

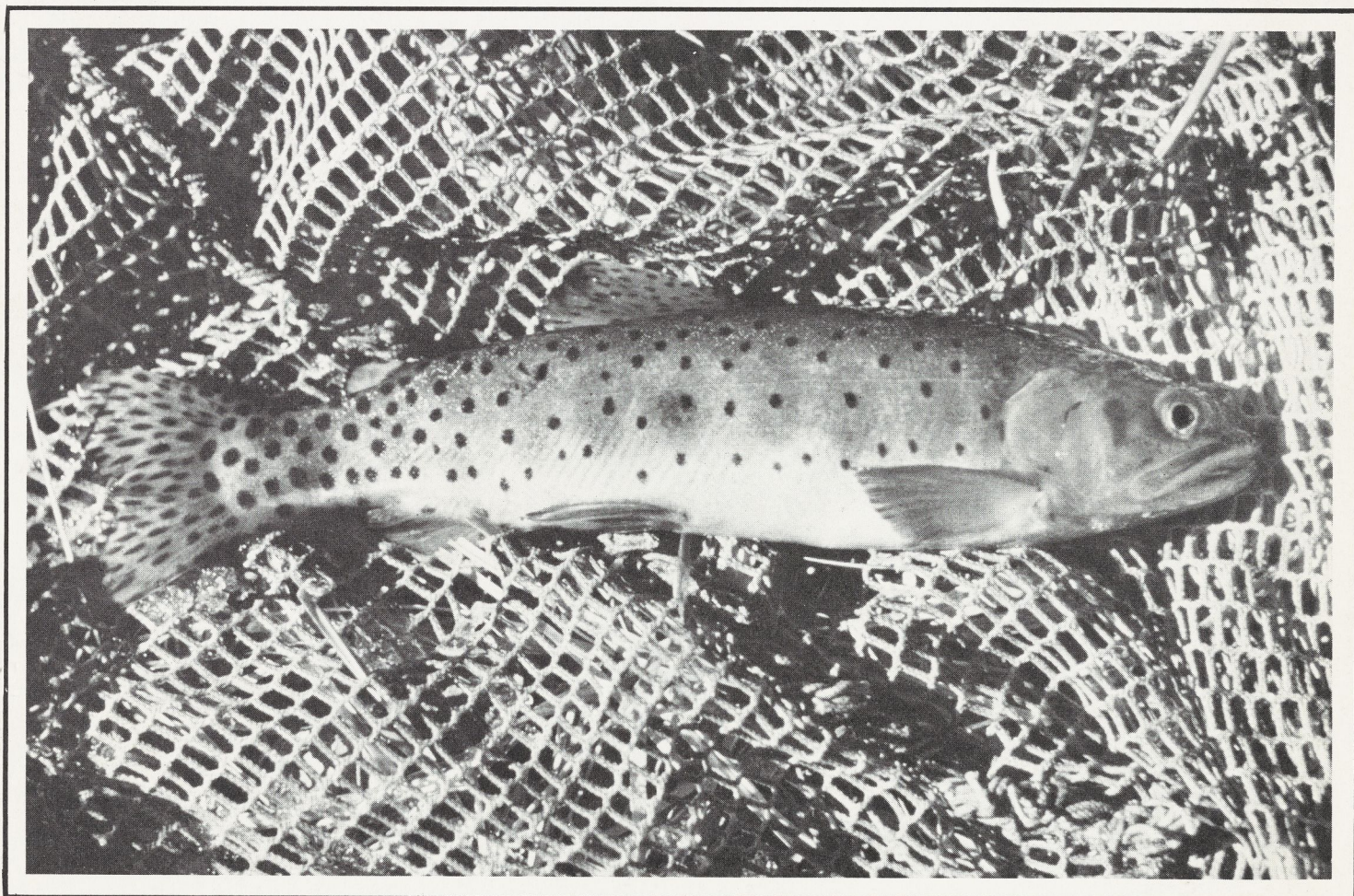
7/26/77

Dr. R. Behnke,

Debby Eaton asked me to send
you a copy of the attached report.

Charlene Swibas
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Research Center

GREENBACK CUTTHROAT TROUT RECOVERY PLAN



GREENBACK CUTTHROAT TROUT

RECOVERY PLAN

Prepared by the
Greenback Cutthroat Trout Recovery Team

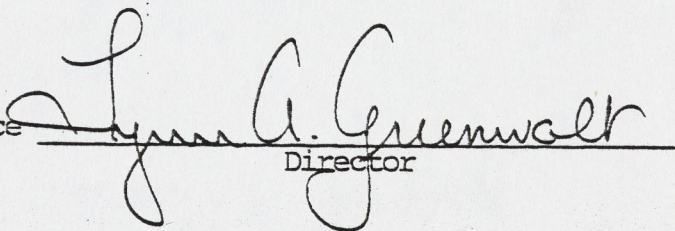
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APPROVED
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11 NOV 1977

U.S. Fish and Wildlife Service


Director

PREFACE

This recovery plan for Greenback Cutthroat Trout is intended to serve as a guide for fishery management activities which will eventually lead to its declassification from endangered species status. To insure the success of such a major fisheries restoration program, the advice and cooperation of team members from several State and Federal agencies have been solicited. As a result, specific programs, funding responsibilities, and timetables have been outlined for implementation by agencies.

This recovery plan has been written and reviewed by representatives of the U.S. Fish and Wildlife Service (Region 6), National Park Service, U.S. Forest Service, and Colorado Division of Wildlife.

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RECOVERY PLAN

Greenback Cutthroat Trout, Salmo clarki stomias

Part I. INTRODUCTION

When European man came to that part of the country later known as Colorado, the greenback cutthroat trout was the only trout found in the Arkansas and South Platte River systems. Rapid economic development leading to irrigation diversions and de-watering of streams, mining pollution, timber logging, livestock grazing and widespread introduction of non-native trout, caused a precipitous decline in the native trout. Green (1937) believed they were extinct. Cutthroat trout are common in high elevation streams and lakes of the South Platte and Arkansas River basins, but only a few of the populations closely resemble the native greenback trout (Wernsman, 1973). Most populations are the result of introductions of various non-native races and crosses of cutthroat trout, usually with traces of rainbow trout hybridization.

Analysis of all specimens examined to 1970 suggested only two pure populations; one in Como Creek, an isolated tributary of North Boulder Creek, Boulder County, Colorado, and one in the very headwaters of the South Poudre River, above a barrier falls in Larimer County, Colorado.

Recent conservation efforts commenced in 1959 when trout from the headwaters of the Big Thompson River in Forest Canyon of Rocky Mountain National Park were stocked into Fay Lakes of the Park after removal of non-native trout with rotenone. A population did not establish in Fay Lakes, but the descendants of this introduction have maintained a self-producing population in Caddis Lake, immediately below Fay Lakes, where they were identified in 1972.

In 1967, a cooperative venture of the U.S. Forest Service, the Colorado Cooperative Fishery Unit and Colorado Division of Wildlife, made Black Hollow Creek, a tributary of the Poudre River, Larimer County, Colorado, a sanctuary for greenback cutthroat trout by construction of a barrier and elimination of a dense brook trout population above the barrier with rotenone. Introductions of adult greenback trout from Como Creek established a self-producing population. Subsequent surveys indicated brook trout may have been re-established. The stream should be monitored to determine future action.

In 1971, a transplant of the pure greenback trout from Como Creek into a barren headwater section of the North Fork Big Thompson River in Rocky Mountain National Park evidently failed. Examination in July 1973 indicated no established trout population at the introduction site.

A larger scale restoration project was carried out in October, 1973 in Hidden Valley Creek in Rocky Mountain National Park. Brook trout were eliminated above a natural barrier with antimycin, and adult fish from Como Creek were introduced. Complete elimination of brook trout was considered a difficult task in Hidden Valley Creek due to the presence of about 15 acres of beaver ponds and associated backwaters (Mullan, 1973). This project appears to have been successful since greenback reproduction and no brook trout were found when examined in 1974 and 1975.

The latest restoration effort was made in the fall of 1975 in Rocky Mountain National Park. On October 6, Bear Lake, 11.2 acres, was treated with antimycin to remove the brook trout. The reclamation was considered successful, and on November 4, about 65 (51 adults and 14 young of the year) were transplanted from the pure population in Como Creek. No mortality was experienced in the transplant.

At present, there are populations of greenback cutthroat trout in the following locations: Como Creek, South Fork of Cache la Poudre River, Houglass Creek, South Fork of Huerfano Creek, Cascade Creek, Hidden Valley Creek, Black Hollow Creek, Bear Lake, and Big Thompson River. (See Appendix A).

In view of the improved status of this subspecies and on-going conservation efforts, the team recommended a change in federal classification from "endangered" to "threatened". The Colorado Division of Wildlife currently includes the greenback trout on the state threatened species list. A federal reclassification has been jointly requested in a letter by the recovery team and the Colorado Division of Wildlife to the Director of the USFWS. The following recovery plan is directed to restoration of the greenback cutthroat trout so that it can be completely delisted.

Species Description

The greenback cutthroat trout shares many similarities with the Colorado River cutthroat trout, from which it was undoubtedly derived via an ancient headwater transfer from the Colorado to the South Platte River drainage. In general, the greenback cutthroat trout is characterized by the largest spots and most numerous scales of all the subspecies of Salmo clarki.

The taxonomic criteria of S. c. stomias, however, must still be considered as tentative. Scale counts made from available specimens consistently exhibit the highest values of any cutthroat trout (or any trout in the genus Salmo). Mean values for lateral series scale counts from 8 pure (or predominant) greenback trout samples range from 185 for 10 specimens (slightly hybridized) collected in 1963 from the headwaters of South Huerfano Creek, Colorado (trib. Arkansas R.), and 186 for 13 specimens from Twin Lakes, Colorado, collected in 1889 and 1902 (now extinct in Twin Lakes) to 216.5 (range, 206-236) for 8 specimens from an isolated headwater of the South Poudre River, Colorado, taken in 1970. The scale counts above the lateral line

(from origin of dorsal fin to lateral line) are also typically the highest found in any trout. These counts range from 41-62 and mean values from 45-55. Thus, it can be assumed that extremely high scale counts are characteristic of pure populations of S. C. stomias, with some suggestion that those populations native to the South Platte basin may have slightly higher counts than those native to the Arkansas drainage.

The number of pyloric caeca and vertebrae in S. c. stomias are typically lower than most subspecies of S. clarki but there is much overlap in these characters. Caecal counts range from 24-26 and mean values from 29-35. Vertebral counts range from 59-63, typically 60-62. Basibranchial teeth are present and highly variable in number. The most diagnostic field character of stomias is the striking spotting pattern and intense coloration which can develop in mature fish. As mentioned above, stomias typically exhibits the largest and most pronounced spots of any cutthroat trout. The spots are round or oblong in shape and concentrated mainly posteriorly on the caudal peduncle area. The coloration is similar to S. c. pleuriticus with a tendency for blood-red colors to cover the lower sides and ventral region, particularly in mature males.

It should be pointed out that although there is a genetic basis to express characteristic color patterns, the actual manifestation of colors is somewhat dependent on age, sex, and diet. Typically, a lake environment with crustaceans available for food will induce a more intense expression of colors than a small stream environment (taxonomic data from Behnke, 1973; and Wernsman, 1973).

Life History

The greenback cutthroat appears to lack the resiliency and adaptability to successfully coexist with introduced trouts. The mechanism of displacement in relation to temperature preference, habitat preference, food, spawning, etc., are not documented. Cole (1954) and Griffith (1971) indicate that earlier emergence from spawning gravel assures a size advantage which could be the key to displacement.

Life history data has been collected on two "virtually" pure (slightly hybridized) populations which can be considered as "good" representative greenback populations.

Bulkley (1959) gathered information on age-growth, food habits and movement of the population in the headwaters of the Big Thompson River in Forest Canyon of Rocky Mountain National Park. Nelson (1972) provided data on age, growth and fecundity of the dense and unexploited population in Island Lake, a reservoir in the City of Boulder watershed. Jordan (1891) and Juday (1907) also made observations on size and food habits in Twin Lakes, Colorado. There is no indication, however, in these reports of any unique life history attributes of the greenback trout. That is, the data and observations are typical of any trout living under similar circumstances and suggest little insight into the subtle aspects of ecology which make the greenback trout vulnerable to displacement.

The early literature (Jordan, 1891; Juday, 1907; Hallock, 1877; Anon., 1878; and Land, 1913) indicates that the greenback trout was originally abundant but not noted for its large size (max. weight of about 5 lb.), whereas other subspecies of cutthroat trout were known to attain a size of 10-20 lbs. or more.

Habitat Requirements and Limiting Factors

The habitat requirements of the greenback trout are probably little different from other native cutthroat trout (Bulkley, 1959 and Nelson, 1972). Circumstantial evidence indicates that all of those factors relating to habitat alteration and introduction of non-native trouts, which have been proven responsible for declines in the native trouts of the interior United States, have had a particularly severe impact on S. c. stomias.

Two prime causes resulted in the decline and reduction of the former range of the greenback: (1) historical land use practices or irrigation, timbering, mining, introduction of pollution effluents, etc., and (2) introduction of competing species of exotic trouts, notably the Yellowstone cutthroat and the Eastern brook trout. Man-made alteration of often devastating effects include: (1) installation of irrigation and/or hydraulic power diversion structures with subsequent harmful stream flow changes, (2) man-made pollution caused by effluents from mining, industrial, human sewage, and agricultural practices, and (3) physical damages to streams caused by improper watershed uses involved with timbering, overgrazing by domestic livestock, various construction activities such as highway, ski areas, or housing developments. Introduction of exotics can be controlled via upstream barrier devices and assurances from the various State or Federal fish planting agencies in regard to locale of fish plants to avoid introduction of competing species in greenback waters. Certainly the most cogent limiting factor for successful restoration of greenback trout into its original habitat is the presence of non-native trout. A reintroduction program for greenback trout cannot succeed unless the proposed site is completely barren of all non-native trouts and protected against reinvasion.

Part II. OBJECTIVES

The primary objective of this recovery plan for the greenback cutthroat trout is to restore the fish to a non-endangered and non-threatened status in suitable habitat, such as headwater streams and lakes throughout its historic range, by the year 2000. To accomplish this, three secondary objectives have been developed:

- A. Determine if and where additional populations of greenback cutthroat trout exist by a systematic survey of candidate headwater drainages within its historic range. Verification of such populations by field collections and subsequent laboratory analysis of meristic and

other characters must be conducted by qualified taxonomists. Sites for specimen collections will be chosen after review of fish stocking records, examination of appropriate maps, and interviews with persons having geographic knowledge of local areas.

- B. To reintroduce greenback cutthroat trout in suitable headwater streams and lakes throughout its historic range. Sites for greenback restoration will be chosen on the basis of known habitat requirements. Restoration sites will be selected by examining appropriate maps, interviewing knowledgeable persons, and surveying streams and lakes throughout its historic range, including Rocky Mountain National Park. Habitat improvements of potential restoration sites will include exotic salmonid eradication with appropriate fish toxicants, installation of artificial barriers to reinvasion of exotic salmonids, and enhancement of spawning areas. Greenback cutthroat trout will be transplanted to the new sites from Como Creek and other pure populations. No transplants which will jeopardize the status of the "donor" stream will be undertaken.
- C. To monitor and protect known populations of greenback trout until the subspecies is declassified. Population trends will be monitored by electrofishing or other methods. Exotic salmonid presence, yearly recruitment, and "brood stock" abundance will be indexed. Key habitats will be protected from degradation by informing resource developers and others of greenback trout habitat requirements. Should the greenback cutthroat trout be reclassified as threatened with angling permitted or delisted, then control of angler harvest will be accomplished by recommending, enacting, and enforcing appropriate regulations.

Part III. IMPLEMENTATION

- A. To document the occurrence of new populations of greenback trout via specimen collections and taxonomic identification.

Job 1 (Colorado Division of Wildlife, U.S. Forest Service)

- Subobjective: To assemble a priority list of candidate headwater streams for specimen collections.
- Location: Headwater streams in the Arkansas and South Platte drainage basins.
- Status: Specimen collections have been made in several drainages ancillary to other projects. No exhaustive specimen collection inventory has been attempted.
- Procedures: Lists of candidate headwater streams for specimen collections will be established after examining appropriate maps, interviewing knowledgeable persons, and reviewing fish stocking records. Priority will be given to isolated streams with no apparent history of exotic salmonid stocking.

Priority: 1
Schedule: FY 1977: Inventory design; 55 man-days; \$2000.00 (DOW)
Completion Date: October 1, 1977

Job 2 (Colorado Division of Wildlife, U.S. Forest Service)

Subobjective: To collect specimens and estimate population status of high priority candidate headwater streams within the historic range of the greenback trout.

Location: Selected headwater streams within the Arkansas and South Platte River drainage basins. Included are the headwaters of the Purgatoire, Apishapa, Huerfano, St. Charles, Cucharas, and Poudre Rivers.

Status: Several likely greenback trout habitats have been spot-checked supplemental to other fisheries investigations. The status of trout populations in regard to species diversity, abundance, and distribution in many headwater streams of Colorado is unknown.

Procedures: Field work will be conducted to collect specimens of suspected greenback trout from high priority headwater streams for taxonomic identification. Population trends will be established where feasible.

Priority: 2

Schedule: FY 1976: Stream inventory; Federal Aid F-32-D
FY 1977: Stream inventory; 135 man-days; \$6900.00 (DOW) Equipment; \$3450.00 (DOW)
FY 1978: Stream inventory; 135 man-days; \$6900.00 (DOW)
FY 1979: Stream inventory; 135 man-days, \$6900.00 (DOW)

Completion Date: Progress of stream inventory will be reported October 1 annually. Target date for completion of all stream surveys is October 1, 1985.

Job 3 (National Park Service and U.S. Fish and Wildlife Service)

Subobjective: To collect specimens for taxonomic identification and determine status of suspected greenback trout populations.

Location: Pear Reservoir Creek, Rocky Mountain National Park.

Status: Cutthroat trout population known to exist but no other data available.

Procedures: A sample of trout specimens will be collected by electrofishing for taxonomic identification. Species composition and population size will be estimated. Habitat parameters will be recorded.

Priority: 3

Schedule: FY 1976: Collect sample.
Survey habitat.
Determine population status. 1 man-day
\$100.00 (NPS)

Completion Date: October 1, 1977

Job 4 (Colorado Division of Wildlife, U.S. Forest Service)

Subobjective: To collect specimens for taxonomic identification.

Location: South Huerfano Creek, drainage in Arkansas River system (Mosca Pass topographic map).

Status: Suspected population of greenback trout exists, but no verification of purity.

Procedures: Samples of trout specimens will be collected from tributaries of the drainage for taxonomic identification.

Priority: 4

Schedule: FY 1976: Collect samples; no additional funds (DOW)

Completion Date: October 1, 1976

Job 5 (Contracts)

Subobjective: To verify the taxonomic status of suspected greenback trout specimens.

Location: Colorado

Status: Taxonomic criteria of greenback trout and diagnostic characteristics are tentative requiring the advice of taxonomists with expertise in zoogeography and the geologic history of the area as well as familiarity with the native salmonids.

Priority: 5

Procedures: Standard taxonomic techniques.

Schedule: FY 1976: Taxonomic consultation \$1500.00
FY 1977: Taxonomic consultation \$4000.00
FY 1978: Taxonomic consultation \$4000.00
Total \$9500.00

Completion Date: Written reports verifying the identity of specimen collections will be submitted by October 1, annually.

- B. To reintroduce greenback trout in suitable headwater streams and lakes throughout its historic range.

Job 1 (Colorado Division of Wildlife, U.S. Fish and Wildlife Service, U.S. Forest Service)

Subobjective: To assemble a priority list of candidate headwater streams and lakes for potential restoration within the historic range of the greenback trout, exclusive of Rocky Mountain National Park.

Location: Headwater streams and/or lakes in the Arkansas and South Platte River drainage basins.

Status: Several candidate drainages have been spot-checked. No exhaustive systematic survey has been attempted.

Procedures: A list of candidate headwater streams for greenback restoration will be assembled after examining USGS topographic maps and interviewing knowledgeable persons. Field inspections will be conducted where necessary using standard fishery methods. Priority will be given to those upper waters possessing natural barriers and those waters in which no exotic salmonid stocking has occurred.

Priority: 1

Schedule:	FY 1976: Site selection; 30 man-days; \$1200.00 (DOW)
	FY 1977: Site selection; 35 man-days; \$1500.00 (DOW)
	Total \$2700.00

Completion Date: October 1, 1977.

Job 2 (National Park Service and U.S. Fish and Wildlife Service)

Subobjective: To identify waters suitable for greenback restoration in Rocky Mountain National Park.

Location: East slope drainage system in Rocky Mountain National Park.

Status: Pertinent information is lacking on several of the drainage systems and is needed to fully evaluate their potential for greenback restoration.

Procedure: Field work utilizing standard fishery methods.

Priority: 2

Schedule:	FY 1976:	Habitat inventory; 5 man-days; \$500.00 (NPS)	
		Environmental assessment; 10 man-days;	\$500.00 (USFWS)
	FY 1978:	Treat and restock; 15 man-days;	<u>\$1500.00</u> (NPS, USFWS)
		Total	\$2500.00

Priority: 4

Completion Date: October 1, 1978

Job 5 (Colorado Division of Wildlife, U.S. Forest Service)

Subobjective: To improve greenback habitat by constructing an artificial barrier to reinvasion of exotic salmonids. To eradicate brook trout and restore a greenback trout population with a transplant from a donor stream.

Location: South Branch of Boxelder Creek, on Maxwell Ranch, Colorado State University property.

Status: A brook trout population exists in a small spring-fed creek. An artificial barrier must be constructed, followed by eradication of exotic salmonids.

Procedures: An evaluation of the feasibility of this project will be prepared. If environmentally acceptable, an artificial barrier will be constructed, followed by brook trout eradication. The fish poison will be detoxified below the barrier with potassium permanganate. The creek will be stocked with pure greenback trout from a donor stream.

Priority: 5

Schedule:	FY 1977:	Environmental assessment; 10 man-days;	\$500.00 (DOW)
	FY 1978:	Construct barrier; 40 man-days;	\$6000.00 (DOW)
	FY 1979:	Treat and restock; 15 man-days;	<u>\$1500.00</u> (DOW)
		Total	\$8000.00

Completion Date: October 1, 1979

Job 6 (National Park Service and U.S. Fish and Wildlife Service)

Subobjectives: To improve greenback habitat by eradicating exotic salmonids and constructing an artificial barrier to reinvasion of exotics. To restore a greenback trout population by transplanting pure greenbacks.

Location: Cow Creek, Rocky Mountain National Park.

Status: Population of exotic salmonids (brook trout) established in Cow Creek. Excellent trout habitat exists. An artificial barrier to re-invasion of brook trout following their eradication is needed.

Procedures: Conduct habitat survey on Cow Creek to determine extent of trout habitat, accurate stream flow, and exact site for artificial barrier construction. After preparation of environmental assessment, barrier will be constructed near park boundary to prevent exotic salmonid reinvasion. Cow Creek will then be stocked with greenback trout from a pure population.

Priority: 6

Schedule:

FY 1977:	Habitat inventory; 5 man-days;	\$ 500.00	(NPS)
FY 1978:	Environmental assessment;		
	10 man-days;	\$ 500.00	(USFWS, NPS)
	Construct barrier; 40 man-days	\$6000.00	(USFWS, NPS)
FY 1979:	Treat and restock; 15 man-days	\$1500.00	(USFWS, NPS)
	Total	\$8500.00	(NPS)

Completion Date: October 1, 1979

Job 7 (National Park Service)

Subobjective: To improve greenback habitat by enhancing stream spawning areas.

Location: Bear Lake outlet, Rocky Mountain National Park.

Status: In 1975, brook trout were eradicated from Bear Lake and 65 greenback trout were transplanted from Como Creek. Beaver activities and accumulation of driftwood have slowed and blocked the outlet flow so as to reduce scouring of gravel substrate and limit spawning areas. Modification may improve natural reproduction.

Procedures: Driftwood and a few key beaver dams will be removed on the Bear Lake outlet to restore natural flow and improve gravel beds for spawning.

Priority: 7

Schedule: FY 1976: Plan and assess.
Environmental impact project.
Implement plan. 10 man-days; \$1000.00 (NPS)

Completion Date: October 1, 1976.

Job 8 (National Park Service and U.S. Fish and Wildlife Service)

Subobjective: To improve greenback habitat by eradicating exotic brook trout, cutthroat trout and cutthroat/rainbow hybrid trout. To restore a greenback trout population by transplanting pure greenbacks.

Location: Fern Lake drainage, including Odessa Lake and Fern Creek, Rocky Mountain National Park.

Status: A poor population of cutthroat trout and cutthroat/rainbow hybrid trout exists in Odessa Lake. A very dense brook trout population is in Fern Lake. This drainage has a natural barrier to upstream trout movement.

Procedures: An environmental assessment will be prepared prior to elimination of present fish populations with Antimycin. Fish poison will be detoxified below Fern Lake with potassium permanganate. Eradicated fish will be recovered for independent statistical analyses. The Fern Lake drainage will be restocked with pure greenback trout from a donor stream.

Priority: 8

Schedule:	FY 1979: Environmental assessment; 10 man-days;	\$500.00 (NPS, USFWS)
	FY 1980: Treat and restock; 15 man-days;	\$1500.00 (NPS, USFWS)
	Total	\$2000.00

Completion Date: October 1, 1980.

Job 9 (Colorado Division of Wildlife, U.S. Fish and Wildlife Service)

Subobjective: To propagate greenback trout fry for reintroduction into historic habitat.

Location: U.S. Fish and Wildlife Service, Research and Development Station, Bozeman, Montana.

Status: Contact with agencies completed, no brood stock at hatchery.

Procedures: Approximately 100 greenback trout will be collected from Como Creek and transported to the hatchery at Bozeman. Spawn will be taken each spring, with infusions of wild brood stock or milt, and cultured. Fry will be transported to Colorado for release into suitable habitats.

Priority: 1

Schedule: FY 1977: Collect brood stock \$1500.00 (DOW, USFWS)
FY 1978: Spawn fish and rear fry (no additional funds)

C. To monitor greenback trout populations until the subspecies is declassified.

Job 1 (Colorado Division of Wildlife and U.S. Forest Service)

Subobjective: To estimate population status and recruitment.

Location: Como Creek, on North Branch of Boulder Creek, Boulder County.

Status: No intensive study of Como Creek has been conducted to estimate population size or recruitment of greenback trout.

Procedures: Population trends will be evaluated in a representative stream section. Population indices and amount of stream inhabited will be considered.

Priority: 1

Schedule:	FY 1977: Population estimate; 5 man-	\$500.00	(DOW, USFWS)
	days		
	FY 1978: Population estimate; 5 man-	\$500.00	(DOW, USFWS)
	days		
	FY 1979: Population estimate; 5 man-	\$500.00	(DOW, USFWS)
	days		
		Total	\$1500.00

Completion Date: Como Creek population size will be reported annually on October 1, until the subspecies is declassified.

Job 2 (Colorado Division of Wildlife, U.S. Forest Service, National Park Service)

Subobjective: To monitor population status and recruitment, determine extent of trout habitat, and assess security of population.

Location: South Fork of Cache la Poudre River, Roosevelt National Forest.

Status: Greenback population known to exist but no other information is available.

Procedures: Reproductive success, population status, and age structure will be determined by electrofishing. The extent and quality of trout habitat will be assessed.

Priority: 2

Schedule: FY 1977: Population monitoring; 5 man-days; \$500.00 (DOW)
FY 1978: Population monitoring; 5 man-days; \$500.00 (DOW)
FY 1979: Population monitoring; 5 man-days; \$500.00 (DOW)
Total \$1500.00

Completion Date: The South Fork of Cache la Poudre River will be monitored until the subspecies is declassified.

Job 3 (National Park Service and U.S. Fish and Wildlife Service)

Subobjective: To monitor population status and recruitment of stocked greenback trout and to monitor population contamination by exotic salmonids.

Location: Hidden Valley Creek, Rocky Mountain National Park

Status: In 1973, 80 greenback trout from Como Creek were planted in Hidden Valley Creek after brook trout eradication. Surveys in 1974 and 1975 revealed successful reproduction and no reinvasion of brook trout.

Procedures: Reproductive success of greenback trout will be checked by electrofishing each year and at the same time reinvasion of exotic salmonids will be monitored.

Priority: 3

Schedule: FY 1976: Monitor population; 3 man-days \$300.00 (NPS)
FY 1977: Monitor population; 3 man-days \$300.00 (NPS)
FY 1978: Monitor population; 3 man-days \$300.00 (NPS)
Total \$900.00

Completion Date: Hidden Valley population status will be reported annually on October 1 until the subspecies is declassified.

Job 4 (National Park Service and U.S. Fish and Wildlife Service)

Subobjective: To monitor population status, evaluate success of spawning habitat improvement, and check reinvasion of exotic salmonids over barrier.

Location: Bear Lake, Rocky Mountain National Park

Status: Bear Lake was reclaimed and planted with 65 greenback trout in 1975.

Procedures: Evidence of natural reproduction, location and identification of spawning areas, and monitoring for reinvasion of exotic salmonids will be conducted.

Priority: 4

Schedule: FY 1976: Population monitoring; 5 man-days \$500.00 (NPS)
FY 1977: Population monitoring; 5 man-days \$500.00 (NPS)
FY 1978: Population monitoring; 5 man-days \$500.00 (NPS)
Total \$1500.00

Completion Date: Bear Lake population status will be reported annually on October 1 until the subspecies is declassified.

Job 5 (Colorado Division of Wildlife and U.S. Forest Service)

Subobjective: To monitor population status and recruitment and to check for reinvasion of exotic salmonids over barriers.

Location: Black Hollow Creek and Hourglass Creek, Roosevelt National Forest

Status: An artificial barrier was constructed on Black Hollow Creek, followed by eradication of exotic salmonids and stocking of greenback trout in 1969 and 1970. A 1975 survey of Black Hollow Creek indicated contamination by brook trout. Hourglass Creek was stocked with original Black Hollow Creek greenback trout.

Procedures: Monitor population status and recruitment of restored greenbacks. Reinvansion of brook trout will be documented. Corrective action will be recommended.

Priority: 5

Schedule: FY 1977: Population monitoring; 3 man-days \$300.00 (DOW)
FY 1978: Action if necessary.

Completion Date: Contamination of Black Hollow Creek greenback population will be determined by October 1, 1977. Population status will be reported annually on October 1 until the subspecies is declassified.

Job 6 (National Park Service and U.S. Fish and Wildlife Service)

Subobjective: To monitor population status and recruitment, and reinvasion of exotic salmonids in potential greenback populations.

Locations: West Creek, Cow Creek, and Fern Lake drainage, Rocky Mountain National Park.

Status: These locations have been proposed for greenback trout restoration and funds for monitoring the populations will be necessary.

Procedures: Population status and recruitment will be monitored. Reinvasion of exotic salmonids will be monitored using electrofishing gear.

Priority: 6

Schedule:

FY 1979:	Monitor West Creek population; 5 man-days	\$500.00 (NPS, USFWS)
FY 1980:	Monitor West Creek and Cow Creek population; 10 man-days;	\$1000.00 (NPS, USFWS)
FY 1981:	Monitor West Creek, Cow Creek, and Fern Lake drainage; 20 man-days	\$2000.00 (NPS, USFWS)
	Total	\$3500.00

Completion Date: Population status will be reported annually on October 1 until subspecies is declassified.

Job 7 (Colorado Division of Wildlife, U.S. Forest Service)

Subobjective: To monitor population status and recruitment and reinvasion of exotic salmonids in potential greenback populations.

Location: South Branch of Boxelder Creek, on Maxwell Ranch, Colorado State University property.

Status: This location has been proposed for greenback trout restoration and funds for monitoring population will be necessary.

Procedures: Population status and recruitment will be estimated. Reinvasion of exotic salmonids will be monitored using electrofishing gear.

Priority: 7

Schedule: FY 1980: Monitor population; 5 man-days; \$500.00

Completion Date: Population status will be reported annually on October 1 until the subspecies is declassified.

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Appendix A: Existing Habitat

The former range of this fish included the South Platte and Arkansas River drainages from their headwaters to the foothills regions along the Front Range of Colorado. A list of areas in which they are known to occur follows:

1. Como Creek (tributary to North Boulder Creek) and drainage area above the 8,000' elevation line.
2. Black Hollow Creek and drainage area above its confluence with the Cache la Poudre River.
3. Hourglass Creek and drainage area above Hourglass Reservoir.
4. South Fork of the Cache la Poudre River and drainage area above the 9,080' elevation line.
5. Several Rocky Mountain National Park drainages east of the Continental Divide and including Bear Lake, Caddis Lake, Big Thompson River, and Hidden Valley Creek.
6. The South Fork of the Huerfano River and Cascade Creek in San Isabel National Forest.
7. And those areas in which additional populations may be found or those into which successful reintroductions are made in the future as a unit-by-unit basis.

Appendix B: Funding Responsibilities of Agencies

Colorado Division of Wildlife

<u>Job</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
A-1		\$ 2000				
A-2		10350				
B-1	\$1200	1500				
B-3		600				
B-5		500	\$6000	\$1500		
B-9		750				
C-1		250	250	250		
C-2		500	500	500		
C-5		300				
C-7					\$500	
	\$1200	\$16750	\$6750	\$2250	\$500	

National Park Service

<u>Job</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
A-3	\$ 100					
B-2		\$1000	\$1000			
B-4	500		750			
B-6		500	6250	\$750		
B-7	1000					
B-8				250	\$750	
C-3	300	300	300			
C-4	500	500	500			
C-6				250	500	\$1000
	\$2400	\$2300	\$8800	\$1250	\$1250	\$1000

U.S. Fish and Wildlife Service

<u>Job</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
*B-4	\$500		\$750			
*B-6			250	\$750		
*B-8				250	\$750	
*B-9		\$750				
*C-6				250	500	\$1000
	\$500		\$1000	\$1250	\$1250	\$1000
**A-5	1500	\$4000	4000	4000	4000	

U.S. Forest Service

<u>Job</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>	<u>1981</u>
C-1		\$250	\$250	\$250		
		\$250	\$250	\$250		
TOTAL	\$4100	\$20050	\$16800	\$5000	\$3000	\$2000

Appendix C: Recovery Team Members

<u>Name</u>	<u>Agency</u>	<u>Period Served</u>
Rolf Nittmann	Colorado Division of Wildlife	1974-1976
David Langlois	Colorado Division of Wildlife	1976-
James Mullan	U.S. Fish and Wildlife Service	1974-1976
Bruce Rosenlund	U.S. Fish and Wildlife Service	1976-
David Stevens	National Park Service	1974-
Richard Moore	U.S. Forest Service	1974-

ATTACHMENT



United States Department of the Interior

NATIONAL PARK SERVICE
ROCKY MOUNTAIN REGIONAL OFFICE
655 Parfet Street
P.O. Box 25287
Denver, Colorado 80225

FA

IN REPLY REFER TO:
N1423 (RMR)P

FEB 25 1977

Memorandum

To: Regional Director, Fish and Wildlife Service,
Denver, Colorado

From: Regional Director, Rocky Mountain Region

Subject: Greenback Cutthroat Trout Recovery Plan

The draft of the Greenback Trout Recovery Plan has been reviewed. Overall we feel the plan is ecologically sound and practical. It is responsive to the needs of the fish at the present time, and we agree with its declassification to threatened status. The funding levels appear to be realistic, considering the budgetary restraints which we all face.

We see no problem with the timetable in the plan. For 1976, Job A-3, Collection of Fish Specimens in Pear Reservoir Creek, and Job B-7, The Improvement of Spawning Area in Bear Lake have been completed. Monitoring of Hidden Valley Creek (Job C-3) was conducted this fall. Bear Lake (Job C-4) and Hidden Valley will be scheduled to be monitored annually. Job B-4 will be initiated in 1977 with habitat evaluation of West Creek.

The only funding not presently covered in the park program in cooperation with the Fish and Wildlife Service is the barrier for Cow Creek (Job B-6). We hope that this can be picked up in future programs.

for *Glenn T. Bean*
Deputy Regional Director
Lynn H. Thompson





United States Department of the Interior
FISH AND WILDLIFE SERVICE

IN REPLY REFER TO:

HFR - 719

MAILING ADDRESS:
Post Office Box 254H6
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
10597 West Sixth Avenue
Lakewood, Colorado
Across From Federal Center

MAR 2 1977

MEMORANDUM

To: Assistant Regional Director (FA)
From: Assistant Regional Director (HFR)
Subject: Review - Draft of Greenback Cutthroat Trout
Recovery Plan

We have no meaningful comments regarding the recommended programs and schedules.

In regard to the proposed FWS budget, we cannot foresee any difficulties in allocating the small amounts involved from existing office funding.

Danny M. Ryan



Richard D. Lamm, Governor
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE

Jack R. Grieb, Director
6060 Broadway
Denver, Colorado 80216 (825-1192)



April 15, 1977

Mr. Harvey Willoughby, Regional Director
U. S. Fish and Wildlife Service
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225

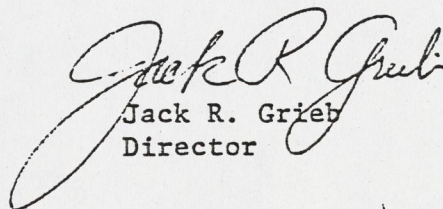
Dear Mr. Willoughby:

We have reviewed the greenback cutthroat trout recovery plan submitted to us by the U. S. Fish and Wildlife Service on February 4, 1977. The objectives, schedule, priorities, and financial estimates of the recovery plan appear to be realistic, and the overall document looks good. The following suggestions should be considered for revision of the plan:

1. Include a listing of team members, the agencies they represent, and the period served;
2. Rather than show specific fiscal years of work, use 1st, 2nd, 3rd, etc. year designation (several places in the plan);
3. Include a preface explaining the purpose of the plan, how it was developed, and how it can best be implemented;
4. Table of contents - Appendices A and B should have specific titles such as "Appendix A: Existing Habitat" and "Appendix B: Funding Responsibility by Agency";
5. Include a discussion of the relationship of protection of donor streams to potential for artificial propagation and fishing harvest;
6. Develop a job to address artificial propagation of greenback trout as a vehicle for stocking reclaimed streams.

Thank you for the opportunity to review the recovery plan for the greenback cutthroat trout.

Sincerely,


Jack R. Grieb
Director

JRG:am

Copy

UNITED STATES DEPARTMENT OF AGRICULTURE
Forest Service
11177 West 8th Avenue
P.O. Box 25127
Lakewood, Colorado 80225

COPY

2630
March 8, 1977

Harvey Willoughby, Regional Director
U.S. Fish and Wildlife Service
P. O. Box 25486, Federal Center
Denver, Colorado 80225

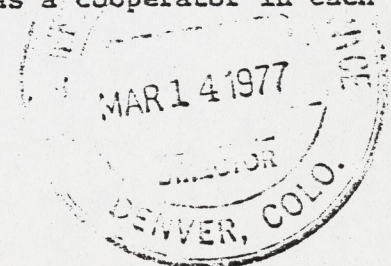
Dear Harvey:

We appreciate the opportunity to review the proposed "Recovery Plan for the Greenback Cutthroat Trout." Our comments follow:

In general, successful transplants in recent years and the potential for further introductions into barren headwater streams are the primary bases for our concurrence in the Recovery Team's recommendation to re-classify this fish from endangered to threatened. This desired change will facilitate state regulations of the greenback and interagency actions to further widen its occurrence throughout its original geographic distribution. Also, this would be very consistent with the action already approved to change three other cutthroats—the Lahontan, Paiute and Apache—from endangered to threatened.

More specifically, we find the proposed plan to be well-considered and adequate to accomplish the greenback's recovery. The remainder of our comments relate to specific parts of the plan:

1. On page 1, fourth paragraph, change the word "about" to "above."
2. On page 5, II-C, suggest changing second sentence to reflect more flexibility in the timing and method of monitoring known populations of greenback trout. We doubt the need or desirability for electro-fishing the streams every year and other methods will likely be more feasible in the lakes.
3. On page 5-Job 1, page 6-Job 2, page 7-Job 4, page 9-Job 3, page 10-Job 5, page 12-Job 2 and page 15-Job 7—in all these instances, the Colorado Division of Wildlife is listed alone. We recognize their role in leading these jobs, but are concerned that land managing agencies be kept advised of field work being planned. Perhaps it would help to show the land managing agency as a cooperator in each of these jobs.



4. On page 7, III-B-Job 1, the National Park Service apparently is not involved in this segment.
5. On page 8, Jobs 1 and 7, the costs per man-day seems inconsistent with most others that follow. We suggest they be reviewed.
6. On page 10, Job 5, the first sentence under procedures should be changed. As written, it sounds like we have already made the decision to construct the barrier and will prepare an Environmental Assessment report to justify the action.

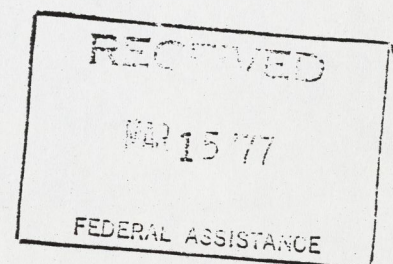
This entire job, of which the barrier is a part, should be evaluated by an environmental assessment before the decision is made to proceed.

Although there is little Forest Service funding shown in the first few years of the recovery plan, we expect Regional Office and Roosevelt National Forest staff officers to participate in the recovery effort. We hope our funding for Endangered and Threatened Species will increase as the recovery effort gains momentum.

Sincerely,

F.A. DORRILL
for CRAIG W. RUPP
Regional Forester

RLMoore:jl



CC: DR. ROBERT BEHNKE
FIRST DRAFT

RECOVERY PLAN
Greenback Cutthroat Trout, Salmo clarki stomias

Part I. INTRODUCTION

Species Description

Index
5 spec → The greenback cutthroat trout shares many similarities with the Colorado River cutthroat trout, from which it was undoubtedly derived via an ancient headwater transfer from the Colorado to the South Platte River drainage. In general, the greenback cutthroat trout can be characterized by possessing the largest spots and most numerous scales of all the subspecies of Salmo clarki.

Index
5 spec → Because of the extreme rareness of pure, or virtually pure populations, and the paucity of ancient museum specimens, the taxonomic criteria of S. c. stomias must be considered as tentative. However, scale counts made from available specimens consistently exhibit the highest values of any cutthroat trout (or any trout in the genus Salmo). Mean values for lateral series scale counts from 8 pure (or predominant) greenback trout samples range from 185 for 10 specimens (slightly hybridized) collected in 1963 from the headwaters of South Huerfano Creek, Colorado (trib. Arkansas R.), and 186 for 13 specimens from Twin Lakes, Colorado, collected in 1889 and 1902 (now extinct in Twin Lakes) to 216.5 (range, 205-236) for 8 specimens from an isolated headwater of the South Poudre River, Colorado, taken in 1970. The scale counts above the lateral line (from origin of dorsal fin to lateral line) is also typically the highest found in any trout. These counts range from 41-62 and mean values from 45-55. Thus, it can be assumed that extremely high scale counts are characteristic of pure populations of S. c. stomias, with some suggestion that those populations native to the South Platte basin may have slightly higher counts than those native to the Arkansas drainage.

The number of pyloric caeca and vertebrae in S. c. stomias are typically

lower than most subspecies of S. clarki but there is much overlap in these characters. Caecal counts range from 24-46 and mean values from 29-35. Vertebral counts range from 59-63, typically 60-62. Basibranchial teeth are present and highly variable in number. The most diagnostic field character of stomias is the striking spotting pattern and intense coloration which can develop in mature fish. As mentioned above, stomias typically exhibits the largest and most pronounced spots of any cutthroat trout. The spots are round or oblong in shape and concentrated mainly posteriorly on the caudal peduncle area. The coloration is similar to S. c. pleuriticus with a tendency for blood-red colors to cover the lower sides and ventral region, particularly in mature males. It should be pointed out that although there is a genetic basis to express characteristic color patterns, the actual manifestation of colors is somewhat dependent on age, sex and diet. Typically, a lake environment with crustaceans available for food will induce a more intense expression of colors than a small stream environment (taxonomic data from Behnke, 1973; and Wernsman, 1973).

Status and Population Trend

The circumstantial evidence suggests that the greenback cutthroat trout may be one of the most vulnerable of all the western trouts to extinction. When the white man came to Colorado, the greenback cutthroat was the only trout (or game fish) found in the Arkansas and South Platte river systems of the state. Rapid development leading to irrigation diversions and de-watering of streams, mining pollution, logging, grazing and widespread introductions of non-native trouts, caused a precipitous decline in the native trout. Greene (1937) believed they were extinct. Cutthroat trout are common in high elevation streams and lakes of the South Platte and Arkansas River basins, but virtually none of the populations thus far examined closely resemble the native greenback trout (Wernsman, 1973), and are the result of introductions of various non-native races and

crosses of cutthroat trout, usually with traces of rainbow trout hybridization.

Analysis of all specimens examined to 1970 suggested only two pure populations, one in Como Creek, an isolated tributary of North Boulder Creek, Boulder County, Colorado, and one in the very headwaters of the South Poudre River, above a barrier falls in Larimer County, Colorado. Because of the extreme rareness, S. c. stomias was listed as endangered by the U. S. Department of the Interior.

Distribution

The original distribution included the South Platte and Arkansas River basins of Colorado and a small area of southeastern Wyoming. Permanent trout habitat, however, did not extend far from the foothills region.

With the advent of white man's civilization, the greenback trout was rapidly pushed back to headwater areas and replaced in the larger streams by brown trout and rainbow trout, and by brook trout in the smaller tributaries. Continued introductions in headwater streams and lakes further displaced or hybridized the native greenback trout to the point of virtual extinction.

Life History

Only the most generalized statements can be made, except to emphasize again that the greenback cutthroat appears to lack the resiliency and adaptability to successfully coexist with introduced trouts. The mechanisms of displacement in relation to temperature preference, habitat preference, food, spawning, etc., are not known.

Some life history data has been collected on two "virtually" pure (slightly hybridized) populations which can be considered as "good" representative greenback populations.

Bulkley (1959) gathered some information on age-growth, food habits and

movement of the population in the headwaters of the Big Thompson River in Forest Canyon of Rocky Mountain National Park. Nelson (1972) provided some data on age, growth and fecundity of the dense and unexploited population in Island Lake, a reservoir in the City of Boulder watershed. Jordan (1891) and Juday (1907) also made observations on size and food habits in Twin Lakes, Colorado. There is no indication, however, in these reports of any unique life history attributes of the greenback trout. That is, the data and observations are typical of any trout living under similar circumstances and suggest little insight into the subtle aspects of ecology which make the greenback trout so vulnerable to displacement and extinction.

The early literature (Jordan, 1891; Juday, 1907; Hallock, 1877; Anon., 1878; and Land, 1913) indicates that the greenback trout was originally abundant but not noted for its large size (max. weight of about 5 lb.), whereas other subspecies of cutthroat trout were known to attain a size of 10-20 lbs. or more.

Habitat Requirements and Limiting Factors

No factual evidence can be cited in specific reference to greenback trout habitat requirements or limiting factors. The circumstantial evidence, however, indicates that all of those factors relating to habitat alteration and introduction of non-native trouts, causing declines in the native trouts of the interior United States, have had a particularly devastating effect on S. c. stomias. Certainly the most cogent limiting factor for successful restoration of greenback trout into its original habitat is the presence of non-native trout. A reintroduction program for greenback trout cannot expect success unless the proposed site is completely barren of all non-native trouts and protected against reinvasion.

Protective Measures

S. c. stomias is officially recognized as "endangered" by the U.S. Department

of Interior under the 1973 Endangered Species Law and entitled to the full protection of the law. The intent of the endangered species law is commendable, but, ironically, the official endangered status of the greenback trout actually hinders management and restoration efforts as discussed below.

In 1967, a cooperative venture of the U.S. Forest Service, the Colorado Cooperative Fishery Unit and Colorado Division of Wildlife, made upper Black Hollow Creek, a tributary of the Poudre River, Larimer County, Colorado, a sanctuary for greenback cutthroat trout by construction of a barrier and elimination of a dense brook trout population above the barrier with rotenone. Introductions of adult greenback trout from Como Creek established a self-reproducing population. Subsequent surveys indicate brook trout may have been re-established. The stream will continue to be monitored to determine future action.

A larger scale restoration project was carried out in October, 1973 in Hidden Valley Creek in Rocky Mountain National Park. Brook trout were eliminated above a natural barrier with antimycin and adult fish from Como Creek were introduced. Complete elimination of brook trout was considered a difficult task in Hidden Valley Creek due to about 15 acres of beaver ponds and associated backwaters (Mullan, 1973). This project appears to have been successful since greenback reproduction and no brook trout were found when examined in August 1975.

FORK A transplant of Como Creek trout into a barren headwater section of the North Big Thompson River in Rocky Mountain National Park in 1971 evidently failed. Other transplants and an active propagation program have utilized virtually pure greenback populations. In 1959 trout from the headwaters of the Big Thompson River in Forest Canyon of Rocky Mountain National Park were stocked into Fay Lakes of the Park. A population did not establish in Fay Lakes, but the descendants of this introduction have maintained a self-reproducing population in Caddis

Lake, immediately below the Fay Lakes, where they were identified in 1972.

Since 1971 the Colorado Division of Wildlife has been granted permission by the City of Boulder to take eggs from a "good" representative greenback population in Island Lake, and up to 100,000 eggs per year have been taken and propagated. These trout are stocked into several mountain lakes in northeastern Colorado as part of the fisheries management program of the Colorado Division of Wildlife.

The latest restoration effort was made in the fall of 1975 in Rocky Mountain National Park. On October 6, Bear Lake, 11.2 acres, was treated with antimycin to remove the brook trout. The reclamation was considered successful, and on November 4 about 65 (51 adults and 14 young of the year) were transplanted from the pure population in Como Creek. No mortality was experienced in the transplant.

The present status of the greenback, considering the probable success of the Bear Lake project, appears to warrant consideration of reclassification to "threatened". In the opinion of the recovery team, the greenback trout is no longer in danger of extinction.

Part II. OBJECTIVES

The primary objective of this plan for the greenback trout is to secure the fish in a non-endangered status within its historic range. In order to do this, five sub-objectives are recommended. Most important is that the habitat of the present populations be protected from degradation or invasion by non-native trout.

H. 1). To survey and determine status of existing greenback populations.

Much of this job is complete, but the identification of any possible unknown populations must continue if protection is to be afforded them.

- B 2). To protect known pure populations. The habitat must be protected from destruction, i.e., quality degradation or invasion by non-native fish. All waters where greenback have been identified will be closed to public fishing. These regulations must be enforced to insure the safety of these populations, although most of them have been protected in the past by inaccessibility. New regulations need to be recommended and evaluated to secure each individual population when managed as a "threatened species".
- C 3). To reclassify as threatened. A petition will be submitted to the Director of the Fish and Wildlife Service to reclassify the greenback trout from endangered to threatened.
- D 4). To continue to monitor existing populations to insure that deleterious changes in the habitat are not occurring. When deemed necessary, corrective action will be taken.
- E 5). To restore greenback to additional suitable water within its historic range. Waters for restoration or rehabilitation will be chosen based on known habitat requirements. Primary emphasis will be on the presence or possibility of providing a barrier to reinvasion by non-native trout. Transplanting stock will be as pure as available. No transplanting which will endanger the brood streams will be undertaken.
- F 6). To improve habitat for greenback where shown to be beneficial in critical areas.

Part III. IMPLEMENTATION

- A 1). To survey and determine status of existing populations. For FY 1975, \$1500 has been made available from endangered species funds, to be used primarily for consultant fees.

Job 3 (Division of Wildlife)

Location: Selected headwater streams within the South Platte and Arkansas River drainage basins.

Objective: To determine status of population of greenback trout.

Status: The status of fish populations in regard to species composition, numbers, size, etc. in many headwater streams of the State is unknown. An ongoing inventory program (F-30-R now F-32-D) will be utilized to determine presence of greenback trout in these waters.

Procedures: Standard fishery methods of capture will be employed i.e. electrofishing, nets, seines, etc.

Schedule: 1976 - Stream surveys. Federal Aid funding, F-32-D.
1977 - Stream surveys. Federal Aid funding, F-32-D.
1978 - Stream surveys. Federal Aid funding, F-32-D.

B. To protect pure populations.

All agencies.

1. Enforce closure regulations.
2. Protect habitat from degradation.

No additional funds required.

C. Reclassify as "threatened".

Request to be submitted. All agencies.

D. To monitor populations and habitat to determine trends and maintain status.

Job 1 (National Park Service)

Location: Hidden Valley Creek

Procedures: a. Monitor status and reproduction of restored greenback.

- b. Monitor reinvasion of non-native fish over barrier.
- c. Take protective action if necessary.

Schedule: Annually. No additional funds.

Job 2 (National Park Service)

Location: Bear Lake

- Procedures:
- a. Monitor success of transplant.
 - b. Determine spawning areas and protect.
 - c. Monitor reinvasion of outlet stream by non-native fish.

Schedule: Annually. No additional funds.

Job 3 (Division of Wildlife and U.S. Forest Service)

Location: Black Hollow Creek and Hourglass Creek.

- Procedures:
- a. Monitor status and reproduction of restored greenbacks.
 - b. Monitor reinvasion of non-native fish over barrier.
 - c. Take protective action if necessary.

Schedule: 1976 - No additional funds.

1977 - Action if necessary.

1978 - Action if necessary.

E. Restore greenback trout to suitable waters within historic range.

Job 1 (Rocky Mountain National Park)

Location: West Creek, Rocky Mountain National Park.

Objective: To restore greenback to about 4 miles of West Creek.

Status: Natural barrier present to upstream movement of fish. Population of non-native brook trout presently established.

- Procedures:
- a. Survey stream to determine extent of trout habitat and accurate rate of flow.
 - b. Prepare environmental assessment.
 - c. Treat with antimycin to remove brook trout.
 - d. Restock with "pure" strain of greenback trout.
 - e. Monitor success of transplant.

Schedule:	1976 - Survey stream; complete environmental assessment	\$1,000
	1977 - Treat and restock	\$1,500
	1978 - Monitor	<u>\$ 500</u>
	Total	\$3,000

Job 2 (Rocky Mountain National Park)

Location: Cow Creek, Rocky Mountain National Park.

Objective: To restore greenback trout to about 2¼ miles of Cow Creek.

Status: Population of non-native brook trout; excellent trout habitat.

- Procedures:
- a. Survey stream to determine extent of trout habitat, accurate rate of flow and site for barrier.
 - b. Prepare environmental assessment.
 - c. Construct barrier at park bound upstream movement of fish.
 - d. Treat with antimycin to remove brook trout.
 - e. Restock with "pure" strain of greenback trout.
 - f. Monitor success of transplant.

Schedule:	1976 - Survey stream	\$ 500
	1977 - Complete environmental assessment	\$ 500
	- Construct barrier	\$6,000
	1978 - Treat and restock	\$1,500
	1979 - Monitor	<u>\$ 500</u>
	Total	\$9,000

Job 3 (Rocky Mountain National Park)

Location: Fern Lake Drainage

Objective: Restore greenback trout to Odessa Lake, Fern Lake and about 3 miles of Fern Creek and to learn more about the habitat requirements of the fish.

Status: Presently a poor population of cutthroat and cutthroat/rainbow hybrids exists in Odessa Lake while a very dense brook trout population is in Fern Lake. This drainage has a natural barrier to upstream fish movement.

- Procedures:
- a. Prepare environmental assessment.
 - b. Eliminate present fish populations by applying antimycin.
 - c. Detoxify antimycin with potassium permanganate below Fern Lake.
 - d. Recover killed fish for statistical analysis.
 - e. Restock with "pure" strain of greenback trout.

Schedule:	1978 - Complete environmental assessment	\$ 500
	1979 - Treat and restock	<u>\$1,500</u>
	Total	\$2,000

F. Improve habitat for greenback where shown to be beneficial in critical areas.

Job 1 (Rocky Mountain National Park)

Location: Bear Lake.

Objective: To enhance spawning area for greenback trout.

Status: Beaver activities and driftwood have slowed or blocked outlet and inlets to point that spawning area is drastically limited.

Procedures: a. Review literature.
b. Remove driftwood and a few key beaver dams to allow natural flow to form gravel beds for spawning.
c. Monitor.

Schedule:	1976 - Plan project and assess environmental impact of project.	No funds.
	1977 - Implement plan.	\$1,000

Job 2 (Division of Wildlife and U.S. Forest Service)

Location: Como Creek

Objective: Utilize structures to increase size and population numbers of greenback by improving depth and number of pools.

Status: Ratio of pool to riffle is too low for optimum growth and survival of greenback trout.

Procedures: a. Plan project and assess environmental impact.
b. Install wire barriers in streambed.
c. Utilize natural material and driftwood to build dams.

Schedule: 1976 - Survey for location and install barriers.

\$5,000

1977 - Monitor area for success of
installations.

1978 - Monitor area for success of
installations.

RN

APPENDIX

Critical habitat for the greenback native trout should be designated for those areas within its former range where it presently occurs and those areas into which potential introduction can be made successfully. The former range of this fish included the South Platte and Arkansas River drainages from their headwaters to the foothills regions along the Front Range of Colorado. A list of areas in which this fish occurs follows:

- 1). Como Creek (tributary to North Boulder Creek) and drainage area above the 8,000' elevation line.
- 2). North Boulder Creek and drainage area above the rainbow lakes road (county highway no. 116) above the 9,685' elevation line and including all of the Green Lakes, Triple Lakes and Albion Creek within the City of Boulder watershed.
- 3). Black Hollow Creek and drainage area above its confluence with the Cache la Poudre River.
- 4). Hourglass Creek and drainage area above Hourglass Reservoir.
- 5). South Fork of the Cache la Poudre River and drainage area above the 9,080' elevation line.
- 6). South Huerfano Creek headwaters area and drainage basin where green back native trout are found. No elevations are known at this time.
- 7). All of the Rocky Mountain National Park area east of the Continental Divide and including all of the drainages therein.
- 8). And those areas in which additional populations may be found or those into which successful reintroduction are made in the future as a unit by unit basis.

Two prime causes resulted in the decline and reduction of the former range of the greenback: (1), historical land use practices of irrigation, timbering, mining, introduction of pollution effluents, etc., and, (2), introduction of competing species of exotic trouts, notably the Yellowstone cutthroat and the Eastern brook trout. Man made alteration of often devastating effects include (1), installation of irrigation and/or hydraulic power diversion structures

with subsequent harmful stream flow changes, (2) man made pollution caused by effluents from mining, industrial, human sewage, and agricultural practices, (3) and physical damages to streams caused by improper watershed uses involved with timbering, over-grazing by domestic livestock, various construction activities such as highway, ski areas or housing developments. All of these cited activities should be prohibited by the controlling agencies. Introduction of exotics can be controlled via upstream barrier devices and assurances from the various State or Federal fish planting agencies in regard to locale of fish plants to avoid introduction of competing species in greenback waters..

Habitat requirements?

References

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- (a) Diversion dams should be modified where necessary to enable migration of trout and cui-ui.
- (b) Revegetation should be done where necessary to restore a satisfactory canopy of riparian vegetation to aid in reduction of water temperature and provide shade and cover.
- (c) Any future channel clearance should be done only after consultation with fisheries personnel of the Bureau of Sport Fisheries and Wildlife and the Nevada Department of Fish and Game and the Pyramid Lake Tribe.
- (d) Grazing of livestock should be controlled along the river to assist in the revegetation effort.
- (e) Numana Dam fishway should be modified to enable cui-ui to ascend the fishway and to make it easier for trout to pass the dam.

Job 1 (U.S. Forest Service, Division of Wildlife, and National Park Service)

Location: South Fork of Cache la Poudre River, Roosevelt National Forest.

Objective: To determine status of population of greenback trout.

Status: Known population exists but no other data is available.

Procedures: a. Sample with electric shocker to determine age structure and reproductive success of population.
b. Determine extent of habitat.
c. Assess security of population.

Schedule: 1976 survey. No additional funds.

Job 2 (National Park Service and Fish and Wildlife Service)

Location: Pear Reservoir Creek, Rocky Mountain National Park.

Objective: To determine taxonomy and status of cutthroat population.

Status: Population of cutthroat trout exists but no other data available.

Procedures: a. Collect sample of population for taxonomic identification.
b. Sample by electric shocker to determine status of population.
c. Survey stream to determine extent of habitat.

Schedule: 1976 - Collect sample. No additional funds.
Survey habitat. No additional funds.
1977 - Determine population status. No additional funds.

A REPORT ON THE GREENBACK CUTTHROAT TROUT
INVENTORY PROGRAM, JULY TO OCTOBER, 1977

Prepared for
Colorado Division of Wildlife

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INTRODUCTION

A total of 24 streams in the Arkansas and South Platte River drainages was surveyed for the identification of new populations of Salmo clarki stomias (greenback cutthroat trout). Taxonomic analysis of seven samples of 78 specimens from these streams and statistical comparisons of these trout with other known pure populations of greenback cutthroat trout and with other subspecies of cutthroat trout were made.

Historically, the greenback cutthroat trout was the only game fish on the eastern slope of Colorado. Its original distribution included the headwaters of the South Platte and Arkansas River basins in Colorado and a small area in southeastern Wyoming, but permanent trout habitat did not extend much beyond the foothills region. The greenback cutthroat trout probably gained access to the South Platte drainage via an ancient headwater transfer from the Colorado River basin; a later transfer occurred from the South Platte basin to the Arkansas basin (Behnke 1976). Behnke (1976), Wernsman (1973), and Behnke and Zarn (1976) have discussed the status of the greenback cutthroat trout up to this time.

To date, there is still the problem of better defining the characteristics of S. c. stomias. This results from the scarcity of old museum specimens and the extreme rareness of pure populations. Therefore, the natural range of variability of diagnostic characters can only be roughly estimated. No authoritative method exists which would determine if a population with slightly aberrant characters is within the natural range of variability or due to slight hybridization with introduced rainbow trout or other subspecies of cutthroat trout (Behnke 1976). Continued search for pure populations is the best hope for better defining the taxonomic attributes of S. c. stomias. It is not likely that many pure populations of S. c. stomias remain, but good representatives should be identified for special recognition in relation to perpetuation and protective efforts. It was our purpose to initiate a systematic survey of isolated headwater areas of the South Platte and Arkansas River drainages in order to find and identify other pure or virtually pure greenback trout populations, as well as, determine potential sites for reintroduction. Very few streams have been inventoried in the Arkansas River basin for the presence of greenback trout. For this reason our sampling effort concentrated more in the Arkansas drainage rather than the South Platte drainage.

No pure populations of S. c. stomias were identified from this survey. There exists one good representative of S. c. stomias from S. Apache Creek in the Arkansas drainage; however, S. c. stomias was absent from Hourglass and Black Hollow Creeks.

Included in this report are the use of computer analytical techniques (a numerical taxonomy program). This analysis offers some interesting potential to better quantify the diagnostic characters of subspecies of cutthroat trout and perhaps define acceptable limits of variation in "pure" populations (Behnke 1977).

SURVEY OF STREAMS

The following is a list of streams that were surveyed during August and September 1977. Fish were collected by either hook and line or backpack electroshocker. Table 1 summarizes the results of the survey.

Arkansas River Drainage

Wahatoya: The Wahatoya and its tributaries (Spanish Peaks quad., R68W T30S Secs. 25,26) were surveyed on 2 August 1977. The flow was approximately 2.5 c.f.s. The stream fish fauna consisted only of brook trout. Brook trout persisted until a natural bedrock barrier was encountered 1.2 miles upstream from the Wahatoya camp. Above this barrier the Wahatoya and its tributaries were barren. The small percipitous tributaries probably never had native cutthroat trout. The steep inclines and intermittent flows have kept all fish from these tributaries. We talked with property owners at the Wahatoya Camp who said they have stocked rainbow and brook trout since 1939. Also, Division of Wildlife records show that rainbows have been stocked.

There are numerous small deep pools in the main channel both above and below the barrier. This stream may be considered for greenback introduction upon eradication of the brook trout. However, the stream receives moderate fishing pressure and the habitat is not ideal.

Greenhorn Creek: The discharge of this stream (San Isabel quad., R68W T24S Secs. 31,32) was approximately 2.5 c.f.s. on 10 August 1977. This stream is reasonably isolated and the headwater area is barren of fish. About three miles downstream (drop of 2500-3000 ft. elevation) brook trout occur on private lands. The headwater area had many deep pools. The available trout habitat is excellent with many good redd areas. Several natural barriers exist which prevent brook trout from entering the upper reaches. This stream would be excellent for introduction of greenback cutthroat trout.

Turkey Creek: The headwater region of this creek (San Isabel quad., R69W T25S Secs. 1,2) was surveyed on 10 August 1977. The discharge was approximately 2 c.f.s. The top 1.5 miles of the stream were barren but brook trout inhabit the rest of the stream. There exists no natural barrier to prevent brook trout from reaching the top. The canyon has a gentle gradient. The stream is impacted by cattle grazing.

South Apache Creek: Cutthroat trout were collected from this stream (Hayden Butte quad., R69W T25S Secs. 22,23,25) on 11 August 1977. The cutthroat population began about 200 yards below the Apache Falls tributary and continued sporadically down to the mouth of the canyon. Specimens were collected from this upper area in order to compare those specimens collected in the lower area on BLM land in June, 1977. The cutthroat trout were in good condition; however, as a result of the drought many trout were located in deep pools and not too many trout were found elsewhere. The habitat appeared good and the discharge was approximately 2.5 c.f.s.

Table 1. Streams Surveyed for S. c. stomias

<u>San Isabel National Forest</u> (Arkansas drainage)	<u>Cutthroats</u>	<u>Barren</u>	<u>Other</u>
Wahatoya Creek			brook
Price Canyon			brook
Greenhorn		X	
North Muddy Creek		X	
Middle Muddy Creek		X	
North Apache Creek	X		rainbow
South Apache Creek	X		
Turkey Creek			brook
Newlin Creek		X	
Hiltman Creek		X	
Cottonwood Creek		X	
Venable Creek		X	
South Colony Creek			brook
Cascade Creek	X*		
Hennequin Creek		X	
St. Charles River			rainbow/brook
<u>Roosevelt National Forest</u> (South Platte drainage)			
Nunn Creek (North Platte)	X		brown
Middle Rabbit Creek	X		
Sawmill Creek	X		brown
Roaring Creek	X		
Black Hollow Creek			brook
Hourglass Creek			brook
Upper Joe Wright Creek		X	
Montgomery Creek		X	

*--not personally collected

North Apache Creek: This stream (Hayden Butte quad., R68 T25S Secs. 22,23,24) was surveyed on 16 August 1977. The discharge was approximately 1.5 c.f.s. The upper reaches of the stream were barren of fish but one mile downstream from where Bartlett's trail crosses the stream rainbow trout were dominant and rainbow/cutthroat hybrids were dominant near the bottom of the canyon. The rainbow were found above several barriers (log and waterfall). There were a number of old mining shacks suggesting the rainbows were packed above the barriers. Apparently the cutthroats come from South Apache Creek since both the north and south branches meet in the foothills-plains region. Perhaps during high water (spring runoff) the cutthroats are able to enter the north fork and then are prevented from returning when the lower reaches dry up.

Newlin Creek: We surveyed Newlin Creek (Rockvale quad., R70W T20S Sec. 25) on 18 August 1977. Water at present is being diverted by the city of Florence. We found no fish and a discharge of about one c.f.s.

North and Middle Muddy Creeks: Both streams (San Isabel quad., R68W T24S Secs. 16,17,20,21) were very small with very few deep pools; mostly riffle areas about 3-4 inches deep. The flow in both was approximately 0.5 c.f.s. on 17 August 1977, but even during spring runoff there is apparently not much of a flow. Some parts of the stream were starting to silt in. It is extremely doubtful if cutthroat trout were ever native to these streams. As it was, both streams were barren of fish.

Price Canyon: Brook trout were found the first 1.5 miles of the stream (Cuchara quad., R69W T30S Secs. 9,16) with the last mile or so barren of fish (due mainly to the steep gradient). The stream had a discharge of only one c.f.s. and the brook trout were not numerous. It appears that the cutthroat population that was there in the 1930's (according to Les Denton) was eliminated via heavy fishing (due to the limited habitat it wouldn't take much to deplete the population) rather than competition with brook trout. The stream would not be very suitable for greenback introductions.

St. Charles River: Sections of this stream above Lake San Isabel were surveyed on 17 August 1977 (San Isabel quad., R69W T24S Secs. 11,15). Rainbow trout and brook trout were found. Stocking records show numerous stockings of rainbow trout. With such stockings and the presence of brook trout it is doubtful that native greenback cutthroat trout exist either above or below Lake San Isabel on the St. Charles River.

Cascade Creek: No cutthroats were personally collected from this stream (Mosca Pass quad., R72W T28S) since specimens had been collected and analyzed earlier (Behnke 1977). These trout were found to be virtually pure greenback cutthroat trout. The discharge was approximately one c.f.s. on 25 August 1977. Brook trout were found above the falls. The falls has been described as a cascading falls but is actually a straight drop of 90-100 feet. No trout could have been native above the falls; therefore, the greenbacks that are present were probably backpacked above the fall using the existing trail. The Division of Wildlife does not have any records of stocking for Cascade Creek. The source of the fish in Cascade Creek may be the many "natives" that were stocked in the past above the South Fork confluence to the Huerfano River. However, "natives" from stocking records are not true natives -- mainly yellowstone cutthroats.

The cutthroat trout were in some of the pools which occurred every 5-10 feet. They were not numerous but then the stream is such that it couldn't support many fishes.

Hiltman, Hennequin, Cottonwood, Venable, South Colony Creeks: These streams are located on the east slope of the Sangre de Cristos near Westcliffe, Colorado. The survey of these streams occurred on 23 August 1977 and 24 August 1977. South Colony contained brook trout while the other four creeks were barren. All of these streams have steep gradients and flows of 3-4 c.f.s. Most of the streams draining the east side of the Sangre de Cristos are too steep to support much of a fisheries even though flows are excellent. The high mountain lakes are stocked regularly (usually Pikes Peak brood) so greenback trout, if at all present in the past could not have persisted. The only areas where greenback trout would have consistently survived are the lower reaches which have been susceptible to angling pressures and livestock grazing.

South Platte Drainage

Nunn Creek: This stream was surveyed on 10 September 1977 (Deedman quad., R75W T9N Secs. 9,10). This stream is actually part of the North Platte drainage, but its headwaters are close to the South Platte drainage (Roaring Creek). Cutthroat trout and brown trout were found together. The brown/cutthroat trout ratio was approximately 9/7. The stream is impacted by cattle grazing, but good deep pools exist with a gradual gradient. Cutthroat trout are apparently being pushed upstream by the ever-increasing brown trout population. Cutthroat trout were not found in the lower reaches of Nunn Creek; they were only found in the very headwaters. Eventually cutthroat trout will probably be eliminated by the brown trout. There does not appear to be heavy fishing pressure. Access to areas of cutthroat trout is accomplished only by 4-wheel drive vehicles.

Roaring Creek: This stream was also surveyed on 10 September 1977 (Deedman quad., R75W T9N Sec. 11). Dieffenbach (1966) originally sampled this population. Behnke (1976) describes this cutthroat population as a good representative of greenback cutthroat trout (refer to taxonomy section). We found small-sized cutthroat trout and no other species. There were few good pools; however, one large pool (remnant of a beaver dam) contained 8-10 cutthroat trout. Access is by a 4-wheel drive jeep trail. The area appears well traveled by hunters and fishermen and livestock grazing is apparent.

Middle Rabbit Creek: This stream was sampled on 18 September 1977 (Livermore Mountain quad., R71W T10N Sec. 21). A small population of cutthroat trout was found in a one-quarter mile section of a severely degraded stream. Above the cutthroat population the stream went underground. The flow was extremely minimal with trout only existing in a few good pools. The cutthroat trout population is probably less than 30 in number for that one-quarter mile section. The habitat is such that overwintering of trout seems unlikely. The stream segment with the cutthroat trout was on private property about one-half mile from the Cherokee Park Wildlife Preserve fence line.

Montgomery: This stream was surveyed on 30 September 1977 (Clark Peak quad., R76W, T7N Sec. 24). The flow was approximately 0.5 c.f.s. The stream was barren of fish and did not represent good trout habitat.

Upper Joe Wright: This stream was also surveyed on 30 September 1977. The flow was approximately one c.f.s. It was also barren of fish and the habitat was poor (lacked cover and pools).

Sawmill: The flow was 2.5 c.f.s. on 30 September 1977. Cutthroat trout and brown trout were found. The stream provided good trout habitat; several deep pools (some 6 ft. deep) were seen. Clear-cutting occurs in the area.

Black Hollow and Hourglass: Both streams were surveyed as a follow up to past stockings of greenback cutthroat trout (Hourglass - Commanche Peak quad., R79W, T7N Secs. 13,14; Black Hollow Kinikini quad., R74W, T8N Secs. 2,10,11,14). See Behnke (1976) for history of past stockings in these creeks. Hourglass Creek was found to contain only brook trout and these were not numerous. No cutthroat trout were found. Black Hollow represented the same situation. Brook trout were found to be numerous above the barrier that was built in 1967. No cutthroat were found. If greenback cutthroat trout are to be re-established in Black Hollow Creek another reintroduction is necessary upon eradication of brook trout.

Glacier Creek: This stream was not surveyed by us personally but specimens of cutthroat were sent to us for taxonomic analysis. Glacier Creek is located near Twin Lakes (Leadville, Colorado).

TAXONOMIC ANALYSES

The taxonomic analyses of all of the trout mentioned in this report were carried out at Colorado State University, either by the authors or by Dr. Behnke and his graduate students.

Morphological measurements were made according to the procedure described by Hubbs and Lagler (1958). Gillrakers were stained with alizarin and counts were made from the first gill arch. Alizarin stain was also used on the basibranchial teeth to facilitate counting, all teeth on the basibranchial plate were counted. Scale counts in the lateral series were made by counting the scales two rows above the lateral line (scale counts of the pored scales are similar in many of the trouts). Pyloric caeca counts were made by pulling every complete tip loose from the intestine. Where applicable all counts and measurements were made on the left side of the fish.

Hybridization between various species and subspecies of Salmo usually can be detected in populations by noting the meristic characters. Hybridization with rainbow trout (Salmo gairdneri) is usually detected by an absence of basibranchial teeth, lower scale counts, higher pyloric caeca counts and a profusion of spots (posterior to anterior, above and below the lateral line).

Table 2 presents data from five selected meristic characters from populations of S. c. stomias (Como Creek, headwaters of Little South Poudre, South Huerfano Creek, Cascade Creek and Albion Creek), S. c. pleuriticus (Rock Creek and headwaters of the Colorado River), S. c. virginalis (Indian Creek) and typical hatchery S. gairdneri (Ruby Valley, Nevada), as well as cutthroat trout collected during this study. Computer analysis, using Hubbs and Hubbs diagrams (Andreasen 1976), (Figs. 1a, 1b, 1c, 1d, 1e) were used to display the data in Table 2 in a more graphic comparison. The program was modified at Colorado State University for use with a CDC 6400 computer. The diagrams indicate the mean (center point), 95 percent confidence limits of the mean (black lined rectangle), one standard deviation on either side of the mean (outer limits of open rectangle), and sample range (basal line). The size of the population sample is indicated prior to the name of the collecting site or subspecies.

S. c. stomias, the native trout of the South Platte and Arkansas drainages, is characterized by high scale counts (185-216, in lateral series and 45-55, above the lateral line), low pyloric caeca counts (29-35), basibranchial teeth present (but low in number) and large spots concentrated posteriorly, compared to other Salmo species (Behnke 1976, Behnke and Zarn 1976).

The most pertinent information obtained from the comparisons in Table 2 and Figure 1 (a,b,c,d,e) is the detection of rainbow and non-native cutthroat hybridization. The trout from Rabbit and Nunn Creeks are obvious rainbow x cutthroat hybrids (note the scales in the lateral series and above the lateral line and the absence of basibranchial teeth). Slight rainbow influence can be detected in the South Apache fish (note scales in the lateral series and above lateral line). Although no rainbow trout were collected from South Apache Creek, North Apache Creek, (at one time joined with South Apache, and still may during flooding), supports numerous rainbow and rainbow x cutthroat hybrids, which may account for this slight rainbow influence in the South Apache Creek cutthroat trout.

The trout collected from Sawmill Creek are good genotypic representatives of S. c. stomias, with the exception that one of nine lacked basibranchial teeth (the small sample size renders this difficult to interpret). Phenotypically (spotting pattern) they are not characteristic S. c. stomias, but rather Yellowstone or rainbow trout hybrids. Two hours of electrofishing over about 0.5 mile of stream, produced only nine cutthroat and two brown trout. We were unable to determine if reproduction was occurring, no young of the year were collected.

The trout collected from Glacier Creek are probably Yellowstone cutthroat, based upon their coloration, spotting pattern, low scale counts and high basibranchial teeth counts.

Behnke (1976) indicated that the Roaring Creek trout were "good representatives" of S. c. stomias. The collection we made was not significantly different from past Roaring Creek collections. Genotypically they are good S. c. stomias except for the absence of basibranchial teeth in one of eight specimens. Phenotypically (based upon spotting pattern) there is a recognizable influence by past introductions of rainbow trout and/or non-native cutthroat trout (the spots are smaller and more numerous than those of S. c. stomias). It has been assumed that these cutthroat were stocked into Roaring Creek since it is unlikely that S. c. stomias was native to this stream. There is a steep gradient barrier separating Roaring Creek from the Cache La Poudre River.

Sixteen morphometric character measurements (Table 3) from 422 specimens of S. c. stomias, S. c. pleuriticus, S. c. virginalis, S. c. utah, S. c. henshawi and an undescribed subspecies from the Humboldt River drainage were analyzed statistically to compare the evolutionary affinities between various subspecies of cutthroat trout. This was accomplished by the use of a computer - aided discriminant function analysis, with the utilization of an SPSS computer program (Nieetal 1975). The program was modified for a CDC 6400 computer at Colorado State University by Mr. Steve Culver. This discriminant analysis gives individual fish a weighted score and prints out a two-dimensional plot along a horizontal axis (best set of diagnostic characters) and along a vertical axis (next best set of diagnostic characters). The result is a group centroid plot (Fig. 2) for each population (group) of trout. In addition to the evaluation of similarities and differences between populations, the discriminant function analysis identifies the population to which each individual in the study is most closely related (Table 4) and which characters have the best discriminating power (Wilks lambda analysis, Table 5).

Table 2. Character Analysis

Locality	Gillrakers	Pyloric Caeca	Scales above Lateral Line	Scales in Lateral Series	Basibranchial Teeth
Nunn Creek 1977 N=11	17-20 (18.5)	28-41 (35.0)	37-44 (39.3)	166-189 (176.7)	0- 5 (1.9) 6 of 11 w/o teeth
Sawmill Creek 1977 N=9	18-22 (19.7)	30-38 (34.2)	40-47 (44.2)	170-206 (193.3)	0-16 (6.7) 1 of 9 w/o teeth
Roaring Creek 1977 N=8	17-20 (18.7)	30-41 (36.6)	43-49 (45.3)	182-207 (195.7)	0- 6 (3.6) 1 of 8 w/o teeth
Rabbit Creek 1977 N=6	18-22 (19.3)	34-44 (39.5)	38-42 (40.8)	164-184 (174.5)	-0-
Glacier Creek 1977 N=10	19-20 (19.9)	33-44 (38.6)	37-40 (38.6)	163-175 (168.9)	3-18 (12.1)
South Apache Creek 1977 N=26	17-21 (19.0)	30-39 (34.4)	36-46 (40.0)	154-186 (174.0)	0-20 (6.7) 1 of 26 w/o teeth
Como Creek* 1969 N=18	17-21 (19.0)	24-42 (29.4)	46-53 (48.4)	174-205 (189.3)	3-12 (6)
Albion Creek* 1955-1963 N=22	17-20 (18.5)	29-46 (34.1)	41-47 (44.6)	168-203 (189.3)	1-23 (8)

Table 2. Character Analysis (cont'd)

Locality	Gillrakers	Pyloric Caeca	Scales above Lateral Line	Scales in Lateral Series	Basibranchial Teeth
Headwaters of Little So. Poudre* 1965, 1970 N=18	19-23 (21.3)	27-50 (35.2)	53-60 (56.7)	205-236 (216.5)	2-17 (11.1)
So. Huerfano headwaters* 1976 N=15	17-22 (19.4)	30-48 (38.4)	39-49 (43.9)	163-210 (191.2)	1-13 (5.9)
Cascade Creek* 1976 N=15	17-21 (19.0)	30-48 (39.2)	42-49 (44.5)	179-207 (193.6)	4-21 (9.3)
Rock - Upper Green River, Wyo.* 1974 N=8	17-20 (18.7)	27-46 (37.0)	39-43 (41.0)	175-200 (194.6)	2-11 (6.0)
Headwater Colo. R.* 1970 N=10	18-23 (20.3)	32-43 (37.1)	44-49 (45.1)	187-226 (195.1)	6-33 (14.0)
Indian Creek, N. Mex. <u>S. c. virginalis</u> 1958 N=16	18-21 (19.3)	36-42 (39.3)	38-45 (40.6)	146-186 (163.8)	0- 6 (2.3) 2 of 16 w/o teeth
Ruby Valley, Nevada <u>S. gairdneri</u>	17-22 (19.7)	50-60 (55)	24-33 (28.5)	104-137 (123.8)	Absent

*Data obtained from Behnke 1976 & 1977

Table 3.

Morphomeristic Characters Used in the Discriminant Function Analysis

1. Head length
2. Upper jaw length
3. Snout tip to dorsal fin origin
4. Dorsal fin length
5. Caudal peduncle depth
6. Caudal peduncle length
7. Gillrakers upper
8. Gillrakers lower
9. Gillrakers total
10. Branchiostegal rays right
11. Branchiostegal rays left
12. Scales above lateral line
13. Scales in the lateral series
14. Pelvic fin rays
15. Pyloric caeca
16. Basibranchial teeth

Characters 1-6 were recorded in thousandths of the standard length.

Table 4. Group Classification Results

ACTUAL GROUP	CODE	N	Predicted Group					
			GROUP 1	GROUP 2	GROUP 3	GROUP 4	GROUP 5	GROUP 6
Utah	1	270	245 (91%)	---	3 (1.1%)	20 (7.4%)	2 (.7%)	---
Stomias	2	73	1 (1.4%)	59 (80.8%)	12 (16.4%)	1 (1.4%)	---	---
Pleuriticus	3	26	---	2 (7.7%)	23 (88.5%)	1 (3.8%)	---	---
Virginalis	4	16	---	1 (6.3%)	---	15 (93.8%)	---	---
Humbolt	5	22	---	---	---	---	22 (100%)	---
Henshawi	6	15	---	---	---	---	---	15 (100%)

90% of the groups (subspecies) were correctly classified.

Henshawi and Humbolt subspecies had all specimens correctly classified.

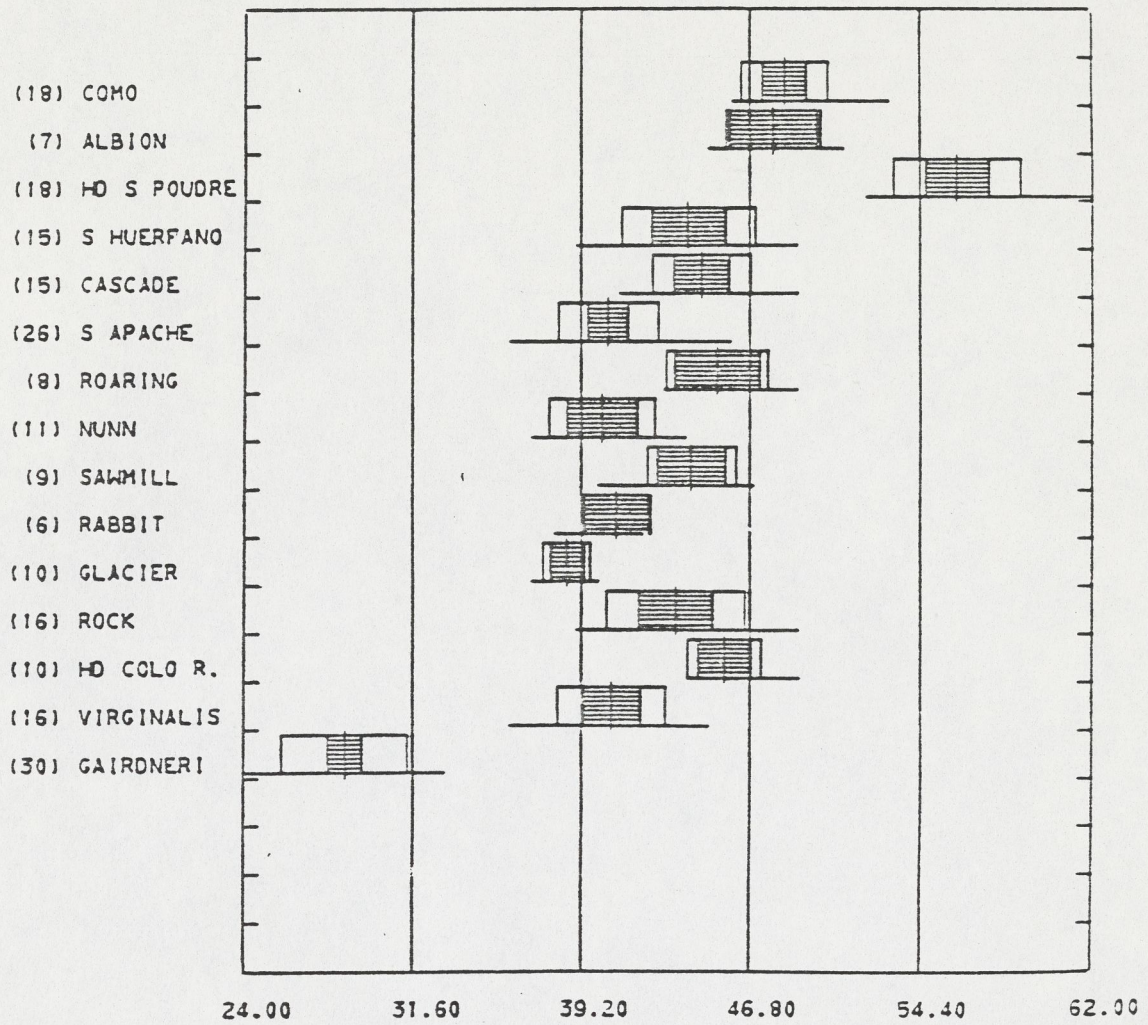
The closer the subspecies (taxonomically) the greater the chance of misclassification.

Table 5. Wilks Lambda and Univariate F-Ratio

CHARACTER	WILKS LAMBDA	F-RATIO
Scales in lateral series	.29825	195.76
Pyloric caeca	.16765	64.65
Basibranchial teeth	.09329	66.00
Head length	.07746	16.87
Branchiostegal rays right	.06472	16.21
Gillrakers upper	.05534	13.93
Dorsal fin length	.04793	12.66
Scales above lateral line	.04226	10.98
Gillrakers lower	.04099	2.51
Branchiostegal rays left	.03986	2.31
Upper jaw length	.03903	1.73
Caudal peduncle depth	.03829	1.56
Caudal peduncle length	.03344	1.46
Snout tip to dorsal origin	.03285	1.40
Pelvic rays	.03245	.98
Gillrakers total	.03238	.16

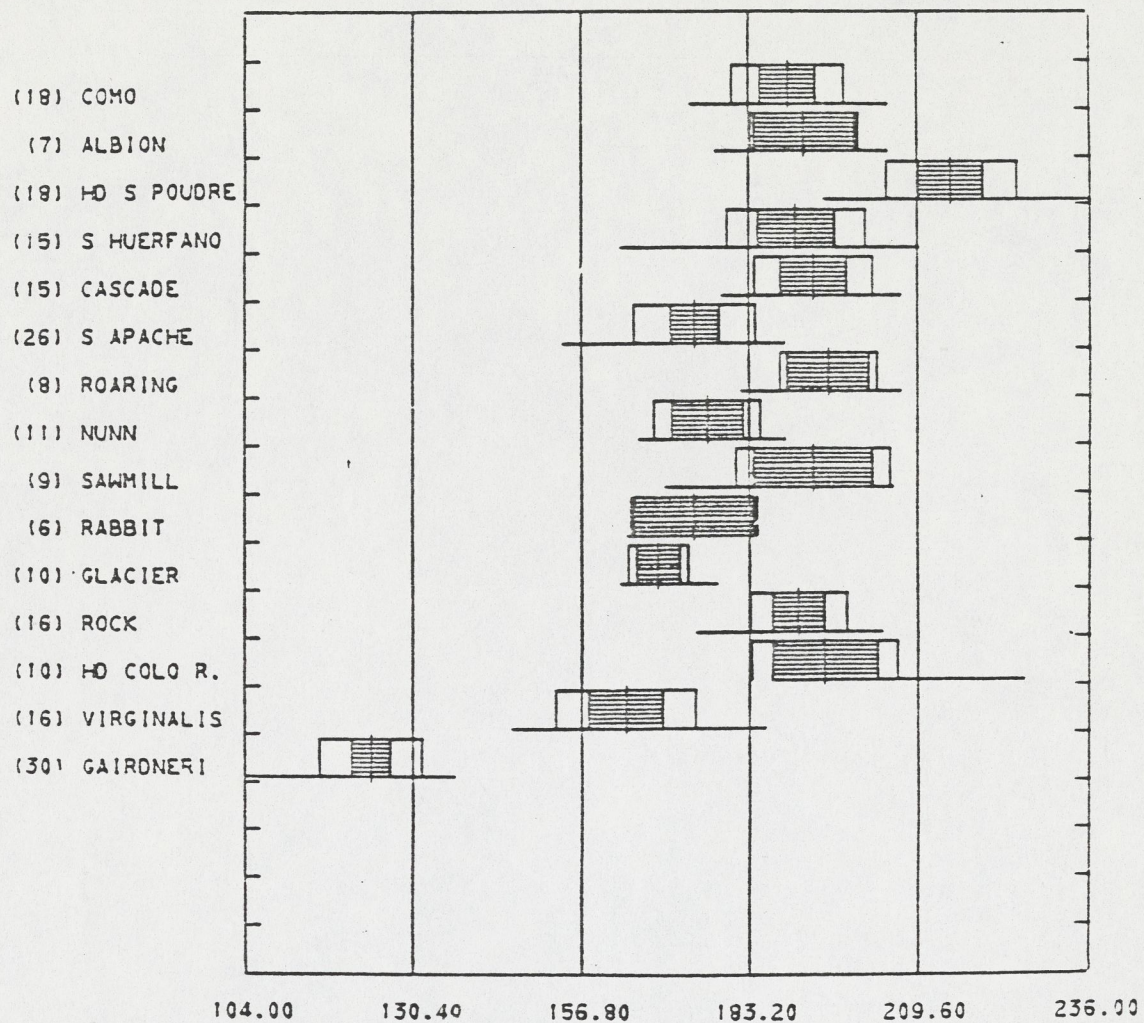
The higher the Wilks lambda score the greater the discriminating power.

Figure 1a. Hubbs Diagram, Scales Above Lateral Line



SCALES ABOVE LATERAL LINE

Figure 1b. Hubbs Diagram, Scales in Lateral Line Series



SCALES IN LATERAL LINE SERIES

Figure 1c. Hubbs Diagram, Basibranchial Teeth

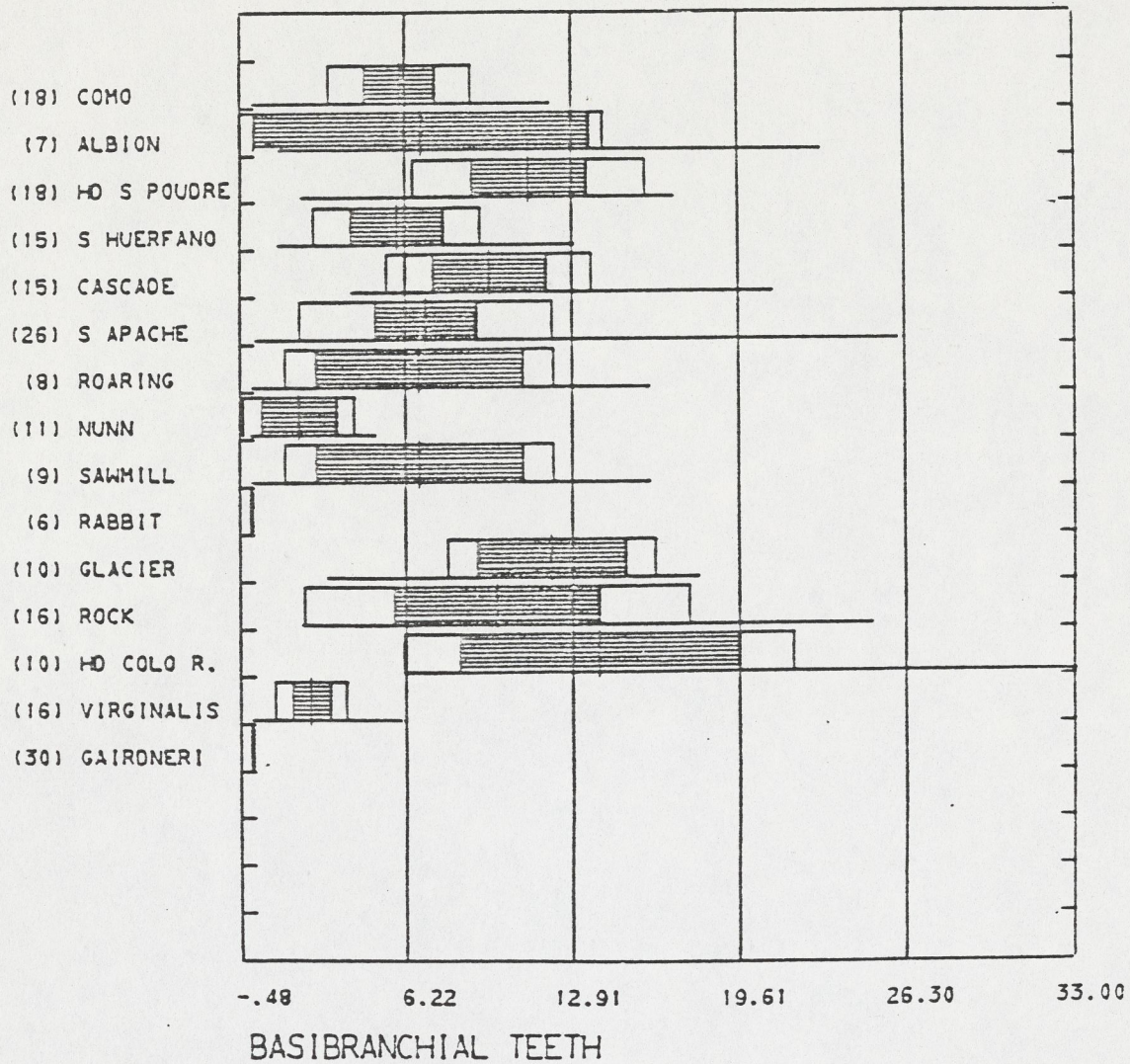


Figure 1d. Hubbs Diagram, Pyloric Caeca

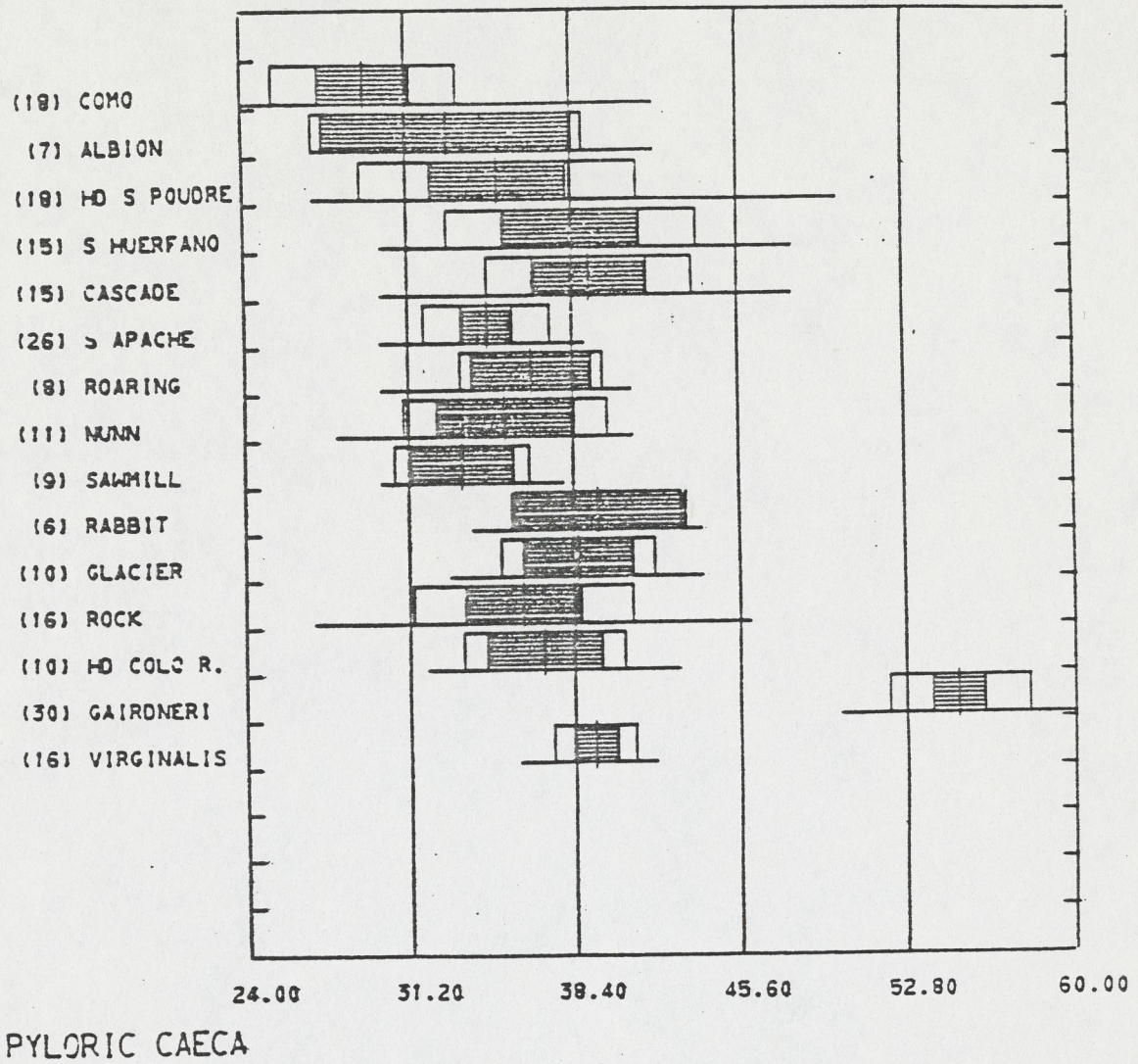


Figure 1e. Hubbs Diagram, Gillrakers Total

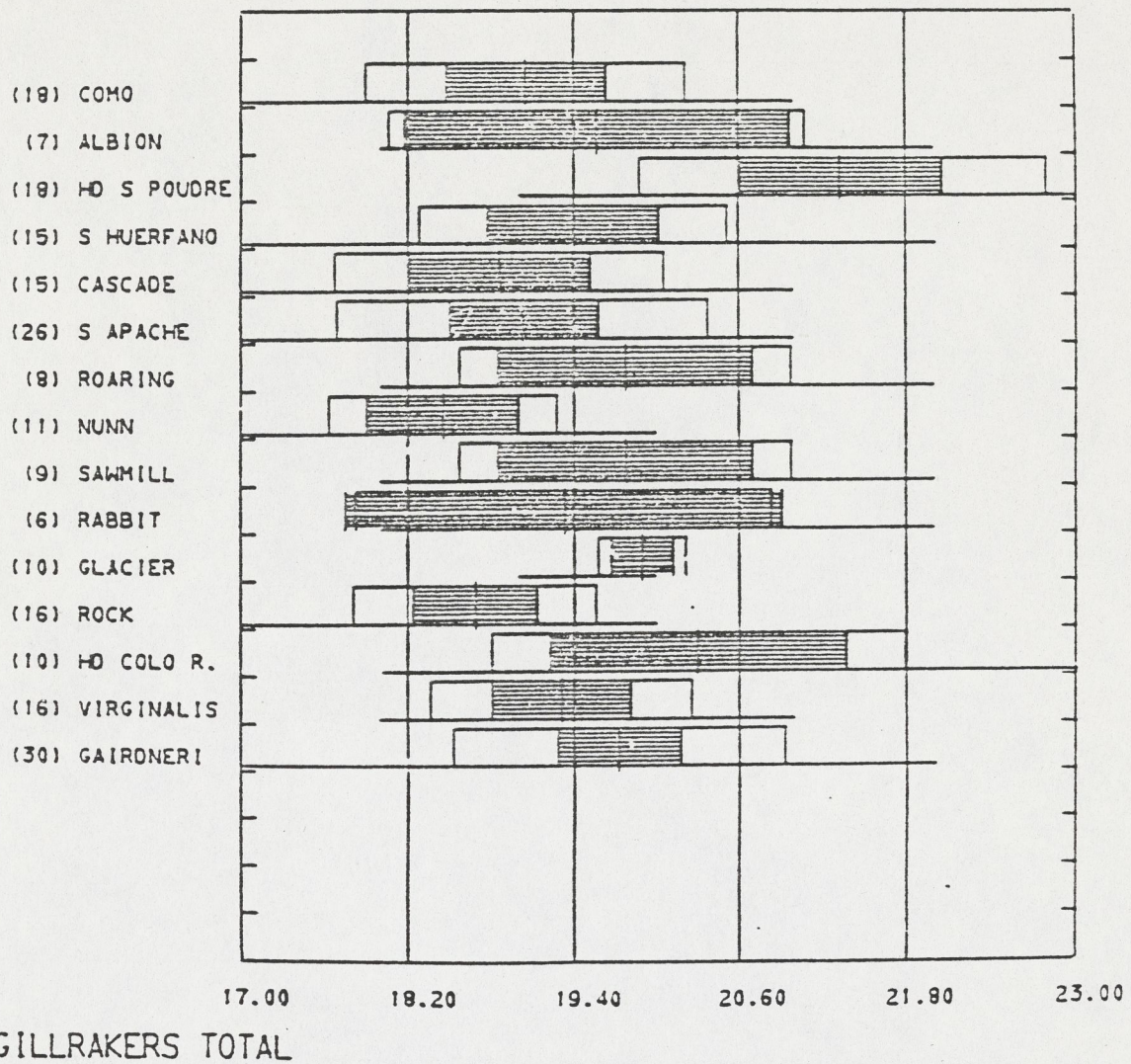


Figure 2. Discriminant Function Plot



Of significance to this study is the similarity depicted in the discriminant function plot between S. c. stomias and S. c. pleuriticus (the closer the group centroid the closer the relationship); the same results were obtained by Hickman and Duff (1977). This supports the taxonomic evaluations of Behnke and Zarn (1976) that S. c. pleuriticus gave rise to S. c. stomias via an ancient headwater transfer and that there exists little taxonomic difference between the two subspecies. Behnke (1976) indicates that modern taxonomists would not likely describe the South Platte cutthroat trout as a subspecies distinct from the Colorado River cutthroat trout. But the names for the two subspecies have already been established and are useful to associate native trout with specific geographical areas. Because of the degree of isolation between pleuriticus from the Upper Green River (type locality) and those from the headwaters of the Colorado River, there are more similarities between stomias of the South Platte drainage and pleuriticus of the headwaters of the Colorado River than between the two pleuriticus populations. There also is more difference between stomias of the South Platte and stomias of the Arkansas drainage than between the South Platte and headwaters of the Colorado River population. This seems reasonable if it is assumed that the ancestral cutthroat made its way from the Green River to the Colorado River into the South Platte drainage and from there into the Arkansas drainage.

There exists a degree of similarity between S. c. utah and S. c. virginalis (mainly due to low scale counts) but phenotypically the large spots concentrated in the caudal region and bright coloration separates virginalis from utah. Although the spotting pattern or coloration were not among the characters used in the discriminant analysis, there is little difference in spotting pattern between pleuriticus and stomias.

Caution should be employed in the interpretation of any type of computer program. The computer can not create any new genetic information about the fish than that which has already been determined by standard taxonomic evaluations.

Misinterpretations can also result from the use of too few specimens in the analysis. Because of the degree of isolation involved with each population of cutthroat subspecies and the high degree of intraspecific variability exhibited by these subspecies, there can be a large amount of genetic variation among populations of cutthroat trout. For example, if the population from the headwaters of the Little South Poudre River were used as a representative of S. c. stomias in a comparison among several Salmo species, S. c. stomias would differentiate from all other trout because of their high scale counts. This difference would not be as significant had other populations of S. c. stomias been considered (see Hickman and Duff 1977 as an example).

Errors are frequently committed when trying to determine which characters are most responsible for separation in the group discrimination process (Table 5). In this study scales in the lateral series was the most important character separating the subspecies, with pyloric caeca and basibranchial teeth also of importance but less than lateral series scale number. Any conclusions on the relative importance of the remaining variables (characters) would be highly speculative and unsupportive (see Nie et al 1975 for further discussion).

MANAGEMENT CONSIDERATIONS

1. Protection and enhancement of greenback cutthroat populations in the Huerfano River headwaters (Cascade Creek and headwaters of the South Huerfano).

Brook trout are located at the base of the waterfalls on Cascade Creek and may have already inundated the headwaters of South Huerfano. Eradication of the non-native trout and extension of the greenback cutthroat populations throughout the headwater area of the Huerfano River should be of top priority in greenback recovery efforts.

2. The South Apache Creek cutthroat should be managed as a "good prehotypic representative" of S. c. stomias. This population is important because of the rareness of S. c. stomias in the Arkansas drainage. A combined management effort between the Colorado Division of Wildlife, U.S. Bureau of Land Management and U.S. Forest Service could be implemented. Eradication of the rainbow hybrids and subsequent stocking of South Apache cutthroat into North Apache Creek would serve to preserve the cutthroat gene pool. Stocking of these cutthroat into some of the barren streams on Greenhorn Mountain would also provide several new populations in the area. Stocking on a large scale, in the Arkansas drainage, should probably be done with the S. c. stomias from the Huerfano River headwaters, since Behnke (1977) indicated that these were pure stomias and the South Apache cutthroat are slightly hybridized.

3. Continuous monitoring of the stomias population in Como Creek and the headwaters of Little South Poudre River. Since these populations represent the most important source of greenback cutthroat trout, yearly inventory analysis should be conducted. The update status of the Little South Poudre population should be made; this has not been done since 1975.

4. Black Hollow Creek should again be considered for restocking of Como Creek brood stock. Obviously, eradication of the brook trout is a prerequisite. Once restocking occurs the stream should be monitored more closely because it appears that the brook trout were transported above the barrier by the hand of man. Hourglass Creek represents an unusual situation. Restocking of this stream may not be worthwhile to the restoration of greenback cutthroat trout. Perhaps other streams might be considered.

5. A most unusual situation is represented in Nunn Creek. In this creek is one of only a few instances of brown trout and cutthroat trout apparently co-existing. Although the cutthroat there are not greenbacks, the situation may be indicative of a typical interaction between these two species. It may be worthwhile to monitor this stream to see if brown trout will indeed extirpate the cutthroat trout. There are few instances of this brown/cutthroat interaction reported. The lack of riparian vegetation along this stream may allow higher temperatures during the summer which would favor brown trout. Therefore the brown trout could exist at the elevation they are now at. If the cutthroat trout are extirpated there would be no loss of a pure native genotype.

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