimated that good representatives of the subspecies were found in less than 1% of its historic range due to overharvesting, dewatering, pollution, siltation, and most significantly introduction of non-native trout (Trotter 1987). Currently it is estimated that they occupy 5% of their historic range (Center for Biological Diversity 1999). Colorado River cutthroat trout were petitioned for listing under the Endangered Species Act in late 1999; due to budget constraints however, the FWS has not acted on this petition.

Colorado River cutthroat trout have been identified or introduced into 14 sites (ten historic and four restoration) within RMNP (Table 3). Eight of the historic sites are conservation sites. In addition to the sites listed in Table 3, good phenotypic CRC are present in Ten Lakes Park, Lake Solitude, and the North Inlet upstream of Hallets Creek.

The most recent CRC restoration project was Bench Lake/Ptarmigan Creek in 1985. Sites proposed for restoration in the near future are Pettingell Lake and the Haynach Lakes. See Section III for detailed information on management of CRC populations.

Table 2. Greenback Cutthroat Trout Waters, 2001. Alphabetical ratings based on Binns rating system, see Appendix III for a further explanation. BKT=brook trout. C&R=catch-and-release.

Site	Comments
1. LSF Cache la Poudre River	Small historic A site. Closed to angling. Broodstock refugium. Mostly outside RMNP.
2. Hunters Creek	Good historic A site. Closed to angling. Broodstock refugium.
3. Upper Hutcheson Lake	Good historic A site. Open to C&R angling.
4. Middle Hutcheson Lake	Small historic A site. Open to C&R angling.
5. Caddis Lake	Good A restoration site. Open to angling.
7. NF Big Thompson River-above 3280 m	Small A restoration site. Opened to C&R angling in 1990.
8. Lake Louise	Experimental A site. Opened to C&R angling in 1994.
9. Hidden Valley Creek	Declining A restoration site. Opened to C&R angling in 1982. BKT dominate.
10. Bear Lake	Good A restoration site. Closed to angling due to user conflicts.
11. West Creek	Small A restoration site. Open to C&R angling in 2001.
12. Ouzel Lake	Good A restoration site. Opened to C&R angling in 1986. BKT present.
13. Ouzel Creek-Lower	Declining A restoration site. Open to C&R angling in 1986. BKT dominate.
14. Ouzel Creek-Upper	Small A restoration site. Opened to C&R angling in 1986.
15. Fern Lake	Good A restoration site. Opened to C&R angling in 1986.
16. Fern Creek	Good A restoration site. Opened to C&R angling in 1986.
17. Odessa Lake	Small A restoration site. Opened to C&R angling in 1987.
18. Lawn Lake	Good A restoration site. Opened to C&R angling in 1988.
19. Crystal Lake	Experimental A site. Opened to C&R angling in 1990.
20. Roaring River	Good A restoration site. Opened to C&R angling in 1991.
21. Lost Lake	Small A restoration site. Opened to C&R angling in 1990.
22. NF Big Thompson R.iver- Lost Falls to 3280 m	Good A restoration site. Opened to C&R angling in 1990. BKT present.
23. Lower Hutcheson Lake	Small A restoration site. Opened to C&R angling in 1991.
24. Sandbeach Lake	Small A restoration site. Opened to C&R angling in 1991.
25. Pear Lake	Good A restoration site. Opened to C&R angling in 1991.
26. Cony Creek	Good A restoration site. Opened to C&R angling in 1991.
27. Lake Husted	Experimental A site. Opened to C&R angling in 1995.
28. Spruce Lake	Good A restoration site. Opened to C&R angling in 1993.
29. Loomis Lake	Experimental A site. Opened to C&R angling in 1993
30. Lily Lake	Experimental A site. Open to C&R angling.
31. Dream Lake	Small A restoration site. Opened to C&R angling in 1999.
32. Big Thompson River-Forest Canyon	Good historic A- conservation site. Open to angling.
33. Arrowhead Lake	Small A- conservation site. Open to angling.

* Although fish in upper Hague Creek have been assigned an A- rating, this was based on a very small sample size. Additional taxonomic work needs to be done on this site.

Goal 2: Complete surveys to monitor the distribution, condition, and abundance of fish and aquatic habitat

Most waters in RMNP that supported fish populations by natural reproduction contained non-native fish stocked prior to 1969. To document the fisheries resources of RMNP and changes following the end of stocking, an aquatic survey program was conducted from 1970 through 1989.

Table 3. Colorado River Cutthroat Trout Waters, 2001. Alphabetical ratings based on Binns rating system, see Appendix III for a further explanation. BKT=brook trout. C&R=catch-and-release.

Site	Comments
1. Lake Nanita	Excellent historic A site. Open to angling. Broodstock.
2. Adams Lake	Small historic A site. Open to C&R angling.
3. Timber Lake	Small A restoration site. Opened to C&R angling in 1987.
4. Timber Creek	Good A restoration site. Opened to C&R angling in 1987.
5. Bench Lake	Good A restoration site. Closed to angling. Future broodstock.
6. Ptarmigan Creek	Good A restoration site. Closed to angling.
7. Paradise Creek	Good historic A-/B conservation site. Open to C&R angling.
8. Fifth Lake	Small historic A- conservation site. Open to C&R angling.
9. Columbine Creek	Small historic A- conservation site. Closed to angling.
10. Onahu Creek	Small historic A- conservation site. Open to angling.
11. Boundary Lake	Small stocked B+ conservation site. Open to C&R angling.
12. Colorado River-Upper	Small historic A conservation site. Open to angling. BKT dominate.
13. Willow Creek	Declining historic B+* conservation site. Open to angling. Located east of the Continental Divide. BKT dominate.
14. Ypsilon Lake	Good historic A- conservation site. Open to angling. Located east of the Continental Divide.

* Most recent taxonomic analysis of Willow Creek fish using genetics determined that they were B+ cutthroat trout of unknown taxonomic affinity. Previous analysis using meristic characters determined they were pure CRC.

Although this program was intended to document the distribution of all the fish species and the condition of aquatic habitats, the program led to the discovery of several native fish populations within RMNP; Hunters Creek, Upper Hutcheson Lake, Middle Hutcheson Lake, Paradise Creek, and Columbine Creek. The downstream movement of GBC from headwater restoration projects into the Moraine Park area of the Big Thompson River, and into the Fall River below Fan Lake was also documented. Since 1989, the aquatic survey program has conducted surveys to monitor fish populations at established trend sites. See Appendix IV for a summary of stream surveys from 1984 to 1988.

Currently 50 lakes in RMNP are known to have fish populations (Table 4), but only 45 of these lakes are known to have recruitment. The five lakes with fish populations, but not documented to support recruitment of trout, are GBC experimental introduction projects. Four of these are alpine lakes (Crystal Lake, Loomis Lake, Lake Husted, and Lake Louise) which were stocked with pure GBC to determine if native trout can maintain themselves in harsh habitats under catch-and-release regulations. The fifth, Lily Lake, is a heavily fished roadside artificial lake without stream spawning habitat. This population is used as a native trout educational site and as a research area to document GBC response to heavy angler pressure.

Presently, two lakes are populated by RBT, 11 dominated by BKT, and 37 are dominated by cutthroat trout. Three lakes (Thunder, Ouzel, and Glass) are populated by both cutthroat trout and BKT, with the cutthroat trout being the dominant species.

Table 4. Summary of Lakes With Fish Populations, 2001. Lakes without alphabetical ratings after them contain pure fish populations.

GBC	CRC	CUT	BKT
Upper Hutcheson	Nanita	Glass	Black
Middle Hutcheson	Adams	Little Rock	Box
Caddis	Timber	The Loch	Fan
Bear	Bench	Pettingell	Fourth
Ouzel	Fifth(A-)	Rock	Glass
Fern	Boundary(B+)	Ten Lakes	Lone Pine
Odessa	Solitude(B)	Thunder	Mirror
Lawn	Ypsilon(A-)		Ouzel
Lost		RBT	Peacock
Lower Hutcheson	YCT	_____	Poudre
Sandbeach	_____	Jewel	Sky Pond
Pear	Haiyaha(B)	Mills	Sprague
Spruce	Haynach(B)		Thunder
Dream			Verna
Crystal*			
Louise*			
Husted*			
Loomis*			
Lily*			
Arrowhead(A-)			

* Experimental population-no recruitment documented

Six of the lakes that once supported BKT (Bear, Fern, Ouzel, Lost, Lawn, and Husted) are now GBC restoration sites. Of the 37 lakes dominated by cutthroat trout, 19 are pure GBC (two historic and 17 restoration sites), and four (two historic and two restoration sites) are pure CRC. Twenty-seven of the 50 lakes are populated by “B”, or better native salmonids within their native drainages.

Although most of the lakes within RMNP were heavily stocked with YCT up to the late 1940's, the GBC/CRC phenotype dominates in most cutthroat trout lakes. Both GBC and CRC were probably stocked into these lakes prior to the establishment of the park in 1915, with the current phenotype of most lakes reflecting one of these subspecies, or a mixture of the two subspecies, rather than the YCT phenotype. Although evidence of YCT can still be observed in the DNA of current hybrid cutthroat trout populations.

Systematic disease testing of RMNP fish populations has been conducted since 1993. This testing has been part of the *National Wild Fish Health Survey* (USFWS 1997), an ongoing effort to monitor wild fish populations for the presence of certain fish pathogens, since 1997. The organisms responsible for salmonid whirling disease and bacterial kidney disease have been found within fish populations in RMNP, although no clinical signs of the disease have been observed. See Appendix V

for more detailed information on fish disease testing.

Existing data on RMNP waters were entered into a Dbase III file in 1987, updated in 1994, and converted to a Lotus Approach database in 1999. The database is updated annually and is used in conjunction with the RMNP Geographic Information System to provide information to any interested party. Summary tables for RMNP waters developed from this database can be found in Appendix I. These tables divide waters by drainage, elevation, and the species/subspecies present. They also include physical and biological characteristics of each water. The latest survey data is included for waters that contain fish.

New problems such as nitrogen deposition, whirling disease, and global warming underscore the importance of continued monitoring of all park aquatic resources.

Goal 3: Allow angler use according to NPS policy, and within limits necessary to perpetuate fish populations and riparian vegetation

Recreational fishing is a recognized part of the heritage of national parks and is allowed when it does not interfere with the functions of natural aquatic ecosystems of riparian zones (NPS 2001a). Catch-and-release restrictions allow much more expansive angling opportunities than would otherwise be available.

Exit interviews of RMNP visitors conducted in the 1970s estimated annual angler use at 50,000 angler days. Exit surveys conducted in 1994 and 1995 indicated fishing was the main activity of 3.6% of the visitors surveyed. With park visitation at 3.3 million people in 1999 (NPS 2001b), approximately 119,000 people visited RMNP primarily to fish.

A special permit is not required to fish park waters. However, a valid Colorado fishing license is required for all persons over 14 years of age. Angling is allowed for both native and non-native fish species. A number of non-native fish species were established in RMNP through earlier stocking which maintain themselves through natural reproduction. Non-native species established within RMNP include brown trout (BNT), brook trout (BKT), rainbow trout (RBT), and Yellowstone cutthroat trout (YCT). RMNP anglers are allowed to harvest fish, other than greenback cutthroat trout (GBC), with a possession limit of eight fish of which at least six must be BKT. The other two fish can be a combination of non-GBC cutthroat trout, RBT, or BNT and must be 10 inches or more in length. An additional 10 BKT may be taken if under eight inches each in length.

Waters which contain pure native cutthroat trout are limited to catch-and-release angling only, except Caddis Lake and Lake Nanita which have a limit of two fish per angler per day. Some waters are closed while restoration efforts are being completed. See Appendix II for RMNP fishing information and regulations.

Creel Survey Program: The current creel survey program has been conducted in RMNP since 1984 to assess angler success, fish population health and numbers, and distribution of species. Information is gathered by FWS technicians, RMNP rangers, permitted fishing guides, and volunteers by having anglers fill out creel survey cards. In most cases, anglers are interviewed away from the waters which

they fish, with the anglers identifying the species and judging the sizes of fish caught. However, all anglers do not identify fish species correctly, with anglers occasionally reporting species that are not known to be present within the water that they are fishing. Despite this problem, the creel survey program provides valuable information on angler success and fish populations within RMNP.

Angler Success. Based upon data collected by the creel survey program, anglers reported catching a yearly average of 1.13 to 3.18 fish/hour, with individual waters ranging from 0.0 to 22.0 fish/hour on the east side of RMNP from 1984 through 2000. On the west side of RMNP, anglers reported catching a yearly average of 0.88 to 25.0 fish/hour, with individual waters ranging from 0.0 to 36.0 fish/hour from 1984 through 2000.

Fluctuations in the average catch rate from year to year within the South Platte drainage (east side) and the Colorado River drainage (west side) mirrored each other from 1989 to 1998. For both drainages the highest catch rates have occurred in 1992 (excluding west side data from 1996 when only two anglers, fishing for a total of one hour, were interviewed) and the lowest catch rates occurred in 1997 (Figure 1).

Since 1996, creel survey data collected from Lily Lake made up a large portion of the total data collected from the east side of RMNP. This is due to the large number of anglers which fish at Lily Lake and to the large amount of data collected by Trout Unlimited volunteers conducting visitor use surveys since 1997 (see Section IV). Due to the heavy fishing pressure and lack of reproduction, Lily Lake has a lower catch rate than most other areas of the park. The influence that Lily Lake has on east side fishery statistics can be observed in Table 5.

On the east side of the park, BKT represented the majority of fish caught by anglers from 1984 to 1992. Since 1995, cutthroat trout have represented the majority of fish reported caught (Figure 2). The percentage of cutthroat trout reported caught by anglers on the east side of RMNP rose steadily from 1991 to 1998 when it peaked at 77.07%, while the percentage of BKT reported caught decreased. This is due in part to the number of waters, 14, that have opened to catch-and-release

Table 5. Lily Lake Contribution to East Side Creel Survey Data, 1996-2000.

Year	% Angler Days	% Angler Hours	East Side Catch Rate (fish/hour)	
			w/ Lily Lake	w/o Lily Lake
1996	34	48	1.70	2.68
1997	72	82	1.13	2.64
1998	32	29	1.82	2.35
1999	54	52	1.39	2.17
2000	22	18	2.05	2.36

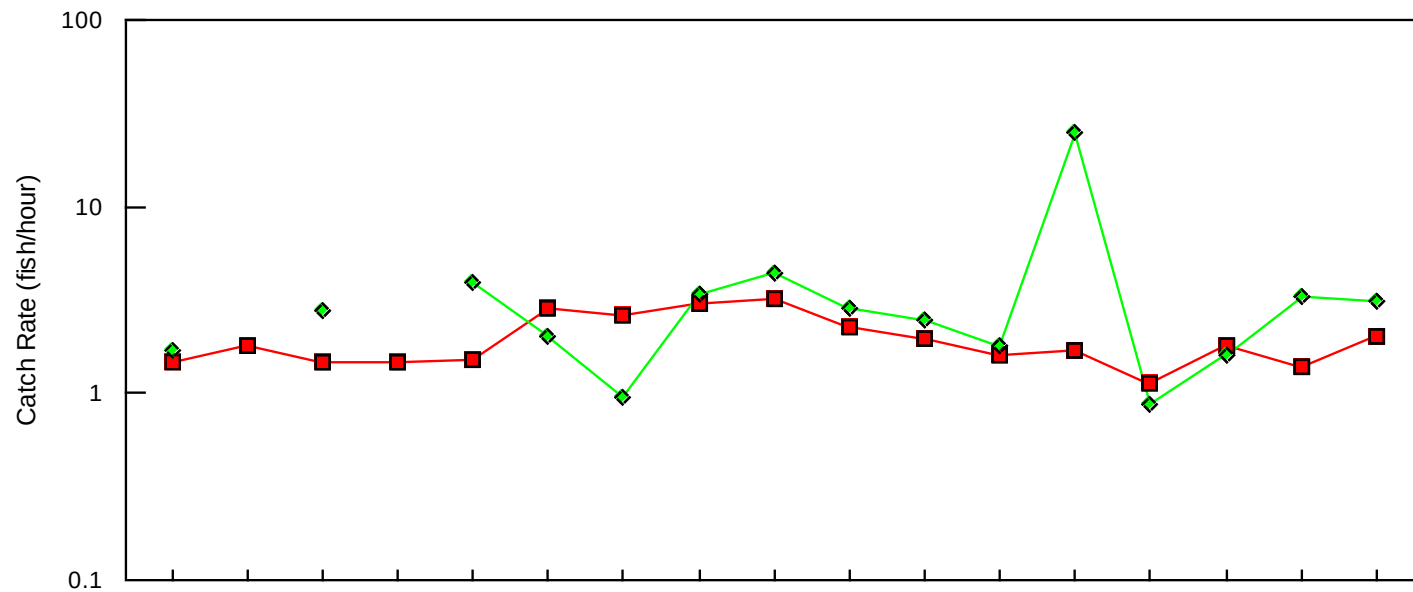


Figure 1. Rocky Mountain National Park Angler Catch Rates, 1984-2000. No creel survey data was collected from the west side of the park in 1985 and 1987.

angling for GBC since 1990. Another factor possibly affecting the decline in the percentage of BKT being caught is the decline in the number present in some of the lower elevation areas which are most accessible to anglers and for which a lot of creel survey data is collected. Electrofishing surveys conducted on Big Thompson River through Moraine Park, one of the most heavily fished areas of RMNP, have shown an increase in the number of BNT and a decrease in the number of BKT present. Average angler catch rates for BKT have also declined on the Big Thompson River since 1992.

On the west side of the park, BKT have represented the majority of fish caught by RMNP anglers since the inception of the creel survey program in 1984, with the exception of 1996 and 1999 (Figure 3). In 1996 only two anglers, both of which were fishing in cutthroat trout only waters, were interviewed. In 1999 cutthroat trout represented the majority of fish caught largely due to the large number of fish reported caught at Lake Nanita. See Appendix II for information on specific waters.

Release of Fish: Data collected by the RMNP creel survey program has shown a steady increase in the percentage of fish released by anglers since anglers were first asked to report release of fish in 1985. Release rates for the east side have been above 95% since 1996 and have reached a plateau around 97% since 1997 (Figure 4). Release rates for the west side have shown a downward trend since 1998. This is due to the increasing amount of data being collected from roadside fisheries and other areas close to trailheads, which attract the more casual anglers who tend to keep more fish. However, release rates are still over 90%.

Although some RMNP waters are designated as catch-and-release only areas, anglers also appear to be keeping less than their limit of legally harvestable trout species caught within RMNP waters. Anglers may keep a cumulative total of two RBT, BNT, or non-GBC cutthroat trout over 10 inches in length and up to 18 BKT per day. Anglers reported releasing 95 % of these species on the east side of RMNP, and 91% on the west side in 2000. Along the heavily fished sections of the Big Thompson River through Moraine Park and the Colorado River anglers reported releasing 100% of the fish they caught in 1997 and 1998. Since 1999 release rates at these two areas have been above 95%.

Native Species Angling Program: Currently, 30 sites in RMNP are open to angling for GBC. Twenty-five of these sites contain pure GBC and have catch-and-release only regulations, with 14 of these sites opening since 1990 (Table 6). West Creek will open to catch-and-release angling in 2001. Catch rates for GBC waters ranged from 0.05 to 9 fish/hour in 2000.

Of all the GBC restoration areas where there are multiple years of creel survey data before and after restoration, only one, Sandbeach Lake, has a lower average catch rate after its restoration. Prior to the restoration of Sandbeach Lake the average catch rate was 0.81 fish/hour. After the restoration catch rates have averaged 0.78 fish/hour. The catch rates at Crystal, Lost, Ouzel, Fern, Odessa Lawn Lake, Pear, and Spruce Lakes, the Roaring River and Cony Creek have all increased since their restoration to GBC. This is in spite of the fact that some of these areas were stocked in years when creel survey data was collected prior to restoration. Some of these increases have been significant. Spruce Lake catch rates have increased from 0.58 fish/hour prior to its restoration to 4.44 fish/hour after restoration. Catch rates at Cony Creek (1.67 vs 5.05), Pear Lake (0.73 vs 3.97), and Fern Lake (0.74 vs 3.19) also have increased significantly. Part of this increase at Lawn, Pear, and Lost Lakes

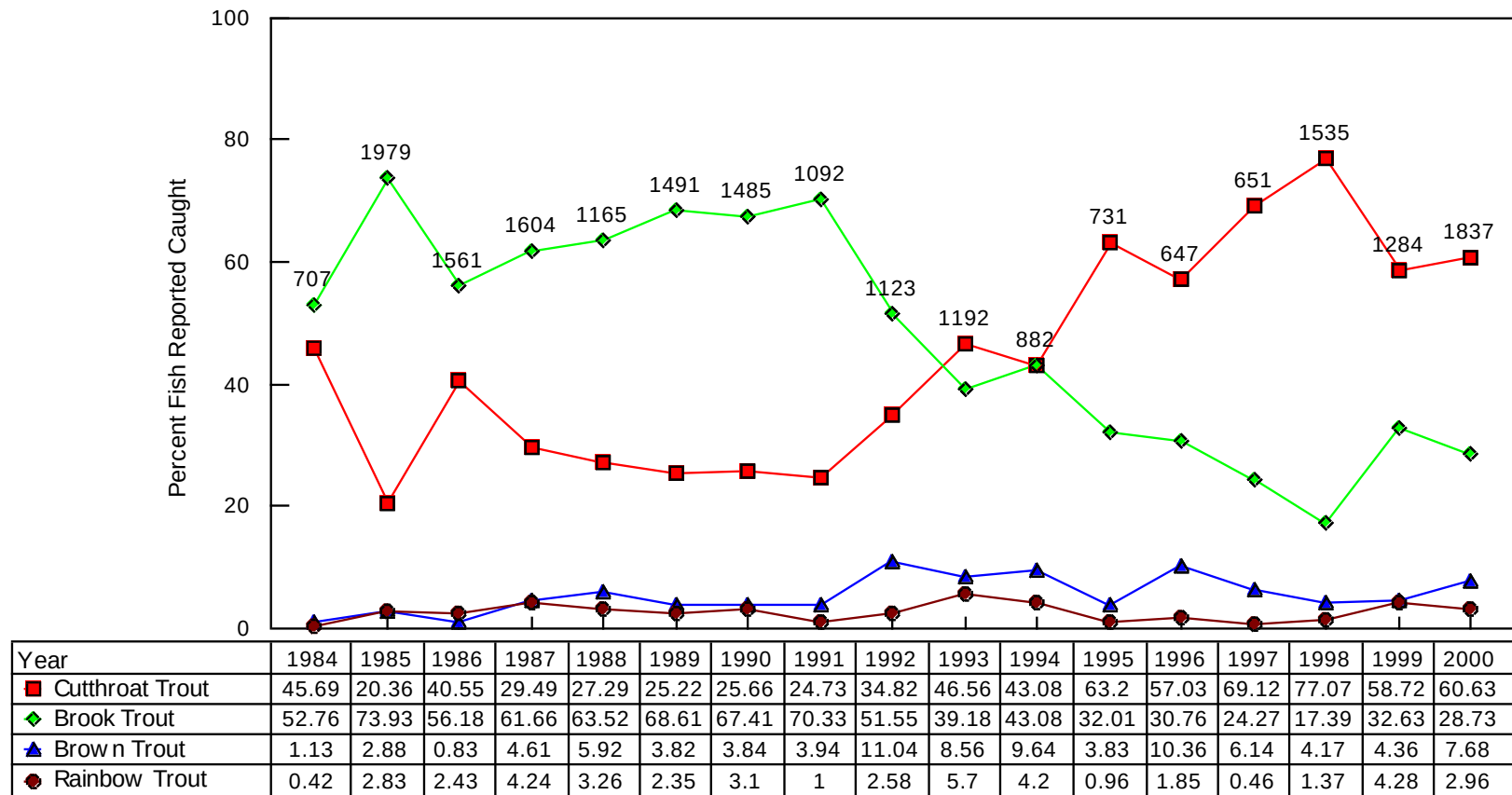


Figure 2. East Side Rocky Mountain National Park Relative Abundance of Species Reported Caught by Anglers, 1984-2000. Numbers above data points are the total number of fish reported caught for that year.

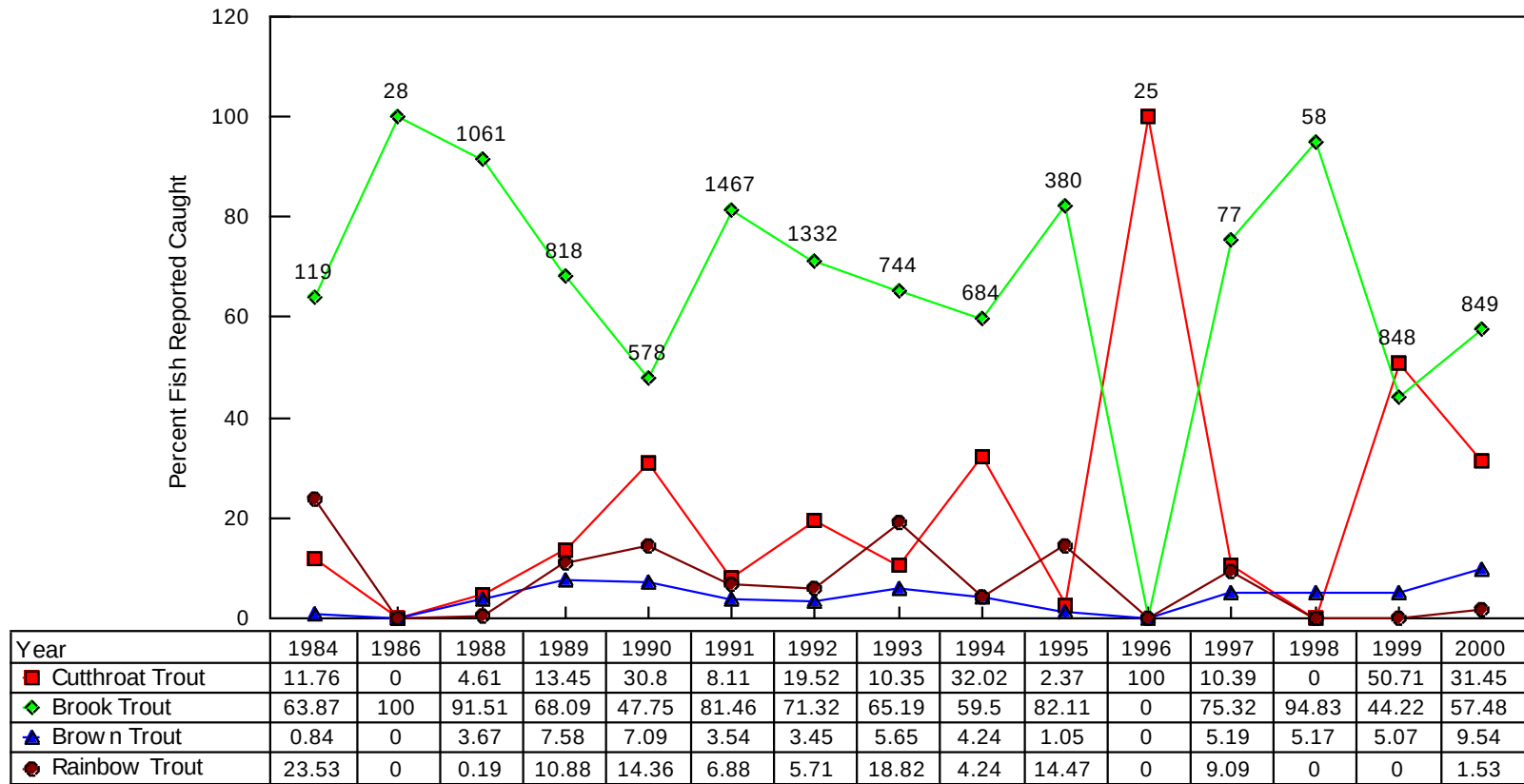


Figure 3. West Side Rocky Mountain National Park Relative Abundance of Species Reported Caught by Anglers, 1984-2000. Numbers above data points are the total number of fish reported caught for that year. No creel survey data was collected from the west side of the park in 1985 and 1987.

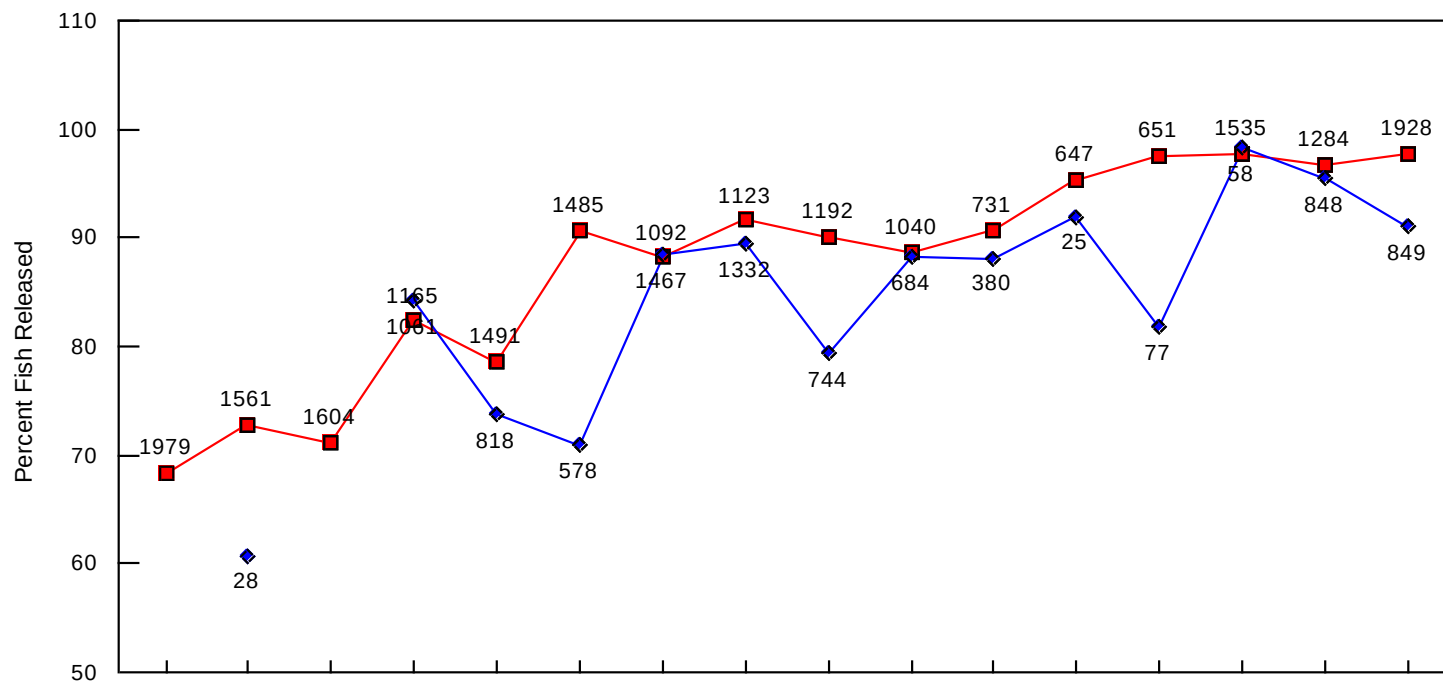


Figure 4. Rocky Mountain National Park Percentage of Fish Reported Released by Anglers, 1985-2000. Numbers above east side data points and below west side data points are the total number of fish reported caught for that year. No creel survey data was collected from the west side of the park in 1985 and 1987.

Table 6. Angler Catch Rates of Greenback Cutthroat Trout Waters Opened Since 1990.

Water	Year Opened	Mean Catch Rate (Fish/Hour)	# Years Data Collected
Crystal Lake	1990	1.03	3
Lost Lake	1990	1.04	5
NF Big Thompson River Above Lost Falls	1990	3.22	1
Lake Louise	1990	12.00	1
Roaring River	1991	3.66	8
Lower Hutcheson Lake	1991	0.88	3
Pear Lake	1991	3.97	4
Sandbeach Lake	1991	0.78	5
Cony Creek	1991	5.05	5
Lily Lake	1992	0.78	9
Spruce Lake	1993	4.44	4
Loomis Lake	1993	10.47	3
Lake Husted	1995	8.32	3
Dream Lake	1999	1.95	2

is due to removal of dams, which increased spawning habitat after dam removal.

Five sites containing pure or virtually pure CRC trout are open for catch-and-release angling; Timber Lake and Creek, Adams Lake, Paradise Creek, and Fifth Lake. Another four, Lake Nanita, Onahu Creek, Boundary Lake, and the upper Colorado River are open to angling with a two fish limit.

Most areas containing CRC are remote high elevation waters, thus they receive little angling pressure and no creel survey data has been collected from some sites. Lake Nanita receives the most angler pressure, with creel survey data collected in 11 out of 17 years since 1984, the start of the current creel survey program. Lake Nanita has an abundance of fish and catch rates have averaged 2.29 fish/hour (0.75 to 5.6) over that time. In 2000 catch rates at CRC waters ranged from 0 to 6 fish/hour.

In the future more creel survey data should be gathered from the west side of RMNP, especially waters containing Colorado River cutthroat trout. An effort should also be made to collect data from Dream Lake, which opened to angling in 1999, and West Creek, which will open to angling in 2001, to assess angler success at these GBC restoration sites.

SECTION II: ROCKY MOUNTAIN NATIONAL PARK NATIVE FISHES EAST OF THE CONTINENTAL DIVIDE.

GREENBACK CUTTHROAT TROUT

The greenback cutthroat trout (GBC), *Oncorhynchus clarki stomias*, was one of the three salmonids native to Colorado present east of the Continental Divide prior to the arrival of European settlers. They occupied the trout habitat of the headwaters of the Arkansas and South Platte River drainages. Attempts to culture GBC at the Leadville National Fish Hatchery (NFH) from 1889 to near the turn of the century failed. The availability of brook (BKT) and rainbow trout (RBT) which were better suited for hatchery rearing, and the large scale availability of Yellowstone cutthroat trout (YCT) led to the abandonment of the GBC by early fish culturists as a source of trout for stocking purposes (USFWS 1998).

Activities related to 19th century development in Colorado lead to overharvest of GBC, and pollution, siltation, and dewatering of streams all of which had negative influences on native fish species. However, the introduction of non-native trout species which hybridized and outcompeted the native species had the greatest impact. All these factors resulted in a drastic decline of the GBC's abundance and distribution.

Although, some considered the species extinct by 1930 (Green 1937), about 2,000 GBC, that

Figure 5. Male Greenback Cutthroat Trout From Bear Lake.

conformed to the meristics of the type specimens, in two small historic populations, were known to remain within Colorado when the species was federally listed as endangered in 1973. These two historic populations, Como Creek and the Little South Fork of the Cache la Poudre River (Poudre River), consisted of about four miles of stream habitat. Part of the Poudre River population is within Rocky Mountain National Park (RMNP). The GBC was downlisted in 1977 to threatened to help facilitate recovery efforts.

Boundary changes in 1981 resulted in more of the Poudre River population to be included within RMNP. Surveys of RMNP lakes and streams led to the discovery of four previously unknown historic populations; Hunters Creek, Upper Hutcheson Lake, Middle Hutcheson Lake, and Hague Creek, that are totally within RMNP. Presently, of the six known historic populations of pure South Platte River GBC known to remain, four exist in part or entirely within RMNP.

By combining advances in the removal of non-native fishes from historic habitats with the ability to stock large numbers of hatchery reared fish for multiple years, a total of 12 restoration projects have been completed within RMNP through 1999. Currently there are 33 sites within RMNP which contain pure or virtually pure GBC.

Broodstock Program

In 1977, 64 GBC from Como Creek were transferred to the Fish and Wildlife Service (FWS) Bozeman Fish Technology Center (BFTC), Montana to create a South Platte drainage captive broodstock. Despite previous failures to rear GBC in captivity at the Leadville NFH in 1889 and 1957 (USFWS 1998), the 1977 experiment proved to be a great success, with over 160,000 fry produced for restoration projects through 1988 (Dwyer and Rosenlund 1988).

In an effort to prevent genetic selection at the hatchery, milt from Como Creek (FS), Hidden Valley Creek (RMNP), Hunters Creek (RMNP), and the Poudre River (FS, RMNP) was shipped to BFTC starting in 1982. Proebstel (undated) found that this influx of new genetic material was successful in increasing the genetic variability of the broodstock based on meristic character evaluation. Due to lack of funding, shipping problems caused by distance and disease classifications, and problems in obtaining fish control permits, the BFTC broodstock program was abandoned in 1993.

A second attempt at starting a captive South Platte drainage broodstock was made at the Saratoga NFH, Wyoming. Eggs were collected from the Poudre River population in 1984 and 1985. Eggs collected in 1984 did not survive. Forty-seven percent of the eggs collected in 1985 hatched, however none of the fry would accept feed and all died (Dwyer and Rosenlund 1988).

Anticipating that the BFTC program would be abandoned, a new South Platte drainage GBC broodstock was initiated at the Colorado Division of Wildlife (CDOW) Fish Research Hatchery (FRH) in Fort Collins, Colorado in 1989. Fertilized eggs were collected from Bear Lake (RMNP), Como Creek, Hunters Creek, and the Poudre River in 1989 and from Upper Hutcheson Lake (RMNP) in 1990 to start this broodstock.

In 1991 and 1992 eggs were collected from the 1989 year class, except the Poudre River eggs which did not survive. The entire 1989 year class was lost in 1992 due to fungus, so eggs were collected from Hunters Creek to restart the broodstock program.

During yearly disease inspection at FRH in May 1993, *Renibacterium salmoninarum*, causative agent of bacterial kidney disease was found in the hatchery (Schler and Mandis 1993). Following disinfection, eggs were once again collected from Hunters Creek in June 1993 to restart the South Platte drainage GBC broodstock program. Additional eggs were collected from Hunters Creek in 1995, 1996, and 1997 and Upper Huteson Lake in 1996. However, FRH tested positive for whirling disease in 1997. The hatchery has been disinfected and is now disease free and housing GBC.

Five hundred fertilized eggs were collected from Hunters Creek on 27 June 2000 and shipped to the Saratoga NFH. The fish hatched from these eggs may be used as a broodstock to stock future GBC restoration projects within RMNP and other areas.

PURE HISTORIC POPULATIONS

Little South Fork Cache la Poudre River

The majority of the Little South Fork Cache la Poudre River (Poudre River) GBC population exists within the Roosevelt National Forest. Only about 0.16 km of the 1.6 km of habitatable stream is located within the northern portion of RMNP (Figure 6). The allopatric GBC portion of this population begins at a waterfall barrier at 2740 m and extends to another waterfall at 2880 m. Riparian vegetation consists of conifer, aspen, and alder. The Poudre River GBC population is managed as a broodstock refugium and is closed to all angling to protect this valuable source of eggs from disease introduction. Survey work and gamete collection operations on this population are conducted by the CDOW, RMNP, and FWS.

Stocking

No known stocking has occurred at this location (Chart, Gillihan, and Krieger 1986).

Taxonomy

Wernsman (1973) described this population as virtually pure GBC based on meristic characters from

Figure 6. Map of Little South Fork Cache la Poudre River Greenback Cutthroat Trout Population.

samples collected in 1970. However, Dr. Robert Behnke (1976) of Colorado State University determined that they were pure GBC. Tissue samples were collected by CDOW in 2000 and sent to Dr. Dennis Shiozawa, Brigham Young University, for genetic analysis.

Gamete Collection

Eggs were collected from this population on 16 July 1984 and 5 July 1985, to establish a captive broodstock at the Saratoga NFH. All the 1984 eggs died and fry produced from the 1985 eggs failed to accept feed and none survived to maturity. To increase the genetic diversity of the BFTC broodstock, milt was collected from these fish on 30 June 1986.

To start the new CDOW FRH broodstock fertilized eggs were collected from this population on 12 July 1989. Although 1989 was a dry year, fish were just starting to spawn by 12 July, at an afternoon water temperature of 7 °C. Twelve fish were captured (range=180-320 mm), but only one of five females was in condition to release eggs. The eggs that were collected from this female produced no fish at FRH.

Eggs were also collected on 7 July 1992 from two females and fertilized with two males. One hundred fifty eggs were taken to FRH. Of these eggs, 54 survived and were stocked into Bear Lake in 1993. Eggs were also collected in 1995, hatched at FRH, and stocked into Zimmerman Reservoir (Arapahoe National Forest) in 1996.

From observations since 1984, spawning of the Poudre River fish occurs from early to mid-July, and leaves little time for the hatching of eggs and their development prior to the decline of water temperatures in September. However, from the hatchery work completed in 1984 and 1985, it appears that the eggs from this population may develop faster than most GBC populations (Dwyer and Rosenlund 1988). Additional investigation into egg development of this population needs to be completed, since this trait could be very beneficial in developing reproducing GBC populations at high elevations.

Surveys

The Poudre River population was estimated at 539 fish (95% C. I.=334-744 fish) in 1983 (Culver 1983). Surveys conducted by CDOW from 1986 through 1998, indicated a fairly stable biomass (Table 7). However, there was a decline in standing crop from 14 fish/100 m in 1986 to 7.4 fish/100 m in 1998, with poor survival of young fish and few year classes present. Habitat improvement structures were installed by the Forest Service in the 1990's. Despite the area being closed to angling the CDOW reported signs of angling activity on this stream late in 1989.

Genetic deformities, such as shortened opercles and deformed caudal peduncles, have been observed (K. Kehmeier, CDOW, personal communication). In 2000 ten adult GBC from Roaring Creek were stocked to infuse new genetic material into the Poudre River population.

Table 7. Summary of Little South Fork Cache la Poudre River Electrofishing Surveys, 1983-2000. Conducted by CDOW.

Year	Species	Mean TL (mm)	Range of Length(mm)	Fish/ 100 m	Kg/ ha	Source
1983	GBC	208	80-317	33.7	-	Culver 1983
1984	GBC	200	132-236	-	-	Davis and Culver 1984
1986	GBC	208	161-277	14.0	29.0	Chart, Gillihan, and Krieger 1986
1987	GBC	219	172-285	12.0	28.5	Chart, Haneke, and Krieger 1987
1988	GBC	242	186-302	9.5	28.5	Kehmeier, Haneke, and Garrison 1988
1991	GBC	-	-	9.5	17.9	Kehmeier 2001
1993	GBC	-	-	8.4	20.5	Kehmeier 2001
1998	GBC	250	150-300	7.4	30.1	Kehmeier 2001

- Data not available

In 1999, Dr. Michael K. Young of the USDA Forest Service-Rocky Mountain Research Station conducted a population estimate on the entire Poudre River population. He estimated that there are 170 fish (✓ 98 fish) in 1640 m of habitat where GBC are allopatric. Fish sampled had a mean TL of 230 mm. This estimate represents a significant decrease from Culver's 1984 estimate of 539 fish. However, the corresponding standing crop estimate of 10.37 fish/100 m represents a slight increase from the CDOW estimate in 1988.

Current Status

Although the biomass of this population is stable, habitat and the limited number of year classes present, prohibit it from being considered a stable, self-sustaining population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998). Despite the cold water temperatures and late spawning, which will always limit this population, it has persisted for a long time.

Hunters Creek

The Hunters Creek GBC population inhabits about 2.2 km of stream within the North St. Vrain drainage in southeastern RMNP (Figure 8). Fish extend from the top of a steep canyon wall (2910 m) northwest of the Wild Basin Ranger Station to Lyric Falls (3160 m). Based on habitat surveys conducted in 1988 as part of the RMNP Stream Survey Program, adequate year-round flows and good cover exist. Riparian vegetation consists mostly of conifers interspersed with aspens.

Stocking

The only known stocking of Hunters Creek came in 1939, when 8,000 “black-spotted” trout were stocked. However, a record from 1923 states that there were native trout present in the creek at that time, so this population was not founded from the 1939 stocking. Dr. Behnke (1985a, page 3) speculated on the original source of this population.

Figure 7. Collecting Eggs From Hunters Creek Greenback Cutthroat Trout.

Figure 8. Map of Hunters Creek Greenback Cutthroat Trout Population.

“Around the turn of the century, irrigation companies constructed many water storage reservoirs in the headwaters of Boulder Creek, St. Vrain and Big Thompson drainages in what is now Rocky Mountain National Park. These headwater areas were barren of fish due to impassable falls. The workmen probably transported trout from the nearest sources into the originally barren waters... The trail to Sandbeach Lake crosses Hunter’s Creek. Workmen regularly using this trail probably made a transplant of greenback trout from the North Fork of the St. Vrain to Hunter’s Creek. Such a transplant must have occurred prior to hybridization of greenback and rainbow trout in the St. Vrain.”

Taxonomy

This historic population was discovered in June 1985 and was confirmed as pure GBC by Dr. Behnke (1985a, page 1) using meristic characters:

“The specimens are consistently uniform in spotting pattern and phenotypic appearance. The strikingly pronounced large spots on the body and red-pink spawning coloration of males indicate the sample was drawn from a pure population of S. c. stomias.

In all of the diagnostic characters, the Hunter’s Creek specimens are intermediate between the Como Creek population and Little South Poudre population. All specimens have nine pelvic fin rays

(typically 10 in rainbow trout and hybrids). The uniform spotting pattern, high scale counts, low caecal counts, well developed basibranchial teeth, and number of pelvic fin rays, all agree that no hereditary material from rainbow trout occurs in the Hunter's Creek population. The first gill arch of the specimens possess posterior gillrakers, a character typical of S. c. stomias but absent in rainbow trout."

Tissue samples were collected by angling and during egg collection in 2000. These samples will be evaluated by Carl Ostberg of Biological Resources Division/U.S. Geological Survey, Western Fisheries Research Center, Seattle, Washington. He is developing a genetic protocol for differentiating between cutthroat and rainbow/steelhead trout, and between the cutthroat trout subspecies and will use these samples to test his system. Additional samples were sent to Dr. Dennis Shiozawa, Brigham Young University by CDOW for analysis.

Gamete Collection

Spawning typically begins in Hunters Creek in late June to early July. From 1986 to 1988 milt was collected to improve the genetic diversity of the BFTC captive broodstock. To start the new CDOW South Platte broodstock at FRH, eggs were collected from Hunters Creek on 23 June 1989. Most of the females were running eggs, with 3,688 eggs collected. For future broodstock at FRH 1,185 eggs were collected in 1992, 1,600 in 1993, 3,600 in 1995, and 2,000 in 1997.

To start a new South Platte broodstock at the Saratoga NFH, fertilized eggs were collected from fish above the Sandbeach Lake trail crossing on 27 June 2000. Most of the males and females were spent and only about 300 fish were hatched from these eggs. The eggs hatched after 28 days at a constant water temperature of 8.9 °C (249 Celsius temperature units) and started to feed after 45 days (401 Celsius temperature units). These values are lower than others reported for cutthroat trout (Varley and Gresswell 1988; Behnke 1992) and similar to those for the Little South Fork Cache la Poudre River.

Surveys

A survey by Bulkley (1959) on 22 August 1958 at the top of the steep wall found cutthroat trout to be abundant. Flows were 0.24 cms and aquatic food was described as abundant. Analysis of stomach contents showed terrestrial organisms in 80% of fish stomachs and made up 52.6% of the total volume of organisms collected. Aquatic organisms were found in all fish sampled but made up a smaller percentage of the total volume. Hymenoptera was the dominant terrestrial organisms and mayflies was the dominant aquatic organism.

In 1985 the Hunters Creek population was estimated at 1,080 fish for fish >150 mm (Dwyer and Rosenlund 1988). A two-pass population estimate was conducted near the Beaver Mill campsite and above the Sandbeach Lake trail crossing in September 1988. Standing crop was estimated at 26.24 fish/100 m and 51.5 kg/ha at the Beaver Mill site and 36.08 fish/100 m and 97.4 kg/ha at the Sandbeach Trail site. Although people were removing the closed to fishing signs in 1989, the population was considered excellent with 98 GBC >120 mm handled for spawning. Mean TL of fish

Table 8. Summary of Fishery Statistics for Hunters Creek, 1958-1986.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	1.14	-	416.7	CUT, RBT, BKT
1960	1.00	1	3.0	RBT, BKT
1963	0.50	3	12.0	CUT
1964	0.80	2	5.0	CUT
1969	1.76	5	17.0	CUT
1975	1.67	2	12.0	BKT
1986	Closed to angling			

* In order of relative abundance

- No data recorded

spawned was 194 mm (range=121-280 mm).

A two-pass electrofishing survey was conducted in September 1999 to obtain a population estimate for the entire Hunters Creek population. Using methodology developed by Dr. Michael K. Young of the USDA Forest Service Rocky Mountain Research Station it was estimated that there are 670 ($\pm$ 239) fish present. The corresponding standing crop estimate of 36.73 fish/100 m is similar to the 1988 estimates. Mean TL of adult (i. e. >100 mm) fish sampled was 195 mm. The range of length of all fish sampled was 66-312 mm.

Angler Use

To maintain the integrity of this population for broodstock purposes this population was closed to angling in 1986 after its discovery and remains that way currently. Although RBT and BKT have been reported caught in Hunters Creek, these fish were probably caught below the GBC population. Fish were very easily caught during tissue collection in 2000 with no signs of illegal angling. A summary of fishery statistics from prior to the creek closing to angling can be found in Table 8.

Current Status

Hunters Creek is managed as a broodstock refugium and is closed to all fishing to protect this valuable source of GBC eggs from disease. This population meets all the requirements of a stable self-sustaining population as defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Upper and Middle Hutcheson Lakes

The Hutcheson Lakes are a chain of seven lakes and ponds located in four cirques at the head of Cony Creek in southeastern RMNP (Figure 10). Upper Hutcheson Lake (Figure 9) is the second highest lake (3420 m) in this chain and has a surface area of 3 ha. Despite its high elevation, water temperatures are warm enough to support successful GBC recruitment, the highest lake in RMNP to do so. It is deep and ample spawning habitat exists in the outlet. Middle Hutcheson Lake (3370 m, 1 ha) is located 0.6 km downstream and is separated by a barrier from Upper Hutcheson Lake. It has adequate spawning habitat in the inlet. The shorelines of both lakes are comprised mostly of boulders with some grass and willow present.

Stocking

One stocking record from 1952 reports stocking of “Boundary Lakes” with 12,000 “black-spotted” trout from Yellowstone. The location of the stocking is that of the Hutcheson Lakes.

Upper Hutcheson Lake was proposed for stocking in 1963 because the “fish population indicates that it is not perpetuating itself as it could” (Thompson and Linn 1963), however there are no records showing any stocking in the 1960’s. Lower and Middle Hutcheson Lakes were located outside of RMNP until 1981 when a boundary change incorporated them into the park. Prior to the boundary change they were managed by CDOW who stocked Lower Hutcheson Lake with RBT. It was assumed that Middle Hutcheson was stocked as well. However, if Upper and Middle Hutcheson Lakes were stocked with RBT there is no evidence of this based on taxonomic analysis.

Figure 9. Upper Hutcheson Lake.

Figure 10. Map of Hutcheson Lakes Greenback Cutthroat Trout Populations.

Taxonomy

Following the discovery of the Hunters Creek population of pure GBC in 1985, other populations of cutthroat trout within the North St. Vrain drainage were examined. The Hutcheson Lakes were known to contain a phenotypic population of GBC, but were considered to be hybridized due to the past stockings of the lakes in the drainage with RBT. However, fish samples collected from the Upper Hutcheson Lake in 1986 and from Middle Hutcheson Lake in 1987 were determined to represent pure GBC (Behnke 1986, 1987) based on analysis of meristic characters.

Tissue samples were collected in 2000 and will be evaluated by Carl Ostberg of Biological Resources Division/U.S. Geological Survey, Western Fisheries Research Center, Seattle, Washington. He is developing a genetic protocol for differentiating between cutthroat and rainbow/steelhead trout, and between the cutthroat trout subspecies and will use these samples to test his system. Additional samples were sent to Dr. Dennis Shiozawa, Brigham Young University, by CDOW for genetic analysis.

Gamete Collection

To supply the FRH broodstock with wild eggs, 300 fertilized eggs were collected from Upper Hutcheson Lake on 10 July 1990. Another 7,000 eggs were collected on 5 July 1996 to restart the FRH broodstock program following disease disinfection at the hatchery. Ten thousand one hundred eggs were also collected 10 July 1997 and sent to the CDOW hatchery in Pueblo for rearing. In addition to the egg collection in 1997, 190 adult and 5 immature fish were removed and stocked by

Table 9. Summary of Upper Hutcheson Lake Gill Net Sampling, Outlet Trend Site, 1963-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/Net Hour	Kg/Net Hour
08/16/63	GBC	-	203-305	1.50	-
07/31/81*	GBC	237	178-321	3.38	0.47
07/24/86	GBC	255	205-330	27.00	4.58
07/10/90	GBC	235	163-320	44.00	6.13
08/11/98	GBC	265	211-305	15.00	2.43

- No data recorded

* Overnight net set

helicopter into Dream Lake.

Surveys

Upper Hutcheson Lake. A gill net survey in 1963 conducted by Thompson and Linn (1963) caught six fish in four hours (Table 9). Fish were fat, in good condition, and ranged in length from 203 to 305 mm. Analysis of stomach contents found caddisflies, mayflies, stoneflies, diptera, amphipods, and other terrestrial insects.

Following incorporation of Middle and Lower Hutcheson Lakes into RMNP, all of the Hutcheson Lakes were surveyed in 1981. A gill net set for 16.25 hours caught 55 fish (3.38 fish/hour). Several

Table 10. Summary of Middle Hutcheson Lake Gill Net Sampling, 1981-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/Net Hour	Kg/Net Hour
07/30/81*^	GBC	296	216-419	0.43	0.16
08/26/86*~	GBC	252	223-269	0.16	0.03
08/05/87*#	GBC	313	254-345	0.09	0.04
08/10/98%	GBC	338	272-418	11.66	4.55

* Overnight net set

^ Net set at outlet

~ Location of net set unknown

2 nets set, one at inlet, one at outlet

% Net set at southwest cove at false inlet

year classes were present and all females were spawned out. Fish were fat and feeding mostly on caddisflies with some ants, gnats, and other terrestrial insects also present.

Gill net surveys conducted in 1986, 1990, and 1998 found fish to be abundant and in good condition. Fish were still spawning in the outlet during the 10 July 1990 survey at a water temperature of 10 °C. During tissue collection in 2000 fish captured by hook-and-line had a mean TL of 281 mm (range=256-315 mm) with most fish in good condition.

Middle Hutcheson Lake. The 1981 gill net survey caught 9 fish in a 20.75 hour net set (Table 10). Fish were feeding on scuds, moths, and stoneflies and females were spawned out. Catch rates for surveys conducted in 1986 (0.16 fish/hour) and 1987 (0.09 fish/hour) were even lower than the 1986 survey.

The last gill net survey, conducted on 10 August 1998 had a much higher catch rate (11.66 fish/hour) than the previous surveys. However, the previous surveys, prior to identification of these fish as pure GBC, were overnight net sets which have been observed to have much lower catch rates than shorter net sets (typically 1 hour) which are used for pure native fish populations in RMNP.

Angler Use

Both Middle and Upper Hutcheson Lakes are open to catch-and-release angling, but due to their remoteness fishing pressure can be described as light. Access to these lakes requires a 10.4 km trail hike to Pear Lake plus another 1.6 to 3.2 km cross-country hike. The closest campsites are located at Pear Lake, however there is a cross-country camping zone near Lower Hutcheson Lake, 0.2 km below Middle Hutcheson Lake.

Upper Hutcheson Lake. Catch rates at Upper Hutcheson Lake are among the highest in RMNP (Table 11). Little sign of angler use has been observed during surveys since 1981. Two anglers

Table 11. Summary of Fishery Statistics for Upper Hutcheson Lake, 1985-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1985	2.00	2	2.0	CUT
1987	5.18	3	22.0	CUT, RBT
1988	1.80	2	25.0	CUT
1993 [^]	5.21	5	30.3	CUT
1995	7.56	2	18.0	CUT
1998	4.53	2	30.0	CUT
2000	6.66	2	3.8	CUT

* In order of relative abundance

[^] Anglers reported their location as Hutcheson Lakes

Table 12. Summary of Fishery Statistics for Middle Hutcheson Lake, 1993-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1993 [^]	5.21	5	30.3	CUT
1995	5.80	4	5.0	CUT
1998	1.00	2	5.0	CUT

[^] Anglers reported their location as Hutcheson Lakes

interviewed in 1998, who have fished the Hutcheson Lakes yearly for the last ten years, said that the fishing appeared to be down in 1998 from previous years. Creel survey data agrees with this, however catch rates are still the highest among the Hutcheson Lakes chain.. During tissue collection in 2000, fish up to 400 mm were easily caught in all areas of the lake.

Middle Hutcheson Lake. Although a gill net survey in 1998 produced the highest catch rate at Middle Hutcheson Lake, creel survey data for 1998 shows anglers had the poorest success of any year in which data was collected (Table 12). In addition to data shown in Table 16, three volunteers assisting in the gill net survey in 1998 caught 1 GBC in a total of 1.5 hours of angling.

Current Status

Upper Hutcheson Lake is the third highest lake in RMNP with a recruiting fish population, and contains the largest population of GBC within RMNP. It meets all the requirements of a stable, self-sustaining population as defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998). Middle Hutcheson Lake most likely does not support the 500 fish minimum required to maintain maximum genetic diversity. Thus, it does not meet the definition of a stable, self-sustaining population.

Hague Creek

Hague Creek is a tributary of the Cache la Poudre River and is located in the northwestern RMNP (Figure 12). This population inhabits only one beaver pond above a barrier at 3150 m (Figure 11). Above this pond up to a waterfall barrier at 3170 m the habitat consists mostly of riffle with very few resting areas for fish. Good habitat with large pools exists above the waterfall but no fish have been observed. Adequate flows and spawning substrate exist in the pond for reproduction. Riparian vegetation consists mostly of grasses with some conifers.

Stocking

Records show three records of stocking of black spotted trout into Hague Creek. Five thousand fry were stocked into an unknown section in 1936, 42,240 eggs were stocked into an unnamed headwaters lake (3474 m) in 1940, and 5,000 fry were stocked in the lower section of the creek in 1942.

Figure 11. Canyon Below Barrier on Upper Hague Creek.

Figure 12. Map of Upper Hague Creek Cutthroat Trout Population.

Taxonomy

Tissue samples were collected from three fish in 1999 and were taken to Don Proebstel for genetic analysis. Based on this small sample size Don determined that the upper Hague Creek population are A- cutthroat trout of unknown taxonomic affinity from multiple sources. Additional taxonomic work needs to be done on this population.

Surveys

A survey conducted in 1957 (Bulkley 1957) found no fish above the waterfall barrier, although the area above the falls was examined and fished carefully. Below the falls both cutthroat trout and BKT were present with BKT being exceedingly abundant. All fish were small in size with some emaciated specimens captured. The area below the falls is where the current population exists. No BKT have been caught or observed through this section since Bulkley's survey. This could be the one of the few known instances where cutthroat trout have displaced BKT in a stream habitat. Cutthroat trout were caught down to an elevation of 3050 m. Currently very few, if any, cutthroat trout inhabit Hague Creek at this elevation. Specimens were collected during the 1957 survey at sent to "the San Francisco Museum." Attempts were made in 2000 to locate these specimens at the California Academy of Sciences, however no catalogued specimens exist in their collection from Hague Creek. Only large cutthroat trout were caught by hook-and-line during surveys in the early 1980's. All fish collected and observed were confined to a small area above the barrier (Don Proebstel, Colorado State University, personal communication).

Visual and hook-and-line surveys conducted in 1998, 1999, and 2000 found all fish confined to the one beaver pond with one exception. In 1999 two fish, 375 and 244 mm, were caught out of the pond with several other fish in three to four year classes also observed. Another fish, 242 mm, was caught below the barrier amongst a dense BKT population.

Angler Use

Although this population is open to angling it receives very little visitation. It is located in a remote area of RMNP with access to this area requiring a 4.5 km trail hike plus another 3 km of cross-country travel. With very few people knowing of the existence of this population, few would venture past the very good BKT fishing in lower Hague Creek to fish this area.

No creel survey data is known to have been collected from upper Hague Creek. However, anglers have reported catching cutthroat trout in unknown sections of Hague Creek since 1961. In 1963 and 1964 anglers reported catching cutthroat trout at the Hague Creek/Cache la Poudre River junction. This may indicate that cutthroat trout were at one time more common within the Hague Creek drainage.

The beaver pond containing cutthroat trout was fished for 3 hours with no fish caught in 1998. During tissue collection in 1999 two cutthroat trout were caught in two hours. A short canyon below the barrier was also sampled by hook-and-line in 1999. In 1.25 hours of fishing 30 BKT and 1 GBC were caught in this area.

Current Status

Due to the small size of this population, it does not meet the requirements of a stable, self-sustaining population as defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998). Additional taxonomic work needs to be conducted to determine if these fish are pure GBC. Although this population is very small no genetic deformities have been observed in any fish. Fish have persisted in this area for a long, however due to the restrictive habitat and the few fish present it is expected that they will become extirpated from upper Hague Creek.

RESTORATION PROJECTS

Caddis Lake

Caddis Lake is the lowest elevation lake (3290 m) in a string of three lakes known as the Fay Lakes which also includes Fay Lake (3360 m) and Faylene Lake (3420 m). The Fay Lakes are located along an unnamed tributary of Ypsilon Creek in the Fall River drainage in northeastern RMNP (Figure 14). Caddis Lake is a small (0.98 ha), shallow (0.76 m maximum depth) lake with a silt bottom. A half km of good fish habitat exists in the inlet and outlet stream. Vegetation around the lake is comprised mostly of grasses with riparian vegetation along the inlet and outlet consisting of conifers.

Restoration

In the late 1950s the FWS discovered what was thought to represent a genetically pure population

Figure 13. Bright Coloration of Male Caddis Lake Greenback Cutthroat Trout.

Figure 14. Map of Caddis Lake Greenback Cutthroat Trout and Ypsilon Lake and Creek Colorado River Cutthroat Trout Populations.

of GBC in the Forest Canyon section of the Big Thompson River in RMNP (Bulkley 1957). At the time this would have been one of the few GBC populations known to exist at that time. Surveys were conducted in 1957 in RMNP to assess habitat for potential reintroductions of GBC. Based on these surveys it was determined that the Fay Lakes drainage was the most suitable location despite no fish being present in Fay or Faylene Lakes.

On 9 September 1958 the Fay Lakes drainage was chemically treated with rotenone to a 60 foot barrier below Caddis Lake (Bulkley 1959). One hundred thirteen fish, mean length 164 mm (range=88-367 mm), were recovered from Caddis Lake and its inlet and outlet stream. In addition numerous dead fry (30 to 35 mm in length) were also observed in the inlet, outlet, and along the shoreline. These fish appeared to be YCT. No fish were recovered from Fay or Faylene Lakes.

In 1959 fish were removed from Forest Canyon and taken to the Fall River hatchery in Estes Park and held until 6 August when 97 fish were stocked by helicopter into Fay Lake (Cope 1959). Another 112 fish were stocked on 4 September. The range of length of these fish was 114 to 254 mm. No mortality was observed in either stocking.

In the early 1960s stocking records were found that showed that non-native fish were stocked into

Forest Canyon in the 1920s and 1930s. With the fish in Forest Canyon found to be contaminated the project in the Fay Lakes was abandoned and the drainage was returned to its original management status and stocked with cutthroat trout in 1962.

Taxonomy

In 1961 two specimens were collected from Fay Lake and taken to Dr. Robert Rush Miller, Curator of Fishes, University of Michigan Museum. He could not positively identify the specimens as GBC due to the vagueness of the original description.

Additional specimens were collected and examined by Dr. Behnke who concluded from meristic characters (Mullen 1972, page 32):

Six specimens collected in July 1972 from Caddis Lake were examined and found to be similar in their characters to the trout of the headwaters of the Big Thompson in Forest Canyon. The present Caddis Lake population were likely derived from a plant of Forest Canyon cutthroat trout into Fay Lake in 1959, although Fay Lake itself is now apparently barren of fish.

Evidently, Fay Lake was stocked once more with cutthroat trout from an unknown source in the early 1960's. These trout, if supplied by Colorado Game and Fish, were probably from their Pike s Peak brood stock. The Pike s Peak cutthroat trout is not sharply differentiated from Forest Canyon trout, but does have lower mean values in scale counts and more numerous pyloric caeca. Both forms develop bright, almost gaudy colors, particularly in males during spawning. It is possible that some of the trout introduced into Fay Lake in the 1960s migrated downstream into Caddis Lake and hybridized with the previously established Forest Canyon population. If the subsequent introduction was from the Pike s Peak brood stock, it would be virtually impossible to detect the effects of slight hybridization. I am confident, however, that there is no influence of Yellowstone cutthroat trout in the Caddis Lake specimens examined, and they can be considered (phenotypically, at least) as a good representative of the greenback cutthroat trout, Salmo clarki stomias, once native to the waters of Rocky Mountain National Park."

Tissue samples were collected from 15 fish and taken to Don Proebstel for genetic analysis in 1999. He determined that they were pure GBC from a single source (Appendix III).

Surveys

Inspection of Fay Lake in the summer of 1960 did not reveal the presence of any fish (Azevedo and Wallis 1962). An angler who fished the lake in 1960, without knowing that it was closed to angling, reported trout were present. In follow-up investigations in 1961, several trout were observed, and two specimens were collected.

Two gill nets were set overnight in Fay Lake on 18 and 19 July 1972 without catching any fish (Mullen 1972). Evening and morning observations of the lake's surface failed to disclose any evidence of fish life. Trout were observed to be relatively abundant in the inlet and in Caddis Lake

Table 13. Summary of Caddis Lake Gill Net Sampling, Inlet Trend Site, 1979-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/10/79	GBC	225	185-272	10.5	-
07/20/88	GBC	233	110-281	8.0	1.03
07/09/99	GBC	226	169-296	17.1	1.95

- No data recorded

proper.

Surveys of Caddis Lake on 10 July 1979 found fish just starting to spawn with temperatures ranging between 4 and 8 °C. In addition to fish caught in a gill net, numerous fish were observed throughout the lake and in the inlet stream. Fish were feeding mostly on mosquitoes, with one male feeding on trout eggs and caddisfly larvae. A gill net survey in 1988 found fish to be abundant and in good health (Table 13).

On 9 July 1999 a gill net survey conducted near the inlet caught 18 GBC in 63 minutes. Fish were in good condition with all males ripe and exhibiting intense red coloration (Figure 13). Females were a week or two away from spawning. An additional 12 fish were caught in the inlet and one in the lake by hook-and-line. These fish had a slightly larger mean TL than the fish caught by gill net in the lake, 244 mm compared to 225 mm.

Angler Use

Caddis Lake is located about an hour cross-country hike from Ypsilon Lake where the closest trail and campsites are located. Fishing pressure was described as sporadic in the early 1960's. Little visitation was apparent during surveys in 1988 and 1999.

Table 14. Summary of Fishery Statistics for Caddis Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958-198?	Closed to Angling			
1968	8.00	2	0.5	RBT, CUT
1996	4.50	1	4.0	CUT
1999	1.62	4	8.0	CUT

* In order of relative abundance

Caddis Lake opened to angling in the 1980s (exact year unknown). Limited creel survey data suggests the same as net survey data, that this GBC population is in good condition (Table 14). Anglers reported catching fish in all three lakes(?) in 1968. One of those anglers reported catching six cutthroat trout in six hours from Caddis and Fay Lakes. Of the 13 fish that volunteers caught by hook-and-line in 1999, 12 were caught in the inlet stream.

Current Status

The Caddis Lake GBC population is in good condition with an abundant amount of fish and several year classes present during surveys. However, it does not meet the minimum habitat and probably does not meet the minimum number of fish requirements for it to be considered as a stable self-sustaining population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

North Fork Big Thompson River, Lost Lake, and Lake Louise

The North Fork of the Big Thompson River (North Fork) is located in northeastern RMNP (Figure 16). The portion of the North Fork occupied by GBC is divided into two sections. The lower section extends from Lost Falls (3000 m) to a barrier at 3280 m and includes Lake Husted and Lost Lake (3275 m). Brook trout are also present in this section, except in Lake Husted. Good pool habitat is present between Lost Falls and Lost Meadow and riparian vegetation is comprised of conifers. Above Lost Meadow to the barrier the gradient is lower and riparian vegetation is comprised of dense willows. Sparse pool habitat exists within most of the section with willows. Lost Lake (Figure 15) was a reservoir until RMNP removed the dam in 1985. Without the dam the surface area of the lake is 3.7 ha and the maximum depth is 6.4 m. The shoreline has little or no vegetation up to the old high water mark. Inlet flows decrease following spring runoff and are mere trickles by fall. Good spawning substrate exists in the inlet and outlet, however low flows may limit reproduction. Lake Husted is currently an experimental population with no recruitment documented. For further information on this population see page 116. The upper section of the North Fork extends from the barrier at 3280 m to another barrier at 3365 m and includes Lake Louise (3365). Only GBC are present in this section. Willow is the dominant riparian vegetation and pool habitat is more abundant in the upper portion of this section. Lake Louise has a surface area of 2.6 ha and a maximum depth of 5.5 m, however half of the lake near the outlet is shallow. The north shore consists mostly of willows and the south shore is mostly rock. Good spawning substrate exists in the outlet, however recruitment has not been documented.

Figure 15. Lost Lake.

Figure 16. Map of the North Fork Big Thompson River Greenback Cutthroat Trout Restoration Projects. Numbers correspond to the antimycin application sites in Table 19

Restoration

The headwater lakes of the North Fork drainage were stocked once with “black spotted natives” in the 1930’s. This plant failed to establish lake or stream fish populations above a potential fish barrier at 3230 m based on surveys conducted by Bulkley (1959) and Mullen (1969).

In 1970, 50 GBC from Como Creek were introduced into 1.7 km of the fishless North Fork above the barrier at 3280 m (Mullen 1970). The project was expanded in August 1986 by removing BKT from the North Fork between Lost Falls and the barrier at 3280 m (Figure 16 and Table 15). This project included Lake Husted, Lost Lake, and an additional 3 km of the North Fork.

The North Fork was stocked with 3,000 GBC fry on 16 September 1987, 7,000 fry on 14 September 1989, and 1,500 fry on 11 October 1990. Lake Husted was stocked with 2,000 fry on 24 September 1986 and 2,000 fry on 16 September 1987. Lost Lake was stocked with 4,000 fry on 16 September 1987, 1,350 fish at 161 mm in length on 30 June 1989, and 3,000 fry on 14 September 1989. Lake Louise was stocked once on 14 September 1989 with 3,500 fry. All of these fish came from the BFTC broodstock.

The North Fork also contains a population of boreal toads, which is listed as an endangered species by the state of Colorado and is federally a candidate species for listing under the Endangered Species Act. Activities related to the restoration of the North Fork and Lost Lake, which serves as a breeding locality, to GBC have not shown any long term negative impacts to the toads.

Table 15. Amount of Antimycin Applied to Lake Husted, Lost Lake and the North Fork of the Big Thompson River, 18-19 August 1986. See Figure 16 for location of sites.

Site	Water		Antimycin		
	Flow (cms)	Volume (acf)	Concentration (µg/L)	Duration of Treatment (hours)	Total Units Applied
Lake Husted		75	4.0		7.00
Lost Lake		86	3.6		8.00
North Fork Sites:					
1	0.14		8.0	8	1.04
2	0.03			8	0.14
3	0.03			8	0.31
4	0.04			8	0.20
5	0.03			8	0.13
Spray outlet of Lost Lake					0.21
Total Sites 1-5	0.27		12.7	8	2.03
6	<0.01			8	0.05
7	<0.01			8	0.05
8	<0.01			8	0.05
* Total Antimycin to N.F (1 thru 8)	0.40		9.6*	8	2.18
12 KMnO ₄	0.40		1.0 mg/L	12	

*includes antimycin applied to 6 inlets at Lost Lake in 8 hours

Note: From site 1 to site 8, loss of 183 m in elevation. Fish reacted slowly to antimycin indicating a high loss of antimycin, although it only took 1.83 hours for the dye to travel from station 1 to station 8. An additional 4 µg/L should have been added at Lost Meadow (3195 m elevation) to compensate for the elevation loss.

Surveys

North Fork Big Thompson River. An electrofishing survey conducted in 1973 found no fish through the 1970 introduction site and it was assumed that the project had failed. However, a recruiting population of GBC was documented in 1978. Upstream migration of fish into shallow ponds below Lake Louise was observed in 1984. One fish collected from these shallow ponds was 393 mm in length with a condition factor (K) of 1.3.

During the 1986 restoration fish originating from the 1970 introduction were found to have migrated downstream and were co-existing with the dominant BKT population through the entire length of the North Fork upstream of Lost Falls. Of the 461 trout greater than 50 mm in length recovered between site 3 and the KMnO₄ station, 14.5% were GBC. In this section, BKT did not exceed 280

mm in length, while GBC to 304 mm in length were collected.

During an electrofishing survey conducted on 14 August 1986, BKT were found to have migrated around the small barrier at 3230 m, but were stopped by the small barrier at 3280 m. This new barrier is only a few meters below the GBC population established in 1970. Greenback cutthroat trout standing crop was estimated at 15.7 fish/100 m and 62.4 kg/ha above the stream junction at 3290 m.

The first survey conducted following the expansion of the North Fork project was on 6 September 1989. Electrofishing found GBC present in most pools from Lost Falls to the Sugarloaf Campsite with no fish found through Lost Meadow. Mean TL of fish sampled was 145 mm.

During hook-and-line surveys in 1993 a BKT was caught near Lost Meadow with no other BKT caught or observed in three hours of angling. A report of BKT being present was also made by RMNP Rangers in 1999. The 1986 removal of non-native fish from the North Fork was an unpopular project and it is believed that a deliberate reintroduction of BKT was made by a disgruntled resident.

In an effort to give the GBC a competitive advantage over BKT an electrofishing removal project was undertaken in August 2000. Kulp and Moore (2000) eradicated non-native fish using this type of project while Moore et al. (1986) and Thompson and Rahal (1996) eliminated over 95% of adult fish, effectively eliminating reproduction. One hundred thirty-five BKT (10.5 kg), representing 60% of fish captured, were removed from 1,800 m of the river above Lost Falls. Due to high water flows and dense vegetation only 1,300 m of the 1,800 m was electrofished using a two-pass method. Through the two-pass section GBC standing crop was estimated at 5.79 fish/100 m and 13.4 kg/ha for fish >100 mm. A few males and one female were still ripe. Brook trout standing crop was estimated at 10.53 fish/100 m and 17.12 kg/ha for fish >100 mm. This project will continue in 2001.

Lost Lake. Two gill nets set overnight in Lost Lake and retrieved on 6 August 1970 caught 9 BKT and 2 RBT-cutthroat trout hybrids (Mullen 1970). Mean TL of BKT was 344 mm (range=272-399 mm) and the TL of the hybrid cutthroat trout were 312 and 345 mm. Both hybrids were females with immature ovaries. The location of these net sets is unknown and not included in Table 16.

Many female BKT examined during surveys in 1978, 1983, and 1986 had abnormally developed ovaries. Testes of male fish were also observed to be abnormal in 1986. The cause of these abnormalities is not known but one possibility is the presence of parasites. Brook trout were found to be feeding on caddisflies, midges, mosquitoes, lady bugs, fish eggs, and moths in 1983.

Catch rates for GBC since the restoration have been higher than those for BKT prior to the restoration. A sharp decline in the gill net catch rate occurred from 1989 to 1990. No rises or fish were observed during visual surveys using lights in the evening in 1990. Although no fry have been observed during surveys some recruitment is occurring based on small sizes of fish collected in gill net and hook-and-line surveys.

Table 16. Summary of Lost Lake Gill Net Sampling, Outlet Trend Site, 1978-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
09/12/78*	BKT	293	210-356	0.72	-
07/22/83*	BKT	294	217-375	1.30	0.33
08/15/86*	BKT	325	250-356	0.76	0.27
09/06/89	GBC	217	168-275	37.00	4.04
09/05/90	GBC	194	135-240	5.00	0.52
08/24/93	GBC	252	156-360	3.50	0.82
06/30/98	GBC	212	152-340	9.75	1.52

* Overnight net set

- No data recorded

Lake Louise. Based on surveys by Bulkley (1958) and Mullen (1969), Lake Louise was fishless prior to 1970, despite stocking of “black spotted natives” in the 1930’s. It wasn’t until 1984 that fish from the 1970 stocking had worked their way up to the ponds below Lake Louise. Fish sampled here were close to 400 mm in length, the largest cutthroat trout observed at the time in RMNP.

The first gill net survey after the 1989 stocking was in 1993 (Table 17). An abundance of fish were still present. Some females had spawning scars and the males were without milt. Deformities such as short opercles and deformed pectoral fins were observed in 26% (6/23) of fish sampled. Analysis of stomach contents showed that fish were feeding on mosquitoes.

A visit to Lake Louise on 1 July 1998 found some fish spawning in the outlet at an afternoon water temperature of 12 °C. A gill net survey conducted on 26 September 1998, had a much lower catch rate than the 1993 survey. Fish were within a narrow range of length, which would seem to indicate that recruitment is not occurring in the lake. Deformities such as shortened jaws and deformed pectoral fins were observed in 33% (3/9) fish sampled.

Table 17. Summary of Lake Louise Gill Net Sampling, Outlet Trend Site, 1969-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
09/16/69	No fish caught in a 20 hour set				
08/25/93	GBC	240	210-276	23.0	2.44
09/26/98	GBC	265	255-273	9.0	1.35

Special Studies

Harig and Fausch (2000) conducted habitat surveys on 1.7 km of the North Fork above the barrier at 3280 m in 1997. These surveys were part of a study to predict translocation success based on habitat variables. An index of relative trout abundance of high was assigned to the North Fork with 62 GBC/km observed in pools. Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in the upper North Fork has a 36.2% chance of becoming fishless, a 52.5% chance of supporting low numbers of cutthroat trout, and a 11.3% chance of supporting high numbers of cutthroat trout. Habitat variables used to calculate these probabilities were as follows: 8.1EC mean daily July water temperature, 3.1 m mean bankfull pool width, and 18 pools with a residual depth $\geq$ 30 cm. The watershed area for this section of the North Fork population was estimated at 8.3 km².

A section of the North Fork of the Big Thompson River below Lost Meadow was selected as a site for the *Mechanisms for Displacement of Greenback Cutthroat Trout by Brook Trout in Montane Streams in Rocky Mountain National Park* study conducted by Claire McGrath (2000). Preliminary results are not yet available but fish were observed in the field to be opportunistically feeding on worms that were washed into the river by thunderstorms. One unidentified fry was also observed in a BKT stomach.

Angler Use

North Fork Big Thompson River. Bulkley (1959) reported that little fishing pressure is exerted in this remote area. Although a maintained trail parallels the North Fork and the Lost Lake outlet stream, it is a 13 km hike to the lowest section of this area. Despite several campsites along the North Fork fishing pressure can still be described as light. Most anglers who visit this area seem to prefer to fish at Lost Lake. Since the North Fork was opened to catch-and-release fishing in 1990 creel survey data has only been collected in one year (Table 18). In 1996, one angler fishing near Lake Louise reported catching 16 GBC in 4 hours and two anglers fishing above Lost Falls reported catching 13 GBC in 5 hours of fishing.

Lost Lake. Although Lost Lake is located 16 km from the closest trailhead it has access by a trail

Table 18. Summary of Fishery Statistics for the North Fork of the Big Thompson River, 1974-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1974	2.13	2	8	CUT
1986-1989	Closed to Angling			
1996	3.22	3	9	CUT

Table 19. Summary of Fishery Statistics for Lost Lake, 1960-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1960	0.55	11	59.0	BKT, CUT
1961	0.36	46	359.0	BKT, CUT
1962	0.53	12	108.0	BKT, CUT
1963	0.16	14	50.0	BKT
1964	0.41	14	68.0	BKT, CUT
1965	0.54	15	52.0	CUT, BKT
1966	0.44	1	32.0	CUT, BKT
1967	0.00	3	2.0	
1969	3.50	5	10.0	CUT, BKT
1974	0.00	2	6.0	
1984	0.25	2	4.0	RBT
1986-1989	Closed to Angling			
1990	4.20	4	6.5	CUT
1992	1.00	2	4.0	CUT
1994	1.25	3	4.0	CUT
1999	0.00	2	4.0	
2000	0.05	5	17.0	CUT

* In order of relative abundance

and several campsites. Due to its remoteness angling pressure can be described as moderate. Catch rates averaged 0.41 fish/hour in the 1960's (Table 19). Prior to the restoration anglers reported catching 0.44 fish/hour while catch rates since opening for catch-and-release angling for GBC in 1990 have averaged 1.04 fish/hour. In 1998 one angler reported catching fish all the way up the Lost Lake outlet stream until he got to the lake and then did not catch anything.

Lake Louise. Due to its remoteness, 17.3 km from closest trailhead, Lake Louise receives very little angler use. Lake Louise opened to catch-and-release angling in 1990 with only one angler

Table 20. Summary of Fishery Statistics for Lake Louise, 1976-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1976	0.00	2	1.0	
?-1990	Closed to angling			
1999	12.00	1	0.5	CUT

interviewed since then (Table 20).

Current Status

The section of the North Fork of the Big Thompson River above the barrier at 3280 m that was stocked in 1970, including Lake Louise, meets the requirements of a stable, self-sustaining population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998). Although no recruitment has been documented in Lake Louise there are no barriers between it and ponds located a few hundred meters below it where recruitment has been documented. The section of the North Fork between Lost Falls and the barrier at 3280 m, including Lost Lake, is not stable due to the presence of BKT in the stream habitats.

Although recruitment has not been documented in Lake Louise, this is based on limited gill net survey data. In spite of no small fish being observed in gill net surveys, other information on the physical habitat of the lake would seem to indicate that reproduction is possible. Outlet water temperatures were measured at 12 °C on 1 July 1998 and some fry were observed in the outlet on 30 August 2000. Fish probably start spawning in mid-June and emerge sometime in August. This should give fry enough time to gain weight to survive the winter. Spawning substrate in the outlet appears adequate and although Lake Louise is a headwater lake, a permanent snowfield provides adequate flows throughout the summer for egg incubation. A more detailed study of cutthroat trout reproduction in this area is planned for 2001.

Hidden Valley Creek

Hidden Valley Creek is located in the Fall River drainage in the central portion of eastern RMNP (Figure 18). Trail Ridge Road, the only road which transverses the park, parallels the creek for 2.7 km. The road, a picnic area, and an interpretive boardwalk bring thousands of people to Hidden Valley Creek. Greenback cutthroat trout inhabit 3.1 km of the creek from a cascade barrier at 2725 m to 2805 m. This section of the creek is mostly meandering stream through meadow and beaver ponds with short steeper sections connecting these areas. Grasses are the dominant vegetation through the meadows and ponded areas and conifers are the dominant vegetation along the steeper sections. Fall flows have been recorded between 0.04 and 0.06 cms.

Restoration

Hidden Valley was the first site for a roadside GBC restoration project in 1973. It was also the first site where the EPA approved antibiotic antimycin was used for removal of exotic fish species (BKT) in RMNP, and the first, and last, area where removal of non-native fish from a large beaver pond complex (Figure 17) was attempted. Following the treatment of approximately 1.6 km of stream and 2.4 ha of beaver pond habitat upstream of the barrier at 2725 m, the creek was restocked with 82 adult and sub-adult GBC from Como Creek in October of the same year (Mullen 1973).

Supplemental stockings of GBC to infuse new genetic material into the Hidden Valley Creek population occurred in 1989 and 1990. Six hundred thirty-two 161 mm fish were stocked in June

Figure 17. Hidden Valley Creek Beaver Ponds.

Figure 18. Map of Hidden Valley Creek Greenback Cutthroat Trout Restoration Project.

1989 and 736 fry were stocked into two locations in October 1990. Fish from these stockings came from the BFTC broodstock.

Surveys

In 1976 BKT were once again found in the creek, just downstream from the beaver pond complex (Stevens and Mullen 1976). In an attempt to control the BKT in the stream and beaver ponds, an electrofishing and fyke netting removal program was undertaken from 1977 to 1986. Each year the entire length of the creek was electrofished and fyke nets were set in the beaver ponds. All BKT collected were removed and all GBC collected were released. This program maintained the GBC population through 1986 (Figure 19).

To improve the stream BKT removal program, two stream sections were electrofished on 17 and 19 September 1985, and treated with sodium cyanide (NaCN) on October 22 to determine the effectiveness of the two methods in removing BKT. This experiment showed that the cyanide collection was almost 100% effective, compared to a 50% efficiency for a single pass of electrofishing. It was hoped that the cyanide treatment would decrease the number of BKT present in these two sections. However, electrofishing surveys in October 1986 found that the number of BKT in one section actually increased over 1985 (Table 21). Brook trout in the other section remained about the same as in 1985.

The results of this project demonstrates that the fall population of BKT downstream of the beaver ponds represents mainly migratory fish, not excessive carry-over of resident fish missed each year. Adults removed one week are replaced within a few weeks by others migrating downstream to

Figure 19. Relative Abundance of Fish Collected by Electrofishing at Hidden Valley Creek, 1977-1999. No sampling conducted in 1987, 1991-1994, and 1996. Numbers above bars are the total number of fish collected for that year.

Table 21. Brook Trout Population Removal From Hidden Valley Creek, 1985-1986. Section 1 extends from the boardwalk pond downstream to the picnic area and Section 2 extends from the picnic area downstream to the bridge.

Date	Section	Method	Number Removed	Range of Length (mm)
10/22/85	1	NaCN	20	45-220
10/23/86	1	Electrofishing	138	65-285
10/22/85	2	NaCN	51	65-294
10/23/86	2	Electrofishing	36	70-285

spawn. This migratory behavior has also been observed in the GBC. It is probably due to the limited spawning habitat present in the beaver ponds. Fish leave the beaver ponds to spawn and return once they are done spawning.

In 1987 funding was not available to conduct the BKT removal program. When the program resumed in 1988 BKT had become the dominant fish species in the creek. Brook trout removals in subsequent years did not change this and the program was halted. Limited sampling of the stream in 1995 and 1997 showed that BKT comprised over 98% of the fish in Hidden Valley Creek.

Another attempt at restoring Hidden Valley Creek will be done in the near future, due to the recent decline of the beaver population and ponds. To salvage as many fish as possible prior to restoration, the creek was electrofished extensively in 1998. The entire length of the creek above the barrier was electrofished at least once with meadow sections done up to three times. A total of 2,648 BKT were removed and stocked into waters adjacent to RMNP and all GBC sampled were replaced. These surveys found BKT to constitute 99.2% of the fish population. Only 20 GBC were sampled over the five days of electrofishing, with at least 4 of these fish believed to be recaptures. Cutthroat trout ranged from 42 to 250 mm TL with a mean of 196 mm. Fish removal was also conducted in 1999 along two sections of the creek. Six hundred forty-six BKT weighing 18.8 kg and 12 GBC were removed from the creek. Cutthroat trout ranged from 154 to 270 mm TL with a mean of 210 mm. The BKT were stocked outside RMNP while the GBC were marked by fin clipping and stocked into Lily Lake.

Special Studies

To document the mechanisms of competition between BKT and GBC, a study was funded by RMNP. This study was conducted in the stream habitat of Hidden Valley Creek by Dr. Kurt Fausch and Tim Cummings (1986) of Colorado State University.

The results of this study indicate that BKT juveniles were the dominant competitor, and excluded

juvenile GBC from energetically favorable stream positions. Evidence of interactions between GBC and BKT greater than 150 mm in length was minimal, so these interactions were not considered a major factor in cutthroat trout displacement. The authors also felt that low water years negatively impacted the cutthroat trout by reducing backwater habitat and forcing cutthroat trout fry into the main channel where they compete against larger fish and expend more energy to maintain position.

Hidden Valley Creek was included in the *Mechanisms for Displacement of Greenback Cutthroat Trout by Brook Trout in Montane Streams in Rocky Mountain National Park* study conducted by Claire McGrath (2000). In 386 m of stream only three GBC were captured compared to 79 BKT. Standing crop estimates for GBC >100 mm were 0.78 fish/100 m and 2.85 kg/ha. Standing crop estimates for BKT >100 mm were 20.46 fish/100 m and 88.22 kg/ha.

Angler Use

Starting in 1982, the beaver pond habitat of Hidden Valley Creek was opened to catch-and-release fishing for GBC and catch-and-kill fishing for BKT, from August 1 to March 31. This was done as an experiment to document the response of GBC to angling and to possibly control BKT through angling. Hidden Valley Creek was the first pure GBC population opened to public fishing. When it first opened this fishery was popular with the fly fishermen, with articles appearing in Fly Fishermen Magazine, Sports Afield, Trout Magazine, and Colorado Outdoor Journal.

The experimental angling program demonstrated that although BKT dominated the beaver pond population in 1982 (191:55), cutthroat trout provided the majority of the angler catch rate. From 1982 to 1986, anglers reported catching 0.86 to 1.6 GBC/hour and 0.4 to 1.34 BKT/hour, and released 45 to 64% of the BKT caught. Although anglers are encouraged to remove BKT from Hidden Valley Creek, anglers released them at about the same rate as they did throughout RMNP.

Some anglers had difficulty identifying the two species, with as many as 7% of the cutthroat trout caught mistakenly kept by anglers. To help reduce the amount of cutthroat trout taken by anglers, color signs were posted and handouts are available that have comparative color paintings of the two species.

Angler catch rates have reflected the decline of the GBC evidenced in electrofishing surveys. Since BKT became the dominant species in the creek in 1987 they have represented the majority of fish reported caught by anglers in most years and since 1994 (Table 22). No GBC were reported caught in 1996 or 1998. With the decline of the GBC in Hidden Valley Creek, fishing regulations were changed in 2000 to allow fishing year-round.

Starting in 1986 other areas containing GBC opened to caught-and-release angling. With the novelty that Hidden Valley Creek provided gone angler interest in this area declined. Despite its roadside location it currently receives little angling pressure. No anglers were interviewed in 2000.

Table 22. Summary of Fishery Statistics Hidden Valley Creek, 1961-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1961	4.00	5	7.8	BKT
1969	0.67	1	3.0	BKT
1971	0.00	13	10.0	
1972	0.57	16	28.0	BKT
1973	0.07	8	14.0	BKT
1974-1981	Closed to Angling			
1982	1.26	475	-	CUT, BKT
1983	1.32	248	-	CUT, BKT
1984	2.65	122	258.0	CUT, BKT
1985	3.01	42	124.5	CUT, BKT
1986	2.14	104	311.0	CUT, BKT
1987	1.00	76	213.1	BKT, CUT
1988	1.00	52	114.0	BKT, CUT
1989	6.42	14	33.0	CUT, BKT
1990	2.10	67	189.0	BKT, CUT
1991	4.10	50	92.4	BKT, CUT
1992	2.20	30	38.0	CUT, BKT, BNT
1993	2.96	13	8.1	CUT, BKT
1994	1.48	26	52.0	BKT, CUT, BNT, RBT
1995	1.62	108	60.4	BKT, CUT
1996	0.66	2	4.5	BKT
1997	3.06	7	15.0	BKT, CUT
1998	1.60	1	2.5	BKT
1999	1.50	3	6.0	BKT, CUT

* In order of relative abundance

- No data recorded

Watchable Fish

Once Hidden Valley Creek is restored again it would make an excellent area for a watchable fish and interpretive program for native and endangered species management. The roadside facilities attract thousands of visitors annually. The interpretive boardwalk currently has signs pertaining to beavers. Since there currently is no beaver activity in this area, some of these signs can be converted to GBC interpretive signs or new signs can be added.

Current Status

Hidden Valley Creek does not meet the requirements of a stable, self-sustaining population as

defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998). Due to its roadside location and accompanying facilities, thousands of people visit Hidden Valley Creek annually. Because of this it is considered a valuable area to have GBC for educational and interpretive purposes. Another attempt at restoration was not considered due to the difficulty in removing BKT from the beaver ponds and the associated complex of tunnels and backwaters. However, in the early 1990's the beaver population started to decline and by 2000 only a few ponds remained during periods of low flow. This low cycle in the beaver and native willow populations provides for an opportunity to more effectively remove BKT. Another attempt at restoration of the area will be done in the near future following removal of an old ski area and restoration of habitat at the headwaters of the creek by RMNP and improvements to the barrier.

Bear Lake

Bear Lake (Figure 20) is located at the end of Bear Lake Road at an elevation of 2895 m in central RMNP (Figure 21). Due to easy access by the road it is a very popular lake with very heavy visitation. The surface area is 4.5 ha with a maximum depth of 11 m. A gradient barrier exists about 0.1 km below lake preventing migration of non-native fish into the lake. Good spawning habitat exists in the outlet with limited spawning habitat existing in the inlet. In spite of the habitat in the outlet the GBC spawn exclusively in the inlet. The shoreline is comprised of conifers and rock.

Restoration

In October 1975 BKT were removed from Bear Lake with antimycin, and restocked with 50 adult and about 15 sub-adult GBC from Como Creek on 11 November 1975 (Mullen 1975). Since survival and reproduction of the 1975 stocking appeared poor based on surveys from 1977 to 1981, 432 GBC at 150 mm in length from BFTC were stocked in 1981.

Figure 20. Bear Lake.

Figure 21. Map of Bear and Dream Lakes Greenback Cutthroat Trout Restoration Projects.

In an attempt to establish a spawning run in the outlet and improve the genetic diversity of the population several stockings were made into the outlet stream. Two hundred GBC sac fry from BFTC were stocked on 11 July 1984, 500 fry were stocked in September 1987, and 271 fish at 161 mm in length were stocked in June 1989.

Gamete Collection

About 600 fertilized eggs were collected from GBC spawning in the inlet in 1989. These eggs were used to help start the CDOW FRH captive broodstock.

Surveys

During restoration a standing crop of 27.5 kg/ha was estimated based on pick up and observation of dead BKT. This estimate includes a correction factor for fish not observed.

Surveys from 1977 up to the 1981 stocking found no fish. These surveys consisted of electrofishing the inlet and outlet streams, netting the lake, and sonar.

The diffuse inlet stream was consolidated it into one channel by a Youth Conservation Corps (YCC) crew in 1978. The increased water velocity caused by the stream consolidation improved spawning habitat by exposing gravel which had been buried by silt. Conditions in the outlet also improved following the installation of fencing around the degraded banks by the YCC in 1978. However, outlet spawning has not been observed.

Inlet spawning activity by GBC was first observed on 7 July 1982, with successful inlet reproduction documented in October 1982. Two year classes of fish (160 and 250 mm) were caught in fyke nets in July 1982 indicating reproduction had occurred prior to the 1981 stocking. Since 1982 inlet spawning has been observed annually. Typically spawning begins between late May to late June depending on the severity of the previous winter.

Fyke net surveys were conducted near the inlet and outlet in 1982, 1984-86, and 1989. In all years except 1985 surveys were conducted in the spring during fish spawning. All spring net sets near the inlet caught several year classes of fish. The 1985 survey was conducted in September and no fish were caught. No fish were caught in nets set near the outlet during any of these surveys. In 1986 spawning fish appeared to serve as a food source for other species (raccoons?), with gill covers, fins, and cached fish found near the inlet.

No sampling of fish has been conducted at Bear Lake since 1989 due to possible conflicts with visitors. However, based on observations of spawning fish the GBC population in Bear Lake is in good condition. Fish appear healthy and several year classes are present each year.

Angler Use

Due to the conflicts between anglers and non-anglers at this popular vista, Bear Lake was closed to all angling in 1962 and will probably never be open to sport angling. A summary of fishery statistics prior to the lake closing to angling can be found in Table 23.

Table 23. Summary of Fishery Statistics for Bear Lake, 1958-1962.

Year	Fish/Hour	# Anglers	Total Hours	Species Reported Caught*
1958	0.16 [^]	-	3728.0 [^]	BKT, RBT
1959	0.36 [^]	-	6028.0 [^]	BKT, RBT
1960	0.70	20	60.0	RBT, BKT
1961	0.90	12	30.0	BKT, RBT, CUT
1962	Closed to angling			

* In order of relative abundance

[^] Estimated totals for year, not actual counts

- No data recorded

Watchable Fish

Each spring an impressive number of large GBC, up to 500 mm, concentrate in the inlet for spawning. Due to the size of Bear Lake fish and the number of Bear Lake visitors, this area would make an excellent place for a watchable fish program. Currently a paved interpretive trail which encircles the lake passes over the inlet stream (Figure 22). However, vegetation limits visibility of spawning fish. Construction of a viewing platform with an interpretive sign and the presence of a knowledgeable interpreter or volunteer would provide for an excellent opportunity to educate the public about native fish restoration.

Current Status

Although inlet spawning habitat is limited and surveys have not been conducted since 1989, Bear Lake should be considered as a stable, self-sustaining GBC population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998). An abundance of fish in several year classes are observed spawning in the inlet annually.

Figure 22. Bridge Over Bear Lake Inlet Greenback Cutthroat Trout Spawning Area.

West Creek

West Creek is located within the West Creek Research Natural Area in northwestern RMNP (Figure 24). The lower extent of this GBC restoration project is West Creek Falls (2485 m). Fish extend for 3 km above the falls to a barrier at 2720 m. The gradient through this section is high with several barriers limiting upstream movement of fish. Downed trees falling from the steep slopes along the creek create an abundance of dammed pool habitat. However, low water temperatures and the lack of slow water nursery areas for young fish may be limiting GBC in West Creek.

Restoration

Brook trout were removed with antimycin from 2.4 km of stream habitat above West Creek Falls in 1978. In 1979, 58 adult and sub-adult GBC from Hidden Valley Creek were stocked into meadows at an elevation of 3050 m. Additional stocking of fish from the BFTC broodstock were made in

Figure 23. West Creek Falls.

Figure 24. Map of West Creek Greenback Cutthroat Trout Restoration Project.

1984, 1987, and 1989. One hundred immature fish at 140 mm were marked with an adipose fin clip and stocked at 2625 m on 11 July 1984. In September 1984, 500 fry were stocked into the meadows at 3050 m, and 2,000 fry were stocked in 1987 and 1989.

Surveys

Standing crop of BKT following the restoration was estimated at 24.67 fish/100 m and 56 kg/ha. These estimates were based on the pick up of dead fish plus a 20% correction factor for dead fish not observed. Fish stocked in the upper meadow in 1979 were still present during electrofishing surveys in 1980, 1983, and 1986. However, no reproduction was documented.

Electrofishing surveys in 1986, 1988, and 1989 found marked fish stocked in 1984 were still present at or near the stocking site. Very few fish were caught between West Creek Falls and the stocking site. Cutthroat trout were also found below the falls in 1983, 1986, and 1988.

In 1999 standing crop was estimated at 12.03 fish/100 m and 17.3 kg/ha for fish > 100 mm based on an electrofishing survey conducted just above West Creek Falls. The mean TL of the fish sampled during this survey was 179 mm (range=137-242 mm).

Another more extensive electrofishing survey was conducted in 2000 using methodology developed by Dr. Michael K. Young, USDA Forest Service. This survey was conducted on the first 800 m above West Creek Falls. Standing crop was estimated at 16.89 fish/100 m and 42.28 kg/ha. Mean TL of fish sampled was 195 mm (range=120-242 mm). The lengths of fish collected would indicate that recruitment is taking place.

Special Studies

Harig and Fausch (2000) conducted habitat surveys on West Creek in 1998 as part of a study to predict translocation success of cutthroat trout based on habitat variables. The creek was surveyed from West Creek Falls to a series of cascades at 2867 m, a total of 5 km. One or two fish were observed in most pools, from West Creek Falls to the barrier at 2720 m, a total of 3 km. Only a few small fish, 80 to 90 mm in length, were observed. West Creek was assigned a population status of low with 16.4 fish/km observed in pools over the entire length of the survey section. The density for the inhabited section of the creek was 27.3 fish/km observed in pools.

Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in West Creek has a 5.7% chance of becoming fishless, a 39.6% chance of supporting low numbers of cutthroat trout, and a 54.7% chance of supporting high numbers of cutthroat trout. Habitat variables used to calculate these probabilities were as follows: 7.1 EC mean daily July water temperature, 4.1 m mean bankfull pool width, and 117 pools with a residual depth $\geq$ 30 cm. The watershed area of West Creek was estimated at 25.3 km². Although the probability to support high numbers of cutthroat trout is high based on this model, it is believed that low water temperatures and lack of nursery areas for young fish will always inhibit GBC in West Creek.

Angler Use

Prior to the restoration of West Creek, catch rates averaged 2.36 fish/hour (Table 24). Since the 2000 electrofishing survey found that fish numbers are high enough to support angling without serious negative impacts, West Creek will be open to catch-and-release angling in 2001. It is believed that difficult access caused by downed timber and topography will limit fishing pressure.

Table 24. Summary of Fishery Statistics for West Creek, 1958-1978. This data is for the entire length of West Creek within RMNP, the majority of it is probably from below West Creek Falls.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	3.71	-	49.1	BKT, CUT
1959	1.61	-	98.8	BKT, CUT
1963	3.25	1	10.0	BKT, CUT
1975	2.00	1	4.0	BKT
1978-2000	Closed to angling			

* In order of relative abundance

- No data recorded

Current Status

Although West Creek meets the minimum requirements for biomass, and year classes of fish present based on the 2000 electrofishing survey, it does not meet the 500 fish minimum requirement to be considered a stable, self-sustaining population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

West Creek, Below West Creek Falls

The best trout habitat of West Creek is downstream of West Creek Falls, and outside of RMNP. In accordance with the Recovery Plan, the Forest Service completed a fish barrier 2.4 km downstream of the West Creek Falls in 1984. Due to problems with this barrier, and abnormally high water flows during 1984, removal of BKT from this area was postponed until 1985.

In 1985, a public hearing was held on the pending West Creek project. It was thought there was little public interest in the project, and the meeting was mainly held to inform people of the project. However, negative comments were received from Glen Haven residents. Another public meeting held in 1986, found citizens of Glen Haven remaining opposed to the projects. Following the 1986 meeting, a petition against the project was circulated. A congressional letter was received along with threats to blow up the barrier and restock BKT.

Due to the severity of the public comments on the project compared to the amount of habitat to be gained, the Forest Service delayed this project for a minimum of five years. To date this area has not been restored.

Greenback cutthroat trout were collected in this section of West Creek (below West Creek Falls) when sampled in 1983, 1986, and 1988. Additional reports of cutthroat trout being caught below the Forest Service barrier were received through 1992. A single pass electrofishing survey was conducted in 1999 a few hundred feet below West Creek Falls. No GBC were sampled in this survey, however one was observed within the survey section. Angling surveys in 2000 caught cutthroat trout as far as 1 km below West Creek Falls. Pools below the falls consisted of approximately 50% cutthroat trout based on angling and visual observations.

Ouzel Lake and Creek

Ouzel Creek is located within the North St Vrain drainage in the southeast portion of RMNP (Figure 26). The lower barrier for this restoration project is Ouzel Falls (2885 m). Above the falls the creek runs for 1.5 km through a treeless area caused by a 1978 forest fire before it enters conifer forest for another 1.3 km to Ouzel Lake (3050 m). This section of the creek is characterized by an abundance of large woody debris dammed pools. Ouzel Lake (Figure 25) is shallow (1 m maximum depth) with a surface area of 2.6 ha. Shoreline vegetation consists of conifers with soft, boggy areas. August outlet flows have been measured between 0.42 and 0.68 cms. Another barrier exists above the lake. Below this barrier BKT and GBC are present. The creek above the barrier to another barrier at an elevation of 3230 m, a total of 1 km, is inhabited only by GBC. This section of the creek consists mostly of riffle with few pools.

Restoration

On 12 August 1980, BKT and hybrid cutthroat trout were removed with antimycin from Ouzel Lake and 4.7 km of Ouzel Creek upstream from Ouzel Falls (Figure 26 and Table 25). Following the restoration, this area was stocked with GBC from the BFTC broodstock in 1981, 1982, and 1983. During this three year period, 17,940 fish were stocked into Ouzel Lake and 15,160 were stocked into Ouzel Creek.

Surveys

Ouzel Lake. Based upon collection of dead fish after treatment with antimycin, Ouzel Lake

Figure 25. Ouzel Lake.

Figure 26. Map of Ouzel Lake and Creek Greenback Cutthroat Trout Restoration Project. Numbers correspond to the antimycin application sites in Table 25.

contained 2,366 fish weighing 140 kg (53.8 kg/ha).

Greenback cutthroat trout fry were first observed in the outlet stream in 1983 and in the inlet stream in 1984. The spawning period for Ouzel Lake GBC typically starts in mid-June and extends to mid-July.

Since 1983, the mean TL of GBC caught in gill net surveys has increased at both the inlet and outlet trend sites almost every time the lake has been surveyed (Tables 26 and 27). This pattern is usually observed in lakes that are not recruiting, however an abundance of fry are observed annually in both the inlet and outlet streams and small fish are being caught in the surveys. Brook trout were documented to have returned to the lake in the 1998 gill net survey, although they were reported to be in the lake in 1995 by anglers.

Lower Ouzel Creek. Following the restoration a total of 1,829 fish were removed and measured, from the outlet of Ouzel Lake to Ouzel Falls. This correlates to 81 fish and 3.4 kg per 100 m of stream. Cutthroat trout collected were up to 330 mm in length, while BKT did not exceed 260 mm in length.

Electrofishing surveys conducted in 1982, 1983, and 1984 found no BKT in the stream, other than the one found in the outlet of Ouzel Lake in 1983. However, on 12 September 1985, an electrofishing survey of collected three year classes of BKT. The area where they were caught was below a small barrier 0.5 km downstream of Ouzel Lake where the stream divided into several channels and back waters, and was treated three times during the 1980 antimycin project.

Table 25. Amounts of Antimycin and Rotenone Applied to Ouzel Lake and Ouzel Creek, 12 August 1980. See Figure 26 for location of sites.

Site	Water		Antimycin(A) or Rotenone®		
	Flow (cms)	Volume (acf)	Concentration	Duration (hours)	Amount Applied(mls)
1. Bluebird Lake	0.16		8.3 µg/L A	5	255 A
trail crossing			1.0 mg/L R	1	1100 R
2. Junco/Ouzel	0.32		8.1 µg/L A	5	470 A
Creek Jct			1.0 mg/L R	1	1100 R
3. 3170 m	0.32		8.1 µg/L A	5	470 A
			1.0 mg/L R	1	1100 R
4. Main Lake Inlet					
@ 3110 m	0.32		8.0 µg/L A	8	800 A
5. Inlet 1-2	<0.01			8	107 A
6. Inlet 3	0.02			8	247 A
7. Inlet 5	0.30			8	150 A
8. Inlet 6	<0.01			8	107 A
9. Ouzel Lake		16.0	9.8 µg/L A	slug	940 A
		with inlets			
10. Ouzel Outlet	0.38		8.7 µg/L A	8	940 A
11. 3025 m	0.38		4.0 µg/L A	8	470 A
12. 2995 m	0.44		3.7 µg/L A	8	470 A
13. 2975 m	0.44		3.7 µg/L A	8	470 A
14. 2940 m	0.44		3.7 µg/L A	8	470 A
15. KMnO ₄	0.44		1.0 mg/L	11	

First dead fish appeared at 1100 hours at Ouzel Lake and 1315 hours at site 12.

In addition to the above antimycin, one unit of antimycin was sprayed to the swampy area upstream from the inlet of Ouzel lake. Another unit of antimycin and 0.5 unit of antimycin sand was sprayed to the swampy area between sites 12 and 13 on 12 August. On 13 August another unit of antimycin was sprayed between sites 12 and 13.

To determine if BKT were isolated below the one small barrier, the stream section above the barrier to Ouzel Lake was sampled with NaCN in 1985, 1986, and 1987. No BKT were found above this barrier until 1987, when adults were found in small numbers all the way to another barrier 50 m downstream of Ouzel Lake.

The barrier just downstream of Ouzel Lake was improved by the RMNP Resource Crew in 1988, but one BKT was found in the inlet in October 1988. No BKT were found above this barrier in 1989. Marked cutthroat trout from a population study in Ouzel Lake were present below the barrier in 1988

Table 26. Summary of Ouzel Lake Gill Net Sampling, Inlet Trend Site, 1984-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
09/13/84	GBC	163	123-205	64.7	3.29
09/12/85	GBC	187	151-230	76.5	4.23
08/21/87	GBC	207	172-240	13.0	2.23
08/05/88	GBC	204	170-237	13.0	1.30
10/12/89	GBC	217	128-260	8.0	0.90
09/21/91	GBC	238	199-266	22.7	3.18
10/07/93	GBC	250	206-270	3.2	0.47
09/08/98	GBC	286	286	1.0	0.21

and 1989, indicating that fish were unable to return to the lake after descending the barrier to spawn. Below the barrier, good numbers of spawning cutthroat trout were present in 1987 and 1988, but no fry were captured during electrofishing surveys in October 1989.

An electrofishing survey conducted in 1991 at a trend site above Ouzel Falls showed that 85% of the fish sampled were BKT. The same site was sampled in 1998 with 91% of fish collected being BKT.

Standing crop for cutthroat trout > 100 mm was estimated at 13.12 fish/100 m and 23.63 kg/ha. Mean TL of cutthroat trout sampled was 210 mm (range=195-223 mm). Standing crop for BKT >

Table 27. Summary of Ouzel Lake Gill Net Sampling, Outlet Trend Site, 1979-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/16/79*	BKT	203	114-251	1.9	0.19
09/09/83	GBC	115	110-120	0.4	-
09/13/84	GBC	173	136-191	-	-
09/12/85	GBC	181	143-223	16.7	-
10/08/86	GBC	197	170-216	9.3	0.73
08/21/87	GBC	211	196-224	7.0	1.18
09/08/98	GBC	268	204-346	51.2	10.16
	BKT	304	209-396	17.1	5.24^

- No data recorded

* Overnight net set

^ This number is low, two fish exceeded capacity of scale being used

100 mm was estimated at 144.32 fish/100 m and 176.84 kg/ha. Mean TL of all BKT sampled was 193 mm (range=60-246 mm). All BKT sampled were removed from this section. This trend site was included in a larger stream reach as part of a study by McGrath in 2000. Cutthroat trout represented only 5% of fish caught by electrofishing.

An increase in BKT has also been observed at a trend site below the small barrier downstream of Ouzel Lake. In 1993, BKT accounted for 18% of fish sampled at this location. By 1998 they represented 55% of the fish caught. Standing crop for BKT > 100 mm was estimated at 90.03 fish/100 m and 136.39 kg/ha. Mean TL of BKT was 204 mm (range=159-262 mm). Standing crop for cutthroat trout >100 mm was estimated at 72.81 fish/100 m and 126.53 kg/ha. Mean TL of cutthroat trout was 215 mm (range=110-309 mm). This trend site was also included in a larger stream reach as part of McGrath's study in 2000. Her study reach ended at the same place as the trend site (the barrier just downstream of Ouzel Lake), but extended 337 m further downstream of where the trend site begins. Cutthroat trout accounted for 12% of fish collected throughout the whole reach, however cutthroat trout were more abundant closer to the lake.

This data, plus the fact that BKT were found in Ouzel Lake for the first time in 1998 indicates that the GBC population in lower Ouzel Creek is in serious decline. In an effort to give them a competitive advantage, a BKT removal project was conducted in 1999. Kulp and Moore (2000) eradicated non-native fish using this type of project while Moore et al. (1986) and Thompson and Rahal (1996) eliminated over 95% of adult fish effectively eliminating reproduction. However, the streams that these studies were conducted in was smaller and less complex than Ouzel Creek. High flows and the abundance of downed trees greatly limited capture efficiency. In 2000 cutthroat trout only represented 5% of fish present through the removal reach based on data collected by McGrath.

During the removal, 588 BKT weighing 37.5 kg were removed from a 1,676 m reach of the creek using single pass electrofishing. A limited number of BKT were measured with adults (i. e. fish > 100 mm) having a mean TL of 197 mm (range of all fish=40-262 mm). Thirty-four GBC or 5.4% of fish collected were sampled over the same stretch. Adult GBC had a mean TL of 219 mm (range of all fish=41-260 mm).

Upper Ouzel Creek. No quantitative surveys have been conducted on this section of Ouzel Creek. Following the 1980 antimycin treatment, 5.6 fish/100 m of stream were collected from this section. A hook-and-line survey conducted on 27 July 2000 found all fish in good condition. Mean TL of fish was 306 mm (range=260-362 mm). Males exhibited bright spawning coloration and no BKT have been observed in this section.

Special Studies

A Petersen mark-recapture population estimate was conducted at Ouzel Lake in August 1987, 1988, and 1989 by Rip Shively (1990) of Colorado State University. In August 1987, 745 GBC were caught in 39.15 hours of angling (19.02 fish/hour) over two days. The fish were marked with a fin clip and returned to the lake. Gill netting of the lake caught 20 fish of which 6 were marked with a fin clip. A population estimate of 2,238 fish and a standing crop estimate of 61 kg/ha was calculated.

Due to low number of recaptures in the net, the 95% C. I. on this estimate is 1137 to 6772 fish. These estimates are very similar to those following the treatment of the lake in 1980.

In 1988, the population was estimated at 2,273 fish (95% C.I.=1,755 to 2,791 fish) and standing crop was estimated at 71.2 kg/ha. A population of 1,838 fish (95% C. I.=1,520 to 2660 fish) and a standing crop of 69.14 kg/ha was estimated in 1989.

Habitat surveys were conducted by Harig and Fausch (2000) through the allopatric GBC population of upper Ouzel Creek in 1997 as part of a study to predict translocation success based on habitat variables. Thirty-six fish/km were observed in pools in this 1 km section. A population status of low was assigned. Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in upper Ouzel Creek has a 48.9% chance of becoming fishless, a 44.1% chance of supporting low numbers of cutthroat trout, and a 7.1% chance of supporting high numbers of

Table 28. Summary of Fishery Statistics for Ouzel Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	2.00	-	237.5	BKT
1960	1.85	12	33.0	BKT, CUT
1961	0.74	14	129.0	BKT, CUT
1962	0.70	4	20.0	BKT
1963	0.95	15	42.0	BKT, RBT, CUT
1965	1.68	8	31.0	BKT, CUT
1966	0.41	29	229.0	BKT, RBT, BNT
1967	1.23	36	97.0	BKT, CUT, RBT
1968	1.43	20	58.0	BKT, CUT
1969	2.17	66	126.0	BKT, CUT, RBT
1972	5.00	1	2.0	-
1974	1.17	11	36.0	BKT, CUT
1976	0.65	5	7.8	BKT
1980-1985	Closed to angling			
1986	3.10	12	28.0	CUT
1992	5.00	1	3.0	CUT
1995	3.29	2	7.0	BKT, CUT
1998 [^]	1.34	5	23.0	BKT, CUT
1999	0.84	5	13.0	CUT
2000	1.46	3	7.5	BKT, CUT

* In order of relative abundance

- No data recorded

[^] Anglers reported their location Ouzel Lake and Ouzel Creek

cutthroat trout. Habitat variables used to calculate these probabilities were: 6 EC mean daily July water temperature; 4.1 m mean bankfull pool width and 12 pools with a residual depth $\geq$ 30 cm. The watershed area for upper Ouzel Creek was estimated at 7 km².

As previously mentioned, two sites on Ouzel Creek were included in the *Mechanisms for Displacement of Greenback Cutthroat Trout by Brook Trout in Montane Streams in Rocky Mountain National Park* study conducted by Claire McGrath (2000). Preliminary results are not yet available other than what appears in the surveys section.

Angler Use

Ouzel Lake. Considerable angling pressure was reported in 1962 due to the fact that Ouzel Lake is on a maintained trail (Azevedo and Wallis 1962). Currently angling pressure can be described as moderate. Ouzel Lake has campsites and is 7.9 km from the closest trailhead. Catch rates since opening to catch-and-release angling for GBC in 1986 have averaged 2.19 fish/hour (Table 28). Prior to the restoration, catch rates averaged 1.30 fish/hour.

Ouzel Creek. Fishing pressure on most of Ouzel Creek can be described as light, while pressure on the section just below Ouzel Lake is moderate. Access to the lowest section of the creek above

Table 29. Summary of Fishery Statistics for Ouzel Creek, 1960-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1960	2.50	2	8.0	BKT
1961	0.61	11	62.0	BKT, CUT
1963	0.25	20	80.0	BKT
1964	0.52	11	140.0	BKT, CUT
1966	1.50	1	2.0	BKT
1969	3.88	6	17.0	CUT
1976	6.00	1	0.5	BKT
1980-1985	Closed to angling			
1987	1.40	3	19.0	CUT
1988	2.60	3	36.0	CUT
1990	1.90	9	27.0	CUT, BKT
1992	3.40	5	18.0	CUT, BKT
1997	3.00	4	12.0	CUT, BKT, RBT
1998 [^]	1.34	5	23.0	BKT, CUT
2000	7.33	2	4.5	BKT, CUT

* In order of relative abundance

[^] Anglers reported their location Ouzel Lake and Ouzel Creek

Ouzel Falls requires a hike of 2 km. Catch rates prior to the restoration averaged 0.72 fish/hour, while they averaged 2.16 fish/hour since the restoration (Table 29).

Current Status

With the decline of the GBC in lower Ouzel Creek and the inability to remove the BKT present by electrofishing it has been decided to let nature takes its course and restore the creek again when there are very few cutthroat trout present. The allotropic GBC population above Ouzel Lake does not meet the requirements of a stable, self-sustaining population defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Fern Lake and Creek

Fern Lake and Creek is located in the central portion of RMNP within the Big Thompson River drainage (Figure 28). This GBC restoration project starts at Fern Falls (2680 m) and runs through Fern Lake (2900 m) to a gradient barrier at 2940 m, a total of 1.4 km of stream and 3.7 ha of lake. The creek is high gradient and conifers are the dominant riparian vegetation. August flows of 0.20 to 0.32 cms have been measured. Fern Lake (Figure 27) has a surface area of 3.7 ha, a maximum depth 9.5 m, and contains very good inlet and outlet spawning habitat. Shoreline vegetation consists mostly of conifers with some grass along the east shore.

Restoration

Brook trout and a few hybridized cutthroat trout were removed with antimycin from Fern Lake and Fern Creek upstream of Fern Falls on 2 September 1982. Fern Lake was restocked with a total of 13,159 GBC from BFTC from 1982 to 1984. Annual lake stocking rates ranged from 135 fish/ha

Figure 27. Fern Lake.

Figure 28. Map of Odessa Lake and Fern Lake and Creek Greenback Cutthroat Restoration Projects.

to 1800 fish/ha, with a total of 3,556 fish/ha stocked over the three year period. Stocking at this rate produced fish to 220 mm in two years, compared to five years to produce 220 mm fish in Ouzel Lake at a total stocking rate of 5,184 fish/ha over three years. Fern Creek was stocked with 2,432 fish 27 to 44 mm in length from BFTC from 1982 to 1985. Annual stocking rates were 415 fish/km to 785 fish/km, with a total of 1,737 fish/km stocked in three years.

Surveys

Fern Lake. Males captured in 1984 and 1985 were running milt in the fall. Females captured in September 1985 contained eggs ready for spawning in 1986, with spawning first observed in the outlet on 9 July 1986. Based on surveys since 1986, spawning typically begins in the outlet in late June with inlet spawning beginning a week after the outlet. Fry were first observed in the inlet on 17 September 1987.

Based upon gill net survey data, cutthroat trout numbers and weight exceeded the previous BKT population by 1985 (Table 30). Some genetic deformities were observed in fish during the 1985 survey. Gill net catch rates are somewhat cyclical but they remain high enough to indicate there is a good population of GBC in Fern Lake. Fish have been observed feeding mostly on terrestrials insects (mosquitoes and chironomids).

Table 30. Summary of Fern Lake Gill Net Sampling, Outlet Trend Site, 1975-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/28/75*	BKT	198	127-368	1.6	0.17
10/12/84*	GBC	216	190-231	0.8	0.08
09/18/85	GBC	165	97-226	4.4	0.21
09/17/87	GBC	211	175-223	1.6	0.22
10/12/90	GBC	242	228-265	3.5	0.45
07/09/91	GBC	246	210-280	10.5	1.51
09/26/91	GBC	225	165-292	7.0	0.81
07/09/92	GBC	244	163-299	17.0	2.15
06/25/93	GBC	252	242-270	16.0	2.28
10/12/93	GBC	257	237-293	7.0	0.84
08/03/00	GBC	259	235-270	5.3	0.92

* Overnight net set

Fern Creek. Fish to 230 mm were caught during electrofishing surveys on 18 September 1985. Standing crop was estimated at 37.16 fish/100 m and 23.37 kg/ha for fish > 100 mm based on an electrofishing survey above Fern Falls in 1988. Fish sampled ranged in TL from 45 to 215 mm. In 1991, another survey was conducted at the same site. Standing crop was estimated at 22.43 fish/100 m and of 24.19 kg/ha of fish >100 mm. Fry were found to be abundant.

Special Studies

Harig and Fausch (2000) conducted habitat surveys on Fern Creek above Fern Falls in 1996 as part of a study to predict translocation success based on habitat variables. Fern Creek was assigned a population status of high, with 25 fish/km observed in pools. Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in Fern Creek has a 5.3% chance of becoming fishless, a 38.1% chance of supporting low numbers of cutthroat trout, and a 56.6% chance of supporting high numbers of cutthroat trout. Habitat variables used to calculate these probabilities were: 7.7 EC mean daily July water temperature; 4.5 m mean bankfull pool width and 56 pools with a residual depth $\geq$ 30 cm. The watershed area for Fern Creek was estimated at 6.8 km²

Angler Use

Fern Lake. Fern Lake is a popular destination with access by trail from Bear Lake (7.9 km) or the Fern Lake trailhead (6.1 km). A number of campsites exist at Fern Lake and the surrounding area. When populated with BKT, volunteer creel survey reported anglers catching 0.74 fish/hour, from 1958 to 1976 (Table 31). Since 1986, when Fern Lake opened to catch-and-release angling for GBC,

Table 31. Summary of Fishery Statistics for Fern Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1958	0.85	-	-	-
1961	0.32	14	149.0	BKT, RBT
1962	0.18	13	120.0	BKT, RBT, CUT
1963	0.05	10	20.0	BKT
1964	1.15	23	161.0	BKT, CUT, RBT
1965	0.70	41	188.0	BKT, RBT, CUT
1966	0.40	18	150.0	BKT
1967	0.78	19	55.0	BKT, CUT, RBT
1968	1.34	24	129.0	BKT, RBT, CUT
1969	0.96	43	132.0	BKT, RBT, CUT
1972	3.33	3	6.0	BKT
1973	0.40	4	10.0	BKT
1974	0.33	2	3.0	BKT
1976	1.38	10	21.0	BKT, RBT, BNT
1982-1985	Closed to angling			
1986	2.44	47	63.0	CUT
1987	5.48	10	13.5	CUT
1988	4.40	8	14.5	CUT
1989	6.00	7	7.0	CUT
1990	6.00	1	1.0	CUT
1992	4.20	6	10.0	CUT
1994	2.00	2	2.0	CUT
1996	6.10	5	9.8	CUT
1998	2.33	10	34.8	CUT
1999	0.20	2	20.0	CUT
2000	3.53	5	19.5	CUT

- No data recorded

catch rates have averaged 3.19 fish/hour.

During tissue collection in 2000, 19% (6/31) of fish caught exhibited hook torn jaws. Another two exhibited eye deformities. Fishing regulations are posted along the trail and at the lake itself and with a ranger patrol cabin located at the lake there is a regular ranger presence. However, some anglers still seem to be using barbed hooks here. This type of damage was not observed in fish at Spruce Lake, about 1 km away, which receives less visitation but is well known by locals who are more familiar with the regulations.

Table 32. Summary of Fishery Statistics for Fern Creek, 1976-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1976	0.63	9	12.8	BKT
1982-1985	Closed to angling			
1989	4.00	1	2.0	CUT

Fern Creek. Fern Creek receives little fishing pressure, probably due to the abundance of good lake fishing close by and the steep terrain. Thus limited creel data exists for Fern Creek (Table 32).

Current Status

Fern Lake and Creek are in very good condition and meet the requirements of a stable, self-sustaining population as defined by the Greenback Cutthroat trout Recovery Plan (USFWS 1998).

Odessa Lake

Odessa Lake (4.5 ha, maximum depth 6.7 m) is located on Fern Creek upstream of Fern Lake at an elevation of 3050 m (Figure 28). The lower limit of this GBC population is a gradient barrier about 0.2 km below the lake. This barrier separates this population from the Fern Lake and Creek restoration project. The shoreline is comprised of conifers and rock with bogs located along the west shore. The outlet stream is mostly riffle with few spawning areas. A few large pools which contain fish exist close to the barrier. Good spawning substrate exists in the west inlet, however it appears that low water temperatures limit reproduction.

Restoration

In the 1920s and 1930s Odessa Lake was stocked with BKT, RBT, and “black spotted natives” (Guse 1962a). From 1939 until 1968, when the stocking of non-native fish ceased in RMNP, cutthroat trout were stocked into Odessa Lake. A 15 hour gill net survey in 1980 did not catch any

Figure 29. Odessa Lake.

fish. At that time the lake was believed to be fishless.

The lake was stocked with 1,120 fry in 1984 and 1,100 fry in 1985 from the BFTC broodstock, for an annual stocking rate of 247 fish/ha. These stockings were done as an experiment to determine if GBC could survive in this lake when other species could not. The final experimental stocking of Odessa Lake was in September 1989, when 4,000 fish were stocked.

Surveys

When sampled by gill net in 1986, Odessa Lake GBC ranged in length from 110 to 230mm (Table 33). The biggest surprise of this survey was the destruction of the gill net in mid-water, and consumption of many of the fish in the net by what appears to have been an otter. Otters were introduced into the Colorado River within RMNP, and are now reported to be in Forest Canyon to the north of Odessa Lake.

An electrofishing survey of the outlet stream on 26 September 1991 turned up several small fish and fry indicating that reproduction was occurring. Males running milt and spent females were collected in 1991, 1992, and 1993. Spawning typically begins in the outlet in early July and very small spawning runs in the west inlet beginning about a week later. However, reproduction is not believed to occur in the inlet.

Table 33. Summary of Odessa Lake Gill Net Sampling, Outlet Trend Site, 1975-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/28/75*	CUT	231	-	0.1	-
	CUT x RBT	403	323-439	0.2	-
07/21/80*	No fish caught in a 15 hour set				
07/22/86	GBC	181	115-285	0.4 +	0.02+
09/17/87	GBC	254	253-257	1.5	0.38
07/09/91	GBC	271	216-306	5.3	1.06
09/26/91	GBC	212	155-330	3.3	0.35
07/09/92	GBC	220	169-305	3.2	0.32
06/25/93	GBC	272	199-340	11.5	2.26
10/12/93	No fish caught in an 80 minute set				
08/28/98	GBC	272	174-330	10.0	2.40

- No data recorded

* Two nets set overnight

+ Otter ate some fish and others lost trying to untangle net

Table 34. Summary of Fishery Statistics for Odessa Lake, 1960-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1960	0.33	2	6.0	RBT
1963	0.00	2	1.0	
1964	0.11	10	65.0	CUT, RBT
1965	0.00	4	8.0	
1967	0.00	2	3.0	
1968	0.00	2	8.0	
1969	0.48	14	31.0	BKT
1984-1986	Closed to angling			
1987	3.00	1	1.0	CUT
1998	2.50	1	2.0	CUT
1999	1.00	1	8.0	CUT

* In order of relative abundance

Although no fish were caught in a October 1993 net survey, the most recent net surveys indicate that the population is currently in good condition with good catch rates and several year classes present.

Angler Use

The easiest access to Odessa is by trail from Bear Lake (6.6 km). A campsite is located along the outlet stream. Fishing pressure is considered moderate with most anglers visiting this area preferring to fish at Fern Lake.

Creel survey data collected from 1960 through 1969 showed anglers catching 0.22 fish/hour (Table 34). Since opening to catch-and-release angling for GBC in 1987 the catch rates have averaged 1.45 fish/hour.

Current Status

In spite of population numbers that are somewhat low, they are believed to be high enough for Odessa Lake to be considered a stable, self-sustaining population as defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Lawn Lake and the Roaring River

The Roaring River is located within the Fall River drainage in the northeast portion of RMNP (Figure 31). Crystal Lake (3510 m) is at the headwaters of the drainage with Lawn Lake located 1.1 km downstream. On 15 July 1982, an 80 year-old earthen dam, which artificially enlarged Lawn Lake, failed; sending 300 acf of water down the drainage and into the town of Estes Park. This flood scoured the river leaving a deeply incised channel.

Currently, the area looks the same as it did shortly after the flood (Figures 30 and 32). Little vegetation is present along the river or Lawn Lake. This restoration project extends from Horseshoe Falls (2800 m) to about 0.9 km above Lawn Lake, a total distance of 7.4 km of stream.

Without vegetation the Roaring River receives an abundance of solar radiation and is extremely productive considering that little pool habitat exists. Several barriers to fish migration exist along the river. Following the failure of the dam, Lawn Lake (3355 m) was reduced to 9.5 ha, and a maximum depth of 8.5 m. Good spawning substrate exists both in the inlet and outlet. However, the extent of spawning habitat in the outlet is limited due to a barrier below where the dam stood. Fish which descend this barrier to spawn are not able to return to the lake.

Restoration

In 1983, the remaining BKT which were not washed away by the flood were removed with antimycin

Figure 30. Lawn Lake.

Figure 31. Map of Lawn Lake and Roaring River Greenback Cutthroat Trout Restoration Project. Numbers correspond to the antimycin application sites in Table 35.

and rotenone from Lawn Lake and 7.6 km of the Roaring River upstream of Horseshoe Falls (Figure 31 and Table 35). From 1984 through 1986, Lawn Lake was stocked with 26,329 GBC between 29 and 44 mm in length from BFTC. The annual stocking rate was 924 fish/ha, with a total of 2,771 fish/ha stocked over the three-year period. The flatter sections of the Roaring River below Lawn Lake were stocked with 15,700 GBC from 1984 to 1987.

Crystal Lake, which was fishless, was also stocked from 1984 through 1986 with a total of 3,740 GBC. Another 10,000 fry were stocked in September 1989. These stockings were an experiment to help define the upper limits of GBC reproduction. Since no evidence of reproduction has been documented to date, Crystal Lake and 0.2 km of the Roaring River below the lake are still considered an experimental introduction. See the Experimental Greenback Cutthroat Trout Introductions section (page 112) for further information on this population.

Surveys

Lawn Lake. It was believed at the time of the restoration that most of the spawning at Lawn Lake would occur in the inlet stream due to the better and more abundant spawning habitat. However,

Table 35. Amount and Location of Antimycin to Lawn Lake, and Rotenone to the Roaring River, 1983. See Figure 31 for location of sites.

Site	Water		Antimycin(A)		
	Flow (cms)	Volume (acf)	Concentration (µg/L)	Duration (hours)	Amount Applied(mls)
Lawn Lake					
1. Crystal Lake					
Outlet	0.17		5.00	10	1.00
2&3. Beaver Pond	0.28		10.00	10	2.00
4&4'. Little Crystal					
Outlet	0.21		8.00	10	1.25
5. Bog	0.01			10	0.20
6&6'.	0.03			10	0.20
Spray to sites 1 through 6					1.00
7. Old waterline	0.34		14.60	16	6.00
8.	~0.03		10.00	10	0.20
9.	~0.03		10.00	10	0.20
10.	~0.03		10.00	10	0.20
Lawn Lake*		360.0	3.25	slug	31.00
Total Lawn Lake					43.00 Units
Roaring River					
A. Lawn Lake Outlet	0.20		2.00	2	1892
B. Jct Unnamed Trib.	0.37		0.69	2	1892
C. 3045 m	0.37		0.69	2	1892
D. > Ypsilon					
Creek	0.37		0.69	2	1892
E. < Ypsilon					
Creek	0.65			2	2838

* Of the 31 units applied to Lawn Lake, four sprayed around shore, 23 applied by injection into the propwash of an electric boat motor, and four pumped into the deepest part of the lake.

surveys of the inlet in the fall of 1986, 1987, and 1988 found no evidence that fish were reproducing. In early September 1989 fry were found to be abundant in the outlet and a few were collected by electrofishing in the inlet. By 1991, fry were found to be abundant in the inlet and small

fish that could not have come from stocking were observed indicating that recruitment was taking place.

Typically, cutthroat trout spawning begins when water temperatures reach 6 to 7 °C. Depending on the severity of the previous winter. This usually occurs in the outlet the first week in July and in the inlet about a week later. Spawning appeared delayed in 1993 due to the cold winter of 1992-93, with no spawning fish observed on 10 July 1993 and no fry were observed in the inlet or outlet on 25 September 1993. This may indicate that reproduction does not occur every year.

Fish from the last stocking in 1986, were first sampled in gill net surveys in 1988. Since then the mean TL of fish sampled during gill net surveys has increased (Table 36). A decrease in the catch rate was also observed from 1988 to 1992.

In 2000 RMNP removed most of the remaining dam and a pipe which was buried in the outlet stream. Trail crews reworked the area where the pipe was located in an attempt to increase spawning habitat. They also tried to rework the barrier to give fish better access back into the lake.

Trail crews worked most of the summer on the dam removal project and reported observing fish spawning in the outlet upstream where they were working in spite of the use of heavy machinery by the crew. Fry were observed by the crew in mid-August.

Roaring River. Before stocking in September 1986, the Roaring River upstream of the Ypsilon

Table 36. Summary of Lawn Lake Gill Net Sampling, Outlet Trend Site, 1971-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/14/71*~	BKT	233	101-302	3.1	-
07/29/82*	BKT	234	142-335	7.53	1.02
08/22/83	BKT	224	135-304	-	-
07/28/86	GBC	143	120-160	3.6	0.11
09/16/87	GBC	223	200-254	2.7	0.35
07/20/88	GBC	215	176-252	20.0	2.16
09/05/89	GBC	235	202-270	12.3	2.34
07/15/91	GBC	240	205-295	10.1	1.49
07/10/92	GBC	252	235-280	6.4	1.10
09/05/96^	GBC	280	178-385	13.7	3.13

* Overnight net set

~ 3 nets set

- No data recorded

^ 2 nets set

Table 37. Summary of Roaring River Electrofishing Surveys, Ypsilon Creek, 1988-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ 100 m*	Kg/ Hectare*
10/18/88	GBC	144	83-241	23.8	-
08/31/89	GBC	144	73-259	29.7	60.81

* For fish > 100mm

- No data recorded

Creek campsite bridge was sampled using NaCN. Fry at 20 mm were caught indicating that reproduction was occurring. Mature adults to 264 mm were also caught. A two-pass electrofishing survey on 18 October 1988 estimated standing crop at 31 fish/100 m at a trend site just upstream of the Ypsilon Creek junction (Table 37). Fish sampled ranged in TL from 80 to 305 mm. In 1989, standing crop was estimated at 29.7 fish/100 m and 60.81 kg/ha at this site. These fish ranged in TL from 73 to 259 mm, with many fry present in side pools.

Another trend site has been established above the Ypsilon Lake trail crossing. In 1989 standing crop was estimated at 27.6 fish/100 m and 42.07 kg/ha at this site (Table 38). In 1991 standing crop was estimated at 42.7 fish/100 m and 79.22 kg/ha, however many fish were missed due to high water flows. The standing crop at this site was estimated at 23 fish/100 m and 52.44 kg/ha in 2000. However, electrofishing was not very efficient and many fish were missed. A correlation between the proximity of the Lawn Lake trail to the river and lower fish densities was apparent. An abundance of stonefly larvae artificial drift was created by the electrofishing in 2000. In all three years fry were abundant in side pools.

An electrofishing survey was conducted on the Roaring River below Horseshoe Falls in October 1998. Cutthroat trout were found to be the second most abundant species in this section, with standing crop estimated at 5.58 fish/100 m and 9.96 kg/ha. These fish are believed to have dropped

Table 38. Summary of Roaring River Electrofishing Surveys, Ypsilon Lake Trail Crossing, 1989-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ 100 m*	Kg/ Hectare*
08/31/89	GBC	158	79-273	27.6	42.07
09/25/91	GBC	196	35-296	42.7	79.22
08/07/00	GBC	162	28-269	23.0	52.44

* For fish > 100mm

Figure 32. Roaring River.

down from above Horseshoe Falls since no cutthroat trout fry were captured or observed. These fish ranged in TL from 103 to 260 mm (mean=163 mm). Brook trout were the dominant species in this section, with BNT and RBT also present. The organism responsible for whirling disease, *Myxobolus cerebralis*, was also found in this section, however no clinical signs of the disease were observed in any fish.

Special Studies

During the restoration in 1983 a study to determine the effects of Antimycin A on macroinvertebrates was conducted by Nancy Jacobson (1983). The morning of the treatment a site on the Roaring River just upstream of Lawn Lake was sampled using a kick sampling procedure. The density of macroinvertebrates for this survey was 21.2 per 10 kick average. Mayflies, stoneflies, flies (order Diptera), and freshwater clams were collected in this sample. Nine days after the treatment the same site was sampled again. The density for this survey was 0.4, with only freshwater clams and caddisflies collected. Because of the proximity of dates and the diversity of organisms sampled prior to the treatment, the decreased density was attributed to the application of antimycin, and not to a natural seasonal population cycle. No additional sampling was done to determine the long-term effects of antimycin on macroinvertebrates.

Harig and Fausch (2000) conducted habitat surveys on 6.5 km of the Roaring River below Lawn Lake in 1997 as part of a study to predict translocation success of cutthroat trout based on habitat variables. From these surveys 18 fish in pools and 1.7 pools per km were observed. The pool density

Table 39. Summary of Fishery Statistics for Lawn Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	1.15	-	1,379.0	BKT, RBT, CUT
1959	1.39	-	1,784.0	BKT, CUT
1960	0.66	8	47.0	BKT, CUT
1961	0.49	85	635.0	BKT, RBT
1962	0.56	57	370.0	BKT
1963	0.76	18	136.0	BKT
1964	0.54	101	1,026.0	BKT, CUT, RBT
1965	1.21	47	181.0	BKT
1966	1.44	19	78.0	BKT, CUT
1967	1.21	74	219.0	BKT, CUT, RBT
1968	1.39	41	109.0	BKT, CUT, BNT, RBT
1969	0.70	75	606.0	BKT, CUT
1972	1.85	15	26.0	BKT
1973	0.82	8	11.0	BKT, CUT
1974	4.21	3	14.0	BKT, CUT
1976	2.87	17	43.5	BKT
1983-1987	Closed to angling			
1988	3.20	12	8.5	CUT
1989	6.00	18	15.0	CUT
1990	1.90	15	15.0	CUT
1992	4.00	2	2.0	CUT
1994	0.72	7	12.5	CUT, BKT
1996	4.37	3	8.0	CUT, BNT
1998	1.28	9	36.5	CUT, RBT
1999	0.74	5	17.5	CUT
2000	0.97	6	36.0	CUT, BKT

* In order of relative abundance

- No data recorded

was one of the lowest of any stream included in the study. Although the Roaring River has few pools it was known, based on electrofishing surveys, to have an abundance of fish. Taking into account the electrofishing data the Roaring River was assigned a status rating of high. Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in the Roaring River has a 0.8% chance of becoming barren, a 9.1% chance of supporting low numbers of cutthroat trout, and a 90.1% chance of supporting high numbers of cutthroat trout. Habitat variables used to calculate these probabilities were as follows: 9.9 EC mean daily July water temperature, 4.9 m mean bankfull pool width, and 21 pools with a residual depth $\geq$ 30 cm. The watershed area of the Roaring River was estimated at 14.6 km².

The 100 m Ypsilon Creek trail crossing trend site plus an additional 623 m of the Roaring River upstream of the trend site were included in the *Mechanisms for Displacement of Greenback Cutthroat Trout by Brook Trout in Montane Streams in Rocky Mountain National Park* study conducted by Claire McGrath (2000). Preliminary results of this study are not yet available but based on field observations caddis and stonefly larvae were the most abundant food sources found in fish stomachs, with some fry also present.

Angler Use

Lawn Lake. Access to Lawn Lake is by a 10 km trail hike. Campsites are present along the lake, which makes this area a very popular for both anglers and non-anglers. Prior to restoration, when the lake was populated with BKT, catch rates averaged 1.0 fish/hour from 1958 to 1976 (Table 39). Since Lawn Lake opened to catch-and-release angling in 1988 anglers have reported catching 1.94 fish/hour. Although anglers have reported catching BKT, BNT, and RBT, in Lawn Lake and the Roaring River, none of these species have been collected in electrofishing or gill net surveys at trend sites located at the most popular angling locations. The presence of species other than GBC in the creel survey data from Lawn Lake is most likely explained by misidentification by the angler.

Table 40. Summary of Fishery Statistics for Roaring River, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	2.50	-	-	-
1962	0.28	5	25.0	BKT, CUT
1963	1.26	10	34.0	BKT
1964	1.46	4	13.0	BKT, CUT
1966	0.80	5	10.0	BKT
1969	3.25	2	4.0	BKT, CUT
1975	1.67	2	6.0	BKT
1976	0.69	10	36.1	BKT, RBT, BNT
1983-1990	Closed to angling			
1992	15.60	3	5.0	CUT
1993	10.00	6	12.3	CUT, BKT, BNT
1994	3.19	24	48.0	CUT, BKT, BNT, RBT
1995	0.57	5	7.0	CUT, RBT, BKT
1996	3.00	6	10.0	CUT
1998	4.07	31	112.8	CUT
1999	1.42	14	35.0	CUT, RBT, BKT
2000	3.18	32	110.0	CUT, BKT

* In order of relative abundance

- No data recorded

Roaring River. Due to the short hike (2.4 km) to access the lowest section and the abundance of fish present, the Roaring River is a very popular fishery. Three campsites are also present near the junction with Ypsilon Creek about 4.2 km from the Lawn Lake trailhead. Catch rates prior to its restoration to GBC averaged 0.9 fish/hour (Table 40). Since opening to catch-and-release angling in 1991 catch rates have averaged 3.66 fish/hour. Based on creel survey information, experienced anglers who know how to fish this water can catch up to 40 fish/hour. This water is considered one of the best fisheries in RMNP, with many guides bringing their clients here. In addition to misidentification by the angler, the presence of nonnative fish in the creel survey data for the Roaring River can be explained by anglers who fish below Horseshoe Falls, the lower extent of this restoration project.

Current Status

For restoration purposes Lawn Lake and 0.9 km of the Roaring River above the lake and the 6.5 km of the Roaring River below Lawn Lake are considered two populations. Both areas meet the Greenback Cutthroat Trout Recovery Plan (USFWS 1998) definition of a stable, self-sustaining population.

Lower Hutcheson Lake and Cony Creek

The Hutcheson Lakes of Rocky Mountain National Park consist of seven lakes and ponds located in four cirques at the head of Cony Creek, and isolated from the North St. Vrain drainage by Calypso Cascades (Figure 34). This restoration project begins at a cascade barrier at 3220 m and extends to a gradient barrier at 3350 m above Lower Hutcheson Lake (3300 m), a total of 1.7 km. Lower Hutcheson Lake (Figure 33) has a surface area of 1.7 ha, a maximum depth of 6.7 m, and good inlet and very limited outlet spawning habitat. The shoreline is comprised of conifers and grasses on the north shore and boulders on the south shore. Below Lower Hutcheson Lake, Cony Creek runs through a meadow before the creek steepens to the lower barrier above Pear Creek. Flows above Pear Creek have been measured at 0.54 cms in late July and falling to 0.26 cms in late August. Riparian vegetation consists mostly of conifers with grasses along the meadow section.

Restoration

The Hutcheson Lakes downstream from Upper Hutcheson Lake were outside RMNP and managed by CDOW before a boundary change in 1981 incorporated this area into the park. Lower Hutcheson Lake was stocked with RBT and contained a population of cutthroat x RBT hybrids in 1986. In the mid-1980's Upper and Middle Hutcheson Lakes were determined to contain pure GBC. Based on these findings and the goals of Greenback Cutthroat Trout Recovery Plan (USFWS 1998), the hybrid cutthroat trout were removed from Lower Hutcheson Lake and Cony Creek upstream of Pear Creek with antimycin on 9 September 1987 (Figure 34 and Table 41).

Figure 33. Lower Hutcheson Lake.

Figure 34. Map of Cony Creek and Lower Hutcheson Lake Greenback Cutthroat Trout Restoration Project. Numbers correspond to the antimycin application sites in Table 41.

Lower Hutcheson Lake was stocked with 1,340 fish at 161 mm in length in June 1989, 1,700 fry in September 1989, and 1,600 fry on 25 September 1991 from the BFTC GBC broodstock. Cony Creek below the lake was stocked with 1,500 fry in September 1989.

Surveys

Lower Hutcheson Lake. Following incorporation into RMNP in 1981, and the accompanying change in fishing and camping regulations, the fish population in Lower Hutcheson Lake changed dramatically. In 1981 the gill net catch rate was 0.6 fish/hour with fish to 280 mm sampled (Table 42). Five years later the catch rate increased to 1.6 fish/hour and fish to 373 mm were caught.

Fish recovery following the restoration was difficult in the lake due to its depth, with only 46 fish ranging from 190 to 498 mm recovered. No standing crop estimates could be made due to the minimal pick up of dead fish.

Lower Hutcheson Lake was stocked at the highest rate per hectare during the June 1989 stocking of 161 mm GBC. These fish grew well, from 161 to 210 mm mean TL, based on a gill net survey on 29 September 1989. However, this lake produced the lowest catch rate (3.0 fish/hour) by over

Table 41. Amount and Location of Antimycin Applied to Lower Hutcheson Lake and Cony Creek, September 1987. See Figure 34 for location of sites.

Site	Water		Antimycin(A)		
	Flow (cms)	Volume (acf)	Concentration (µg/L)	Duration (hours)	Amount Applied(mls)
2. Lower Hutcheson Inlet	0.06			8	1.50
Lower Hutcheson Lake		65	3.0*	slug	5.00
3. Lower Hutcheson Outlet	0.07		8.0	8	0.33
4. Tributary Stream	<0.01			8	0.08
5-7 KMnO ₄	0.07		1.5 mg/L	10	

* An additional 1.5 units were applied to the inlet, total dosage to lake = 3.84 µg/L

a factor of 10, compared to other lakes stocked in June 1989. Salmon eggs and fish heads were observed near the inlet in September 1989, and indicated that the lake was subject to angler harvest. No fry from the stocking two weeks earlier were observed in the inlet or outlet.

Fish were first observed spawning in the inlet on 2 July 1991. No fish were observed in the outlet. Fish that were too small to have come from the last stocking in 1991 were caught during the 1998 gillnet survey, indicating that recruitment is taking place.

Gill net catch rates since restoration to GBC have exceeded those for hybrid cutthroat trout prior to the restoration. However, prior to the restoration nets were set overnight which has shown to have

Table 42. Summary of Lower Hutcheson Lake Gill Net Sampling, Inlet Trend Site, 1981-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/30/81*	RBT	248	210-261	0.3	0.04
	CUT	215	178-280	0.3	0.02
07/24/86*	CUT x RBT	266	161-373	1.6	0.39
09/29/89	GBC	210	175-245	3.0	0.24
07/02/91	GBC	303	255-330	6.0	1.78
08/10/98	GBC	298	222-350	13.3	3.96

* Overnight net set

lower catch rates than short sets (typically one hour) that are used in lakes with pure cutthroat trout.

The last survey in 1998 had the highest catch rate by far than any other survey, however this survey was conducted during a thunderstorm which has been observed to produce higher catch rates than calm weather.

Cony Creek. Following treatment of Lower Hutcheson Lake and Cony Creek, all fish that could be observed were collected and measured. A total of 65 hybrid cutthroat trout were found in Cony Creek from the outlet of Lower Hutcheson to the KMnO₄ station (3.82 fish/100 m). These fish ranged in length from 30 to 330 mm, with 54% of these fish exceeding 210 mm. No fish surveys have been conducted on this section of Cony Creek following the restoration.

Special Studies

Harig and Fausch (2000) conducted habitat surveys on Cony Creek from the barrier above Pear Creek to Lower Hutcheson Lake in 1998. This section contained 26.9 fish/km observed in pools. For the final report this section of Cony Creek and the section from Calypso Cascades to Pear Creek, which was surveyed in 1996, were combined and a population status of high was assigned to all of Cony Creek above Calypso Cascades. Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in Cony Creek has a 0.1% chance of becoming fishless, a 1.3% chance of supporting low numbers of cutthroat trout and a 98.6% chance of supporting high numbers of cutthroat trout. Habitat variables used to calculate these probabilities were as follows: 9.0 EC mean daily July water temperature; 5.4 m mean bankfull pool width, and 146 pools with a residual depth $\geq$ 30 cm. The watershed area for Cony Creek above Calypso Cascades was estimated at 14.5 km².

Angler Use

Lower Hutcheson Lake. This lake appears to have been heavily used by anglers when it was located outside RMNP, with well-established campsites located along the shore observed during surveys in 1981. Improvements to the vegetation were evident by 1986. Currently fishing pressure can be described as moderate. Access consists of a 1 km hike over an unmaintained trail from Pear

Table 43. Summary of Fishery Statistics for Lower Hutcheson Lake, 1987-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1987-1990	Closed to angling			
1993 [^]	5.21	5	30.3	CUT
1995	2.00	2	2.0	CUT
1997	0.50	2	6.0	CUT

[^] Anglers reported their location as Hutcheson Lakes

Lake. A cross-country camping zone is present north of the lake with the closest campsites located at Pear Lake.

Lower Hutcheson Lake opened to catch-and-release fishing in 1991, making the entire Hutcheson Lakes chain open to angling. Limited creel survey data is available for this lake. The data which is available suggests the same as gill net surveys and observations, that the GBC population is low (Table 47).

Cony Creek. For information regarding angler use on Cony Creek see the Pear Lake and Cony Creek section following this section.

Current Status

Although Lower Hutcheson Lake supports a low population of GBC it is believed that it supports enough biomass to be considered a stable, self-supporting population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Pear Lake and Cony Creek

Pear Lake (3225 m) is located along Pear Creek, a tributary of Cony Creek in the southeastern RMNP (Figure 35). It was a natural lake that was expanded by the addition of a stone and concrete dam. Following the problems with Lawn Lake, the dam was acquired by RMNP and in June 1988, it was removed and the outlet stream reconstructed. This restoration project begins above Calypso Cascades (2865 m), extends up Cony Creek to a barrier above Pear Creek (3220 m), and includes Pear Creek and Lake.

Even without the dam, Pear Lake is 6.1 ha and one of the deepest lakes (15 m maximum depth) in RMNP. Due to the impacts of the dam, little vegetation exists around the lake to the high water line. Spawning habitat exists only in the outlet. Late July flows in the outlet stream have been measured at 0.06 cms with flows decreasing to 0.03 cms by late August. This section of Cony Creek is mostly low gradient with riparian vegetation consisting mostly of conifers. Late August flows at the Finch Lake bridge have been measured at 0.26 cms.

Restoration

Following removal of the dam hybrid cutthroat trout were removed from Pear Lake and Cony Creek on 6 September 1988 (Figure 35 and Table 48). Additional treatment was needed on Cony Creek on 7 September to ensure a complete removal. Pear Lake was stocked with 3,164 GBC at 161 mm in

Figure 35. Map of Pear Lake and Cony Creek Greenback Cutthroat Trout Restoration Project. Numbers correspond to the antimycin application sites in Table 44.

Table 44. Amount of Antimycin Applied to Pear Lake and Cony Creek, 1988. See Figure 35 for location of sites.

Site	Water		Antimycin		
	Flow (cms)	Volume (acf)	Concentration (µg/L)	Duration (hours)	Amount Applied
6 September 1988					
Pear Lake		460			20 units
C. Inlet		0.07		8	1 unit
D. Inlet		0.60		8	1 unit
E. Inlet		0.53		8	1 unit
Cony Creek					
7. 3260 m	0.08	1.85	8	8	176 mls
8 3135 m	0.08		3	8	65 mls
9a.	0.08		3	8	64 mls
10a*.			0.4	8	10 mls
10b.			0.4	8	10 mls
11a. 3110 m	0.08		4	8	88 mls
13. Finch Lake Bridge**	0.08		0.4	8	10 mls
15. KMnO ₄	0.08		1.5 mg/L	12	5.1 kg
7 September 1988					
10a.	0.08		16	2.75	123 mls
15. KMnO ₄	0.08		1.5 mg/L	4.0	1.7 kg

*, **. These applications were conservative to prevent any downstream impacts. Considering the amount of elevation loss, could have treated at 4 to 6 µg/l at these sites. Because of the low dosage on 6 September, the area below 10a was retreated on 7 September.

length on 30 June 1989, 5,000 fry in September 1989, and 1,500 fry in October 1990 from the BFTC broodstock. Cony Creek was stocked, from the outlet of Pear Lake to Calypso Cascades with 7,000 fry on 14 September 1989 and 1,500 fry on 11 October 1990.

Surveys

Pear Lake. Gill net catch rates prior to restoration were low, however they were overnight net sets

Table 45. Summary of Pear Lake Gill Net Sampling, Outlet Trend Site, 1963-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/15/63*	CUT	188	102-356	1.1	-
07/29/81*	CUT x RBT	226	159-277	1.5	0.17
08/26/87*	CUT x RBT	283	242-302	0.3	0.09
09/29/89	GBC	208	177-248	46.0	2.74
08/11/98	GBC	237	209-280	7.4	0.99

* Overnight net set

- No data recorded

which typically have lower rates (Table 45). A gill net survey conducted on 29 September 1989, the first after Pear Lake was stocked with GBC, had a very high catch rate, however the lake was stocked with 161 mm fish three months prior to the survey and most of the fish caught were from this stocking.

Based mostly on creel survey data and the 1998 gill net survey it seems that Pear Lake is populated by an abundance of fish. These fish are smaller than the hybrid cutthroat trout that were in the lake prior to restoration.

Cony Creek. On 21 August 1988, prior to the restoration, a two-pass population estimate of Cony Creek was conducted, with 31 fish/100 m of stream found just downstream of the Finch Bridge, and 13 fish/100 m of stream found above the bridge. Combining these two sections a standing crop estimate of 15.2 fish/100 m is obtained.

During the restoration project all visible dead fish were removed and measured within 24 hours of the treatment. A total of 542 fish were recovered over 3.5 km (15.5 fish/100 m). These fish were over a range of 30 to 362 mm in length.

On 26 September 2000 a two-pass electrofishing survey was conducted at the Finch Lake bridge. Standing crop was estimated at 36.4 fish/100 m and 39 kg/ha. The mean TL of fish sampled was 179 mm (range=81-242 mm). The fish/100 m figure is more than double what was estimated prior to the restoration.

Special Studies

During the restoration in 1988 a Petersen mark-recapture population estimate was conducted at Pear Lake by Rip Shively (1990) of Colorado State University. An insufficient number of fish were captured from Pear Lake, so fish were collected from Pear and Cony Creeks, marked, and stocked into the lake. Following treatment, the ratio of marked to unmarked fish recovered was used to

calculate the fish population. A population of 452 fish (96.3 kg) was estimated. This correlates to 74.1 fish/ha and 15.78 kg/ha.

Harig and Fausch (2000) conducted habitat surveys on the lower section of Cony Creek from Calypso Cascades to Pear Creek in 1996. Twenty-two fish per kilometer were observed in pools through this section. For the final report this section and the section above Pear Creek, which was surveyed in 1998, were combined and a population status of high was assigned to all of Cony Creek above Calypso Cascades. Using Harig and Fausch's stream-scale model for predicting translocation success, the habitat in Cony Creek has a 0.1% chance of becoming fishless, a 1.3% chance of supporting low numbers of cutthroat trout and a 98.6% chance of supporting high numbers of cutthroat trout. Habitat variables used to calculate these probabilities were as follows: 9.0 EC mean daily July water temperature, 5.4 m mean bankfull pool width, and 146 pools with a residual depth $\geq$ 30 cm. The watershed area for Cony Creek above Calypso Cascades was estimated at 14.5 km².

Table 46. Summary of Fishery Statistics for Pear Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	0.44	-	568.2	CUT, RBT
1959	0.65	-	340.0	CUT, RBT
1960	0.75	9	44.0	CUT
1961	1.33	4	12.0	CUT
1962	0.81	10	57.0	CUT
1963	0.75	6	24.0	CUT
1964	0.55	22	127.0	CUT
1965	1.03	7	79.0	CUT, BKT
1966	0.79	48	235.0	CUT, BKT, RBT, BNT
1967	1.38	20	82.0	CUT, BKT
1968	4.00	11	10.0	CUT, BNT
1969	1.01	31	146.0	CUT, RBT, BNT
1974	0.59	14	83.0	CUT, BNT, BKT
1976	0.42	4	24.0	CUT
1985	1.27	10	54.0	CUT, RBT
1986	3.18	2	11.0	CUT, BKT
1988-1990	Closed to angling			
1991	4.00	1	1.0	CUT
1992	6.00	30	5.0	BKT, RBT
1995	3.46	3	13.0	CUT
1997	-	1	-	CUT (one fish caught)
1998	3.61	4	10.5	CUT

* In order of relative abundance

- No data recorded

Cony Creek was selected as a site for the *Mechanisms for Displacement of Greenback Cutthroat Trout by Brook Trout in Montane Streams in Rocky Mountain National Park* study conducted by Claire McGrath (2000). Preliminary results for this study are not yet available.

Angler Use

Pear Lake. There are several campsites near the lake giving evidence of heavy visitation, with access by a 10.5 km hike. Currently fishing pressure can be described as moderate.

Since 1991 when Pear Lake opened to catch-and-release angling for GBC catch rates have averaged 3.97 fish/hour (Table 46). Prior to the restoration, when the lake was stocked but no reproduction was occurring due to the presence of the dam, catch rates averaged 0.73 fish/hour. In addition to information collected from creel survey cards, one RMNP ranger reported that he and a friend caught 100 fish in 10 hours of fishing in 1996. In another report in 1997, 3 anglers fishing for 5 hours each caught 40-50 fish each. Both of these parties reported the fish they caught ranged in size from 150 to 330 mm.

Table 47. Summary of Fishery Statistics for Cony Creek, 1960-2000. Data is for all sections of Cony Creek.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1960	2.09	22	64.0	BKT, RBT, CUT
1961	0.67	4	48.0	BKT, RBT
1962	0.40	10	10.0	RBT
1963	1.81	21	86.0	CUT, RBT, BKT
1964	0.85	2	20.0	BKT
1966	0.54	6	13.0	RBT, CUT, BKT
1967	0.50	2	16.0	RBT, CUT, BNT
1969	2.86	14	28.0	CUT, RBT, BKT
1976	0.80	5	25.0	CUT
1985	2.91	3	12.0	CUT
1986	4.07	9	26.0	CUT, BKT, RBT, BNT
1987-1990	Closed to angling above Pear Creek			
1988	2.00	2	2.0	CUT
1988-1990	Closed to angling above Calypso Cascades			
1991	15.00	1	4.0	CUT
1992	7.50	30	4.0	BKT, CUT
1995	1.88	2	16.0	CUT
1997	4.66	3	6.0	CUT
1998	12.00	1	0.5	CUT

* In order of relative abundance

Cony Creek. Access to Cony Creek above Calypso Cascades is by a 7.2 km maintained trail or a 4.4 km unmaintained trail that parallels the creek. The most heavily fished section of the creek is near Finch Lake. The creek flattens out near here and campsites are present at Finch Lake. Current fishing pressure can be described as moderate. Catch rates prior to opening for catch-and-release angling for GBC in 1991 averaged 1.67 fish/hour while catch rates since have averaged 5.05 fish/hour (Table 47). Although creel survey cards ask the location on a stream that anglers are fishing, most anglers do not report this information. Because of this, creel survey data for Cony Creek cannot be broken down into sections.

Current Status

For restoration purposes Pear Lake and Creek and Cony Creek between Calypso Cascades and the barrier at 3220 m are considered two populations. Another barrier on Pear Creek separates these two populations. Both areas meet the requirements of a stable, self-sustaining population as defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Sandbeach Lake

Sandbeach Lake (3140 m) is located at the head of Sandbeach Creek, a tributary of North St Vrain Creek, in the southeastern RMNP (Figure 37). It was a natural lake enlarged with a dam prior to the creation of the park. Following the Lawn Lake incident, the dam was purchased and removed by RMNP in 1988 and the outlet stream was reconstructed. Without the dam, Sandbeach Lake (Figure 36) has a surface area of 4.0 ha and a maximum depth of 7.6 m. The lower barrier for this restoration project is a falls about 0.1 km below the lake. As with other lakes in the park that were previously reservoirs, little vegetation exists along the immediate shoreline. However, Sandbeach Lake has more vegetation than the other lakes of this type with small conifers being the dominant vegetation. Late June outlet flows have been measured at 0.07 cms, with inlet and outlet flows dropping to a trickle by fall. Spawning habitat only exists in the reconstructed outlet.

Restoration

Work on the dam and outlet stream, combined with low inlet flows during 1988, resulted in the reservoir having no outlet flow during September. To take advantage of this, it was proposed that the small RBT population that was present in Sandbeach Lake be removed as soon as possible, and the lake converted to GBC.

On 21 September 1988, RBT up to 500 mm in length, as well as a few longnose suckers, were removed with antimycin. Sandbeach Lake was stocked with 1,862 GBC at 161 mm in length on 30 June 1989 and 4,000 fry on 14 September 1989 from the BFTC broodstock.

Figure 36. Sandbeach Lake.

Figure 37. Map of Sandbeach Lake Greenback Cutthroat Trout Restoration Project.

Surveys

Fish were first observed spawning in the outlet in late June 1990. Typically annual spawning begins in the outlet in mid-June and finishes by the first week in July. The reconstructed outlet stream has not completely sealed and after spring flows subside, water flows above ground for about 30 m before entering a small boulder field for a short distance. The best spawning substrate and juvenile rearing areas are present below this small boulder field. It is believed that this boulder field prohibits most fry from entering the lake. An abundance of fry are observed each fall below the boulders, however the lake does not seem to support a large population of fish.

Due to the cold temperatures of the inlet, barriers to fish migration into the inlet, and low flows, spawning within the inlet stream above the lake is not possible. Fish have been observed trying to spawn at an alluvial fan in the lake at the inlet.

Catch rates for gill net surveys were high in 1989 and 1990 following the stockings in 1989 (Table 48). The 161 mm fish stocked in June 1989 were found to 265 mm by September. Stomachs of fish sampled in 1990 were found to be full of chironomids indicating an abundance of food present in the lake. Catch rates since 1990 have decreased significantly, with a low in 1998, while mean as well as minimum and maximum lengths have increased each time the lake has been surveyed indicating that there is not much recruitment occurring. During hook-and-line surveys in 2000 fish

Table 48. Summary of Sandbeach Lake Gill Net Sampling, Outlet Trend Site, 1964-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
06/30/64*^	RBT	273	165-381	0.5	-
07/16/80*	RBT	335	207-438	0.6	0.23
08/22/88*	RBT	412	368-457	0.1	0.04
09/14/89	GBC	229	185-265	44.0	6.10
06/26/90	GBC	243	205-295	108.0	15.20
09/25/91	GBC	249	210-290	7.5	1.09
08/12/93	GBC	267	235-305	8.0	1.58
09/28/98	GBC	327	276-353	1.5	0.53

* Overnight net set

^ Net set in northwest corner

- No data recorded

down to 176 mm were caught indicating that some recruitment is taking place. Fish to 407 mm were also caught. All fish that have been sampled have been fat and in good health. In addition to gill net surveys conducted at the outlet trend site, surveys have been conducted near the inlet with very poor results.

Angler Use

Reports from 1964 describe angler visitation to Sandbeach Lake as heavy, however angler success was poor despite stocking (Linn 1964). Currently, fishing pressure can be described as moderate. Sandbeach Lake has several campsites on its shores with access by a 6.8 km maintained trail.

Angler catch rates since opening to catch-and-release angling in 1991 have averaged 0.78 fish/hour (Table 49). Prior to the restoration catch rates averaged 0.81 fish/hour. Although the difference is slight, this is the only restoration area in RMNP where catch rates after the restoration are lower than before the restoration.

Twenty-five percent of fish sampled by gill net in 1993 had hook damage to their jaws indicating that some anglers may not be obeying the barbless hook regulation.

Current Status

It appears based on the available data that the number of fish present in the lake are limited by the boulder field in the outlet which prohibits most fry from entering the lake after emergence. The fish that do enter the lake find an abundance of food and grow quickly and are fat and healthy. Although

Table 49. Summary of Fishery Statistics for Sandbeach Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	1.19	-	798.0	RBT, CUT
1959	0.71	-	929.0	RBT
1960	0.25	4	8.0	RBT
1961	0.06	20	106.0	CUT, RBT
1962	0.22	7	76.0	RBT, CUT
1963	0.05	7	42.0	RBT, CUT
1964	1.16	21	128.0	RBT, CUT
1966	0.23	16	64.0	RBT, CUT, BKT
1967	0.00	8	17.0	
1968	0.72	6	18.0	CUT, RBT
1969	0.09	18	47.0	RBT
1976	0.00	5	13.0	
1986	0.00	2	3.0	
1988-1990	Closed to angling			
1993	0.25	7	16.0	CUT
1996	0.00	1	0.5	
1998	1.00	1	6.0	CUT
1999	0.18	4	5.5	CUT
2000	1.38	8	18.0	CUT, RBT

* In order of relative abundance

- No data recorded

the number of fish in the lake is low, the biomass is believed to be high enough for the lake to be considered a stable, self-sustaining population as defined by the Greenback Cutthroat trout Recovery Plan (USFWS 1998).

Sandbeach Creek

Although flows through Sandbeach Creek are low in the fall, two areas below the restoration project were found to contain what looked to be good specimens of GBC. Both areas are in beaver pond habitat, with one located above a steep canyon wall and the other located below the wall. At the time of the Sandbeach Lake restoration Sandbeach Creek was believed to contain a hybrid cutthroat x RBT population.

Tissue samples were collected from both areas in 1999 and taken to Don Proebstel for genetic analysis to determine if these fish are the original hybrids or pure GBC that have dropped out of Sandbeach Lake. The samples collected above the wall were determined to be A- GBC with a slight YCT influence from multiple sources (Appendix III). The fish below the wall were determined to be

B+ GBC with a YCT influence from multiple sources. No influences from RBT were detected at either location. Based on Don's analysis of the samples it appears that pure GBC trout fry that cannot enter the lake through the boulders at the outlet are dropping out of Sandbeach Lake and mixing with the hybrids that were originally present. Tissue samples were taken from fish in Sandbeach Lake in 2000 and will be compared to those from the creek below the lake.

Spruce Lake

Spruce Lake (2950 m) is located along an unnamed tributary of Spruce Creek in the Big Thompson River drainage in the central portion of RMNP (Figure 38). It has a surface area of 1.4 ha and a maximum depth of 1 m. This restoration project starts at a barrier 0.2 km below Spruce Lake and extends to Loomis Lake (3120 m). Due to its shallowness the lake is warm allowing for very good productivity and earlier spawning than other lakes in the area. Very good stream spawning habitat exists in both the inlet and the outlet. Shoreline vegetation consists of conifers, bogs, and grasses. September outlet flows have been measured at 0.01 cms. Loomis Lake is currently an experimental GBC population, see the Greenback Cutthroat Trout Experimental Introductions section, page 119, for further information on this population.

Restoration

On 10 September 1990, RBT were removed from Spruce Lake and the creek upstream of the barrier and BKT were removed from Loomis Lake with antimycin. On 25 September 1991 Spruce Lake was stocked with 1,000 GBC fingerlings from the BFTC broodstock. It was stocked again on 23 September 1992 with 1,100 fingerlings from both BFTC and the CDOW FRH.

Boreal toads also inhabit the lake with no long-term impacts observed from treatment of the lake with antimycin.

Figure 38. Map of Spruce Lake Greenback Cutthroat Trout Restoration Project.

Table 50. Summary of Spruce Lake Gill Net Sampling, North Shore Trend Site, 1979-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/27/79*	RBT	223	124-340	1.3	0.16
09/11/90*	RBT	222	145-307	2.3	0.28
09/23/92	GBC	203	203	1.2	0.15
07/21/93	GBC	203	140-250	42.0	3.29
08/15/95	GBC	253	239-260	14.6	2.58
08/02/00	GBC	269	187-372	25.7	4.26

* Overnight net set

Surveys

Prior to Spruce Lake being restored to GBC it contained a good population of RBT. It appeared that the warm summer water temperatures in Spruce Lake inhibited the success of the fall spawning BKT, which inhabited Loomis Lake upstream of Spruce Lake, and allowed the spring spawning RBT an advantage.

The importance temperature plays in the success of fish species was also observed below Spruce Lake in August 1981, when the outlet stream and Spruce Creek were surveyed. The outlet stream descends about 152 meters in 0.8 km to the junction with Spruce Creek. The water temperature of fell from 20 °C at 2925 m to 12 °C at the junction with Spruce Creek at 2775 m in elevation. A small cliff exists on the outlet of Spruce Lake at an elevation of 2925 m, with spring inlets below this point reducing the stream temperature. Interestingly, although RBT exclusively inhabited the Spruce Lake outlet stream above 2925 m, below the barrier only BKT were observed in the cooler stream section.

Following stocking of GBC, fish were first observed in spawning in the outlet on 25 June 1993. Typically annual spawning begins in the outlet in early June with fish starting to spawn in the inlet about a week later. Spruce Lake has one of the largest spawning runs of any GBC lake in RMNP. Fry have been observed in the inlet stream as early as the first week in August.

Gill net surveys since 1993 have found fish to be abundant and in good health with several year-classes present (Figure 50). Stomach content analysis was conducted on fish sampled in 2000 to determine if they were preying on boreal toads. No toads or tadpoles were found but fish were feeding on amphipods, gammarus, caddisflies, and worms.

Angler Use

Access to Spruce Lake is by a 6.1 km maintained trail to Fern Lake and a 1 km unmaintained trail. Campsites are present at Spruce Lake and Fern Lake. Prior to restoration catch rates averaged 0.58

Table 51. Summary of Fishery Statistics for Spruce Lake, 1960-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1960	3.08	4	13.0	BKT, RBT
1961	0.55	4	20.0	RBT, BKT
1962	0.53	5	40.0	RBT, BKT
1964	0.25	2	12.0	CUT, BKT
1965	0.20	6	25.0	BKT, RBT
1966	0.31	17	248.0	RBT, BKT
1967	0.63	5	30.0	RBT, BKT
1969	0.84	6	19.0	RBT, BKT
1972	1.00	1	1.0	RBT
1973	0.33	6	60.0	BKT
1976	1.40	5	28.5	RBT, CUT
1984	0.33	2	3.0	RBT
1985	2.00	3	4.0	RBT, BKT
1986	0.41	18	36.0	RBT, CUT
1987	1.62	9	18.5	RBT, CUT, BKT
1988	2.50	8	7.5	RBT
1989	2.00	1	2.0	RBT
1990-1992	Closed to angling			
1996	6.00	1	2.5	CUT
1998	3.37	14	43.3	CUT
1999	5.79	3	14.5	CUT
2000	5.25	13	35.8	CUT

* In order of relative abundance

fish/hour, with catch rates averaging 4.44 fish/hour since opening to catch-and-release angling for GBC in 1993 (Table 51). Spruce Lake is one of the best fisheries within RMNP.

The majority of anglers who fish at Spruce Lake are locals who are more knowledgeable about park fishing regulations. By contrast most anglers who fish at Fern Lake, which is located on a popular trail and is 1 km away, do not fish in RMNP regularly and are not as familiar with the regulations. Evidence of this can be seen in the condition of fish at both lakes. During surveys in 2000, 19% of fish sampled at Fern Lake showed damage caused by anglers using barbed hooks. No such damage was observed in fish at Spruce Lake.

Current Status

Spruce Lake contains one of the best populations of GBC in RMNP. Because the lake is shallow, water temperatures are warm allowing for an abundance of food, higher growth rates, earlier

spawning, faster embryo development, and earlier emergence which gives fry extra time to grow before temperatures drop for the winter. Spruce Lake meets all the requirements of a stable, self-sustaining population as defined by the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Dream Lake

Dream Lake (3025 m) is located on Tyndall Creek in the central portion of RMNP (Figure 21). It is a 2.2 ha natural lake, with a maximum depth of 4.5 m. Limited spawning habitat exists in both the inlet and outlet, but barriers above and below the lake limit it to 150 m of stream. Conifers are the dominant shoreline vegetation. July outlet flows have been measured at 0.11 cms.

Restoration

The lake was first proposed for restoration in 1989, but due to problems with obtaining chemical permits the lake was not restored until 1996. On 8 November 1996, hybrid GBC were removed from Dream Lake. The lake was restocked with 190 adult and 5 immature GBC by helicopter from Upper Hutcheson Lake on 11 July 1997. The fish began feeding immediately upon entering Dream Lake.

Surveys

Based on surveys prior to the restoration, Dream Lake did not support a large fish population (Table 52). In fact it was believed to be fishless in 1958 and 1978.

No spawning activity was observed in 1998 or 1999. Fish were observed in pairs in the outlet in mid-June 2000, however no fry were observed in the outlet in the fall.

Figure 39. Dream Lake.

Table 52. Summary of Dream Lake Gill Net Sampling, 1958-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
1958	No fish caught				
07/14/71*^	CUT	280	246-295	0.1	-
07/17/78*#	No fish caught in a 19 hour set				
07/13/87*%	CUT	277	166-349	0.7	0.20
06/15/98~	GBC	294	253-320	13.3	3.53
06/18/99~	GBC	355	330-394	5.6	3.19
06/20/00~	GBC	333	212-390	4.0	1.61

* Overnight net set

^ 2 nets set, locations unknown

- No data recorded

1 net set at inlet

% 1 net set at outlet

~1 net set at inlet and 1 net set at outlet

Gill net trend sites have been established near the inlet and the outlet with surveys conducted annually in the spring since 1998. Catch rates and kg/net hour have decreased each year. Apparently there is an adequate food source in the lake, since the mean TL of fish caught increased 61 mm from 1998 to 1999. Two fish, 212 mm and 232 mm, that were caught during the 2000 survey were too small to be part of the original 1997 stocking indicating that some recruitment is taking place.

Angler Use

Due to its close proximity (1.8 km) to the Bear Lake parking area, Dream Lake receives heavy visitation, however fishing pressure can be described as moderate. From limited creel survey data,

Table 53. Summary of Fishery Statistics for Dream Lake, 1961-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1961	2.00	3	7.0	BKT
1964	0.50	2	2.0	RBT
1976	0.00	2	2.5	
1996-1998	Closed to angling			
1999	2.50	2	2.0	CUT
2000	1.80	5	8.8	CUT

catch rates prior to the restoration averaged 1.3 fish/hour while catch rates after opening to catch-and-release angling in 1999 have averaged 1.95 fish/hour (Table 53).

Current Status

Dream Lake is too recent a restoration project to determine its status. Although recruitment was documented in 2000, it is too early to tell how often reproduction will take place and how much biomass the lake will support.

EXPERIMENTAL INTRODUCTIONS

In some situations, lakes with marginal habitat occurred upstream of a desired restoration area. To determine if pure GBC could reproduce and persist in these marginal habitats, as they have in the North Fork of the Big Thompson River, experimental introductions were made into five such lakes: Crystal Lake, Odessa Lake, Lake Husted, Lake Louise, and Loomis Lake.

Odessa and Crystal Lakes were the first two lakes to have experimental introductions. Annual stocking rates of these lakes were low, 247 fish/ha for Odessa and 125 fish/ha for Crystal to gain more data on GBC stocking rates. Since the experimental introduction, reproduction and recruitment has been documented in Odessa Lake and the lake is now considered stable, self-sustaining population as defined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Lake Louise, Crystal, and Odessa Lakes were considered fishless at the time of their experimental introductions. Lake Husted and Loomis Lake had recruiting populations of BKT prior to their restoration. These lakes lack suitable inlet or outlet spawning habitat. Brook trout apparently maintained wild populations by spawning in seeps and shoreline gravel aerated by wave action. Some reproduction of cutthroat trout has been observed in Crystal, Louise, and Husted; however recruitment has only been documented in Odessa Lake. All of these lakes are currently open to catch-and-release angling. Information regarding Lake Louise can be found in the North Fork of the Big Thompson section, Page 60

Another experimental introduction was made into Lily Lake in 1990. Lily is a low elevation artificial lake with no spawning habitat. It receives heavy visitation, including fishing pressure, due to its close proximity to Highway 7, which runs along the eastern edge of RMNP. This introduction was made to document how GBC respond to heavy angling pressure and to use the lake as a roadside educational area for native fish restoration.

Crystal Lake

Crystal Lake (3511m) is located in a cirque at the head of the Roaring River in northeastern RMNP (Figure 31). It has a surface area of 10.0 ha and is one of the deepest lakes (38 m) in RMNP. It was the highest lake in the park that supported fish up to 10 years past the end of the non-native stocking program and is currently the highest lake in RMNP that contains fish. What appears to be good spawning substrate exists within a cove at the outlet, however a barrier just below the lake limits this area. All flows come from snowmelt and once the spring runoff ends flows are minimal. These low flows are believed to prohibit reproduction. The entire shoreline is made up of rock.

Stocking

In 1983, Crystal Lake (Figure 40) was found to be fishless during the restoration project which included Lawn Lake, located 1.1 km downstream, and the Roaring River. It was stocked with a total of 3,740 GBC from the BFTC broodstock, from September 1984 through 1986. The average annual stocking rate was 125 fish/ha; compared to 923 fish/ha for Lawn Lake. The final experimental stocking of this water was in September 1989 when 10,000 fry were stocked. Reproduction in Crystal Lake would help define the upper limits of GBC reproduction.

Surveys

Fish typically enter the outlet cove in the second week in July to spawn. Although many adults have been observed spawning in the outlet only a few fry have been observed in the fall. The winter of

Figure 40. Crystal Lake.

Table 54. Summary of Crystal Lake Gill Net Sampling, Outlet Trend Site, 1964-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/14/64 [^]	CUT	346	114-496	1.0	-
07/27/79*	CUT	384	320-447	0.1	0.07
07/29/82*	CUT	356	356	<0.1	0.03
08/24/84*	No fish caught in six days (120 hours)				
07/29/86*	GBC	154	133-169	0.5	0.01
07/20/88	No fish caught in a 2.8 hour set				
07/21/88*	GBC	178	154-245	0.4	0.02
07/16/91	GBC	265	140-360	5.3	1.51
09/24/92	GBC	307	307	0.5	0.17
09/25/93	No fish caught in a 1.5 hour set				
08/24/98	GBC	398	396-400	1.2	0.76

[^] Data for two overnight net sets, one at outlet trend site and the other along east shore

- No data recorded

* Overnight net set

1999-2000 was considered mild and fish were observed in the outlet about a week earlier than previous years. If reproduction is possible here it probably would have occurred in 2000. However, no fry were observed in the outlet on 6 September.

Gill net surveys on 29 July 1986 showed the lower stocking rate of fry the previous September at Crystal Lake initially produced larger fish than Lawn Lake; 153 mm and 37.6 g compared to 143 mm and 29.5 g (Tables 36 and 54). However, by 20 July 1988, Lawn Lake fish were larger than those in Crystal Lake (215 mm compared to 178 mm). Both areas were stocked on the same dates.

In three gill net surveys at the outlet trend site since 1992 have caught a total of three fish, all of which have been over 307 mm. In an attempt to locate small fish, several locations besides the outlet trend site were gill netted in 1998. Although more fish were caught (6.29 fish/hour), no fish under 308 mm in length were caught. The absence of small fish indicates that recruitment is not taking place at Crystal Lake.

Deformities, such as shortened snouts (Figure 41), short opercles and deformed pectoral fins, were observed in 53% of the GBC examined in 1998. These deformities have been observed in other populations of GBC founded directly or indirectly from the Como Creek population (Dwyer and Rosenlund 1988).

Table 55. Summary of Fishery Statistics for Crystal Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1958	0.13	-	-	-
1959	0.51	-	686.3	CUT
1960	0.08	5	24.0	CUT
1962	0.31	3	16.0	CUT
1963	0.29	4	7.0	CUT
1964	0.17	6	18.0	CUT
1965	0.38	3	8.0	CUT
1966	1.50	2	4.0	CUT
1967	0.00	3	2.0	
1968	0.93	3	15.0	CUT
1983-1989	Closed to angling			
1995	1.00	1	5.0	CUT
1996	1.00	1	1.0	CUT
1998	1.05	4	8.5	CUT

- No data recorded

Angler Use

Reports from 1964 described angler visitation at Crystal Lake as moderate to heavy. Currently due to its remote location, a 12.4 km hike, it receives little fishing pressure. This in spite of the fact that Lawn Lawn, 2.4 km downstream, is a popular area with several campsites. Crystal Lake opened to catch-and-release angling for GBC in 1990. Pre-restoration catch rates averaged 0.5 fish/hour from 1959 through 1968, while catch rates since the restoration have averaged 1.03 fish/ hour (Table 55).

Current Status

The absence of fish < 300 mm and fry in the fall suggests that reproduction is not occurring at Crystal Lake. It is believed that low water flows seem to be the major limiting factor to reproduction. Once spring runoff ends there is not enough intragravel water flow to supply developing eggs with oxygen and remove wastes and eggs die before hatching. Low water temperatures may also be a factor. Water temperature is used as a cue to begin spawning, 6-7 °C for cutthroat trout. Since Crystal Lake is large and deep and most of the water that flows through the lake is snowmelt, the outlet stream does not reach this temperature until mid-July, which is late to begin spawning. Lower temperatures also cause slower development rates for eggs, delaying hatching and emergence of fry. If fry emerge too late and do not have enough time to feed and gain weight they may not survive the winter. Low temperatures would delay emergence but they would not kill the eggs like lack of oxygen would. The rarity of observations of fry late into September would seem to indicate that low flows are the major limiting factor. However, fry may be emerging but just not observed. Salmonid

fry emerge at night and a lack of cover in the Crystal Lake outlet may force them to enter the lake after emergence. A more detailed study of cutthroat trout reproduction in this area is planned for 2001.

Figure 41. Genetic Deformity of Crystal Lake Greenback Cutthroat Trout.

Lake Husted

Lake Husted (Figure 42) is a headwater lake located in the North Fork of the Big Thompson River drainage (Figure 16). It is at an elevation of 3365 m, has a surface area of 4.1 ha, and a maximum depth of 9.1 m. A gradient barrier and low water flows prevent migration of fish between it and Lost Lake, located 0.7 km downstream. No inlet channel exists, inflow consists of snowmelt flowing underground. Once spring runoff ends very little, if any, water flows through the outlet; late August flows have been measured at 0.004 cms. Limited spawning substrate in the outlet and low flows are believed to prohibit reproduction. The shoreline consists mostly of rock with some grasses.

Restoration

As part of a larger restoration project that included Lost Lake and the North Fork of the Big Thompson River below it, BKT were removed from Lake Husted in 1986 (Figure 16 and Table 15). Lake Husted was stocked with 2,000 fry on 24 September 1986 and 2,000 fry on 16 September 1987 from the Bftc GBC broodstock.

By 1989, BKT were once again found in Lake Husted, possibly due to a deliberate introduction. The lake was retreated on 5 September 1990 with 22% of the fish recovered after treatment being BKT. The lake was restocked on 25 September 1991 with 4,000 BFTC GBC and on 23 September 1992 with a mix of 3,000 fish from BFTC and FRH.

Figure 42. Lake Husted.

Table 56. Summary of Lake Husted Gill Net Sampling, Outlet Trend Site, 1982-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/10/82*	BKT	250	150-304	2.7	0.43
09/07/89	No fish caught in a 2 hour set				
08/25/93	GBC	205	155-245	20.0	1.61
09/26/98	GBC	251	225-293	32.1	4.78

* 2 nets set overnight, one at outlet trend site and the other in south cove

Surveys

Typically annual spawning starts in the outlet by mid-June, which would give eggs plenty of time to develop and hatch. However, very few fry have been observed in the fall.

Gill net surveys since the last stocking in 1992 indicate an abundance of cutthroat trout at both trend sites and no BKT (Tables 56 and 57). Surveys in 1998 had the highest catch rates observed at both trend sites, six years after the last stocking. However, fish were within a relatively narrow range indicating that few year classes were present.

Deformities such as short opercles and peduncles were been observed in 20% (4/20) of fish during the 1993 survey and 11% (3/26) of fish sampled in 1998. Analysis of stomach contents have shown fish feeding on water boatman, terrestrial insects (grasshopper and mosquitoes) and plant material.

Special Studies

Based upon a Peterson population estimate during the first treatment in 1986, the BKT population of Lake Husted was estimated at 56.9 kg/ha by Colorado State University (Bergersen 1988).

Table 57. Summary of Lake Husted Gill Net Sampling, Inlet Trend Site, 1989-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/09/89	GBC	232	220-248	2.4	0.38
	BKT	324	305-340	3.2	1.89
09/26/98	GBC	248	234-267	12.9	1.58

Table 58. Summary of Fishery Statistics for Lake Husted, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	3.77	-	77.9	BKT
1960	3.08	17	88.0	BKT
1961	1.42	19	76.0	BKT, CUT, RBT
1962	1.27	18	66.0	BKT, CUT
1964	3.42	6	36.0	BKT
1967	2.00	2	5.0	CUT
1984	0.87	2	8.0	BKT
1986-1994	Closed to angling			
1998	21.00	1	1.0	CUT
1999	6.67	1	0.8	CUT
2000	7.50	4	14.0	CUT

* In order of relative abundance

- No data recorded

Angler Use

Fishing pressure was described as quite light at Lake Husted in 1961. Due to its remote location, over 17 km from the closest trailhead, it still receives little fishing pressure. Catch rates have averaged 8.32 fish/hour since opening to catch-and-release angling for GBC in 1995 (Table 58). Catch rates prior to the restoration averaged 2.4 fish/hour from 1958 through 1984.

Current Status

Creel survey and gill net survey results indicate that there is an abundance of fish present in Lake Husted. However, fish sampled are over a narrow range of length, indicating that only one or two year classes are present; possibly from the 1991 and 1992 stockings. Low water flows in summer and fall seem to be the limiting factor to cutthroat trout reproduction at Lake Husted.

Loomis Lake

Loomis Lake (Figure 43), is located in the Spruce Creek drainage, a tributary of the Big Thompson River in central RMNP (Figure 38). It is at an elevation of 3115 m, has a surface area of 1.1 ha, and a maximum depth of 4.9 m. The shoreline is comprised of rock and krummholtz. No spawning habitat exists in the inlet and very limited spawning habitat exists in the outlet cove. Just below the lake a cascade barrier exists that prohibits fish leaving the lake to spawn from re-entering. Good spawning substrate is present below this barrier.

Restoration

As part of a restoration project that included Spruce Lake, 0.75 km downstream, BKT were removed from the Loomis Lake on 9 September 1990. Experimental introductions of GBC were made in 1991 and 1992. One thousand fish from the BFTC broodstock were stocked on 25 September 1991 and a mix 700 fish from BFTC and FRH were stocked on 23 September 1992.

Figure 43. Loomis Lake.

Table 59. Summary of Loomis Lake Gill Net Sampling, Outlet Trend Site, 1979-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/27/79*	BKT	202	140-290	1.7	0.16
08/31/90	BKT	-	-	0.7	-
07/21/93	GBC	203	155-236	18.7	1.63
08/15/95	GBC	211	179-242	13.0	0.94
08/02/00	GBC	307	302-315	7.2	1.20

- No data recorded

* Overnight net set

Surveys

In 1998 fish were observed packed into the outlet stream below the cascade starting in late June. About 20 fish were observed in one 1 m by 0.5 m pool. Some fish were trying to re-enter the lake by ascending the cascade but low flows prohibited this. No fish were observed attempting to spawn above the cascade in the outlet cove.

Gill net survey catch rates since the restoration have decreased while mean and minimum TL of fish sampled has increased, indicating that this population is not recruiting (Table 59). Some females sampled in 1993 and 1995 appeared to have spawned with no mature eggs inside their body cavity.

Three fish were caught in 50 minutes of gill netting at the outlet on 2 August 2000. These fish had a mean TL of 307 mm (range=302-315 mm). Additional fish were observed cruising in the lake. An angler fishing at Primrose Lake said that he had caught a few small fish along the south shore, however none were caught or observed during the survey.

Angler Use

Pre-restoration catch rates averaged 1.26 fish/angler hour from 1962 to 1990 (Table 60). Since Loomis Lake opened to catch-and-release angling in 1993 catch rates have averaged 10.66 fish/hour. Access to Loomis Lake is difficult limiting the number of anglers who visit this lake.

Current Status

No spawning activity above the barrier cascade and a lack of small fish would indicate that recruitment is not taking place in Loomis Lake proper. The lake will likely go fishless in the next 5 to 6 years as fish that were stocked in 1991 and 1992 either die or leave the lake and are unable to return.

Table 60. Summary of Fishery Statistics for Loomis Lake, 1962-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1962	0.29	2	24.0	BKT
1965	0.11	6	18.0	BKT
1966	0.50	12	38.0	BKT
1968	2.50	3	6.0	BKT
1972	1.80	5	9.0	BKT
1973	1.43	3	21.0	BKT
1984	4.00	1	4.0	BKT
1985	5.70	2	10.0	BKT
1987	1.23	4	6.5	BKT
1988	6.00	1	0.5	CUT
1989	3.33	1	1.5	BKT
1990	0.50	1	2.0	RBT
1990-1992	Closed to angling			
1998	19.00	1	2.0	CUT
1999	12.00	1	0.3	CUT
2000	4.66	2	3.0	CUT

Access to good spawning substrate seems to be the limiting factor to cutthroat trout reproduction in this area. Many small fish have been observed in Primrose Lake, however there is no suitable spawning habitat in the outlet, and a small falls prohibits access to good spawning substrate in the inlet. What is most likely happening is that fish descend the cascade below Loomis Lake, successfully reproduce, but since their offspring, as well as the spawning fish, are unable to re-enter the lake they drop down to Primrose Lake. Thus once fish have access to suitable spawning substrate, flows and temperatures are good enough for successful cutthroat trout reproduction.

Lily Lake

Lily Lake (Figure 44) is a 6.8 ha artificial impoundment located on the eastern edge of RMNP (Figure 45). The land surrounding Lily Lake was donated to and purchased by RMNP in 1991 and 1992, and boundary adjustments was made to include these lands within RMNP (Lutz 1998). Prior to 1990, the previous owners created the lake, stocked RBT, and aerated the lake to maintain a sport fishery. The lake is very shallow (< 2 meters), clear, relatively warm and supports robust populations of aquatic plant species during the summer months. During the period that ice covers the lake (October-April), decomposing aquatic vegetation removes oxygen, and makes trout survival impossible in most winters without artificial aeration. To provide oxygen during the winter, a liquid oxygen system is installed each fall. Minimal inflow and no outlet stream, provide no spawning habitat. Trout reproduction appears not to occur, or occurs at such a low level, that a long-term trout population cannot be maintained without artificial stocking. The shoreline is comprised mostly of grasses. This area is maintained with GBC as a native fish educational area and to gather data on catch-and-release sport fishing as outlined in the Greenback Cutthroat Trout Recovery Plan (USFWS 1998).

Stocking

Greenback cutthroat trout were first introduced to Lily Lake 11 October 1990, with 2,668 surplus fingerlings from BFTC stocked. Surplus fry were also available from BFTC in 1991 (4,895), and BFTC/FRH in 1992 (2,500), due to surplus production, and some storms blocking the access to

Figure 44. Lily Lake.

Figure 45. Map of Lily Lake Greenback Cutthroat Trout Population.

backcountry restoration sites. No fish were available for Lily Lake from 1993 through 1997. On 18 May 1998, 904 fingerlings from eggs collected at Upper Hutcheson Lake in 1997 at reared at the CDOW hatchery in Pueblo were stocked. All fish stocked in 1998, were marked with an adipose fin clip by school children and volunteers from Trout Unlimited.

Surveys

A few large RBT were caught in gill net surveys in 1990 and 1993 (Table 61), with none caught since 1993. The 1990, 1991, and 1992 stockings of fry and fingerlings were successful in establishing a GBC population. Fish exceeding 337 mm were observed in gill net surveys by October 1992, with gill net catch rates increasing through 1994. Because Lily Lake has inadequate stream spawning habitat, fish attempt to spawn along the shoreline, where wave action exposes gravel and cobble stones. There appears to be little, or no, recruitment from this spawning effort, with no fish under 200 mm captured in gill nets from 1994 to 1997.

Gill net survey catch rates decreased from 1994 through 1996, mean TL increased, and angler success rates declined in a manner consistent with a population not recruiting at a sustainable rate. This pattern can also be observed since the last stocking in 1998. Thirty-eight percent of fish caught in net surveys conducted on 18 May 1999 had adipose clips from the 1998 stocking. The clipped fish had a mean TL of 257 mm (range=225-282 mm). Another survey on 22 October found all fish caught having adipose clips. The mean TL of fish caught increased by 53 mm from the May survey.

Table 61. Summary of Lily Lake Gill Net Sampling, North Shore Trend Site, 1990-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
06/29/90	RBT	539	539	1.7	3.08
10/14/92	GBC	297	246-337	29.3	7.28
10/28/93	GBC	267	190-398	30.0	6.28
	RBT	320	320	1.0	0.30
06/02/94	GBC	279	194-377	83.3	18.93
05/12/95	GBC	290	221-338	11.2	2.88
10/25/95^	GBC	310	281-341	4.7	1.08
10/24/96	GBC	302	257-358	3.3	1.02
09/27/97	GBC	349	320-384	5.3	2.31
05/18/99	GBC	296	225-387	27.0	6.89
10/22/99	GBC	310	264-339	18.0	5.22
10/13/00	GBC	317	296-355	5.1	1.55

^ Net set at southeast inlet

Visitor/Angler Use

Due to its roadside location, Lily Lake attracts many anglers, and other visitors, throughout the summer months. Visitor use surveys have been conducted at Lily Lake by the Alpine Anglers Chapter of Trout Unlimited (TU) since 1997. Data is collected on the number of visitors and their activities on an hourly basis with a daily log form. The number of days and length of time each day that volunteers are present depends on availability (Table 62). In addition to conducting the surveys, volunteers collect creel survey data, advise visitors of park regulations, and do interpretive work.

For all four years daily visitor use peaked around mid-day with smaller peaks in the evening. Angler use also followed this pattern. In 1997 and 1998 overall visitor use peaked around 4 July. In 1999 and 2000 multiple usage peaks were observed between late June and early August.

Table 62. Summary of Lily Lake Trout Unlimited Visitor Use Surveys, 1997-2000.

Year	Days Present	From	To	% Anglers
1997	25	18 May	27 July	51.3
1998	36	22 May	7 September	26.7
1999	48	21 May	5 September	35.5
2000	22	10 June	2 September	26.0

Table 63. Summary of Fishery Statistics for Lily Lake, 1990-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1990	0.80	4	6.0	RBT
1991	0.60	9	14.0	RBT
1992	0.90	25	30.0	CUT, RBT
1993	1.70	46	107.1	CUT
1994	1.23	29	53.0	CUT
1995	1.09	77	113.1	CUT
1996	0.64	51	183.5	CUT
1997	0.80	150	473.8	CUT
1998	0.54	80	243.8	CUT
1999	0.67	177	477.8	CUT
2000	0.62	68	165.8	CUT, BKT

* In order of relative abundance

Since 1996, creel data collected from Lily Lake has made up a large portion of the total data collected from the east side of RMNP (Table 5). This is due to the large number of anglers which fish at Lily Lake and to the large amount of data collected by TU. Lily Lake has a lower catch rate than most other areas of the park because of heavy fishing pressure and lack of recruitment.

Fish from the 1990 stocking entered the creel survey data in 1992. Catch rates increased to 0.9 fish/hour in 1992, and peaked at 1.70 fish/hour in 1993 as fish from the 1990, 1991, and 1992 stockings grew to catchable size (Table 63). Catch rates decreased to a low of 0.54 fish/hour in 1998. As expected due to the 1998 stocking catch rates rose to 0.67 to in 1999.

Current Status

Lily Lake is considered as a valuable place to have GBC for educational purposes and collection of information on catch-and-release angling. It will continue to be maintained by stocking with surplus fish and the use of oxygen in the winter.

CONSERVATION POPULATIONS

Big Thompson River-Forest Canyon

The Big Thompson River is located in the central portion of RMNP (Figure 47). The Forest Canyon GBC population begins at a barrier above Spruce Creek (2574 m) and extends 12.5 km to another barrier within a meadow at 3242 m (Figure 46). The river flows through a series of long alpine meadows which alternate with strips of dense conifer forest. The canyon walls are steep, with heavy timber on the slopes.

Stocking

Surveys in 1957 found this population and at that time there were no known stockings of the area and it was believed that this population was pure GBC (Bulkley 1957). However, in 1962 stocking records were found showing that Forest Canyon was stocked with a total of 140,000 YCT fry in 1922 and 1923 (Behnke 1976).

Taxonomy

In 1961 two specimens were collected from Fay Lake, which was stocked with Forest Canyon cutthroat trout, to try and positively identify these fish as GBC. Dr. Robert Rush Miller, Curator of

Figure 46. Upper Forest Canyon Meadow.

Figure 47. Map of Big Thompson River-Forest Canyon Greenback Cutthroat Trout Population.

Fishes, University of Michigan Museum, could not do this due to the vagueness of the original description (Azevedo and Wallis 1962). From samples collected in 1968, Wernsman (1973) described the fish in Forest Canyon as virtually pure GBC trout based on meristic characters. Meristic analysis of the Forest Canyon cutthroat trout was also done by Dr. Robert Behnke. He also determined that they were GBC and represented as good an approximation of the original native species as could be found at that time (Behnke 1976).

The first attempt at using genetic techniques to identify these fish in 1975 was inconclusive due to the limited knowledge of species specific markers at that time (Mullen 1975). Samples were collected from four sections of Forest Canyon in 1980 and given to Dr. Behnke and Eric Wagner (1982). They were determined by meristic characters to be essentially or virtually pure GBC with little or no taxonomic differences detected between sites. In 1999, tissue samples were taken from 15 fish and given to Don Proebstel for genetic analysis. He determined that they were A- GBC (Appendix III). No YCT or RBT influences were detected. There was evidence that this population was derived from multiple sources and phenotypic variability was also observed based on slides taken at the time of collection.

Surveys

A two day angling survey of this population was conducted on 27 and 28 August 1957 (Bulkley 1957). Fish were found to be abundant in all sections of the river except the section between 2895 m and 3048 m. Fish were relatively scarce in this section and it was believed that this was due to anglers hiking down from Trail Ridge Road and fishing this section. Several year classes of fish were observed throughout the river.

At the time of this survey there were no known records of stocking in Forest Canyon. Due to this and its remoteness and inaccessibility it was believed that these fish were an historic genetically pure population of GBC.

This discovery led to a three-phase program: 1) a life history study of the fish in Forest Canyon; 2) experimental propagation of Forest Canyon fish at the Leadville NFH with no success; and 3) introduction of Forest Canyon fish into renovated habitat typical of park waters.

The life history study of these cutthroat trout was conducted by Bulkley (1959):

Length, Growth and Age. Bulkley (page 24) found that: “the cutthroat in Forest Canyon Creek rarely exceed nine inches in total length. Collections were made over the entire stream, and the largest fish captured measured 236 mm. The average length of adult fish was slightly less than eight inches.”

To determine the length frequency of the population, fish were removed from a 100 yard section of stream. The range of length of fish sampled was 85 to 212 mm. Fish were aged using scales and it was found that two and three-year old fish were the predominant year classes. No fry were captured within the study section but they were observed elsewhere. Mean TL for age 1 fish was 93 mm, 130 mm for age 2 fish, 174 mm for age 3 fish, and 205 mm for age 4 fish.

Food Habits. Analysis of bottom samples from four different locations during the summer indicated low stream productivity. Stomach contents of 40 fish found that three fourths of food present were terrestrial organisms. Stomach contents taken in early June found more aquatic organisms than samples taken later in the summer.

Reproduction. The first spawning was observed on 1 July and spawning was completed by 15 July. A two-way trap was installed in late June to gather information on migrating spawning fish. Few fish were captured in the trap indicating that there is not a large migration to spawn. There is suitable spawning substrate in most stream sections so there is little need for extensive movement to spawn.

Scale analysis of spawning fish caught by angling found that almost all fish were age 3 or 4. Males outnumbered females almost two to one and fry were first observed to have emerged on 26 August. It was estimated that fry mortality was high, however this mortality was not due to predation from adult fish based on stomach analysis.

Fifty GBC were removed from Forest Canyon in 1958 and another 83 were removed in 1959 (Cope 1959) and taken to the Leadville NFH with the hopes of using these fish as a broodstock to stock restoration projects. A similar effort was undertaken in 1957 from another GBC population. Twenty-six fish were removed from Albion Creek and taken to Leadville NFH (Bulkley 1957). These fish proved to be unsuited to hatchery conditions and few survived (Bulkley 1959). The fish that did survive had good growth but problems with asynchronous maturation prohibited spawning at the hatchery. These same problems befell the Forest Canyon GBC as well and the project was abandoned (USFWS 1998).

To expand the range of the GBC within RMNP fish were removed with rotenone from the Fay Lakes drainage in 1958 and Fay Lake was restocked with 209 fish from Forest Canyon. These fish moved out of Fay Lake and into Caddis Lake downstream where their offspring are still present.

Ninety-two GBC were removed from Forest Canyon on 20 July 1965 and taken to the Leadville NFH. It was proposed that these trout would be reared through three generations to determine if they would maintain their characteristics and breed “true” (Wallis 1967). Once again problems with asynchronous maturation prohibited this project from completion and the trout were stocked into Florence Creek, a fishless headwater tributary on the Uinta and Ouray Indian Reservation, Utah in 1967 (Behnke 1969). Behnke (1976) reports that these fish successfully reproduced and became established. Langlois et al. (1979) reported that follow-up surveys found no trout, so BKT were stocked. Since the stocking some GBC were found but BKT were the dominant species in 1979.

Electrofishing surveys were conducted at seven sites in September 1980 to obtain abundance and age structure information (Table 64). Fish were aged using length-frequency and it showed that the majority of fish were in the age 4 and 5 age classes. There was a sharp decrease in the numbers of fish in year classes over age 5. The mean length of fish also was shown to decrease as the elevation increased. Bulkley's 1958 study was in the same area and probably included the same meadow section that was surveyed in 1980. Fish sampled in 1958 had a mean TL of 145 mm (range=85-212 mm), compared to a mean TL of 150 mm (range=102-262 mm) in 1980. The standing crop was

Table 64. Summary of Big Thompson River-Forest Canyon Electrofishing Surveys, 1980.

Site	Fish/100 m	Mean TL (mm)	Mean Weight (g)
Pools @ 2697 m	232.51	205	94
Riffle @ 2697 m	59.00	189	85
Downstream of Gorge Lakes Jct.	76.16	172	58
Upstream of Gorge Lakes Jct.	105.91	183	66
Rock Cut	71.24	186	69
Unnamed Creek @ 3078 m	39.36	148	40
Meadow @ 3194	96.23	150	40

Table 65. Summary of Fishery Statistics for Big Thompson River-Forest Canyon, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958-1961	Closed to angling			
1962	11.0	1	22.0	CUT
1964	1.38	14	70.0	CUT
1965	2.11	6	18.0	CUT
1966	2.43	17	243.0	CUT
1967	1.35	12	37.0	CUT
1969	1.13	59	299.0	CUT, BKT, RBT
1986	5.20	1	2.5	CUT
1999	5.90	4	10.5	CUT

* In order of relative abundance

estimated at 47 fish/100 m in 1958 compared to 96.23 fish/100 m in 1980.

Nine fish (mean TL=206 mm, range=193-259 mm) were caught on 25 September 1985 during a hook-and-line survey conducted near the junction with Hayden Creek. Another hook-and-line survey conducted on 5 July 1999 upstream of the Gorge Lakes stream had very similar results. Seventeen fish (mean TL=206 mm, range=182-251 mm) were caught in 7.5 hours. Most males were ripe and females were about a week away from spawning.

Angler Use

Difficult access into Forest Canyon greatly reduces the fishing pressure. There are no maintained trails and the easiest access is a steep descent from Trail Ridge Road. Following the discovery of what was thought to be a pure GBC population this area was closed to fishing in 1958. It was reopened in 1962 after determining that this area had been stocked with non-native fish in the 1920's.

Recent creel survey data is limited (Table 65), with most of what is available being collected during surveys. During the 1985 hook-and-line survey near Hayden Creek nine fish were caught in one hour out of one pool. In 1999, during tissue collection, 17 fish were caught by three anglers in a total of 6.5 hours. All of these fish were easily caught in a 150 foot section of the river above the Gorge Lakes stream with two fish being caught twice.

Current Status

From all indications this population is in good condition, with an abundance of habitat and a healthy fish population. However, a hybrid population of B+ cutthroat trout exists within the Gorge Lakes

drainage between Forest Canyon and Arrowhead Lake. If these fish are dropping down into Forest Canyon they may be further diluting the GBC. Genetic analysis of tissue samples collected near the Gorge Lakes stream junction in 2000 did not show evidence of influences from YCT that are present in the Gorge Lakes fish.

Arrowhead Lake

Arrowhead Lake (Figure 48) is located on an unnamed tributary (commonly called the Gorge Lakes drainage) of the upper Big Thompson River in the central portion of RMNP (Figure 49). It is the lowest lake in a string of lakes known as the Gorge Lakes, which also includes Doughnut, Inkwel, Azure, and Highest Lakes. It has a surface area of 14 ha and a maximum depth of 25.9 m. Due to its high elevation (3400 m) and depth, water temperature is the major limiting factor to fish production. Further compounding the problem, spawning habitat only exists in the inlet, which warms later than the outlet. Due to these factors it is believed that reproduction only occurs intermittently. The shoreline is composed mostly of rock, with some willow present.

Stocking

The earliest stocking record shows 20,000 “black spotted” fry being stocked in 1913. “Black spotted” fry were also stocked in the 1930’s and 1940’s. Stocking records also show plants of RBT in 1936 and 1937.

By 1960 it was believed that Arrowhead Lake was fishless (Wallis and Azevedo 1961), however, due to the finding of a potentially pure population of GBC in Forest Canyon, downstream of the Gorge Lakes drainage, stocking was suspending pending the outcome of taxonomic analysis of the Forest Canyon cutthroat trout. With the finding that Forest Canyon had previously been stocked with YCT, it was proposed that Arrowhead Lake be stocked with cutthroat trout every third year starting in 1962 (Azvedo and Wallis 1962). The last stocking would have been made in 1968, the



Figure 48. Arrowhead Lake.

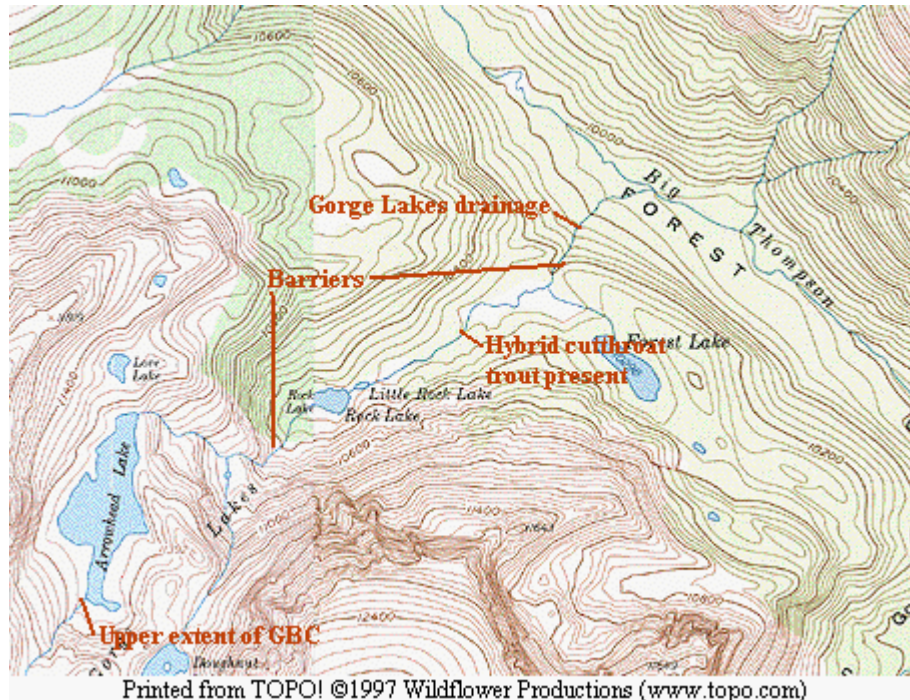


Figure 49. Map of Arrowhead Lake Greenback Cutthroat Trout and Gorge Lakes Drainage Cutthroat Trout Populations.

last year that lakes in RMNP were stocked for recreational fishing.

Since Arrowhead Lake fish do not successfully spawn each year it was decided to try and slowly shift the fish population to an “almost” pure population by stocking pure GBC. On 23 September 1992, a mix of 5,000 GBC fry from FRH and BSFH were stocked at a rate of 60.71 fish/hectare.

Taxonomy

Tissue samples were collected in 1998 and taken to Don Proebstel for genetic analysis. He determined that the fish in Arrowhead Lake are A- GBC with a slight YCT influence (Appendix III).

Surveys

To determine the existence of any fish that might be remaining from the proposed 1960’s stockings, gill net surveys were conducted on 13 and 14 September 1978. Two nets were set, one across the outlet and one across the west side. No fish were caught in the west net which was set for 17 hours and two cutthroat trout were caught in 15.5 hours in the outlet net (Table 66). One of these fish appeared to be a RBT x cutthroat hybrid. Scales were collected from one of the fish and at least eight annuli were counted but were difficult to read. It was assumed that these fish were from the

Table 66. Summary of Arrowhead Lake Gill Net Sampling, Outlet Trend Site, 1978-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
09/14/78*	GBC	442	432-452	0.12	-
08/20/87*	GBC	490 [#]	330-650 [#]	0.11	0.12 [#]
08/31/98	GBC	311	293-330	2.50	0.73

* Overnight net set

- No data recorded

[#] Includes estimates for one fish which escaped before measurements

last stocking of fish in the late 1960s.

Another gill net survey was conducted in August 1987. Nets were set across the inlet and outlet. No fish were caught in the inlet net in 12 hours and two cutthroat trout were caught in 18 hours in the outlet net. One fish measured 330 mm and the other, estimated between 600 and 700 mm, escaped before being measured. Based on the size of the smaller fish at least one successful spawn had occurred since 1968.

A gill net survey conducted at the inlet in June 1992, prior to the stocking of pure GBC, caught 4 fish in 14.5 hours (0.28 fish/hour). Mean TL of these fish was 276 mm (range=180-360 mm). Nine fish were also observed in the inlet spawning.

In addition to the survey data from the outlet trend site a net set was also conducted in the south cove on 31 August 1998. Eight fish (mean TL=324, range=305-356) were caught in one hour. All fish could have come from the 1992 stocking.

Angler Use

The Gorge Lakes are located in a remote area of RMNP with no maintained trails leading to them. In spite of its isolation Arrowhead Lake was at one time a popular destination for anglers. Merlin K. Potts in his 1936 records reports that year the cutthroat trout measure 12 to 15 inches (Wallis and Azevedo 1961, page 11). He further states that “at present this lake is well stocked but the supply is being rapidly depleted by extensive fishing. Parties of 15 to 20 fisherman are common on weekends.”

Currently due to its relative inaccessibility, a difficult 6.5 miles from the closest trailhead, it receives little angling pressure. One angler interviewed in 1999 stated that the fishing was not as good as usual even though 1999 had the highest catch rate of any year where creel data was collected (Table 67).

Table 67. Summary of Fishery Statistics for Arrowhead Lake, 1961-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1961	0.00	10	70.0	
1962	0.00	6	36.0	
1963	0.00	6	24.0	
1964	0.00	7	39.0	
1965	0.13	7	23.0	CUT
1966	1.09	8	86.0	CUT, RBT
1967	0.27	14	48.0	CUT
1968	0.49	13	39.0	CUT
1969	0.78	23	135.0	CUT, BKT
1972	-	1	-	RBT
1976	0.00	1	2.0	
1984	0.07	4	14.0	CUT
1997	0.60	2	10.0	CUT
1999	1.66	1	3.0	CUT

* In order of relative abundance

- No data recorded

Current Status

Arrowhead Lake does not support a high number of fish due to the extreme conditions, high elevation, and limited spawning habitat. However, persistence of this population is expected at the level observed from 1968 to 1992.

OTHER NATIVE FISH SPECIES

The original distribution of native fish within RMNP was not documented prior to 1923. Stocking of native and non-native fish within RMNP probably began in the late 1800s and ended in 1968. However, stocking is still done in waters just outside RMNP and with no barriers stocked fish are entering the park. These fish, especially BNT, are displacing native fish within the lower montane valleys of RMNP.

On the east side of RMNP the white sucker (*Catostomus commersoni*) and the longnose sucker (*Catostomus catostomus*), which are both native species, inhabit the Fall River through Horseshoe Park and the Big Thompson River through Moraine Park. Suckers in both of these areas have been in decline in recent years. This decrease has been accompanied by an increase in the number of BNT present in these waters. There are no records of BNT being stocked and no stocking of any species since 1957. It is suspected that the suckers are being preyed upon by the BNT.

Electrofishing surveys have been conducted on the Fall River near Cascade Cottages dating back to 1965. At that time, suckers and BNT each accounted for 28.6% of the fish population present at that site, (Figure 50). Surveys conducted in 1969 and 1980 showed a rise in the sucker population, with suckers comprising 43 % of the species sampled in 1980. Following the Lawn Lake flood in 1982, sucker populations at Cascade Cottages increased due to siltation, which greatly reduced trout spawning habitat. In 1987, suckers comprised 81.5% of the fish population, with no BNT present. Since 1987, BNT numbers have increased and sucker numbers have decreased based on electrofishing surveys in 1993, 1995, and 1997. By 1997 BNT were the dominant species, 52.4% of the population, at this site. An electrofishing survey conducted in 1998 at a site a few hundred feet upstream from the Cascade Cottages trend site found BNT to be 85.4% of the population, with suckers only 4.7% of the population.

The same situation is also occurring in the Big Thompson River. Electrofishing surveys have been conducted in Moraine Park since 1958. Surveys in 1958 and 1965 found sucker populations around 35% of the species present at several sites, with no BNT present in 1958. By the fall of 1971 BNT were found to be the dominant species, comprising 66.2% of the fish population, at two sites. Starting in 1980, a trend site was established at Mailbox Junction, with BKT found to be the most abundant fish species, followed by BNT, suckers, and RBT (Figure 51). Since the initial survey at this site, surveys have been conducted in 1988, 1990, 1993, and 1997, with BNT being the dominant species since 1988. Brown trout have comprised between 68.2% and 92.2% of the fish population at Mailbox Junction in these years. No suckers were sampled in 1990 and 1997, with only one sampled in 1993.

Suckers were also found in Sandbeach Lake (3140 m), Bear Lake (2890 m), Little Crystal Lake (3510 m), and Hidden Valley Creek. The presence of these suckers was due to previous sport fish stocking, with suckers no longer present.

Figure 50. Relative Abundance of Fish Sampled by Electrofishing at Fall River Cascade Cottages Trend Site, 1965-1997.

Figure 51. Relative Abundance of Fish Sampled by Electrofishing at Big Thompson River Mailbox Junction Trend Site, 1980-1997

SECTION III: ROCKY MOUNTAIN NATIONAL PARK NATIVE FISHES WEST OF THE CONTINENTAL DIVIDE.

COLORADO RIVER CUTTHROAT TROUT

The historic range of the Colorado River cutthroat trout (CRC), *Oncorhynchus clarki pleuriticus*, includes the cool water habitat of the Colorado River basin from the headwaters along the Continental Divide to the Grand Canyon. This area encompasses the western half of Colorado, the eastern half of Utah, southwestern Wyoming and small parts of Arizona and New Mexico.

When European settlers arrived the same problems that befell the GBC led to the decline of the CRC. Activities related to supporting the booming mining industry caused overharvesting of fish and pollution, siltation, and dewatering of streams, all of which had negative affects on native cutthroat trout. However, the largest factor that contributed to their decline was the introduction of nonnative trout which outcompeted and hybridized with them.

By 1979, it was estimated by Dr. Robert Behnke that good representatives of CRC trout occupied less than 1% of its original range (Trotter 1987). In late 1999 the CRC trout was petitioned for listing under the Endangered Species Act (Center for Biological Diversity 1999). Due to financial constraints the FWS has postponed action on this petition. Currently, one of the largest concentrations of CRC trout populations occurs within RMNP. Ten historic sites containing good representatives of the species and 4 restoration sites exist within RMNP.

Figure 52. Male Colorado River Cutthroat Trout From Timber Lake.

PURE HISTORIC POPULATIONS

Lake Nanita

Lake Nanita (Figure 53) is located at an elevation of 3290 m in the southeastern portion of RMNP (Figure 54). It is one of the largest lakes (13.6 ha) in the park and has a maximum depth of 17.1 m. The shoreline is comprised of conifers, grasses, and rock. Good spawning habitat is present in the outlet and a steep cascade barrier exists a short distance below the lake. Spawning habitat is also present in the inlet, however most fish prefer to spawn in the outlet. Early July outlet flows have been measured at 0.2 cms.

Stocking

Mullen (1973) reports that the only known stocking occurred in 1933 when 10,000 Yellowstone “black-spotted” trout fry were stocked. There may have been additional stockings around the same time but these have not been confirmed. A record from 1923 reports that “spotted natives” were present in the lake at that time (Toll 1923).

Taxonomy

Seven specimens were collected by hook-and-line on 9 July 1987 and given to Dr. Behnke for taxonomic analysis. Although YCT were the only fish reported to be stocked into Lake Nanita, he

Figure 53. Lake Nanita.

Figure 54. Map of Lake Nanita Colorado River Cutthroat Trout Population.

concluded from meristic characters that they were pure CRC of mixed parentage and are excellent for reintroduction into other waters (Behnke 1988). Anita Martinez (1990) of CDOW examined the same specimens and concurred that the fish in Lake Nanita were pure CRC based on their meristic characters.

Specimens collected in 1990 were given to Robb Leary and Fred Allendorf (1991) of the Wild Trout and Salmon Genetics Laboratory at the University of Montana. Genetic and meristic analysis of the specimens determined that the fish in Lake Nanita were pure CRC with little genetic variability. Samples of other presumed CRC populations were also analyzed. The Williamson Lakes, California population was the only other one determined to be pure. The population in Trappers Lake, from which the Lake Nanita and Williamson Lakes populations were founded from, was determined to be hybridized with YCT.

Gamete Collections

Trappers Lake contained one of the best populations of CRC within Colorado, with eggs from Trappers Lake used for stocking other waters within the state for many years. Since Trappers Lake cutthroat trout were found to be hybridized, Lake Nanita is considered the best population of CRC

suitable for the taking of eggs. Thirteen thousand eggs were collected on 5 July 1990 with 60% fertility. CDOW collected eggs in 1991, 1992, 1996, and 1998. Thirty-one thousand eggs were collected in 1992 and 20,000 were collected in 1996.

With eggs taken from Lake Nanita, the CDOW has established a CRC broodstock near Kremmling. It is anticipated that this broodstock will produce up to one million eggs annually. Lake Nanita eggs will be required by the CDOW in the future to maintain the genetics of the broodstock, with 10,000 to 15,000 eggs probably being required every other year for this purpose.

Surveys

In the spring, usually in late June, a large number of fish crowd the outlet stream to spawn. In fall an abundant amount of fry have been observed in the outlet.

A survey conducted in 1961 sampled trout between 64 and 305 mm in length. These fish were described to be in excellent condition (Azevedo and Wallis 1962). At that time spawning habitat was described as limited, but natural reproduction was adequate to maintain a balanced population.

On 17 July, 1973, two gill nets, one of which fished ineffectively, set for a total of 4 hours caught five fish (Table 68). These fish “appeared to be greenback cutthroat trout” (Mullen 1973, page 23). Fish were between 272 and 369 mm in length and all fish were ripe or partially spent. A minimum of 100 fish were observed spawning in the outlet.

The last gill net trend survey conducted at Lake Nanita was in 1980 with 1.5 fish/hour caught, similar to the 1.3 fish/net hour in 1973. More year classes of fish were present in the 1980 survey than in the 1973 survey. Fry were found to be abundant in the outlet while none were observed in the inlet.

A hook-and-line survey conducted on 9 July 1987 caught seven fish in one hour. All fish were in good condition and ranged in TL from 145 to 302 mm. The most recent quantitative data on the population at Lake Nanita is from 1990. A gill net set across the outlet caught 24 fish in 1 hour.

Table 68. Summary of Lake Nanita Gill Net Sampling, Outlet Trend Site, 1973-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/17/73*	CRC	-	272-369	1.3	-
09/25/80*	CRC	281	168-374	1.5	0.37
07/05/90	CRC	-	-	24.0	-

* Overnight net set

- No data recorded

However, this catch rate is inflated due to the survey being conducted during spawning operations with fish concentrated at the outlet. Two to three thousand fish were observed in the outlet and about 50 fish were observed around the west outlet. Fifty fish (mean TL=348 mm, range=270-395 mm) were handled during spawning. Disease sampling was also conducted in 1990 and found Lake Nanita fish positive for Enteric Redmouth Disease.

Fly fishing surveys of the outlet stream on 24 July 2000 found fish to have a mean TL of 295 mm (range=160-360 mm). A few of these fish were very emaciated, possibly post-spawning females (Figure 55).

Angler Use

In 1961 fishing pressure was described as moderate to heavy at this type of lake and that there was heavy use of the campsites at Lake Nanita (Azevedo and Wallis 1962). Currently fishing pressure can also be described as moderate to heavy. Although it is an 18 km hike to Lake Nanita and

Table 69. Summary of Fishery Statistics for Lake Nanita, 1961-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1961	0.39	29	261.0	CUT, RBT
1962	0.33	3	3.0	CUT
1964	0.66	18	98.0	CUT
1965	2.08	4	12.0	CUT, BKT
1966	0.24	53	1,059.0	CUT
1967	0.85	55	256.0	CUT
1968	1.15	19	119.0	CUT
1969	0.45	18	137.0	CUT, RBT, BKT
1975	0.81	3	73.0	CUT
1976	1.16	10	39.5	CUT, RBT
1984	1.00	1	4.0	CUT
1989	2.50	8	16.0	CUT
1990	1.12	45	155.0	CUT
1991	2.97	28	56.3	BKT, CUT
1992	5.60	12	24.0	CUT
1993	1.52	9	29.0	CUT
1994	2.77	11	6.5	CUT
1995	2.50	3	2.0	CUT
1997	0.75	3	8.0	CUT
1999	3.35	13	92.5	CUT
2000	4.48	5	8.3	CUT

* In order of relative abundance

currently the closest campsites are 4 km away it remains a popular fishing location.

Lake Nanita is the only area on the west side of RMNP containing pure CRC that is open to harvest (two fish limit). Anglers reported catching 0.47 fish/hour from 1961 to 1969 (Table 69). Limited creel survey data is available from the 1970's and early 1980's. Since 1989, catch rates have ranged from 5.6 fish/hour in 1992 (12 anglers interviewed) to 0.75 fish/hour in 1997 (3 anglers interviewed). The mean catch rate has been 2.29 fish/hour since 1989 with 89.6% of fish reported caught being released.

Current Status

Lake Nanita is an excellent pure population of CRC. There are an abundance of fish present and reproduction occurs annually.

Figure 55. Emaciated Lake Nanita Colorado River Cutthroat Trout.

Adams Lake

Adams Lake (Figure 56) is a headwater lake located on an unnamed tributary of Paradise Creek along the southwestern boundary of RMNP (Figure 64). At an elevation of 3419 m it is the third highest lake in RMNP that contains fish. It has a surface area of 1.83 ha and a mean depth of 3 m. Spawning habitat exists in the outlet and in several of the small inlets that feed the lake. The shoreline is well vegetated with grasses, shrubs, and conifers.

Stocking

The only documented stocking was in 1942 when 6,860 “black spotted” eyed eggs were stocked (Guse 1962a).

Taxonomy

No taxonomic analysis of the Adams Lake cutthroat trout has been conducted. However, specimens from the Paradise Creek, which is just downstream and was also stocked in 1942, were examined by Eric J. Wagner (1982) and found to be pure CRC from the Trappers Lake stock. Adams Lake fish exhibit bright red coloration, which is not observed in YCT that are known to have been stocked in RMNP. This information plus the fact that Adams Lake fish appear to be excellent phenotypes of CRC would indicate that they are pure specimens.

Figure 56. Adams Lake.

Table 70. Summary of Adams Lake Gill Net Sampling, Outlet Trend Site, 1963-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/03/63*^	CUT	-	203-406	0.30	-
08/13/81*	CRC	305	228-369	0.29	0.11
07/17/90	No fish caught in two nets set for 4 hours				

* Overnight net set

^ Net set on east shore

- No data recorded

Surveys

A survey conducted in 1963 (Linn 1963) found four or more year classes of cutthroat trout present (range=203-406 mm) but no small fish were caught or observed (Table 70). Six fish were caught in a 20 hour gill net set on the east shore with an additional six fish caught by hook-and-line. Fish had developed gonads and females were spawned out and were beginning to grow eggs for 1964.

An overnight gill net survey conducted in August 1981 captured 5 fish in a 17 hour set. Mean TL of fish sampled was 305 mm (range=228-369 mm). Additional fish 200-250 mm in length were also observed in the outlet bay.

The last survey conducted at Adams Lake was on 17 July 1990. Two gill nets set for a total of 4 hours did not catch any fish (Proebstel 1990). Approximately 50 fish were observed in the outlet stream about 500 yards below the lake. These fish represented several year classes with a range of length estimated to be from 100 to 400 mm. Five of these fish were caught by hook-and-line, with a size range of 170 to 340 mm. An abundance of terrestrial and aquatic invertebrates were observed in the lake.

Angler Use

Adams Lake is located 14.5 kilometers from the closest RMNP trailhead with most of this distance being crosscountry. Due to its remoteness it receives very little visitation. In addition to the data in Table 71, one angler reported catching 9 fish in six hours from Adams Lake and Paradise Creek in 1961.

Current Status

Based on survey data it appears that the population in the lake is very small and spawning only occurs intermittently. Low temperatures caused by its high elevation and its north facing aspect and low water flows once spring runoff subsides are probably the limiting factors to population. It is

Table 71. Summary of Fishery Statistics for Adams Lake, 1966-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1966	0.83	2	24.0	CUT
1993	0.00	1	0.3	

expected that this population will be surveyed in 2001.

Upper Colorado River

This Colorado River cutthroat trout population is located in a low gradient stretch of the headwaters of the Colorado River in northwestern RMNP (Figure 58). Cutthroat trout are found amongst a dense BKT population above Lulu City (2845 m). This area is greatly affected by the operation of the Grand Ditch, a water diversion that intercepts eleven headwater tributaries of the Never Summer Mountains west of the Colorado River. On average the ditch intercepts 29% of the total annual runoff of the Upper Colorado River watershed (Woods 2000) and diverts it across the Continental Divide to the Cache la Poudre drainage. The ditch alters the natural flow regime of the Colorado River with minimum flows present from mid-May to mid-September when the ditch is in operation. In winter, when tributaries are not diverted, flows in the river are higher than in the summer. Severe erosion of the riparian areas of the Colorado River caused by past operation of the Grand Ditch are present below the confluences of tributaries intercepted by the ditch (Mullen 1975). The riparian vegetation immediately adjacent to the river is comprised mostly of immature conifers.

Figure 57. Upper Colorado River Looking Downstream, Lulu City Site is in Meadow.

Figure 58. Map of Upper Colorado River.

Stocking

Records show that 454,000 cutthroat trout were stocked into unknown sections of the Colorado River from 1931 to 1955 and 40,000 RBT were stocked in 1958 and 1959 (Guse 1962b). Records also show plants of 57,000 “black spotted” fish from 1939 through 1947 into La Poudre Pass Lake (Guse 1962a), a man-made lake formerly at the very headwaters of the Colorado River. In 1955 the dam at this lake washed out and the area where the lake was located is currently a meadow.

Taxonomy

Based on meristic characters from samples collected in 1970, the fish in the Colorado River were described as “surprisingly pure” CRC by Wernsman (1973) and “quite typical of *S. c. pleuriticus*” by Dr. Behnke (1975). Tissue samples were collected from the Colorado River and a few surrounding streams in 2000 for genetic analysis.

Surveys

The existence of this population has been a mystery over the past 30 years. The first discovery of the cutthroat trout in this area occurred when Dr. Behnke's students collected specimens in 1970. The collectors told Dr. Behnke that they left Lulu City where BKT, BNT, and RBT were present, traveled up above the river along the Grand Ditch road for about a mile, then descended to what they thought was the Colorado River and found only cutthroat trout (Behnke 1975). Currently only BKT and cutthroat trout are present at Lulu City. Brown trout, RBT, as well as BKT are present well below Lulu City.

Surveys were conducted in 1974 and 1975 to locate this cutthroat trout population. On 12 July 1974, an angling survey was conducted from Lulu City to the confluence of Lady Creek, a distance of about 2 km. In this stretch only BKT were found (Mullen 1974). On 25 August 1975, the section of the Colorado River from Lady Creek to the Continental Divide was surveyed. Three of the apparently pure CRC were caught amongst a dense population of BKT (Mullen 1975). It was concluded that the cutthroat trout had declined in relative abundance since the early collection in 1970 and that they would eventually disappear.

A survey of the upper Colorado River from the mouth of Little Yellowstone Canyon to Bennett Creek was conducted on 13 September 1979. Electrofishing from the mouth of the canyon to a meadow above the confluence with Specimen Creek yielded only BKT. Above Specimen Creek fish abundance increased as stream size decreased. At the mouth of Bennett Creek a NaCN tablet was placed in the stream and 38 BKT and one 115 mm cutthroat trout were collected. Above Bennett Creek the stream was dry. In 1986, as part of the RMNP Lake and Stream Survey Program, a 91 m section of the river was surveyed just downstream of Lady Creek with only BKT collected.

Based on these survey results it was believed that any cutthroat trout present would soon be totally displaced by BKT. In almost all documented instances of BKT and cutthroat trout living sympatrically in stream habitat, BKT eventually displace cutthroat trout. However, the altered flow regime caused by the Grand Ditch may have an affect on the interrelationships of these two species.

An electrofishing survey conducted at Lulu City in 1999 surprisingly captured two cutthroat trout. These fish represented about 3% of the estimated population in the 113 m survey section. Cursory electrofishing between Sawmill Creek and Lulu Creek upstream of Lulu City found cutthroat trout to make up 6% (3 out of 50 fish sampled) of the fish population in this section. No young cutthroat trout, which would indicate reproduction is occurring in the Colorado River, were sampled. Standing crop for cutthroat trout was estimated at 1.77 fish/100 m and 0.7 kg/ha. Brook trout standing crop was estimated at 57.59 fish/100 m and 57.78 kg/ha.

The most logical explanation for the persistence of the cutthroat trout in the upper Colorado River is that there is an allopatric population above a barrier in one of the tributaries intercepted by the Grand Ditch. Due to the lack of small fish it is improbable that the cutthroat trout that are present are reproducing and persisting in the Colorado River proper.

The presence of the Grand Ditch also adds to the mystery of the location of this potential allopatric cutthroat trout population. When the ditch is in operation headgates are closed and no water is allowed to flow down stream below the ditch. Any fish that may be present in tributaries above the ditch may enter it and when the headgates are opened in the fall, fish that are present in the ditch can enter the streams below the ditch and may work their way down to the Colorado River. Since the ditch runs for 25 km, this potential cutthroat trout population can be located anywhere along the ditch. However, it is likely that the source of the cutthroat trout is closer to the Continental Divide since all of the cutthroat trout that have been sampled have been at or above Lulu City.

All of the Never Summer Mountain streams above the Grand Ditch have been surveyed visually or by electrofishing with no fish found in Lulu, Sawmill, Big Dutch, Mosquito, Opposition, or Bennett Creeks. Cutthroat trout have been sampled from Baker Creek, where the Grand Ditch begins, and La Poudre Pass Creek, where the ditch ends.

In 1975 fish collected from Baker Creek were examined preliminarily by Dr. Behnke (Mullen 1975) and their meristic characters were compared to the previously collected samples from the Colorado River above Lulu City in 1970:

I suspect some slight non-native influence in Baker Creek trout, but overall they are quite similar. The main features of the trout taken above Lulu City in 1970 were high scale counts (0 195) x (45 above lateral line), high basibranchial tooth counts (6-33 x 14), mostly 20, 21 gillrakers, pyloric caeca 0 37 and with bright coloration. The caeca, gillrakers and tooth counts from Baker Creek are quite similar but 10+ of the 20 had no teeth (possible rainbow influence?). I would have to re-check the scale counts of Baker Creek fish, but it looks like they will average 15-20 lower in the lateral series and about 2 less above the lateral line, which may indicate some non-native influence. Overall, however, I would say they are a good approximation of the original trout of this area, if not absolutely pure.

One adult cutthroat trout was collected from La Poudre Pass Creek in 1988 and examined by Dr. Behnke. He concluded that this fish appeared identical to specimens from Willow Creek and similar to fish from the Colorado River (Behnke 1989). Either Baker or La Poudre Pass Creeks may be the source of the fish in the Colorado River.

In 2000 tissue samples were collected from cutthroat trout in the Colorado River, Baker, Neota, and La Poudre Pass Creeks for genetic analysis. Samples from Baker, Neota and La Poudre Pass Creeks will be compared to those from the Colorado River to determine if they may be the source of the fish in the Colorado River. Previous meristic and genetic analysis of fish from Neota Creek indicate that they are A- GBC (Proebstel, Martinez, and Ellis 1996). However, a small sample size prohibited any definitive conclusions.

Along with the movement of water across the Continental Divide comes the movement of fish and other aquatic organisms. At least one population (Willow Creek) of CRC, native to the west slope, is believed to have been established on the east slope within RMNP due to fish transfers via the Grand Ditch.

Angler Use

Access to this part of the Colorado River is by relatively easy 5.9 km trail hike. Despite the ease of access no creel information is known to exist from this part of the Colorado River.

Current Status

It is not known if the cutthroat trout found in this area are reproducing and persisting in the Colorado River proper or if there is an unknown CRC only population in a tributary stream supplying fish to this area. Although the Grand Ditch diverts all water in the upper tributaries when it is in operation, leaks in the ditch as well as springs still provide some water flow to tributaries below the ditch. Further surveys will be conducted in these areas in 2001 to try to locate the source of cutthroat trout in the Colorado River.

RESTORATION PROJECTS

Timber Lake and Creek

This CRC restoration project is located in west central RMNP (Figure 60). It starts at a barrier on Timber Creek at 2865 m and extends to Timber Lake (Figure 59) at 3375 m, a total of 4.4 km. Riparian vegetation along the creek is comprised mostly of conifers, with grasses and willow in meadow areas. The lake has a surface area of 4 ha and a maximum depth of 7.6 m. Limited spawning habitat is located in the outlet. The shoreline is comprised of grasses, mosses, and sedges with several seeps and springs present. Early July flows have been measured in the creek in Jackstraw Meadow at 0.2 cms and in the lake outlet at 0.13 cms.

Restoration

On 5 September 1979, non-native cutthroat trout were removed with of antimycin from Timber Lake and Creek. Timber Lake was restocked with 1,080 CRC fry from Clinton Gulch on 27 September 1979, and 925 fry on 17 September 1980. Timber Creek was restocked with 920 Clinton Gulch CRC fry on 27 September 1979, and 1,850 fry on 17 September 1980.

Surveys

Timber Lake. The total weight of cutthroat trout recovered from Timber Lake following the

Figure 59. Timber Lake.

Figure 60. Map of Timber Lake and Creek Colorado River Cutthroat Trout Restoration Project.

restoration was 9.76 kg, or 2.4 kg/ha. Estimating that the recovery was only 70% effective, the 1979 estimated cutthroat trout population was 3.4 kg/ha, which is very low for RMNP.

Reproduction and maybe spawning itself appears to occur intermittently. Spawning activity has been observed as early as 22 June and has not been observed in some years. The first observation that spawning was taking place was in 1984 when dead eggs were observed in the outlet. Recruitment was not documented until August 1986 when fish too small to have come from stocking were caught during a gill net survey (Table 72).

Following the restoration gill net catch rates from surveys conducted in 1981, 1982, and 1984 were low. Catch rates for surveys in 1986, 1988, and 1991 were higher and fish sampled were from several year classes. Fish from most of these surveys were described as fat and many fish had full stomachs. Terrestrial insects, particularly Diptera, seems to be the main food source.

Although no fish were caught in a one hour net set at the outlet trend site in 1998, three other net sets near the inlet caught 16 fish in 3 hours (5.3 fish/hour). However, no small fish were caught (mean TL=360 mm, range=317-435). Tissue samples were collected from all fish caught in 1998 and were sent to Don Proebstel for genetic analysis. He determined that they were pure CRC from a single source (Appendix III).

Timber Creek. Following the restoration a total of 269 cutthroat trout (6.11 fish/100 m) weighing 11.2 kg (0.25kg/100 m) were recovered from Timber Creek. The best stream habitat, and the largest population of cutthroat trout was found in Jackstraw Meadow, with 40 fish and 1.23 kg/100 m of

Table 72. Summary of Timber Lake Gill Net Sampling, Outlet Trend Site, 1963-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/19/63*	CUT	269	178-356	0.5	-
07/10/74~	CUT	-	117-343	0.4	-
	RBT x CUT	368	343-394	0.1	-
07/11/79	CUT	237	178-310	1.4	0.20
09/30/81	CRC	230	230	0.4	0.05
07/08/82	CRC	168	165-175	0.7	0.03
07/19/84	CRC	304	265-325	1.1	0.38
08/27/86	CRC	178	150-205	3.0	0.82
08/08/88	CRC	260	182-315	3.3	0.80
09/05/91	CRC	283	165-375	3.1	0.78
09/13/98	No fish caught in a 1 hour set				

* Overnight net set

- No data recorded

~ 2 nets set overnight

stream recovered.

Cursory electrofishing surveys in 1981 and 1984 found fish in several sections of the creek. Fish sampled in 1981 ranged in length from 74 to 92 mm, while fish sampled in 1986 ranged in length from 127 to 264 mm. Sampling of Jackstraw Meadows with NaCN on 27 August 1986 collected 72 CRC representing five year classes (range of length=30-255 mm). Angling surveys were conducted in 1991 in Jackstraw Meadow and above the Long Meadows trail. Fish were found in every adequate section of stream in both areas. Fish in Jackstraw Meadow were within a narrower range of length than those near the Long Meadows trail, 165-220 mm compared to 135-250 mm.

Two-pass electrofishing surveys were conducted above the Long Meadows trail and in Jackstraw Meadow in 2000. Standing crop was estimated at 19.3 fish/100 m and 25.15 kg/ha at the Long Meadows trail. Mean TL of fish captured was 139 mm (range=65-192 mm). Standing crop was estimated at 38 fish/100 m and 111.4 kg/ha in Jackstraw Meadow. Mean TL of fish captured was 165 mm (range=76-275 mm).

Angler Use

Access to Timber Creek and Lake is by the Timber Lake trail. It is a 6.4 km hike to Jackstraw meadow, the most fishable section of Timber Creek, while it is a 7.7 km hike to Timber Lake. There are five campsites along the creek. Timber Lake and Creek opened to catch-and-release fishing for CRC in 1987.

Table 73. Summary of Fishery Statistics for Timber Lake, 1961-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1961	0.38	5	13.0	CUT
1962	0.29	2	24.0	CUT
1964	0.12	15	17.0	CUT
1966	2.08	4	12.0	CUT
1967	0.33	2	12.0	CUT
1968	1.72	8	25.0	CUT, RBT
1975	0.00	1	1.0	
1979-1987	Closed to angling			
1988	0.50	3	2.0	CUT
1989	0.33	1	6.0	CUT
1991	0.00	1	0.5	
1992	3.80	2	4.0	CUT
2000	2.75	4	4.0	CUT

* In order of relative of abundance

Timber Lake. Fishing pressure can be described as moderate here. Catch rates through the 1960s were 0.83 fish/hour and 2.64 fish/hour since the restoration (Table 73). Although fish that have been caught during net surveys have been found to be feeding well, they do not seem to feed at the surface. Fishing seems to be hit or miss.

Timber Creek. Fishing pressure can be described as light. One angler reported catching 6.57 fish per hour from the stream through Jackstraw Meadows in 1989 (Table 74). Catch rates appeared good in 1991 based on the angling survey conducted in Jackstraw Meadows and near the Long Meadows trail. Since then catch rates have decreased based on available data. Catch rates have averaged 2.92

Table 74. Summary of Fishery Statistics for Timber Creek, 1972-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1972	0.50	2	4.0	-
1979-1987	Closed to angling			
1989	6.57	1	3.5	CUT
1994	1.00	3	5.0	CUT
1997	0.00	1	1.0	
2000	2.66	1	0.8	CUT

- No data recorded

fish/hour since the restoration.

Current Status

The fish population in Timber Lake appears to be small, however the fish that are present are maintaining themselves and are very healthy. Although fall flows through Timber Creek are low there is an abundance of fish in it, especially through Jackstraw Meadow.

Bench Lake and Ptarmigan Creek

The Ptarmigan Creek is located within the North Inlet drainage in southwest RMNP (Figure 62). This population begins at War Dance Falls (3050 m), extends through Bench Lake (3085 m), and upstream for 1.5 km to a gradient barrier at 3170 m. Bench Lake (Figure 61) has a surface area of 2.6 ha, a maximum depth of 1.8 m, and ample spawning habitat. The shoreline is comprised of sand, rock, grasses, and willow. Late July water flows at the outlet have been measured at 0.75 cms. Most of Ptarmigan Creek above Bench Lake consists of two meadows which are separated by a short steeper section. The riparian vegetation is comprised mostly of grasses through the meadow sections and conifers through the steeper section.

Restoration

On 4 September 1985, the YCT population that existed above War Dance Falls was removed with antimycin, to make habitat available for a pure strain of CRC (Figure 62 and Table 75). In 1986, the

Figure 61. Bench Lake.

Figure 62. Map of Bench Lake and Ptarmigan Creek Colorado River Cutthroat Trout Restoration Project. Numbers correspond to the antimycin application sites in Table 78.

best source of CRC for restocking was Williamson Lakes, a pure population of CRC located in a remote trailless area in the southern Sierra Nevada Mountains in California. CRC eggs were shipped to California in 1931 in exchange for golden trout eggs. Fish hatched from these CRC eggs were stocked into the then fishless Williamson Lakes (Pister and Rosenlund 1988).

After considerable planning, and effort by several agencies, 296 Williamson Lakes CRC were moved from California to RMNP on 20 August 1987. The operation began at 0730 hours at Williamson Lakes, and concluded at 1630 hours the same day at Bench Lake in RMNP. The operation required the use of a California Department of Fish & Game aircraft for transport of fish from Bishop, CA to Kremmling, CO, along with two helicopters and two fish trucks for transfers within California and Colorado.

Of the 296 transplanted at the rate of 125 g/L of water with oxygen and cooling, less than 2% were

Table 75. Location and Amount of Antimycin Applied to Ptarmigan Creek and Bench Lake, 1985. See Figure 62 for location of sites.

Site	Water		Antimycin	
	Flow (cms)	Volume (acf)	Concentration	Duration (hours)
1.	0.01			4
2. Snowdrift Lake Outlet	0.01			7
3. Unnamed Lake Outlet	0.01			7
4. Ptarmigan Lake Outlet	0.04			8
5. Trib. From Ptarmigan Pass	0.04			8
6. Trib. From Peak	0.02			8
- Spray to backwater between sites 1 and 6				
11. Bench Lake*		19.0		
Total Antimycin				
12. Bench Lake Outlet				
KMnO ₄	0.12		1.5 mg/L	11

Rotenone. In addition to the above antimycin, a 1 L slug of rotenone was applied to the outlet of Snowdrift Lake at 0900 hours. Rotenone at Ptarmigan meadow by 1100 hours.

* Bench Lake too shallow to allow for effective use of boat. Antimycin applied by spray to shore, constant flow from inlet and slugs to inlet.

Inlet flow 0.12 cms. Dye placed at site 5 took 2.5 hours to reach Bench Lake.

Started treatment at 0830 hours. Fish dying in upper meadow by 0900 hours due to slug of antimycin and fast running jugs. Fish dying at site 5 by 1000 hours, and dead fish at outlet of Bench Lake by 1530 hours.

KMnO₄ run from 1100 to 2230 hours.

lost. Bench Lake was restocked with 194 adult CRC and Ptarmiagn Creek with 91 CRC.

Taxonomy

It is anticipated that CRC from Bench Lake will serve as a source of eggs for future restoration projects. To ensure that fish are pure CRC additional taxonomic surveys were conducted in 1999. Twenty four specimens from Bench Lake and Ptarmigan Creek were taken to Don Proebstel for taxonomic analysis. He determined based on meristic characters that (Proebstel 1999, page 1):

Specimens are judged to be “pure” Colorado River cutthroat trout with no detectable morphological difference between the sampling locations. A high degree of variability in spotting patterns within the collections is attributed to similar characteristics of the source population.

In 1999 twenty-seven whole fish samples were taken to Robb F. Leary of the University of Montana for taxonomic analysis. Results are not yet available. Samples for genetics will also be collected from Ptarmigan Creek in 2001. It is expected that Bench Lake will be used as a broodstock in the near future if all testing comes out favorably.

Surveys

Bench Lake. Following restoration 284 YCT (mean TL=241 mm, range=89-393 mm) were recovered from Bench Lake (109 fish/ha). A mark recapture study was also conducted during the restoration. Thirty seven fish were marked and 29 were recaptured following the treatment (Shively 1990). A Peterson population estimate of 361 fish (95% C.I.=254 to 531 fish) was calculated. The mean weight of fish measured was 146.8 g, resulting in a standing crop estimate of 20.38 kg/ha for Bench Lake.

Bench Lake was surveyed by gill net on 27 September 1988, one year after stocking CRC. A net set for two hours captured only one fish (Table 76). Two adults were also observed in the lake and 19 mm fry were present in the inlet stream, indicating that reproduction had occurred. Although there were signs of angler use and no “closed to fishing” signs at the lake, the impacts of the anglers appeared to be minimal. The lake was sampled again on 26 September 1989, with no fish caught in a gill net set for two hours. No fish were observed in the lake, but fry were again captured from

Table 76. Summary of Bench Lake Gill Net Sampling, Inlet Trend Site, 1981-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/14/81*	YCT	269	175-379	0.95	0.20
09/27/88	CRC	237	237	0.50	0.05
09/26/89	No fish caught in a 2 hour set				

* Overnight net set

the inlet area, indicating that at least some adult fish were present through the spring of 1989.

It appeared that most of the CRC stocked into Bench Lake in 1987 were gone by September 1989. This could be explained by migrations of fish out of the lake because of unsuitable habitat or angler harvest. Due to the shallowness of the lake and the silt bottom there is a lack of cover. Fish may have moved upstream into Ptarmigan Creek or downstream into the North Inlet. Cutthroat trout are known to be easily caught by hook-and-line and signs of angler use were found during surveys in 1988 and 1989.

In July 1991, only three fish were observed in the inlet bay in 16 hours of observing and angling. Since 1992 fish have been found to be abundant in Bench Lake. In October 1992 over 30 fish were observed below the ice in the inlet area. On 7 July 1998, 66 fish (mean TL=251 mm, range=164-310 mm) were caught by gill net and angling near the inlet. Most of the females were flowing eggs. Seminal and ovarian fluid samples were also taken for disease testing, which were found to be negative for viral agents.

Thirty fish (mean TL=264 mm, range=225-305mm) were collected by gill net and hook and line on 13 July 1999. Females caught from the lake were mostly spawned out while fish in Ptarmigan Creek above the lake were still spawning. Disease sampling was also conducted in 1999 with fish found to be negative for viral agents.

Ptarmigan Creek. A total of 653 YCT (mean TL=206 mm, range=89-343 mm) were recovered after the restoration from Ptarmigan Creek above Bench Lake (44 fish/100 m).

Electrofishing selected pools on 26 September 1989, collected 15 adult fish (mean TL=239 mm). In addition to adults, fingerlings spawned in 1988 (90 mm) and fry (19 mm) were present in good numbers throughout the creek.

Angling surveys in 1991 caught fish ranging in size from 150 to 305 mm. The higher meadow was found to have a greater number of smaller fish than the lower meadow. Observations in October 1992 found several year classes of fish including fry in both meadows.

Forty two fish (mean TL=198 mm, range=162-230 mm) were caught during angling surveys in 1998. No deformities were observed. Female fish caught in Ptarmigan Creek were a week behind the Bench Lake females in spawning. During specimen collection for taxonomy on 13 July 1999, 9 fish (mean TL=230 mm, range=205-270 mm) were collected and spawning was observed throughout the creek.

Angler Use

Access to Ptarmigan Creek requires a hike of 10.8 km on the North Inlet trail and another 1.2 cross-country hike up a steep wall. Due to its inaccessibility Bench Lake was described as having minor visitation in 1964 (Linn 1964). To protect this potential source of eggs for future restoration projects from introduction of disease, Bench Lake and Ptarmigan Creek are currently closed to angling. Catch

Table 77. Summary of Fishery Statistics for Bench Lake, 1961-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught
1961	2.18	9	60.0	CUT
1964	0.00	2	4.0	
1968	1.22	7	27.0	CUT
1969	0.83	11	29.0	CUT
1976	3.00	1	1.0	CUT
1981	2.67	2	6.0	CUT
1985	Closed to angling			

rates prior to the restoration averaged 1.63 fish/hour (Table 77). During sampling in 1998 and 1999 fish were very easily caught.

Current Status

This is a good population with an abundance of fish and annual reproduction.

CONSERVATION POPULATIONS

Paradise Creek

Paradise Creek is located in the Paradise Creek Research Natural Area in southwestern RMNP (Figure 64). A gradient barrier separates the creek from the East Inlet. Above this barrier Colorado River cutthroat trout occupy about 1.3 km of low gradient stream. The riparian vegetation is comprised of grasses and conifers. Above this area a very large cascade barrier separates this population from another above the cascade. A large debris dam provides an abundant amount of habitat above this cascade. This area, known as Paradise Park (Figure 63), also is low gradient. Riparian vegetation is comprised mostly of grasses and willow with short higher gradient sections, which pass through conifers. The Paradise Park population extends for 2.6 km to another barrier at 3170 m. Spawning habitat is limited through this area with most of it located at the tail end of inactive beaver ponds.

Stocking

Records show a total of 211,640 black spotted fry and eggs were stocked from 1925 to 1947. Boundary Lake, at the headwaters of Paradise Creek, was located outside RMNP until 1981, and stocked by CDOW with Trappers Lake CRC. See page 195 for further information on this population.

Figure 63. Paradise Creek Through Lower Paradise Park.

Figure 64. Map of Paradise Creek and Adams Lake Colorado River Cutthroat Trout Populations.

Taxonomy

Specimens were collected from Paradise Park in 1981 and determined to be pure CRC by Eric J. Wagner (1982, page 3):

Based on the taxonomic characters, it appears that the trout of Paradise Creek are descendents of Trappers Lake-endemic native crosses. Thus being of pure lineage (Behnke 1979), the pleuriticus of Paradise Creek are pure and should be managed as an A population as described by the alphabetic grading system developed by Binns (1977).

Tissue samples were taken from both populations in 1998 and 1999 and given to Don Proebstel for genetic analysis. He determined that the fish in the lower meadow were A- CRC (Appendix III). The fish in Paradise Park were determined to be B CRC with YCT and RBT influences. Phenotypic variability based on slides taken at the time of collection and evidence of derivation from multiple sources was also observed.

Surveys

During surveys on 2 July 1985 fish were observed spawning at an elevation of 3000 m, as well as in Paradise Park at 3110 m. In 1998 hook-and-line surveys conducted in the lower meadow collected fish with a mean TL of 207 mm (range=142-272 mm). In 1998 and 1999 hook-and-line surveys in lower Paradise Park found fish to be abundant with several year classes present. Fish caught had a mean TL of 233 mm (range=171-312 mm).

Angler Use

Access to Paradise Creek requires an 8 km hike on the East Inlet trail and another 1.3 km to the lower meadow or 2.5 km to lower Paradise Park on an unmaintained trail. Since it is located in a Research Natural Area, no camping is allowed along Paradise Creek. The closest campsites are along the East Inlet trail.

Catch rates through the 1960's, when the majority of creel survey was collected, averaged 1.35 fish/hour (Table 78). During collection of samples in early August 1998 two volunteers fishing for a total of about 14 hours caught 14 fish in the lower meadow. Three fish were caught in about 2 hours of angling in Paradise Park. No signs of other anglers were apparent at either site. In 1999, four anglers collecting tissue samples caught 13 fish in 6.5 hours.

Current Status

Both sections of Paradise Creek are in good condition. Although there is abundant amount of habitat in Paradise Park, the silty bottom limits the amount of spawning habitat that is present,

Table 78. Summary of Fishery Statistics for Paradise Creek, 1964-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1964	0.83	1	6.0	CUT
1965	0.50	4	10.0	CUT
1966	0.93	20	135.0	CUT
1968	2.36	11	95.0	CUT
1969	1.14	28	128.0	CUT, RBT, BKT
1972	0.50	2	4.0	CUT
1975	5.60	4	6.0	CUT
1976	1.25	4	4.0	CUT
1992	4.00	2	2.0	CUT
1999	2.00	4	6.5	CUT

* In order of relative abundance
which probably limits the amount of fish present.

Another population of hybrid CRC is located below Boundary Lake near the headwaters of Paradise Creek. These fish are the most hybridized fish in Paradise Creek, followed by the fish in Paradise Park, with the fish in the lower meadow being the closest to pure. Currently there appears to be a fishless stretch between the Boundary Lake population and the one in Paradise Park. However, the Boundary Lake population is expanding its range and in time these fish will further hybridize those in Paradise Park. The same can be said for fish dropping into the lower meadow from Paradise Park.

Fifth Lake

Fifth Lake (Figure 65) is the highest in a string of lakes along upper East Inlet in southwestern RMNP (Figure 66). It is located at an elevation of 3310 m, has a surface area of 3 ha, and a maximum depth of 9.4 m. A cascade barrier just below the lake excludes BKT which inhabit the stream and lakes downstream. Spawning habitat exists in both the inlet and outlet, however the outlet habitat is only 100 m long before the stream drops over the barrier. The shoreline is comprised mostly of grasses, with some boulders and conifers.

Stocking

The only mention of stocking appears in a 1962 report by Azevedo and Wallis. They write that the last recorded stocking of cutthroat trout was made in 1938, however no records confirm this stocking. They recommended that Fifth Lake should be restocked every fourth year with 1,500, 2-3" cutthroat trout. There are no stocking records that the lake was stocked after this report.

Taxonomy

Meristic analysis of samples collected in 1987 was conducted by Dr. Behnke (1987). He stated that they were extremely close to being pure CRC adding (page 2):

My overall summary and interpretation of the totality of characters of this sample is that the population is predominantly of Trappers Lake ancestry but has been slightly influenced by other

Figure 65. Fifth Lake.

Figure 66. Map of Fifth Lake Colorado River Cutthroat Trout Population.

parental sources probably including a very slight influence from rainbow trout.

Genetic analysis was conducted on tissue samples and meristic characters were analyzed from specimens collected in 1998 by Don Proebstel. He determined these fish to be A- CRC with no RBT or other non-native trout influence (Appendix III). There was evidence that this population was derived from multiple sources.

Surveys

Azevedo and Wallis (1962) surveyed Fifth Lake in 1961 and found the population to be small. They observed that the spawning areas available in the inlet and at the head of the outlet were “insufficient in quality and extent to maintain a satisfactory trout fishery.” A survey on 12 July 1998 found the spawning substrate in the inlet to be adequate, however the inlet temperature was only 4 °C.

An overnight gill net survey in 1987 caught eight fish in 14.5 hours (Table 79). All fish, especially fish <360 mm, were in excellent condition. Two females were spawned out. Dr. Behnke (1987, page 2) also commented on the diet and the ripeness of the specimens collected in 1987:

Table 79. Summary of Fifth Lake Gill Net Sampling, Outlet Trend Site, 1987-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
07/21/87*	CRC	310	246-380	0.6	0.28
07/13/98*	CRC	279	135-420	0.6	0.23

* Overnight net set

“The Fifth Lake fish were in excellent condition with enormous fat deposits around the pyloric caeca. Evidently a large flight of flying ants had landed on this lake shortly before the fish were sampled. Most stomachs were gorged with ants. Small chironomids (2-3 mm larvae, 4 mm adults) made up the bulk of the rest of the diet. One specimen contained numerous stonefly larvae. Evidently feeding conditions are excellent in relation to density of this population. The sample from Fifth Lake was made on July 21. All females contained only immature eggs and no mature unspawned eggs of recent spawning were seen in body cavity. Most likely, with a short growing season, females do not spawn annually. The males had mature, but not turgid testes, indicating recent spawning.”

The last gill net survey was conducted on 13 July 1998 with 10 fish caught in a 15.5 hour net set (0.6 fish/hour). Several year classes of fish were present and the catch rate was identical to the previous survey conducted in 1987. The two largest fish, 385 and 420 mm, looked old with rippled back and bellies. One female was spawned out while the others still had their eggs. Lake water temperature was 5 °C, which is very low to have successful reproduction.

Angler Use

Due to its location, almost 15 km from the closest trailhead, Fifth Lake receives little visitation. The only creel data available was collected in 1963 and 2000. In 1963 two anglers reported catching seven cutthroat trout in a total of six hours. Although fish were observed, none were caught by one angler in two hours of fishing in 2000. The closest campsite is located 3.5 km away with three lakes with good fishing between it and Fifth Lake.

Current Status

Although the Fifth Lake population is small, has limited spawning habitat, and reproduces only intermittently, it seems to be perpetuating itself.

Columbine Creek

Columbine Creek is a tributary of the Colorado River and is located in the southwestern portion of RMNP (Figure 68). This population was unknown until 1987 when it was discovered during a survey conducted as part of the RMNP Lake and Stream Survey Program. The section of creek populated by CRC starts above a barrier located at 2733 m and extends 1.1 km through a meadow at 2780 m (Figure 67). Spawning habitat is present but there is a lack of deep pool habitat for fish to overwinter. Above the meadow excellent pool habitat is present, however very few fish have been observed in this section. Riparian vegetation is comprised of grasses and willow through the meadow and conifers through the forested parts of the creek. Late July water flows have been measured at 0.1 cms.

Stocking

The only documented stocking of Columbine Creek was in 1931 when 25,000 “black spotted” trout were stocked. Another document in 1938 states that “black-spotted natives” were present in the creek at that time.

Taxonomy

Specimens were collected in 1987 and taken for taxonomic analysis to Dr. Robert Behnke. Definitive conclusions could not be made based on these specimens because by the time he received them they were badly faded, bleached and internally decomposed. Indications were that they were pure CRC

Figure 67. Columbine Creek Through Meadow at 2780 m.

Figure 68. Map of Columbine Creek Colorado River Cutthroat Trout Population.

(Behnke 1988). Additional specimens were collected in 1988. From these specimens Dr. Behnke (1989, page 4) concluded based on meristic characters that:

The taxonomic characters of this sample appear to represent a pure population of pleuriticus probably established from one introduction. Their characteristics are distinctly different from the pleuriticus native to the headwaters of the Colorado River in the Park... and from Trappers Lake.

In 1998, 12 tissue samples were collected by hook-and-line for genetic analysis by Don Proebstel. Don determined that these fish were A- CRC (Appendix III). Although there was no evidence of influence from non-native fish, they were not considered pure due to evidence that this population was derived from multiple sources and phenotypic variability observed from slides taken at the time of collection.

Surveys

Columbine Creek was surveyed on 29 July 1987 as part of the RMNP Lake and Stream Survey Program. Five cutthroat trout (mean TL=184 mm, range=151-220 mm) were sampled by electrofishing.

Another survey was conducted in 1988 to collect more specimens for taxonomy. A two pass electrofishing survey conducted below the meadow estimated standing crop at 13.54 fish/100 m and 16.5 kg/ha. Fish through this section had a mean TL of 161 mm (range=87-227 mm). The meadow was also electrofished with fish having a mean TL of 172 mm (range=125-263 mm).

In 1998 a hook-and-line survey was conducted in the meadow to collect tissue samples for genetic analysis. Eleven fish were sampled (mean TL=184 mm, range=145-290 mm) and all were in good shape with no genetic deformities. No fish were observed in the creek between the barrier and the meadow. Based on fish caught by angling, a pool below the barrier was half BKT and half cutthroat

trout.

It is believed that low water temperature is limiting this population. To assess this, a thermograph was placed in a pool located above the meadow in June 1999 and retrieved in June 2000. Cutthroat trout usually begin spawning when water temperatures reach 6-7 °C. The Columbine Creek water temperature reached 6 °C in early July in 1999 and in late June in 2000 after a mild winter of 1999-2000. Published data indicate that cutthroat trout eggs hatch after accumulating 310-330 Celsius temperature units (CTU) and emerge from the gravel after another 300 CTU (Varley and Gresswell 1988; Behnke 1992). Based on these data the eggs in Columbine Creek would have hatched in the second week of August and the fry would have emerged in mid-September in 1999. Water temperatures started to drop in early September and fry that may have emerged may not have been able to attain a large enough size to survive the winter. However, data collected from two historic long established RMNP cutthroat trout populations indicate that it takes fewer CTU for eggs to hatch and fry to take feed, which is equivalent to emergence. Eggs that were collected from Hunters Creek and the Little South Fork Cache la Poudre River and incubated in a hatchery required 250-260 CTU to hatch. Fry from Hunters Creek started to feed after accumulating 405 CTU (Elfing 1985; E. Stege, Saratoga NFH, personal communication). If these data are used, Columbine Creek eggs would have hatched around 3 August 1999 and fry would have emerged around 20 August 1999, giving them about two weeks to gain weight for the winter. At the time the thermograph was retrieved no fish were observed or caught in 3.5 hours of angling.

Angler Use

Access to this population is by an easy 5 km hike. A well-constructed, but unmaintained trail runs from the Colorado River to the meadow where the cutthroat trout are present. When this trail was open Columbine Creek probably received more visitation, but currently it receives very little.

Columbine Creek above 2745 m is closed to angling to protect this cutthroat trout population. The only possible angler reports from this area were from 1967. Four anglers fishing for a total of four hours caught 12 cutthroat trout. During collection of specimens in 1998, three volunteers fishing for a total of about 12 hours caught 11 fish in the meadow.

Current Status

This population is very small and may well be close to becoming extirpated from Columbine Creek. Low water temperatures and/or a lack of overwinter habitat may be the cause, however these fish have persisted up to this point and show no signs of genetic deformities. A more extensive of this population is planned for 2001.

Onahu Creek

Onahu Creek is a tributary of the Colorado River in west central RMNP (Figure 70). The CRC population extends from a barrier at 3194 m, through a series of meadows, to Julian Lake (3385 m), a total of 0.7 km. Most fish are in the lowest and largest meadow (Figure 69) with few fish in the upper meadows. Riparian vegetation is comprised mostly of grasses.

Stocking

Records show four plants of a total of 491,000 “black-spotted” trout into Julian Lake from 1934 to 1959 (Guse 1962a). It was also proposed for stocking in the 1960’s (Azevedo and Wallis 1962), however records show no stocking took place during this time. Unknown sections of Onahu Creek were also stocked with a total of 110,000 “black-spotted” trout from 1918 to 1952 (Guse 1962b). Most likely the upper Onahu Creek CRC population was founded from the stockings into Julian

Figure 69. Onahu Creek Meadow at 3220 m.

Figure 70. Map of Upper Onahu Creek Colorado River Cutthroat Trout Population.

Lake.

Taxonomy

The two fish from the creek were collected and taken to Dr. Behnke for taxonomic analysis. Although it was a small sample size he concluded (Behnke 1989, page 2):

“The larger specimen has a greenback-like spotting pattern, but with more numerous spots than typical of stomias (more typical of stomias x pleuriticus hybrid). The smaller specimen has a spotting pattern indicative of a rainbow trout influence with spots on top of head (pure cutthroat trout lack spots on top of head). Although these fish do not represent a pure population, the rainbow trout influence is slight and detectable only by spotting pattern... They are overwhelmingly cutthroat trout (mainly stomias x pleuriticus) with a very slight influence of rainbow trout.”

Tissue samples were collected from 15 cutthroat trout in 1999 and taken to Don Proebstel for genetic analysis. He determined these fish to be A- CRC (Appendix III). They appeared to be derived from multiple sources and phenotypic variability was observed based on pictures and slides taken at the time of collection.

Surveys

A hook-and-line survey conducted by Linn (1963) at Julian Lake on 20 August 1963 found an abundance of cutthroat trout in three year classes (range of length=150-350 mm). Fish were also observed in Onahu Creek below the lake.

A 14 hour gill net survey conducted on 1 August 1979 caught no fish in Julian Lake. Cutthroat trout were captured by hook-and-line in two small meadows below the lake. These fish ranged in TL from 150 to 280 mm. Spawning behavior was observed in these meadows at a water temperature of 10.5 °C.

Another larger meadow is located farther downstream at an elevation of 3220 m. Although good fish habitat exists in this meadow, no fish were captured or observed. Reliable reports from RMNP personnel indicate that fish were abundant in this meadow in 1977. A colder drainage of equal size enters Onahu Creek from the east in the middle of this meadow. Water temperatures were measured at 8.7 °C at the end of the meadow, compared to 10.5 °C in the upper meadow. It was believed that the colder water temperature was to explain for the decline in fish.

Julian Lake was gill netted again in early August 1988 and again no fish were caught in a 11.5 hour set. Five fish were observed in the creek below the lake with two caught by hook-and-line in 15 minutes. These fish measured 260 and 288 mm in TL.

A hook-and-line survey of upper Onahu Creek on 5 August 1999 found the opposite of the 1979 survey. Only three fish were observed in the small meadows just below Julian. One of these fish (258 mm) which appeared very old was caught. Many fish were observed in the lower meadow, however, they were easily spooked and difficult to catch. Mean TL of five fish caught was 258 mm (range=213-298 mm). Late afternoon water temperatures in the eastern tributary and in Onahu Creek above and below the tributary were within 1 °F of each other. Bear scat was also observed in the area and could explain why fish were so easily spooked.

Another hook-and-line survey on 24 August 1999 found fish easily caught in the lower end of the lower meadow. Nine fish were caught in 15 minutes out of two pools. Mean TL of these fish was 219 mm (range=203-236 mm).

Angler Use

This portion of Onahu Creek is open to angling with a two fish limit. However, due to its relative inaccessibility, five miles from closest trailhead with two miles of cross-country travel, this area receives little angling pressure. No known creel data exists from this area, except for that collected in surveys described above.

Current Status

Although most of the fish inhabit only about 0.3 km of stream there is an abundance of fish present.

These fish do not exhibit any genetic deformities that would indicate inbreeding.

Boundary Lake

Boundary Lake (Figure 71) is located near the southern boundary of RMNP at the headwaters of Paradise Creek (Figure 72). It is located at an elevation of 3318 m, has a surface area of 0.72 ha, and a maximum depth of 3.35 m. Although one small inlet with good spawning substrate is present, water temperatures have been measured between 2.5 and 8 EC in mid-August, which is too cold for successful egg incubation so late in the year. Outlet water temperatures are adequate for successful spawning, however very little spawning substrate is present. The shoreline is comprised of grass and boulder. Mid-August outlet flows have been measured at 0.01 cms.

Stocking

The lake was located outside RMNP until a boundary change in 1981 incorporated it into the park. Prior to the boundary change, the fisheries were managed by CDOW. Surveys of Boundary Lake in 1961, 1964, and 1968 found it fishless despite NPS stocking records showing a plant of 6,800 “black spotted” eyed eggs in 1942. Apparently, from about 1969 up until 1981, Boundary Lake was also stocked with 800 Trappers Lake CRC at 50 mm in length on odd numbered years.

Taxonomy

Eric J. Wagner (1982, page 3) determined: “the spotting and meristic characters all indicate pure pleuriticus and constitute an “A” population” based whole fish samples were collected in 1981.

In 1999 tissue samples were collected from an unnamed lake on Paradise Creek below Boundary

Figure 71. Boundary Lake.

Figure 72. Map of Boundary Lake Colorado River Cutthroat Trout Population.

Lake. Previous surveys of this area found it to be fishless, so it is believed that these fish migrated from Boundary Lake. Don Proebstel genetically analyzed the samples and determined that they were B+ CRC (Appendix III). Some evidence of YCT was present and fish are believed to be derived from multiple sources.

Surveys

A 1981 survey found four year classes of fish from stockings in 1975, 1977, 1979 and fry from the 1981 stocking present (Table 83). Males from the 1979 stocking were mature while the females were immature. The oldest fish captured (390 mm) was evidently from the 1975 stocking and was impacted with eggs that should have been released in 1981.

At the time of the 1981 survey, there was a heavy bloom of zooplankton in the lake, with most of the fish sampled found to be utilizing it as a food source, along with Caddis nymphs. One 175 mm fish was found to have eaten one of the fry stocked in 1981, that were easily observed along the shores and in the outlet forebay.

The last gill net survey was conducted in July 1990 with 17 fish caught in a half hour net set with no fish under 255 mm (Proebstel 1990). Ten to 20 fish were observed in outlet area attempting to spawn.

Table 80. Summary of Boundary Lake Gill Net Sampling, Outlet Trend Site, 1981-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/12/81*	CRC	226	165-394	0.5	0.11
07/16/90	CRC	301	255-335	34.0	8.35

* Overnight net set

It was originally believed that fish were confined only to the lake. However surveys conducted on 12 July 1999 found fish in an unnamed lake along Paradise Creek about 1.75 km below Boundary Lake. Fish were observed above this lake for about 0.5 km but no fish were observed in a pond below the lake. A gill net survey was conducted on the unnamed lake with 5 cutthroat trout caught in a 74 minute set (4.1 fish/hour). Mean TL of fish captured was 320 mm (range=303-336 mm). Females appeared to be spent. Another 295 mm fish was caught by hook-and-line in the creek above the lake, where fish were exhibiting spawning behavior.

Angler Use

Due to its remote location, an eight hour hike from the closest RMNP trailhead, Boundary Lake receives very little visitation. The lake is part of the Paradise Park Research Natural Area and camping is not allowed. The closest camping is outside RMNP, in the Arapahoe National Forest. Notes from the 1981 survey indicate that there were old as well as new campsites along the lake indicating some visitor use. No creel survey data has been collected from Boundary Lake.

Current Status

Since it has been 11 years since it was last been surveyed, Boundary Lake's status is unknown. In all probability most fish have moved out of the lake and are occupying Paradise Creek below the lake. This area has more spawning habitat, however no small fish were observed in 1999 to indicate that recruitment is taking place. A survey of Boundary Lake and upper Paradise Creek is planned for 2001.

Willow Creek

Willow Creek (Figure 73) is located in the Specimen Mountain Research Natural Area in the Cache la Poudre River drainage in northwestern RMNP (Figure 74). Brook trout are also found in the creek and are the dominant species. No barriers are present in the drainage to prevent further migration of BKT into the section of the creek populated with cutthroat trout. Its believed that the cutthroat trout population begins at an elevation of 3170 m, with the upper limit of the population unknown. Willow Creek is a low gradient creek with riparian vegetation comprised of grasses and willow. Mid-August flows have been measured at 0.15 cms.

Stocking

The source of the present cutthroat trout population in Willow Creek may have been from a trans-basin transfer via the Grand Ditch, which drains water from west of the Continental Divide into La

Figure 73. Willow Creek @ 3170 m.

Figure 74. Map of Willow Creek Cutthroat Trout Population.

Poudre Pass Creek. Along with the transfer of water, fish were also believed to have been transferred (Behnke 1985b). From La Poudre Pass Creek cutthroat trout migrated up creeks in the area where they are still present.

Taxonomy

Specimens collected in 1985 were taken to Dr. Behnke for taxonomic examination. He concluded from meristic characters (Behnke 1985b, page 1):

Considering the lack of physical isolation of Willow Creek and past stocking of cutthroats and rainbows in the upper Poudre, I wouldn't claim Willow Creek to have a pure population, but I can find no evidence of hybridization. I am sure they are pleuriticus, not stomias, based on spotting. They appear very close to the fish in the unnamed tributary to Long Draw Reservoir and may represent original invaders into the upper Poudre via Grand Ditch (probably Baker Creek fish) when upper Poudre was barren above falls.

Tissue samples collected in 1998 were genetically analyzed by Don Proebstel. He determined that

the fish in Willow Creek are B+ cutthroat trout, of unknown taxonomic affinity (Appendix III). Evidence of YCT influence and phenotypic variability were present.

Surveys

A hook-and-line survey conducted in 1985 found cutthroat trout to dominate the uppermost meadow, with cutthroat trout also present in the second highest meadow. Cutthroat trout caught had a mean TL of 220 mm and BKT caught had a mean TL of 189 mm.

Dr. Kurt Fausch (1988) of Colorado State University conducted electrofishing surveys at four sites along the creek in 1988. Brook trout and cutthroat trout were found at all sites with BKT comprising 83% of the fish sampled at the lowest site at an elevation of 3135 m, and 17% at the highest elevation site at an elevation of 3294 m. Two passes were conducted at the three lowest sites. Six fish were collected in one pass at the highest site.

Special Studies

Willow Creek is included in a study to determine the *Effects of Nonnative Brook Trout on Colorado River Cutthroat Trout Populations* (Peterson and Fausch 2000). Brook trout standing crop was estimated at 23.72 fish/100 m in 1998 (Table 81; Peterson and Fausch 1998). One of Dr. Fausch's 1988 sample sites is included within the 1998 section. Dr. Fausch found BKT to comprise 30% of the population in his 37 m section, compared to 89% from the 1998 survey. Despite all BKT collected being removed each year, standing crop estimates for 1999 and 2000 are almost identical. Recaptures of fish during electrofishing and collection of fish at two way weirs above and below the study reach indicate that BKT and cutthroat trout tend to move upstream, but BKT move at a significantly greater rate than cutthroat trout. Thus BKT that are removed are replaced by fish migrating upstream from outside the study reach. No cutthroat trout <age 2 have been collected

Table 81. Summary of Willow Creek Electrofishing Surveys, 1998-2000. Source Peterson and Fausch 1998, 2000, and Peterson personal communication. BKT removed each year.

Year	Species	Range of Fork Length(mm)	Fish/ 100 m*	Kg/ Hectare*
1998	CUT	150-282	4.1	23.42
	BKT	34-260	23.7	102.81
1999	CUT		2.4	14.14
	BKT		9.5	37.57
2000	CUT	140-310	2.2	15.59
	BKT	65-260	9.1	34.79

* For adult fish

during electrofishing surveys, indicating that no reproduction is taking place in the survey reach.

A few cutthroat trout fry were collected in the weirs in September 1999, however they were small and emaciated and it was not believed that they would not survive the winter. No BKT fry were collected in the study reach in 2000 indicating that removal of fish was having an impact on BKT reproduction.

Angler Use

The only creel survey data collected from Willow Creek was from 1994 when anglers fishing the lower section of the creek reported catching 43 brook trout/hour and 5 cutthroat trout/hour. Anglers fishing the upper section reported catching 18 brook trout/hour and 12 cutthroat trout/hour.

Current Status

Survey data have shown that cutthroat trout are not as abundant and their range within Willow Creek has decreased since 1985. Since there are no barriers to exclude BKT, electrofishing to remove the BKT and preserve this population is not an option. Given that Peterson and Fausch are not finding any cutthroat trout reproduction it appears that the cutthroat trout will become extirpated from Willow Creek.

Ypsilon Lake

Ypsilon Lake (3215 m) is located along Ypsilon Creek, a tributary of the Roaring River, in northeastern RMNP (Figure 14). Although it is located on the east side of the Continental Divide, the historic range of the GBC, it has been determined that the fish that occupy the lake are CRC. It has a surface area of 3 ha and a maximum depth of 17 m. Limited spawning substrate is present in the inlet and outlet. Fish migration barriers exist just above and below the lake. The north shoreline is comprised of rock and krummholtz and the south shoreline is comprised of conifers. Mid-July outlet flows have been measured at 0.75 cms and early August flows have been measured at 0.57 cms.

Stocking

A record from 1923 states that “spotted natives” were present in the lake at that time (Toll 1923). Stocking records show stockings of cutthroat trout, RBT, and BKT from 1923-1955 (Guse 1962a). Biennial stocking of 2,500 cutthroat trout fingerlings from 1962 to 1968 was proposed (Azevedo and Wallis 1962) and it is believed that these stockings were made (Mullen 1973). Despite all this stocking, only cutthroat trout were found by 1972.

Taxonomy

Specimens were collected in 1979 for Dr. Behnke (1980), who classified these fish based on meristic characters as virtually pure CRC. Genetic analysis of samples collected in 1998 was conducted by Don Proebstel in 1998. He determined that these fish were A- CRC with a slight YCT influence (Appendix III). Evidence of derivation from multiple sources was also observed.

Surveys

Based on a 1957 survey by Bulkley, where no fish were caught in a 12 hour gill net set (Table 85) and no fish were observed in 4 days of camping on the shore, it was believed that Ypsilon Lake could not support a recruiting population of trout. Because of this the biennial stocking of cutthroat trout was proposed for the 1960's.

Surveys in August 1961 found fish, but the population was described as low (Azevedo and Wallis 1962). Several males still retained their brilliant spawning color.

A gill net survey on 19 July 1972 caught 24 cutthroat trout in 22 hours (Mullen 1973). All fish appeared in excellent condition, even the recently spawned out females, and contained large amounts of visceral fat. Several year classes were present with only the largest fish being associated with the last stocking in 1968.

Two gill net surveys in early July 1979 had similar results. Most fish were ready to spawn with some spawning fish observed in the outlet. However, the outlet water temperature was 7.6 °C, indicating that spawning probably had just begun.

Table 82. Summary of Ypsilon Lake Gill Net Sampling, Inlet Trend Site, 1957-2000.

Date	Species	Mean TL (mm)	Range of Length(mm)	Fish/ Net Hour	Kg/Net Hour
08/06/57*	No fish caught in a 12 hour set				
07/19/72*	CUT	-	165-379	1.1	-
07/09/79	CRC	299	297-300	1.3	0.34
07/10/79^	CRC	291	257-342	1.8	0.48
07/18/88	CRC	225	160-280	6.8	0.79
08/21/98	CRC	265	210-302	6.4	1.32

* Overnight net set

- No data recorded

^ 2 nets set

The last two gill net surveys have had higher catch rates than those in the 1970's. In contrast to the 1957 and 1961 surveys, many fish were observed in the lake and outlet stream besides those caught during the surveys. In 1998 gill netting captured fish ranging in length from 210 to 302 mm while angling produced a greater range of length, from 132 to 330 mm. Deformities, such as shortened opercles, snouts, and jaws, were found in 12.5% of the fish sampled in 1998.

Angler Use

Access to Ypsilon Lake requires a 7.2 km hike and the closest campsite is located 0.5 km away. Fishing pressure was described as moderate in 1962 (Azevedo and Wallis 1962), which it can also be called currently.

An abundant amount of creel survey data is available from Ypsilon Lake. Catch rates were very low in the late 1950's and early 1960's prior to the biennial stocking of cutthroats in the 1960's. During the 1960's stocking program catch rates increased (0.3 fish/hour). Interestingly, after stocking ceased after 1968 the catch rates increased to over 1 fish/hour for the first time. Catch rates have averaged 0.7 fish/hour since 1969.

Current Status

Based on the gill net survey data, as well as creel survey data, it would appear that successful recruitment occurs intermittently. This is probably due to low water temperatures delaying the start of spawning in some years. The limited spawning substrate may also have an effect.

Interestingly gill net catch rates and average creel survey catch rates have increased since the end of stocking. However, due to the intermittency of recruitment the abundance of fish appears to

Table 83. Summary of Fishery Statistics for Ypsilon Lake, 1958-2000.

Year	Fish/Hour	Angler Days	Total Hours	Species Reported Caught*
1958	0.06	-	-	-
1961	0.07	9	82.0	CUT
1962	0.25	29	170.0	CUT, BKT
1963	0.48	11	46.0	CUT, RBT
1964	0.55	12	60.0	CUT
1965	0.36	13	85.0	CUT, RBT, BKT
1966	0.45	21	142.0	CUT, BKT
1967	0.25	24	102.0	CUT, BKT, RBT
1968	0.02	11	123.0	CUT, BKT
1969	0.43	33	123.0	CUT, RBT
1973	16.0	1	1.0	CUT
1976	0.44	3	4.5	CUT
1984	0.00	3	9.0	
1986^	1.50	2	10.0	BKT, CUT
1987	1.46	12	26.0	CUT, RBT
1988	1.20	4	6.5	CUT
1989	0.66	7	21.0	CUT, BKT
1992	1.70	3	7.0	CUT
1996	0.22	2	4.5	BKT
1998	1.15	4	9.5	CUT
1999	0.00	1	4.0	

* In order of relative abundance

- No data recorded

^ Includes data from Ypsilon Creek

fluctuate. The latest gill net surveys may have been conducted during an upswing in this cyclical pattern. At any rate the most recent information indicates that the fish population in Ypsilon Lake is in good condition.

Since GBC are descendants of CRC, the two subspecies are difficult to separate with current taxonomic methods. Due to the scarcity of both subspecies, no management action to remove, or modify this population is recommended at this time.

OTHER NATIVE FISH SPECIES

The original distribution of native fish within RMNP was not documented prior to 1923. Stocking of native and non-native fish within RMNP probably began in the late 1800s and ended in 1968. However, stocking is still done in waters just outside RMNP and with no barriers stocked fish are entering the park. These fish, especially BNT, are displacing native fish within the lower montane valleys of RMNP.

The mottled sculpin, *Cottus bairdi*, is the only native fish species, other than Colorado River cutthroat trout, that still inhabit the west side of RMNP. They inhabit the Colorado River from the park boundary to at least the bridge upstream of Opposition Creek. They have also been found in the stomachs of BNT in the North Inlet in Summerland Park. The only other fish species that possibly could have been native to the west side of RMNP is the mountain sucker, *Catostomus platyrhynchus*. One unverified specimen was sampled in a 1972 electrofishing survey. According to John Woodling (1985) of the CDOW, in Colorado's Little Fish, A Guide to the Minnows and Other Lesser Known Fishes in the State of Colorado: Only one record of mountain sucker (Snyder 1981) exists from the upper reaches of the Colorado River system.

An electrofishing survey conducted in 1972 at five sites along the Colorado River found BNT to be the dominant species, with sculpins “present, but are comparatively scarce as are all prey-size food” (Mullen 1973). Electrofishing surveys have been conducted at two trend sites, Sun Valley Ranch bridge and Never Summer Ranch bridge, since 1980. The Sun Valley site is along the park boundary and the Never Summer site is about 11.3 km upstream of Sun Valley. Surveys conducted in 1980, 1988, 1993, and 1997 indicate that sculpins are more abundant at the Never Summer site with the population estimated between 1.3% and 6.6% of the fish population for those years. The accuracy of these numbers is uncertain, due to the small size of sculpins many may be missed during surveys. In 1997, sculpins comprised 1.3 % of fish sampled, while BNT comprised 93.3% of the sample at the Never Summer site. The figure for sculpins is the lowest since surveys were begun at this site, while the figure for BNT is the highest for that species. At the Sun Valley site no sculpins were sampled in 1995 or 1997, while BNT comprised over 92 % of the sample in both of those years.

White suckers and longnose suckers also inhabit the Colorado River, however neither of these fish are native to the west side of RMNP. These species were inadvertently introduced into western Colorado during the massive trout stocking operations of the late 1800s (Woodling 1985). The sucker populations in the Colorado River have also decreased as the BNT populations have increased.

Section IV: Emphasis for Future Fisheries Work.

In addition to regular monitoring of native and periodic monitoring of non-native fish populations, future fisheries work should focus on the areas listed below. These areas are highlighted in this section because of their importance to the fisheries and aquatic resources of RMNP or because they are in need of more attention. Proposed future work in some of these areas can be found in Table 84.

Native Cutthroat Trout Restoration: The NPS and FWS recognize that fish are important biological components of the national park system, providing benefits for ecosystem sustainability and recreation. Unfortunately, native cutthroat trout in RMNP are threatened by past introductions of non-native trout. Current fisheries management policies of the NPS emphasize the restoration and preservation of natural assemblages of native species.

Restoration of park waters to native fish species is the primary goal of the RMNP fisheries program. Although the park has some of the highest concentrations of greenback (GBC) and Colorado River cutthroat trout (CRC) populations, additional restoration of park waters to these two subspecies should continue. The pace of the native cutthroat trout restoration program was slowed due to funding problems and problems obtaining fish control permits. If these problems are resolved it is expected that one GBC and/or one CRC restoration project will be completed each year.

Disease Testing: Regular disease testing for certain viral, bacterial, protozoan, and metazoan pathogens has been conducted in RMNP since 1993. The results of this testing have found the organisms responsible for salmonid whirling disease (WD) and bacterial kidney disease (BKD) in fish populations within the park.

Although *Myxobolus cerebralis*, the causative organism for WD, was found in all sites located in the lower montane valleys of the Fall and Colorado Rivers, none of the fish in sites that tested positive showed clinical signs of the disease. This disease has the potential to be a serious threat to RMNP fish populations, so continual monitoring for WD is essential.

Twenty of 26 sites sampled since 1995 have tested positive or suspect for *Renibacterium salmoninarum*, the pathogen responsible for bacterial kidney disease BKD. Like fish that tested positive for WD, no clinical signs of BKD were observed in any fish sampled from positive populations. BKD is a chronic disease that is slow to develop, but once established, is difficult if not impossible to cure. Brook trout are highly susceptible to BKD.

Anthropogenic Impacts: Nitrogen deposition, commonly called acid rain, and climate change are two potential threats to the fisheries and aquatic resources of RMNP. Monitoring to assess any adverse effects that they may have on fish populations is necessary.

Of 11 national parks participating in The National Atmospheric Deposition Program, which is a

Table 84. Fisheries Related Activities, 2001-2006.

	<u>Year</u>					
	2001	2002	2003	2004	2005	2006
Restoration Projects						
Lake Haiyaha	X	X				
Poudre Lake/Cache la Poudre River		X	X			
Hidden Valley Creek			X	X		
Mummy Pass Creek				X	X	
Black Lake					X	X
Pettingell Lake	X	X				
Haynach Lakes		X	X			
Monitor Restoration Projects						
Dream Lake	X	X				
Lake Haiyaha			X	X	X	X
Poudre Lake/Cache la Poudre River				X	X	X
Hidden Valley Creek					X	X
Mummy Pass Creek						X
Pettingell Lake			X	X	X	X
Haynach Lakes				X	X	X
Watchable Fish						
Bear Lake	X					
Hidden Valley		X				
Lily Lake			X			
Sprague Lake				X		
Collect Creel Survey Data	X	X	X	X	X	

network to collect precipitation data to evaluate trends of air pollutants, RMNP has the highest recorded concentrations of nitrates. These nitrates come from automobile emissions, industrial activities, and animal wastes from cattle, hogs, and chickens. The Front Range of Colorado is one of two “hot spots” in the western United States for nitrogen deposition. Continued nitrate deposition will lower the pH of park waters. The adverse impacts of low pH on fish and amphibians have been well documented (see Johnson 1982 and Woodward et al. 1991).

Temperature is very important in the life cycle of fish, especially in alpine habitats. At high elevations the biggest effect that climate change, a warming or cooling, would have on fish would be

the timing of snowmelt. A cooling, which has been the trend locally over the past decade, could caused delayed spawning of fish in the park. This could limit the growing season to the point where fry would not be able to attain a large enough size to survive their first winter. A warming could cause streams to become dewatered in late summer once snow has melted.

Education: In 1990 the National Park Service signed a memorandum of understanding pledging to cooperate in carrying out a Watchable Wildlife Program. The ultimate goal of the Watchable Wildlife Program is to help maintain viable populations of all native species by building effective, well-informed public support for conservation (NPS 2001c).

In Yellowstone National Park more people participate in watchable fish programs than in angling programs (Kaeding *et al.* 1994). Opportunities for watchable fish programs also exist within RMNP, and include GBC spawning at Bear and Lily Lakes, the Hidden Valley Creek boardwalk, and the fall spawning run of brook trout in Sprague Lake and brown trout in Baker Creek. Signing these areas to inform visitors of what they are observing or stationing a knowledgeable ranger , interpreter, or volunteer in these areas would provide a much needed public outreach program on fisheries issues.

Angler education is another area in need of more attention. Informing anglers on how to disinfect their gear to avoid transfers of WD is very important. Since no stocking of fish for recreational purposes is done in RMNP, the importance of catch-and-release angling should also be stressed to anglers.

Research: Conducting, assisting with and/or funding research that is pertinent to RMNP fisheries will help better manage fisheries and aquatic resources. Better understanding of WD, fish migration barrier definition, and improving of taxonomic methods to differentiate between cutthroat trout subspecies would refine RMNP fisheries and aquatic management. Currently two researchers are conducting research in RMNP into the mechanism by which brook trout displace cutthroat trout in stream habitats. Doug Peterson, Colorado State University, is looking at immigration/emigration, reproductive disruption, decreased survival from competition or predation, and introduction of diseases as possible mechanisms. Claire McGrath, University of Colorado, is looking at feeding as a possible mechanism.

Other Candidate Aquatic Species: There are two other aquatic species in RMNP that were candidate species for listing under the Endangered Species Act, the boreal toad and the Rocky Mountain capshell. Monitoring of these species may provide information on the aquatic health of RMNP waters and may foretell of any negative effects that may befall fish populations.

Since 1990 the USGS-Biological Resources Division, with assistance from RMNP Division of Resources Management and Research, has managed and monitored park boreal toad populations. The boreal toad was once common to the southern Rocky Mountains, however its numbers have declined drastically over the past 15 to 20 years (Loeffler 2001). The reasons for this decline have not been definitively identified but recent information points to chytrid fungus as being a major factor. Currently there are four known boreal toad populations within RMNP.

Since 1997, numbers of breeding age toads and egg masses observed during monitoring at the North Fork of the Big Thompson River population have decreased each year. Numbers observed in 2000 were the lowest since the inception of the current survey methodology in 1990. Chytrid fungus has been identified as the cause of death for several toads in this population and is most likely the cause of the decreased number of toads observed. Spruce Lake, which is a breeding locality within the Big Thompson River population, has been monitored on a limited basis since 1996. Numbers of breeding age toads and/or egg masses observed has remained somewhat constant since 1998 and it is believed that toads at Spruce Lake are free of chytrid fungus.

The Rocky Mountain capshell is an extremely small aquatic mollusk (<5 mm in diameter) that was thought to exist in only 11 sites. These included a lake near Nederland, Colorado, a lake in Glacier National Park, and nine sites within Canada. During 1993 volunteers within RMNP found a new Rocky Mountain capshell population in Finch Lake. Other lakes within RMNP (including Spruce and Twin Lakes) were surveyed, but no additional capshell populations were found. This mollusk is extremely difficult to see and recognize due to its small size, coloration and habit of hiding under rocks.

Collection of Creel Survey Data: Although a fair amount of information is already being collected, still more is needed. Since management of native fish populations is the primary goal of the RMNP fisheries management program, non-native fish populations are surveyed only periodically. For remote areas these surveys may be very infrequent. Information from creel survey data may be the best way to assess non-native populations. Creel survey data provides valuable information on fish abundance, population structure, health, and species distribution.

Efforts have been started to try and distribute as many creel survey cards as possible to anglers at entrance stations, visitor centers, ranger stations, backcountry camping permit offices, and by rangers and volunteers. These efforts need to be expanded to collect as much information on all fish populations within the park. Emphasis should be placed on collecting information on areas where there is a lack of information, such as backcountry waters, the west side of the park, and recent native trout restoration waters.

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