

Monday -
15-7-85

Bb,

I tried several times today to reach you. Attached is the greenback story. It probably won't run until Thursday, August 1 so if you want corrections give me a call. (5549)

If I am going to change it any I need to know ^{on or before} July 22-24 since I leave town July 25th for Europe.

Also attached are your ~~papers~~ papers that I borrowed. Very interesting reading. Almost all the facts I used came from them. Thanks.

I really appreciate your help. Let's keep in touch. Maybe next fall I can do the yellowfin story, or a note about that giant cutthroat you've got mounted in the box.

Jerry Eckert
Agr. Econ.
5549

I don't want someone saying that Jerry doesn't always get his facts right.

SLUG GREENBACKS

A previously unknown population of pure greenback cutthroat trout has been discovered this summer on a small creek high in Rocky Mountain National Park. This find becomes only the fourth known source of pure strain greenbacks and is thus a significant addition to the genetic pool needed for preserving this rare trout.

Dr. Robert Behnke of CSU, one of the nation's foremost authorities on rare native trout, made this positive identification based on detailed examination of seven specimens taken in June.

The cutthroat trout is the only trout species native to Colorado, Wyoming and Utah. Four subspecies have been identified in this state. One, the yellowfin trout, became extinct before 1900. The most common cutthroat in the state is the Colorado River subspecies found on western slope drainages. A Rio Grande cutthroat populates the headwaters of the river for which it was named.

The greenback cutthroat is the rarest of Colorado's natives and is one of the most beautiful of all cutthroat subspecies. Coloration tends toward orange, gold and blood-red over the lower sides and the ventral region, especially in mature males. Its back is no more green than other trout in the species. But its most striking feature is its spots, the largest of any cutthroat.

At the time of settlement, the greenback was the only game fish native to the South Platte and Arkansas River drainages. The fish was abundant but not noted for its size. It reached a maximum weight of about five pounds. Its range at that time did not extend much above the foothills. As human activity spread into the mountains, sheepherders, loggers and prospectors took trout to higher waters to provide food and recreation where they worked. It is fortunate that

they did because the only pure strains known today are found in high mountain headwaters, above natural barriers that prevent the influx of more competitive non-native species.

The greenback was first identified in 1856 by an army expedition exploring various eastern slope drainages. By 1890 the fish was already declining from loss and degradation of habitat due to mining, logging, grazing and irrigation projects. The coup-de-grace which forced the greenback to the brink of extinction was widespread introduction of non-native species. Brown trout replaced it in larger rivers and brook trout in the smaller tributaries. Rainbow trout hybridized with it and replaced it in streams of intermediate size and elevation. One authority declared the greenback extinct in 1937 although periodically their survival was rumored.

In the late 1950s Dr. Behnke began intensive research on cutthroat trout. An early objective was to define the exact taxonomic characteristics that would distinguish the greenback from other subspecies and hybrids. By 1973, Behnke and his colleagues had determined that two pure greenback populations existed, one each ⁱⁿ ~~on~~ the ^{drainages} ~~headwaters~~ of the Poudre River and ~~on~~ Boulder Creek. Both sites were completely isolated by barrier falls and had no known stocking history. *They are now also closed to all fishing by state law.*

A Greenback Cutthroat Recovery Team was formed to increase the population and re-establish this fish throughout its former range. The recovery team is a cooperative effort of the Colorado Division of Wildlife, U.S. Fish and Wildlife Service, U.S. Forest Service, National Parks Service and CSU specialists. Originally, funding was available from the federal Endangered Species Act but this has been curtailed. Currently, the effort is supported primarily by Colorado's voluntary non-game wildlife tax checkoff.

The greenback is one of the most vulnerable of all native trout. Having evolved in complete isolation, they did not develop robustly competitive life habits and apparently cannot coexist for long with non-native species. A single breeding pair of brookies introduced into greenback habitat can become the dominant fish in three to four years and the only fish in as little as five years. Furthermore, the greenback is easily caught. Actual catch statistics show that it is 5-10 times as susceptible to angling as the brook trout, which itself is several times more vulnerable than the brown.

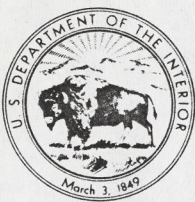
Thus survival requirements boil down to isolated habitats with protection from competitive species, and some limits to angling pressure.

Under the recovery plan, a brood stock of purebred greenbacks is maintained at a specialized hatchery in Bozeman, Montana. Eggs laid in Bozeman are fertilized by sperm collected from wild trout in Colorado to prevent domestication. Due largely to the efforts of the greenback recovery team the fish has been downgraded from "endangered" to "threatened" status.

"The ultimate goal of the program," says Rolf Nittmann, *Aguaic Senior Biologist* of the Division of Wildlife, "is to establish at least 20 viable populations drawn from the ~~now four~~ ^{may} known pure strain sites." At that time, catch and release fishing ~~will~~ again be possible for Colorado's unique native trout. Greenbacks have been introduced or reintroduced to about 15 sites to date.

Meanwhile, you can legally fish for greenbacks in the beaver ponds on Hidden Valley creek in RMNP. Fishing is permitted there after August 1 using only artificials with barbless hooks. Brook trout caught should be retained while any greenbacks must be returned unharmed to the water. This is a fish management experiment to see if differential trout removal can keep the natural competition from brookies under control, thus allowing the greenbacks to coexist.

The recovery plan is apparently working well. From a few hundred remnant fish, thousands are being reintroduced annually and the greenback cutthroat is returning rapidly from near-extinction. While they will never again reach their former abundance, greenbacks may ^{, within a decade,} ~~soon~~ offer an exceptionally high quality fishing opportunity to Colorado's anglers. The discovery of a new remnant population will strengthen the program ^{measurably} while, at the same time, reinforcing ^{our} historic links to ^{the} ~~our~~ past that this fish embodies.



United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

July 10, 1985

MEMORANDUM

To: Team Members - Greenback Cutthroat Trout Recovery Team

From: Bruce D. Rosenlund, Project Leader
Colorado Field Office, Golden, CO

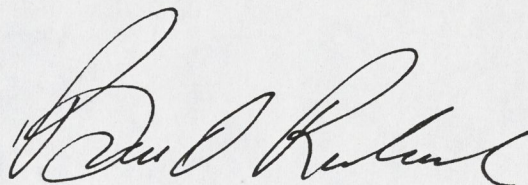
Subject: Discovery of a fourth population of pure
greenback cutthroat trout

While conducting a stream survey of Hunters Creek, Rocky Mountain National Park, 13 June 1985, cutthroat trout were collected that appeared to be pure greenbacks. Seven fish were taken to Dr. Behnke for examination. After examining the fish, Dr. Behnke confirmed that the cutthroat trout present in Hunters Creek are pure greenbacks. A copy of Dr. Behnke's report is attached.

The Hunters Creek greenback population apparently inhabits about 1.5 miles of stream habitat within the North St. Vrain drainage. The population exists above a steep canyon wall northwest of the Wild Basin Rangers Station, with the greenbacks not existing upstream from Lvrlic Falls.

All lakes and most streams within the St. Vrain drainage of RMNP have been surveyed. Good to fair phenotypes of greenbacks exist in the Hutcheson Lakes and Thunder Lake, and rainbow and greenback hybrids are present in Pear Reservoir and the stream below Sandbeach Lake. Sandbeach Lake is populated by rainbow trout, and it was surprising to find a pure population of greenbacks so close to Sandbeach Lake. Campers Creek lies just to the east of Hunters Creek and was found to be barren of fish life, probably due to minimum flows.

The Recovery Plan lists Thunder Lake and the Hutcheson Lakes as future restoration sites. Possibly, fish from Hunters Creek could be used for Thunder Lake and Hutcheson Lakes since they all occur within the North St. Vrain drainage.

A handwritten signature in cursive script, appearing to read "Paul R. Kuntz".

cc: Jim Bennett, CDOW
Dave Stevens, RMNP
Bob Stuber, FS
Al Collot FS
Endangered Species, Denver
Fisheries, Denver
Dr. Fausch, CSU
Dr. Behnke, CSU
FDCC

GREENBACK CUTTHROAT TROUT,

Salmo clarki stomias

Robert Behnke

The greenback cutthroat trout is one of the rarest and most beautiful subspecies of cutthroat trout. The greenback is native to the headwaters of the South Platte and Arkansas river drainages in Colorado and a tiny segment of the South Platte drainage in southeastern Wyoming. The greenback and the Rio Grande cutthroat trout, S. c. virginalis, in New Mexico, represent the easternmost limits of native trout distribution in the West. The origin of the greenback trout probably occurred several thousand years ago when one or more extreme headwater tributaries in the Colorado River basin became connected to a headwater in the South Platte and/or Arkansas drainage. This connection allowed the Colorado River cutthroat trout, S. c. pleuriticus, to cross the Continental Divide and become established on the east slope of the Rocky Mountains. This headwater transfer must have been very minor because the cutthroat trout is the only species common to the Colorado River basin and the South Platte and Arkansas drainages.

The time since the separation of the Colorado River cutthroat trout from the greenback is not ancient in geological time because the two forms are little differentiated from each other. They have not had sufficient time to evolve distinctive differences. As such, pleuriticus and stomias are not "good" subspecies in the sense of clear-cut differentiation, but these names have been long recognized and they serve a practical function to designate the native trout of two distinct geographical areas. Separate taxonomic recognition has also benefitted both subspecies by facilitating conservation programs for the protection and restoration of these rare trout.

The greenback is highly vulnerable to extinction. Apparently it cannot coexist with non-native species of trout. The cutthroat trout is the only species of trout native to Colorado, Wyoming, and Utah. Thus, the inland forms of cutthroat trout lack an evolutionary history of coevolution and coexistence with other species of trout. The nineteenth century angling literature makes it clear that greenback trout abounded in all mountain and foothill streams along the Front Range of Colorado. By 1878 they were considered "fished-out" around Denver and Denver sportsmen would travel north to Fort Collins to fish the Poudre River, which still had greenbacks in abundance. By the turn-of-the-century greenback abundance drastically declined. They were replaced by brown trout and rainbow trout in the large and medium size rivers. Brown and rainbow trout are better adapted to tolerate pollution from mines, industry and towns and reduced flows and warmer more silted water due to irrigation diversions, logging and livestock impacts. The widespread stocking of brook trout into headwater streams just about administered the coup de grace to S. c. stomias. As brook trout thrived and became dominant in small tributary streams, the greenback was

eliminated.

The story of Twin Lakes, Colorado, clearly illustrates the fate of the greenback trout and also typifies the fate of native cutthroat trout throughout the West. The Twin Lakes story also illustrates a moral for fisheries management in regards to man's ill-conceived attempts to improve on nature. In the 1860's and 70's, Twin Lakes swarmed with greenback trout. Parties of two or three fishermen could haul away more than 1000 trout in two or three days of fishing. Most significant, however, is the fact that Twin Lakes is the only lake known to have contained two distinct forms of cutthroat trout. Besides the abundant greenback, which attained a maximum size of only about 12 inches in Twin Lakes, the lakes also had a much larger cutthroat trout whose silvery coloration and tiny spots distinctly differentiated it from the greenback trout. The large, silvery trout became known as the yellowfin trout. Its maximum size was given at 12 to 18 pounds. Because of the abundance of greenback trout and the presence of the large yellowfin trout in Twin Lakes, the U.S. Fish Commission in 1890 selected a site near Leadville, Colorado to construct the first federal fish hatchery west of the Mississippi. The Leadville hatchery soon initiated exchanges of fish with hatcheries in other states and within a few years, Twin Lakes was stocked with rainbow trout, brook trout, lake trout, and even Atlantic salmon. During the "Johnny Appleseed" era of fish stocking, the addition of non-native species to an established fish fauna was believed to be entirely beneficial. The concepts of species interactions, environmental limitations, and the probability that new species would eliminate more valuable native species, were not taken into consideration.

The U.S. Fish Commission conducted an intensive fishery and limnological survey of Twin Lakes in 1902 and 1903 led by the distinguished limnologist Chauncey Juday (later gaining fame at the University of Wisconsin but then teaching at the University of Colorado). Juday and his crew could not find a single specimen of the yellowfin trout (and no specimen has been recorded since then) during two years of sampling. Rainbow trout was the dominant trout in Twin Lakes by 1902. When I examined the museum specimens of Twin Lakes greenback trout collected by Juday, I found that hybridization with rainbow trout was already underway by 1902. The greenback soon followed the yellowfin trout to extinction in Twin Lakes. The yellowfin trout, however, was known only from Twin Lakes. The entire branch of cutthroat trout evolution and diversity represented by the yellowfin trout was abruptly terminated within 10 years after the introductions of non-native trouts. This potentially valuable resource of a large, lake adapted cutthroat trout was lost forever.

A later introduction of opossum shrimp (Mysis relicta) into Twin Lakes resulted in such a drastic change in the invertebrate fauna that the lake trout is the only salmonid species able to maintain a viable population in Twin Lakes today. Although by lake trout fishery standards, the present Twin Lakes fishery is considered good (annual catch of about one pound of lake trout per surface acre--but the lake trout's diet is subsidized by catchable rainbow trout stocking), the present lake trout catch must be considerably less than the catch of 100 years ago when the fishery was based on the native greenback and yellowfin trout.

In the twentieth century, the greenback rapidly disappeared from the Arkansas and South Platte river drainages. A bulletin on Colorado trout

published by the Denver Museum of Natural History in 1937 considered the greenback extinct. The problem was: how would a greenback trout be recognized if a population were to be found? The original description of the taxon stomias in 1872 and all subsequent descriptions were so general and imprecise that no diagnostic characters were known to identify stomias from any other subspecies of cutthroat trout. For example, the "back" or dorsal surface of stomias is no more green than the backs of any other subspecies of cutthroat trout.

Many years ago I examined all of the nineteenth century museum specimens of stomias in the collections of the U.S. National Museum, Stanford University, and the California Academy of Sciences. I recorded data from many characters and compared these data with data from other subspecies. I found that specimens of stomias and pleuriticus (Colorado River cutthroat trout) were very similar, as would be expected of geologically recent common ancestry. I noted a trend for stomias specimens to have larger spots (about the largest of any cutthroat trout) and to have more scales in a series counted above the lateral line (one population averages 216 lateral series scales, the highest number I have found in any trout of the genus Salmo). Thus, I was relatively confident that I could recognize a pure population of greenback trout if they were discovered. After I came to Colorado in 1966, my students and I, assisted by the Colorado Division of Wildlife, initiated a search for remnant populations of greenback trout. This search was greatly expanded in recent years by the Colorado Division of Wildlife's endangered and threatened species program. After several years of effort, three populations, judged to be pure greenback cutthroat trout, have been found. One is in the Arkansas River drainage and two in the South Platte. All three populations exist in tiny headwater streams above barrier falls that protected the greenback from invasion by non-native trouts.

The greenback trout, although only a subspecies, was one of the first fish to be listed as an endangered species by the U.S. Department of Interior. Their status was changed to "threatened" in 1978 to facilitate transplants and management. The greenback will never again become a common fish in its original range, but funding and impetus from the Endangered Species Act has definitely reversed the trend to extinction. Anglers now have the opportunity to catch (and release) greenback trout in Rocky Mountain National Park.

Under the Endangered Species Act, a greenback trout "Recovery Team" was established, consisting of representatives of the U.S. Fish and Wildlife Service, U.S. Forest Service, National Park Service, and Colorado Division of Wildlife. The effectiveness of such a team is determined by the knowledge and dedication to achievement of its members. Bruce Rosenlund, the U.S. Fish and Wildlife Service's representative, with excellent cooperation from the other agencies, has consistently increased greenback trout abundance from year to year by transplant into new waters. Two small brood stock ponds were established for the remnants of the Arkansas River greenback and a brood stock for the South Platte greenback was established at the Bozeman, Montana National Fish Hatchery (sperm from wild greenbacks is used each year to fertilize the eggs from hatchery females to avoid harmful hereditary changes from "domestication"). Headwater streams and lakes with barriers protecting against upstream migration are sought for greenback stocking. When a suitable site is found, the waters above the

barrier are chemically treated to kill all fish (typically stunted brook trout), after which, greenbacks are stocked. In 1983, 22,500 greenback trout were stocked into 10 streams and lakes.

One of the early attempts to restore greenbacks was in Hidden Valley Creek in Rocky Mountain National Park. In 1973, the brook trout in Hidden Valley Creek were poisoned and greenbacks were stocked. Hidden Valley Creek situated along the main road through the Park had been a popular fishery. The federal endangered status of greenback trout at the time required that Hidden Valley Creek be closed to angling. Many anglers were angry over the fishery closure and perhaps someone restocked some brook trout. In any event, brook trout were found in Hidden Valley Creek in 1976 and they rapidly increased in abundance. Despite efforts to control brook trout by netting and trapping, brook trout became more numerous than greenback trout in the beaver ponds of Hidden Valley Creek. In 1978 fyke nets captured and removed 181 brook trout and captured and released 129 greenback trout. A similar netting operation in 1981 took 191 brook trout and only 55 greenbacks.

The change in status from endangered to threatened allowed regulated angling to occur for greenback trout. In August, 1982, (and every year thereafter) anglers were invited to fish the beaver pond section of Hidden Valley Creek. Angling was restricted to flies and lures with barbless hooks; all greenbacks caught were to be released, and anglers were urged to keep the brook trout they caught. The goal of this fishery was to favor the greenback trout by differential removal of brook trout. This goal was only partially fulfilled. Trout Unlimited members made up a large segment of anglers on opening day. Most of the T.U. anglers were so imbued with the catch-and-release philosophy and so believing in the concept of the sanctity of wild trout that they could not bring themselves to keep the brook trout they caught. Of the 171 brook trout caught on opening day, 112 (65%) were released. Subsequent creel censuses in 1982 and 1983 showed the same trend--most of the brook trout caught were being released. The catch statistics also further documented the extreme vulnerability of cutthroat trout to angling and their great value for catch-and-release fisheries in which fish are caught again and again to maintain a high catch rate on a limited stock of fish. As mentioned, the net sampling of the previous year (1981) captured 191 brook trout and 55 greenback trout. If this sampling was an accurate indication of the true ratio of the species (and there is no reason to suspect bias for one species or the other), then brook trout predominated over greenback trout by a ratio of 3.5:1. On opening day, anglers caught 344 greenback trout and 171 brook trout--greenbacks predominated the catch by 2:1. That is, the vulnerability factor (comparative susceptibility to being caught by angling) of greenback trout in Hidden Valley Creek is 7 times that of brook trout. Another way to interpret these statistics is to conclude that it would take 7 times more brook trout than cutthroat trout in a catch-and-release fishery in a given water to support the same catch rate. When it is realized that the vulnerability factor of brook trout is 5-10 times greater than that of brown trout, some insight and perspective can be had regarding the significance of species differences for determining the success of special regulations. Such enlightenment should also make understandable some of the practical, common sense, reasons to save rare forms of trout from extinction.

Prepared by Robert Behnke
Colo. Fish Office

GREENBACK CUTTHROAT TROUT FROM HUNTER'S CREEK,
ROCKY MOUNTAIN NATIONAL PARK

Robert Behnke
June, 1985

ABSTRACT

Seven specimens collected in Hunter's Creek, tributary to North Fork St. Vrain River in Rocky Mountain National Park are identified as pure greenback cutthroat trout, Salmo clarki stomias. I assume that the population in Hunter's Creek represents St. Vrain River greenback trout, transplanted into Hunter's Creek at an early date before hybridization with rainbow trout occurred in the St. Vrain. The Hunter's Creek population is the fourth known source of pure S. c. stomias.

Considering possible sources of non-native (to South Platte drainage) cutthroat trout that may have been stocked into Hunter's Creek -- Colorado River cutthroat, S. c. pleuriticus, and Yellowstone cutthroat, S. c. bouvieri -- the spotting pattern, coloration, caeca, scales and basibranchial teeth counts of Hunter's Creek specimens eliminate Yellowstone cutthroat and the spotting pattern and a mean value of more than 50 scales above the lateral line, rule against pleuriticus as a founder of the population.

Although only seven specimens were examined, the evidence is convincing that Hunter's Creek has a pure population of S. c. stomias. As such, it becomes only the fourth known source of pure populations of this taxon -- that is, the Hunter's Creek population represents 25% of the known interpopulational genetic diversity of S. c. stomias.

ORIGIN

The topography of the Hunter's Creek watershed, draining through a bench, high above the North Fork St. Vrain River, which isolates upper Hunter's Creek from access to fishes from the St. Vrain, makes it relatively certain that the Hunter's Creek greenback was stocked by man. This situation is similar to the other known greenback populations in the Little South Poudre, Como Creek and Cascade Creek -- all were introduced above impassable falls where they were isolated and protected from non-native trouts.

It is unlikely that hatchery trout were used to stock Hunter's Creek. The only early propagation of greenback trout occurred at the Leadville federal hatchery from 1890 to 1896. The Leadville greenbacks were propagated from spawners from Twin Lakes. The Twin Lakes greenback possessed the lowest scale counts I have found in stomias specimens (42-53 (46.2) above lateral

IDENTIFICATION

Seven specimens from 178 to 261 mm TL collected June 13, 1985, by Bruce Rosenlund (USFWS, Colo. Field Office) were taxonomically examined and compared with criteria for greenback cutthroat trout, Salmo clarki stomias.

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.

Table 1 lists diagnostic meristic characters of the seven specimens and compares them with data from stomias populations from Como Creek and the headwaters of the Little South Poudre River.

Table 1. Character analysis.

	Gillrakers	Pyloric caeca	Scales above 1.1. and in lat. ser.	Basibranchial teeth
Hunter's Crk. <u>N</u> = 7	18-22 (19.9)	27-35 (31.6)	48- 57 (51.6) 187-212(195.7)	7-12 (8.9)
Como Crk. <u>N</u> = 18	17-21 (19.0)	24-42 (29.4)	46- 53 (48.4) 174-205(189.3)	1 of 18, no teeth 17 w/ 3-12 (6.0)
Little So. Poudre <u>N</u> = 18	19-23 (21.3)	27-50 (35.2)	53- 60 (56.7) 205-236(216.5)	2-17 (11.1)

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.

line and 170-202 (186.0) in lateral series, based on 20 specimens collected in 1889 and 1903). From the 1890's to 1940's the predominant cutthroat trout propagated in hatcheries and stocked in Colorado were Colorado River cutthroat, Yellowstone cutthroat and various hybrid mixtures.

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. Many of these reservoirs still contain greenback x rainbow trout hybrids. 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.

Keplinger Lake is at the headwaters of Hunter's Creek and a barrier falls occurs on Hunter's Creek about one-half mile above the Sandbeach Lake trail crossing. Keplinger Lake is barren of fish and Hunter's Creek above the above-mentioned falls is barren of fish (Bruce Rosenlund, personal communication). Thus, it can be assumed that if Keplinger Lake was ever stocked with non-native trout, they did not become established in Hunter's Creek, as no fish are found above the falls where adequate trout habitat exists.

BIOLOGICAL NOTES

The specimens consist of four females (178, 191, 200, 217 mm TL) and three males (198, 204, 261 mm TL). They are in excellent condition with

abundant fat deposits around pyloric caeca, especially in the largest male. The three largest females had not yet spawned. One had released the eggs into the body cavity and would have spawned, probably within a day or two. The smallest female had only immature eggs but two empty egg shells in her body cavity indicated she had spawned. The testes in the two smaller males were less turgid than in the largest male, suggesting partial spawning. Based on this limited sample, it appears that spawning had not yet peaked by June 13, 1985.

Although a detailed parasitological examination was not made, the 191 mm female specimen contained several small nematodes of from 8-10 mm associated with the pyloric caeca and intestine. The nematodes were not encysted and may have exited from the stomach or intestine after the specimen was preserved in formalin.

I examined scale samples but accurate aging was not possible. I "estimate" that most of the specimens were completing their third or fourth year of life, perhaps the fifth year for the largest specimen, but distinct annuli could not be discerned.

Species: Greenback Cutthroat Trout

Salmo clarki stomias

DRAFT

Status: State and Federally Threatened Subspecies

Habitat Requirements and Limiting Factors

In general, habitat requirements of the greenback cutthroat trout are similar to those of other inland cutthroat trout except that inhabited streams must be devoid of introduced trout. Greenbacks are adapted to clear, cold (less than 70°F), well-oxygenated streams with moderate gradient, abundant riparian vegetation, and rocky-to-gravelly substrates. Cover must also be present and is usually composed of undercut banks, overhanging vegetation, and eddies behind in-stream boulders which provide resting and feeding stations. Water depth should be at least six inches. These elements in combination provide reproductive sites, production areas for aquatic and terrestrial food organisms, and cover for juveniles and adults.

The introduction of non-native fish species has been the most critical cause for the decline in greenback cutthroat trout populations in the South Platte and Arkansas River drainages. Genetically pure populations are destroyed because greenback trout readily "hybridize" with rainbow trout and other cutthroat subspecies. Brook trout displace greenbacks by mechanisms still not clearly understood, but may gain some advantage due to earlier sexual maturation and the relatively large size of the young.

Other reasons for greenback cutthroat trout decline include habitat degradation and destruction due to dewatering, timbering, overgrazing and mine drainage. Such practices lead to elevated water temperature, silted stream bottoms, heavy metal contamination, turbid water and dry stream beds.

Geographic Distribution

Historic: Greenback cutthroat trout originally inhabited the colder headwaters of the South Platte and Arkansas River drainages. They were not found in the North Platte drainage. Warmer waters at lower east slope elevations were not suitable greenback trout habitat.

Occupied Range:

South Platte Drainage

I. Boulder County

Como Creek¹

Big Crystal Lake (RMNP) - Larimer County

Odessa Lake (RMNP) - Larimer County

Upper Hetcheson Lake

II. Gilpin County

Bard Creek

Bruno Creek²

III. Larimer County

South Fork, Cache la Poudre¹

North Fork, Big Thompson River¹

Hidden Valley Creek¹

West Creek (above falls)

Black Hollow Creek¹

Bear Lake¹

May Creek

Hourglass Creek

Husted + Lost Lake + N.F. Big Thompson River, RMNP
Williams Gulch

Ouzel Lake and Ouzel Creek¹

Sheep Creek¹

Fern Lake & Fern Creek¹

Cornelius Creek

George Creek

Lawn Lake

Hunter's Creek¹

Roaring River

Fall River (RMNP)

Pennock Creek²

IV. Jefferson County

Zinn Ponds³

Arkansas Drainage

I. Custer County

Cottonwood Creek

II. El Paso County

Little Turkey³ Creek

Lytle Springs Pond³

Boehmer Reservoir

Duck Pond (Ft. Carson)

III. Huerfano County

Cascade Creek¹

McAlpine Pond³

IV. Lake County

Virginia Lake

Recovery Efforts and Future Management:

The objective set forth by the Greenback Cutthroat Trout Recovery Plan is the removal of this subspecies from the USFWS threatened species list. Recovery will be considered successful when 20 stable greenback trout populations are documented within the South Platte and Arkansas River drainages. At present, 11 stable populations exist (see Occupied Range). This objective includes first, the maintenance of existing historic and stable populations and their habitats. Second, the establishment of new populations within the native range or documen-

1 = stable population

2 = recently reclaimed

3 = brood pond

tation of any historic populations discovered. Third, the establishment of hatchery and wild population broodstock. Fourth, the documentation of the response of greenback trout to angling pressure. Fifth, to conduct an information and education program, and finally, the preparation of long-term and cooperative management plans for the greenback cutthroat trout.

References.

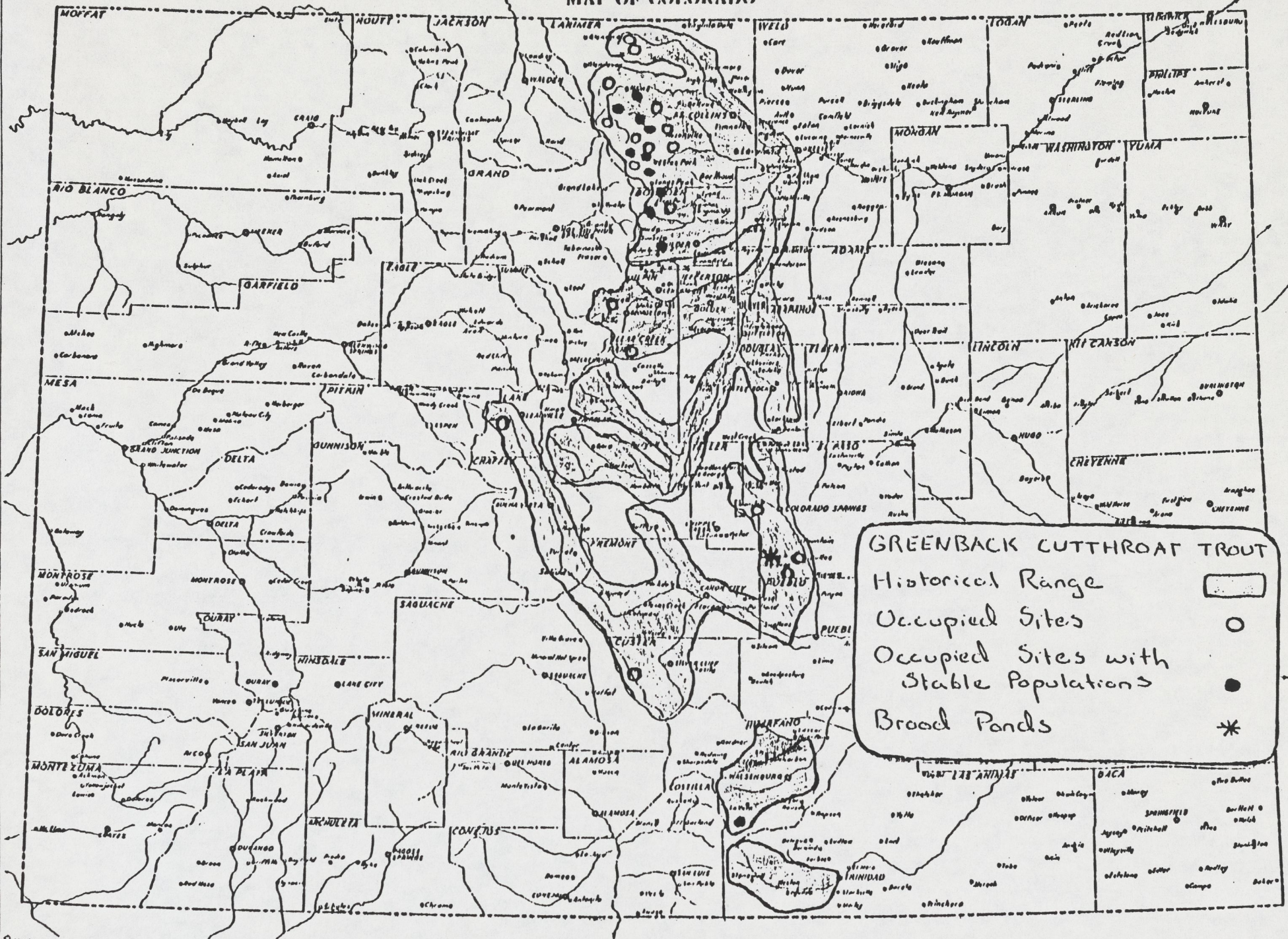
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MAP OF COLORADO



GREENBACK CUTTHROAT TROUT

- Historical Range
- Occupied Sites
- Occupied Sites with Stable Populations
- Broad Ponds *

GREENBACK CUTTHROAT TROUT RESTORATION IN ROCKY MOUNTAIN NATIONAL PARK

Stevens, David R. Rocky Mountain National Park, Estes Park, CO 80517
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ABSTRACT:

The greenback cutthroat trout (Salmo clarki stomias), a threatened species, is the native trout in the headwaters of the South Platte River in Rocky Mountain National Park. Due to overharvesting, competition, and hybridization with introduced trout the species was considered near extinction. Recovery efforts through 1985 identified four genetically pure native populations within Colorado which have formed the basis for a renewed effort to restore the species as a viable entity in their historic range. Two of the populations of pure greenback occur within the park. A experimental research/management program was initiated in Rocky Mountain National Park as part of the broader Greenback Cutthroat Trout Recovery Plan. In 1970, fish were successfully transplanted to a small section of the North Fork of the Big Thompson River. This initial project was followed by two more experimental restoration projects along the east slope of the park that required the removal of non-native fish populations above natural fish barriers. The removal was accomplished by the use of the fish toxicant "antimycin". After the completion of the Greenback Trout Recovery Plan in 1976, four more restoration projects were conducted. Hidden Valley Creek, restored in 1973, was opened for fishing on a catch-and-release basis in 1982. This program has generally been successful and catch-and-release angling for greenbacks will be extended to two other restored populations in 1986. Although brook trout have now reinvaded two of the restored areas, the restoration program is still considered successful and will continue according to the Recovery Plan.

INTRODUCTION

The greenback cutthroat trout (Salmo clarki stomias) is the subspecies which was the native trout in the headwaters of the South Platte and Arkansas River drainages in Colorado. Lack of competitiveness, hybridization with non-native trout introduced in the 1800's, habitat destruction, and susceptibility to angling, resulted in the native populations rapid decline, and by early in this century the greenback was considered extinct.

The greenback is closely related to the west slope native Colorado River Cutthroat (Salmo clarki pleuriticus) and share similar origins (Behnke, 1979). The back of the greenback cutthroat is not especially green, with the most unique field characters being the bright red ventral coloration of males during spawning and large round posterior spots. They also possess fewer vertebrae and pyloric caecum, than other subspecies of S. clarki and have the highest scale counts of any trout in the genus Salmo (Behnke, 1976).

The National Park Service has a policy to restore extirpated species where possible in order to "conserve, perpetuate, and portray as a composite whole the indigenous aquatic and terrestrial fauna and flora and the scenic landscape." (National Park Service, 1978). Therefore, since sources of the native fish were found to exist, programs to insure its survival were initiated as early as 1958.

This paper describes the greenback cutthroat trout in Rocky Mountain National Park, and the efforts being made to restore it to a semblance of its original status and future prospects.

STATUS OF THE GREENBACK CUTTHROAT TROUT

Four populations are now recognized as possessing the characteristics of pure greenback cutthroat trout. Two of these exist within Rocky Mountain

National Park, one in the Arkansas River drainage, and one in the Boulder Creek Drainage. These populations have formed the basis of the present restoration program.

The early confusion about the identity of the subspecies primarily came from the fact that the collections were not well labeled when collected in 1856. This scarcity of good type specimens of greenbacks made it difficult to describe distinguishing characteristics and find pure populations. However, Wernsman (1973), Behnke (1976) and Behnke and Zarn (1976) have published the accepted meristic description that is used today.

The fish was classified as "Endangered" with the advent of the Endangered Species Act in 1973, with less than 4,000 pure greenbacks known to exist at that time. With the apparent success of restoration projects, the fish was reclassified as "threatened" in 1976. This classification allowed for future catch-and-release angling and increased the numbers of available restoration sites, although the fish remained on the Federal list. A recovery team with representatives of the Colorado Division of Wildlife, Fish & Wildlife Service, Forest Service, National Park Service, and Bureau of Land Management was established, and a recovery plan was completed in 1976 with revisions in 1983.

One of the most important populations to the restoration of pure greenback was located at Como Creek outside the park in 1969 (Figure 1). Although this is a relatively small stream that flows 4.8 km through the University of Colorado Mountain Research Station in the Boulder Creek watershed, it has served as a source of fish for restoration projects and the Fish & Wildlife Service brood stock program.

Another population confirmed to be pure by Behnke was discovered at about the same time in the South Fork of the Poudre River. This population inhabits about 1.6 km of stream habitat south of Pingree Park. The population density is low and very vulnerable to angling pressure.

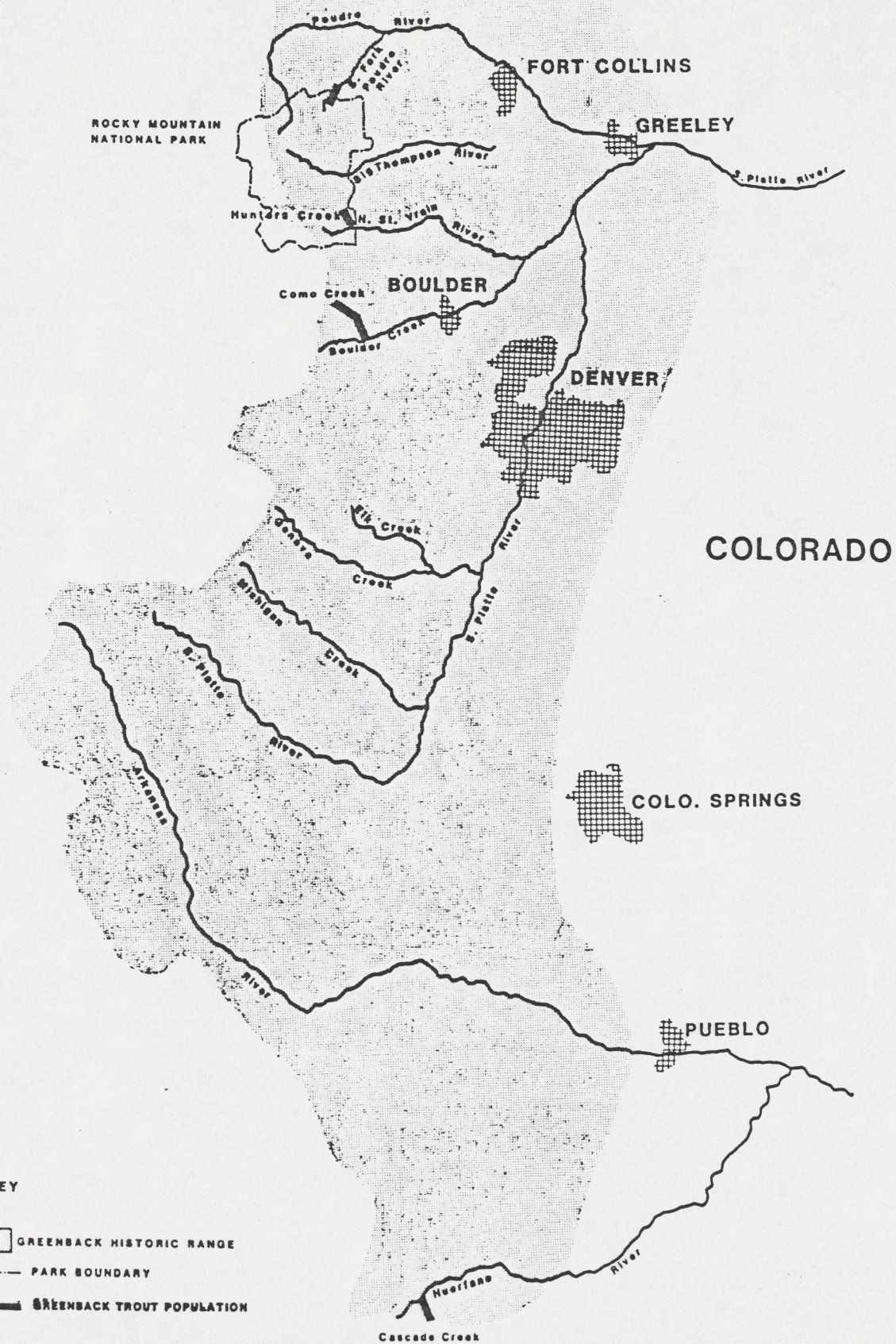
The only known genetically pure population of greenback trout in the Arkansas River drainage was discovered in Cascade Creek, a tributary of Huerfano Creek, in 1977. Cascade Creek is a small stream flowing about .028 cms (1 cfs) in August with a steep gradient of cascades and plunge pools. The fish inhabits about 2.4 km of the stream above a barrier falls with an estimated population of 620.

In June 1985, the second pure population of greenback cutthroat trout was documented within the park. While undertaking a general survey of stream fish populations, the National Park Service and Fish & Wildlife Service collected several trout from Hunters Creek that were phenotypic greenbacks. These specimens were later confirmed through meristic characters by Behnke to be pure. Hunters Creek is located in the headwaters of the North St. Vrain River. The fish inhabit about 2 km of stream between Lyric Falls, and a steep cascade above the Wild Basin Ranger Station. Although the trail to Sandbeach Lake crosses the stream it appears to be fairly secure.

THE ENVIRONMENT

Rocky Mountain National Park lies in the Front Range of the central Rocky Mountain cordillera. The mountains were formed by precambrian metamorphic schists and gniess intruded by granite (Richmond 1974). Present physiography is the result of extensive alteration by pleistocene glaciation. The soils are relatively infertile being very sandy with poor development from decomposed granitic substrates.

WYOMING
COLORADO



KEY

□ GREENBACK HISTORIC RANGE

--- PARK BOUNDARY

— GREENBACK TROUT POPULATION

Cascade Creek

The climate is typical of the central Rocky Mountains. At lower elevations, around 2,400 meters, the annual precipitation is 41 cm with a mean annual temperature of 6°C. Precipitation increases with elevation to as much as 66 cm annually on the alpine tundra. Highest precipitation occurs in March and April in the form of heavy, wet snow. High runoff in the streams is in early July.

The vegetation of the study area represents three climax regions (Marr, 1961). Above 3,500 meters elevation is the alpine tundra. Vegetation is a complex mosaic of types related to numerous environmental factors. Meadow and low willow marsh are common along stream courses.

The sub-alpine forest region is below the alpine tundra down to about 2,740 m elevation. Dominant vegetation is the Engelmann spruce (Picea engelmanni)/subalpine fir (Abies lasiocarpa) forest. In openings and along stream courses are herbaceous meadow and willow carrs. Below 2,740 m is the Upper Montane Forest. Dominant vegetation is the ponderosa pine (Pinus ponderosa)/shrub savannah, lodgepole pine (Pinus contorta) forest and closed canopy Douglas-fir (Pseudotsuga menziesii)/Ponderosa pine forest on north exposures. Interspersed in swales and bottom areas along stream courses are meadows dominated by Calamogrostis canadensis and willow (Salix spp.) carrs. Aspen (Populus tremuloides) and alder (Alnus tenuifolia) are also common along streams.

The aquatic ecosystem of the park consists of 147 lakes (446 ha) and 761 km of stream. The waters are oligotrophic, cold and clear, typical of high mountain watersheds. As of 1984, there was no indication of the effects of acid precipitation (Baron et al, 1984), but a very low buffering capacity was noted.

Lakes average three hectares in size and are typically deep and cold, mostly related to alpine glacial cirques. The environment is harsh, with intense solar radiation, low air temperatures, high precipitation and strong, persistent winds. With a short growing season and low nutrient availability, food production is very low. Terrestrial insects form a large portion of the available food for non-native trout (Mullan, 1975), and greenbacks (Fausch, 1986).

Originally most of the mountain lakes were barren of fish since cascades and waterfalls formed barriers to upstream movement. Where present the native fish on the east slope were the greenback cutthroat trout, and the Western longnose sucker (Catostomus catostomus griseus). Introduced fish are the brook trout (Salvelinus fontinalis), brown trout (Salmo trutta), rainbow trout (Salmo gairdnerii) and various subspecies of cutthroat trout. Brook trout dominate most of the higher elevation streams and lakes in which they are present.

INITIATION OF RESTORATION

Although considered extinct during the 1930's, Fish and Wildlife Service biologists found what appeared to be a pure population of greenback cutthroat trout in 1957 in the headwaters of the Big Thompson River. At the time, this discovery was considered a breakthrough and a three phase program was initiated (Bulkley, 1959). First a life history study of the population was made. This was followed by an unsuccessful attempt at experimental propagation of greenback cutthroat trout at the Leadville National Fish Hatchery.

The third phase was the restoration of greenback to another park drainage. To accomplish this hybrid cutthroats were removed from the Faye Lakes with rotenone in 1958.

The habitat consisted of two deep alpine cirque lakes and Caddis Lake, a shallow subalpine 0.3 ha pond at an elevation of 3,280 m. Maximum depth was 0.76 m. The stream drains into Ypsilon Creek which is a tributary of Roaring River and Fall Rivers. In 1959, 209 greenback from the Big Thompson River were restocked into the middle lake.

This first attempt at greenback restoration ended when records were found that revealed that 270,000 cutthroat fry, listed as "spotted natives", had been planted in the headwaters in 1922-23. Further examination of these fish revealed that they had fewer basibranchial teeth than the type specimens. Based upon this and the stocking records, the Big Thompson River fish were classified as "good representatives" but not pure greenback cutthroat trout. Although the transfer of fish to Faye Lakes was successful in establishing a reproducing population they are still only considered good representatives of the species.

When a pure greenback population was discovered in Como Creek, south of the National Park by Dr. Behnke, a new impetus was put behind restoration of the fish in 1970. Discussions with Fish and Wildlife Service led to a program with the ultimate goal of restoration of the native fish to east slope waters. The objectives of the research/management program were:

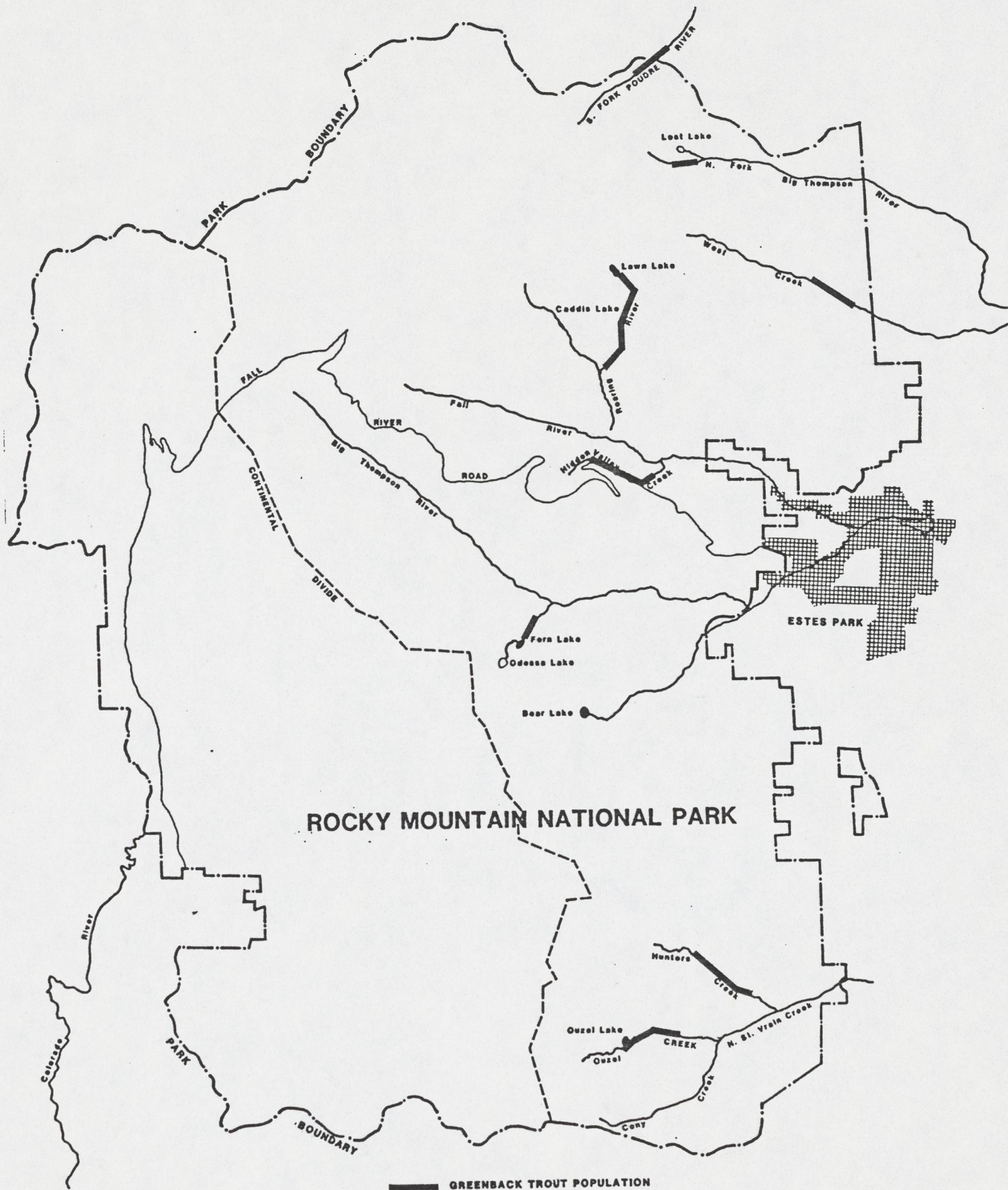
1. To test methods of removing non-native trout from historic greenback habitat.
2. To re-establish pure greenback cutthroat trout in a few accessible drainages for demonstration purposes, research, and to provide stock for further restoration.
3. To determine the feasibility of widespread restoration of the greenback cutthroat trout to historic native habitats.

Following a 1969 survey of the North Fork of the Big Thompson drainage Mullan (1969) recommended the headwaters of the North Fork above Lost Lake as the first experimental restoration site (Figure 2). This was a section of stream and shallow lakes that represented excellent physical habitat but barren of fish, although "cutthroats" had been previously stocked upstream in several alpine lakes and had not survived. A cascade blocked upstream movement of brook trout from Lost Meadows.

Utilizing fish captured in Como Creek a total of 50 greenback cutthroat trout were transferred by helicopter to the North Fork and released in October 1970. Although initial survey in 1973 found no fish and the project was considered a failure, a survey in 1978 to determine the cause of the apparent failure found a reproducing greenback population. This project documented the possibility of establishing greenbacks in colder water conditions within the park when protected from angler harvest.

Since the historic range of the greenback is dominated by non-native fish populations, the next experimental project planned was the rehabilitation of a drainage occupied by brook trout. Specific project objectives were:

1. To learn whether brook trout could be eliminated from a stream drainage with beaver ponds.
2. To determine the effectiveness of the toxicant antimycin in park waters as a restoration tool.
3. To establish another pure greenback population.
4. To obtain population statistics on an existing fish population.
5. To establish an accessible wild brood stock for the greenback cutthroat trout.



— GREENBACK TROUT POPULATION

Hidden Valley Creek was chosen as the site that would best meet these objectives. The creek originates near treeline and falls rapidly through the spruce/fir forest to the base of the Hidden Valley Ski Area at 2,926 m elevation. The gradient decreases for about 1.6 km as it enters a series of beaver ponds bounded by a willow carr. Dropping through a steeper forested area it meanders through an open meadow before dropping steeply again to its confluence with Fall River at 2,590 m.

Antimycin "A" was chosen as the best toxicant for park conditions because it demonstrated extreme toxicity to salmonids; it was very effective in cold, soft waters of low pH; it was relatively harmless to waterfowl and mammals; it degraded rapidly and has shown irreversible toxicity once fish are exposed. (Mullan, 1973). Antimycin is an antibiotic which is produced by streptomyces. It enters the fish through the gills and irreversibly blocks cellular respiration at the cytochrome level in the oxidative-phosphorylation pathway (Lennon, 1970). It is colorless and odorless in water and does not repel fish. Antimycin can degrade within a few days (24 to 96 hours) in water depending on temperature and pH. Detoxification can be accomplished by the addition of potassium permanganate.

The treatment of 7.5 km of Hidden Valley Creek and over 2.4 ha of beaver ponds was conducted on September 10, 1973. The minimum standing brook trout crop calculated from fish removed was 101 kg/ha (90 pounds per acre) for .6 surface hectares of stream, and 45 kg/ha (40 pounds per acre) for the beaver ponds.

On October 16, 1973 Hidden Valley Creek was restocked with 82 green-back cutthroat trout 8 to 23 cm in length from Como Creek.

In 1976, several adult brook trout were found during an electroshocking survey. Although for several years brook trout were removed by electro-shocking

and fyke nets from the ponds, the population continued to increase in respect to the greenback cutthroat trout population.

In 1982 an experimental catch-and-release fishing area was established in the beaver ponds of Hidden Valley for the greenback cutthroat trout. The regulation encouraged harvest of the brook trout in an attempt to put pressure on the increasing brook trout population. The season opens each year on August 1 following greenback spawning, with anglers expending over 2,000 hours during August. Although greenbacks are the minority in the beaver pond habitat, they are the majority of the fish caught, with anglers landing an average of 0.86 greenbacks per hour and 0.40 brook trout per hour. Unfortunately, anglers released nearly 60% of the brook trout landed despite requests to keep them.

Difficulties arose with the inability of anglers to distinguish between the two fish, and resulted in a loss of greenbacks although color plates illustrating the two fish were posted at the two main parking areas. In 1986 identification pamphlets were made available to anglers which hopefully will improve the identification process. Monitoring is continuing and the project is still considered experimental.

In 1975 a third experimental restoration project was conducted in Bear Lake, a subalpine lake covering 4.5 ha and 11 m deep. The objectives were similar to the Hidden Valley project. This effort was necessary to document that antimycin could be applied effectively in a lake habitat before a regular program could be instituted.

On October 6 a total estimated population of 1,480 brook trout yielding 26 kg/ha (23 lbs. per acre) was removed from Bear Lake. The lake was restocked with 65 Como Creek greenback cutthroat trout captured in Como Creek on November 11, 1975.

From 1976 through 1981, spawning was not observed, although both the outlet and inlet streams were cleared of debris and the spawning habitat improved. In 1981, 432 greenbacks, 130 cm in length, from the Fish and Wildlife Service Hatchery in Bozeman, Montana were released into Bear Lake and the outlet stream. The first spawning was documented in 1982 in the inlet, and since then spawning adults have also been noted in the outlet. No brook trout have been found in Bear Lake in the eleven years following the antimycin treatment.

To document the proper dose and test the viability of the antimycin on hand a bioassay was conducted by the U.S. Fish & Wildlife Service in 1978. Results indicated a lethal dose could be delivered with either a low concentration for an extended period (2 $\mu\text{g}/\text{l}$ for 8 hrs) or a higher concentration for a shorter period (7 $\mu\text{g}/\text{l}$ for 5 hrs). These results were utilized in planning all subsequent treatments. (Table 1)

Studies on the effects of antimycin have continued. A survey of aquatic insects before and after the 1983 Lawn Lake antimycin treatment showed considerable impact on macroinvertebrates (Jacobsen, 1983). In these cases macroinvertebrate reductions were found to be temporary. Because of these findings, restocking is now postponed one year to allow recovery of invertebrate populations, and to monitor the success of the fish removal.

THE GREENBACK RECOVERY PLAN

A recovery team for the greenback cutthroat trout that included Park Service representation was designated by the U.S. Fish and Wildlife Service in 1975.

The first recovery plan was completed in 1976 following the successful effort by the team to change the classification from endangered to threatened. The present plan is a revision approved in September 1983.

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The objective of the Greenback Recovery Plan, as well as the park program, is removal of the fish from the threatened and endangered species list.

The first of the six steps to recovery is to maintain and enhance historic and stable greenback cutthroat trout populations and their habitat. In the park this requires enforcement of protective regulations and the monitoring of the two "native" populations of greenback cutthroat trout to insure that the habitat is maintained and that the population is not depleted due to illegal angling.

The second is to establish or document the existence of 20 stable populations of pure greenback cutthroat trout within the historic range. Although most of the waters of the park have been surveyed there may still be some relic populations in small presently unsurveyed waters, (e.g. Hunters Creek in 1985). Aquatic surveys will continue until all park waters are examined. Restoration programs in the park will also continue until all of the ten sites presently programmed, or in the planning stages, are restored. This is consistent with the Aquatic Ecosystem Management Plan for the park which calls for restoration of the greenback cutthroat trout where feasible.

The third step to recovery is to establish hatchery and wild populations of pure greenback for brood stock. In 1977, 64 greenback were taken from Como Creek to the Fish and Wildlife Service Fish Technological Center at Bozeman, Montana. These fish were successfully spawned, with a total of 129,000 greenback fry stocked into greenback restoration projects since 1981. In 1985, 16,190 greenback cutthroat fry were stocked into park waters.

To prevent genetic drift in the hatchery brood stock, milt from wild populations has been collected and shipped to Bozeman to fertilize eggs since 1982. To reduce inbreeding problems the Recovery Team recommended that genetic material from the three South Platte populations should be mixed with the Bozeman Hatchery greenback brood stock starting in 1986.

The Recovery Plan also calls for the documentation of the greenback cutthroat trout's response to angling. Major steps have been taken toward this goal with the opening of Hidden Valley Creek in 1982 and Ouzel Lake and Fern Lake in 1986 to catch-and-release fishing for greenback cutthroat trout.

The fifth step is to conduct an information and educational program on the greenback cutthroat trout and the recovery program.

The final step is a cooperative agreement among the agencies to insure the compliance with the recovery programs and future management of the 20 greenback populations.

MANAGEMENT PROJECTS

With the information obtained from the North Fork, Hidden Valley and Bear Lake supported by the 1976 Aquatic Resources Management Plan, it was possible to plan a series of projects as part of the Greenback Trout Recovery Plan. Four of these projects have been completed to date.

The West Creek drainage lies north of Estes Park and contains about 3,237 ha. The stream originates at about 3,650 m elevation on Mt. Dunraven and flows about 8 km east to the park boundary at 2438 m elevation. Brook trout inhabited about 2.4 km of stream from the West Creek Falls upstream to about the 2,650 m elevation level. On August 8, 1978 the stream, flowing .22 cms at 6°C, was treated with antimycin from stations extending 3.2 km above the falls.

No brook trout have been found in this area following the treatment in 1978. Calculations of the total number removed indicated about 247 brook trout per km or 56 kg/ha (50 lbs. per acre).

In 1979 West Creek was restocked by helicopter with 58 adult and sub-adult greenbacks captured in Hidden Valley Creek by electro-shocking. However, successful reproduction by these fish was not documented by 1984, with some

greenback adults apparently migrating out of the restoration site. On July 11, 1984, 100 hatchery greenbacks averaging 140 mm in length from Bozeman, Montana were released with these fish remaining near the release sites through October 1986.

The next project occurred in the Ouzel Creek drainage in the southeastern corner of the park in Wild Basin. The habitat included Ouzel Lake, a 2.58 hectare lake, with a maximum depth of 1.07 m and about 3.5 km of stream below the lake. This drainage was moved up in priority following the 427 ha fire in the fall of 1978. The fire altered the vegetation but did not affect the fish population significantly.

The lake and stream were treated with antimycin in August 1980. In Ouzel Lake a total of 37 kg/ha (33 lbs. per acre) of brook trout were removed. The drainage was restocked by helicopter with 16,750 fry in 1981, 5,200 in 1982, and 4,300 in 1983, all from the Fish and Wildlife Service hatchery in Bozeman, Montana.

Unfortunately, 19 brook trout were found in Ouzel Creek about .5 km downstream of the lake in 1985. Apparently a few brook trout fry were missed in a bog area during the treatment, and these spawned by 1983. Survival, growth, and reproduction in the greenback population has been excellent upstream of the brook trout with 11% of the trout sampled in 1985 over 200 mm.

Restoration of the greenback cutthroat trout also included the Fern Lake drainage, a tributary of the Big Thompson River. The upper lake, Odessa, although previously stocked, did not contain a fish population when sampled in 1980. A population of brook trout and a few hybrid cutthroat trout existed downstream from Odessa Lake (at 2926 m). Fern Lake has a surface area of 3.7 ha

with a depth of about 9 m. Fern Creek extends about 1.6 km below the lake to the barrier at Fern Falls. In August 1982 the Fern drainage was treated with antimycin.

In September 1983, 4,600 greenback cutthroat trout were stocked into the lake and 560 downstream. Stocking continued in 1984 and 1985. Electro-shocking showed successful survival and greenback cutthroat trout up to 250 mm in length present in both the lake and the stream by 1985.

The last project to date was also planned in high priority because of a major change. With the break of the Lawn Lake Dam in 1982, the lake had been reduced from 19 to 8 surface ha. and the streambed downstream was extremely scoured and had very few fish. It was, therefore, a good candidate for rehabilitation and restoration of greenback cutthroat trout.

The habitat consists of two lakes above treeline, Crystal and Little Crystal lakes. Crystal Lake, at an elevation of 3,511 m, contained a very small intermittent spawning population of hybrid greenback cutthroat trout. Little Crystal was barren of fish life. Crystal Lake was not considered for treatment because the chance of movement downstream into Lawn Lake did not justify the cost of treatment.

Lawn Lake was still 8.5 m deep and had a dense population of brook trout which also had originally inhabited the inlet and Roaring River to Fall River. Some brook trout still existed in the outlet.

In late August 1983, the Lawn Lake inlets and the lake were treated with antimycin below the 3,400 m elevation level. No detoxification station was established because of the impact of the flood and a vertical drop of 700 m to

Fall River was expected to neutralize the toxicant. This proved to be a mistake since apparently organic matter is important in neutralizing antimycin and fish were killed for a significant distance down Fall River.

Since no fish were found alive in the drainage in 1984, Lawn Lake was restocked in September with 11,600 fish from the Bozeman facility. An additional 1,200 greenbacks were stocked into Big Crystal Lake. In 1985 and 1986, the stocking in Lawn Lake, Big Crystal and Roaring River was repeated.

The next restoration project planned for August 1986 is the expansion of the 1970 North Fork restoration to include two lakes and a section of stream above Lost Falls.

CONCLUSIONS

Since the identification of a pure population of the greenback cutthroat trout in Como Creek in 1969, seven projects totaling 14.6 km of stream and 21.2 ha of lakes have been completed in Rocky Mountain National Park. Of these seven projects, five are presently believed to be totally successful restorations. Two projects have been reinvaded by brook trout, and are the subject of experimental brook trout control by angling, chemical and mechanical means. Although instituted as an ongoing management program, the projects continue to be intensively monitored because of their experimental nature.

Hidden Valley is especially important in order to study catch-and-release angling and to evaluate its effectiveness as a management tool. Ouzel Lake and Ouzel Creek and Fern Lake and Fern Creek were opened for catch-and-release in 1986. A section of Ouzel Creek presents a similar problem to Hidden Valley, with the presence of an increasing brook trout population.

Again by regulations, we are attempting to harvest brook trout to the benefit of the greenback. Catch-and-release fishing will be instituted eventually on all restoration projects with the exception of Bear Lake. Visitation is too high in the Bear Lake area to allow fishing of any kind.

The Greenback Trout Recovery Plan calls for an additional eight restoration projects in the park. Rocky Mountain National Park will continue to be committed to this effort in order to remove fish from the "threatened" category.

Antimycin is still believed to be the most effective and safe toxicant available for these purposes. Although it has not been foolproof we feel that the knowledge that has been gained in previous applications can be utilized to improve future projects.

Continued monitoring of results and effects on the total ecosystem is important if we are to meet our obligations for perpetuation of the park aquatic ecosystem.

With the general success of this program we feel the greenback cutthroat trout is again becoming a viable part of the park aquatic ecosystem.

ACKNOWLEDGMENTS

We would like to acknowledge the support of the Colorado Division of Wildlife and the Roosevelt-Arapaho National Forests. Dr. Robert Behnke, Colorado State University, has assisted in all phases of this program. Early work was conducted by James Mullan and Don Bartchi of the Vernal office of the Fish and Wildlife Service. The Greenback Recovery Team and its various members have been instrumental in recent planning and assistance with projects. Thanks are also due to all of the personnel of the Park Service, Colorado Division of Wildlife, Fish and Wildlife Service and Forest Service that have assisted on the various projects.

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Figure 1. Historic Range and Remnant Greenback Populations.

Figure 2. Pure Greenback Trout Populations in Rocky Mountain National Park.

- Hutchinson Use?

- Little So. Powder - incubation temp units