GREENBACK CUTTHROAT TROUT
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BY

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INTRODUCTION

The Bozeman Fish Technology Center became involved with the greenback cutthroat trout recovery in 1977. In the fall of that year 66 fish from Como Creek were brought to the FTC for the purpose of establishing a broodstock. In the years since then broodstock fish have been established using eggs from greenbacks at the FTC and sperm from populations in Hidden Valley and Como Creek (as directed by task 3.3 of the 1983 Recovery Plan). In addition, over 100,000 Type A fry have been returned to Colorado for introduction within the South Platte drainage as specified in Task 2.4 of the Recovery Plan.

SUMMARY OF 1984

This year 177 2-year-old and 47 5-year-old females were spawned from May 22 to July 30. The average number of eggs per female was 102 and 1100 for the 2-year and 5-year-old fish respectively.

Sperm was collected from Hidden Valley or Como Creek populations and sent by airline to Bozeman. This was used when available to maintain the gene pool. This worked well most of the time, however that used on July 6 appeared to be less motile than other shipments. This was used anyway since the females were ready and the only males available were progeny of the fish we were spawning and Hidden Valley or Como Creek males. There was no development in these eggs.

September 11, 1984, 39,623 (24 lbs) fry were delivered to Recovery Team members at Fort Collins, Colorado by personnel of the Fish Technology Center. This brings the total number of fish delivered by the Bozeman FTC to 108,108.

Two age classes of 600-700 broodstock each are being maintained at the FTC. These will be 2 and 3-year-old in June 1985. Normally, about 50% of the 2-year-old females spawn producing 100 small eggs and consequently small fry. The egg quality of the 3-year-old fish is expected to be good. Barring unforseen problems, 75,000 fry will be available September 1985.

GREENBACK CUTTHROAT TROUT RECOVERY PROJECT

1984 Progress Report

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INTRODUCTION

This report summarizes the greenback cutthroat trout (Salmo clarki stomias) recovery efforts in the Northeast Region of the State of Colorado during 1977-1984.

Historically, S. c. stomias was endemic to the South Platte River and Arkansas River drainages (Fig. 1). Greenback cutthroat trout were very similar to Colorado river cutthroat trout (S. c. pleuriticus) and were thought to have invaded the South Platte basin through a headwater transfer (Behnke 1979). Later, a second transfer between the South Platte and Arkansas basins established S. c. stomias in the latter basin.

Greenback cutthroat trout were very susceptible to extinction. By the end of the nineteenth century, greenback cutthroat trout numbers had been drastically reduced by man's activities: logging, reduced water flows, livestock grazing, mine wastes, and siltation (Behnke 1979). The introduction of nonnative trout, rainbow (Salmo gairdneri), brook (Salvelinus fontinalis) and brown trout (Salmo trutta) reduced greenback cutthroat trout number through competition and hybridization with rainbow trout and other subspecies of cutthroat trout. The decline was so drastic that Green (1937) thought that the greenback cutthroat trout were extinct. Subsequently, three isolated populations of "pure" greenback cutthroat trout were found within Colorado:

South Platte Drainage

Como Creek, Boulder County, Roosevelt National Forest

Little South Fork, Cache La Poudre River, Larimer County, Roosevelt National Forest

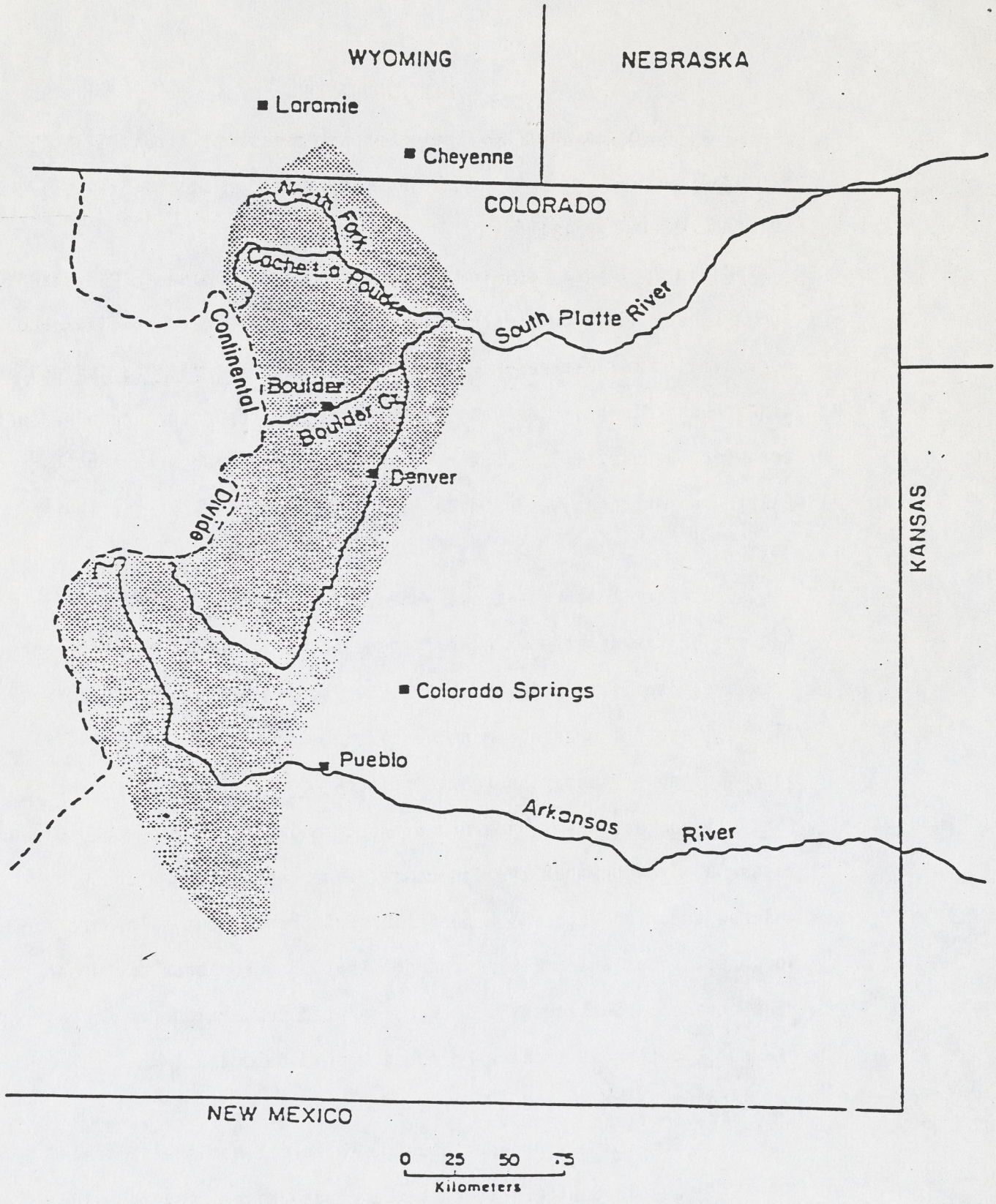


Figure 1. Historic distribution of Salmo clarki stomias (from Behnke and Zarn 1976)

Arkansas Drainage

Cascade Creek, Huerfano County, San Isabel National Forest

Early attempts to artificially raise greenback cutthroat trout were abandoned for various reasons. Recent restoration efforts began in 1965. Because of lack of direction, these attempts failed to achieve the desired results. Enactment of the Endangered Species Act 1973 provided the necessary emphasis to restore recovery efforts for the greenback cutthroat trout. This fish was immediately classified as endangered but was upgraded to threatened to allow enhancement projects to begin. In 1977, an interagency organization, Greenback Cutthroat Trout Recovery Team, was established. The members were Colorado Division of Wildlife, U.S. Fish and Wildlife Service, U.S. Forest Service, and U.S. National Park Service (Rocky Mountain National Park). The recovery team issued a revised "Greenback Cutthroat Trout Recovery Plan" in 1983.

The goal of the Recovery Plan is the removal of this subspecies from the USFWS Threatened and Endangered Species List. The objective is to establish 20 stable greenback cutthroat trout populations within its native range. The recovery team defines a "stable population" as ". . . a reproducing population occurring within a stable aquatic habitat and managed to maintain that stability. Population of greenbacks will be considered stable when accepted as such by the majority of cooperating agencies, after consideration of habitat quality and stability, potential greenback population size, time since reintroduction, current population, reproductive success, growth, absence of nonnative salmonids, and current and proposed management objectives." To meet these goals and objectives, six tasks need to be completed.

1. Maintain and enhance historic and stable greenback cutthroat populations and their habitat.
2. Establish or document the existence of 20 stable populations of pure (type A) greenback cutthroat trout within species historic range.
3. Establish hatchery and wild populations of pure (type A) greenback cutthroat trout for brood stock.
4. Document response to angling pressure.
5. Conduct information and education programs.
6. Prepare a long-term management plan and cooperative management agreement for the greenback cutthroat trout.

In 1984 efforts were directed toward achieving tasks 1, 2, and 3. One stream was surveyed for potential restoration site, one new habitat was reclaimed for introduction of type A greenback cutthroat trout. Two instream barriers were constructed and one additional barrier was planned and materials purchased for construction in 1985. Greenback cutthroat trout fry and fingerlings were stocked into 7 streams. Population estimates were conducted on 7 streams and habitat evaluations were performed on 11 streams including 3 potential restoration sites.

A rating system was adapted from one developed by Binns (1977) to aid in the management of S. c. stomias populations. Each greenback population was assigned a letter ranging "A" (pure) to "F" (obvious hybrid). Only populations rated "A" were used to establish new populations of pure greenback cutthroat trout. The Colorado Division of Wildlife, Northeast Region, Nongame Management Program has been charged with the establishment of 13 stable populations of type A greenback cutthroat trout within the South Platte River basin. There are 7

introduced greenback cutthroat trout populations at present (Fig. 2), May Creek, Black Hollow Creek, Bard Creek, East and West Forks, Sheep Creek, George Creek, Cornelius Creek and Williams Gulch. Zinn Ranch Ponds will be stocked in 1985 (Fig. 3). Potential restoration sites are Craig Creek, Wigwam Creek and Pennock Creek (Figs. 2 and 3).

STREAM SURVEYS 1981-1984

A list of possible streams for reintroduction of greenback cutthroat trout was established after examination of U.S. Forest Service and U.S. Geological Survey maps and stream survey files on all streams in the Northeast Region. In 1981, the 692 potential streams were narrowed down to a list of 173 streams and revised in 1982, 1983, and 1984 to 68 streams (Table 1) by using the following criteria:

1. Streams must be in the headwaters of the South Platte River drainage.
2. The headwaters of the stream must be protected from invasion of nonnative trout by a waterfall, steep cascade, other impassable barrier, or have a suitable site for construction of a man-made barrier.
3. The stream must be in a low-use area.
4. The stream must have suitable habitat to support a reproducing population of greenback cutthroat trout.
5. Streams must be barren or nonnative fish can be removed with relative certainty.

A classification system based on species present, habitat, impassable fish barrier or potential barrier site, area use, and potential for eradication of nonnative species was set as follows:

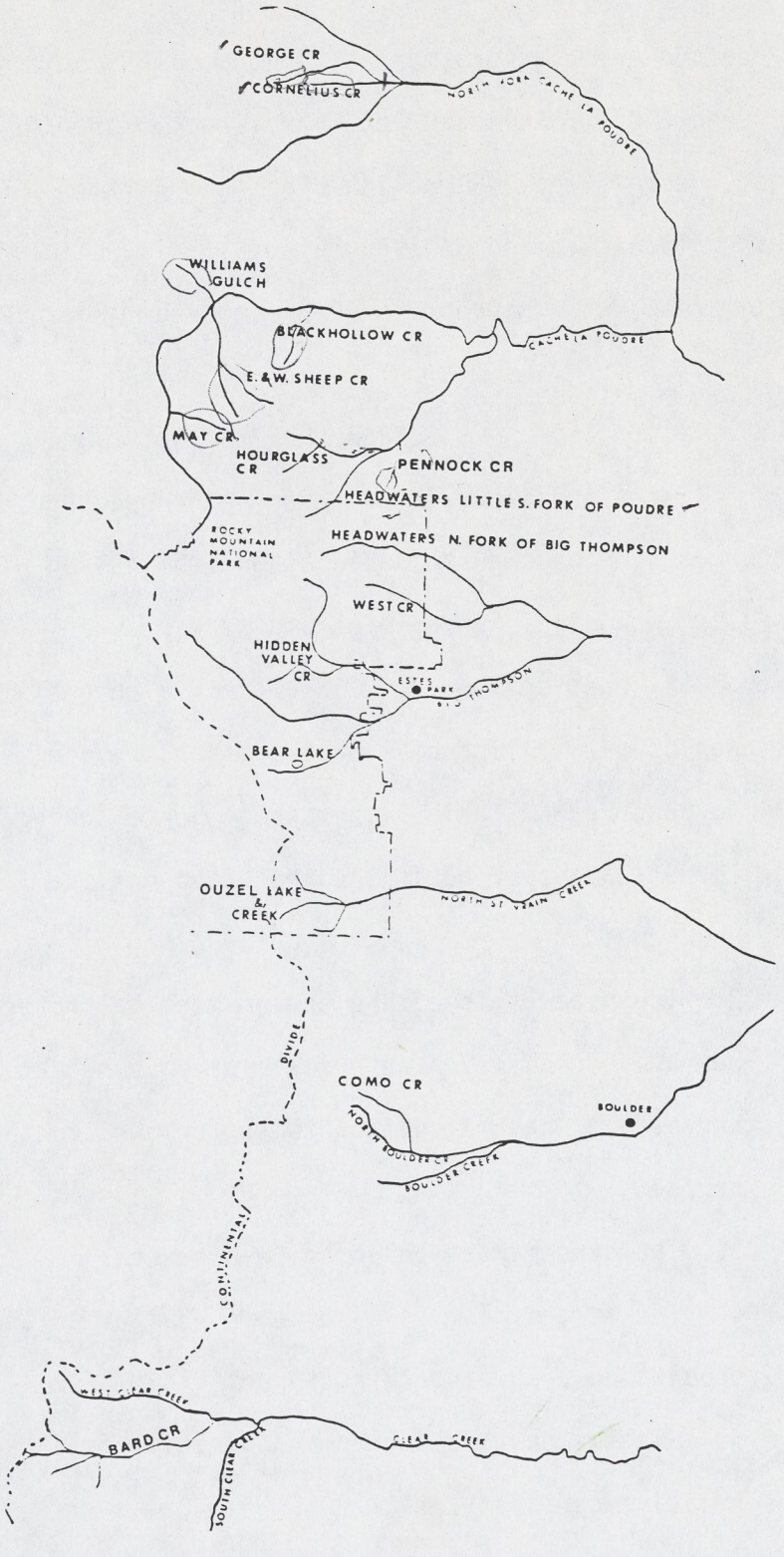


Figure 2. Greenback cutthroat trout distribution map for South Platte River drainage north of Clear Creek.

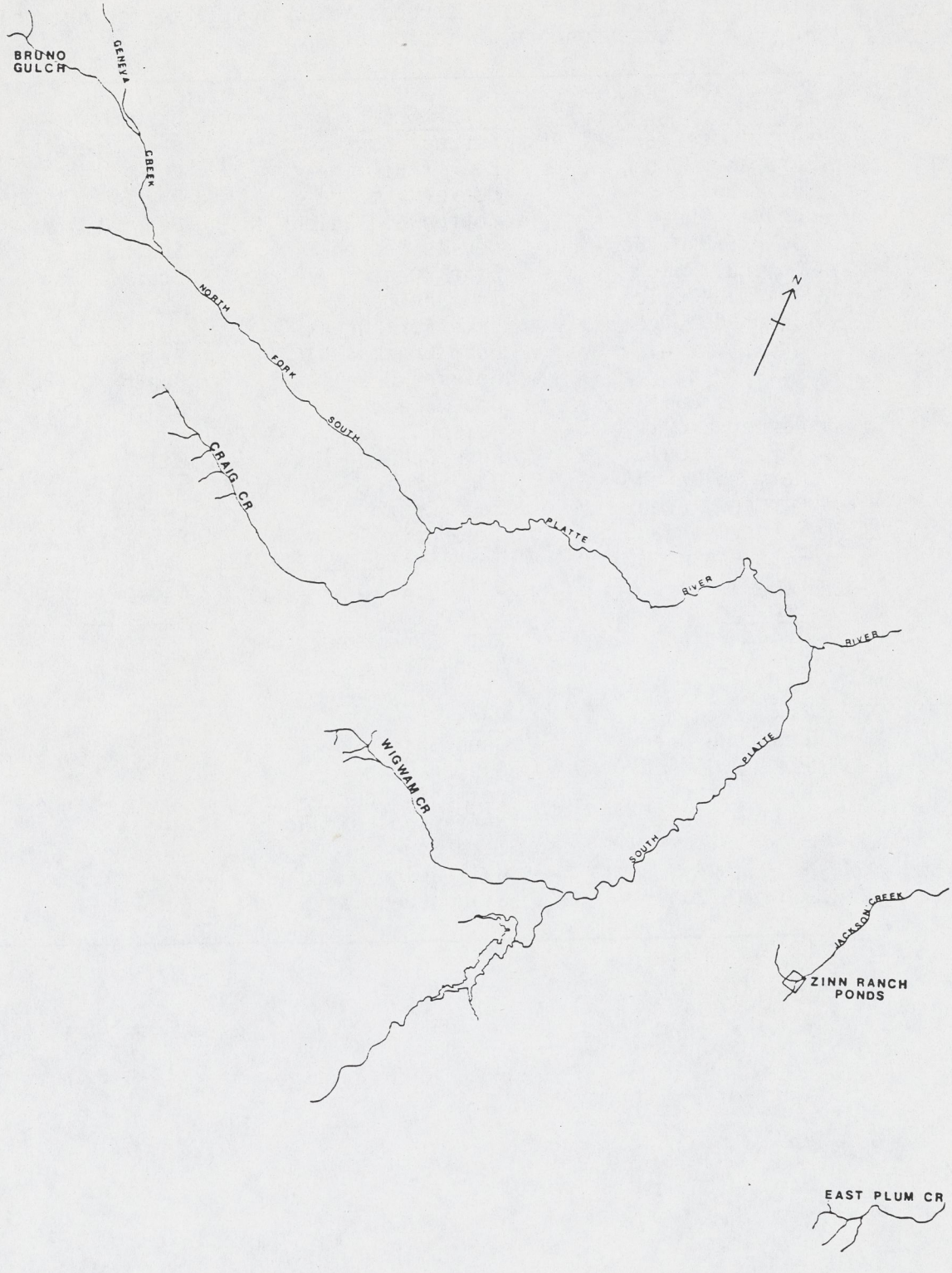


Figure 3. Potential greenback cutthroat trout restoration sites distribution map for South Platte River drainage south of Clear Creek.

Table 1. Revised list of streams to be evaluated for greenback cutthroat trout introduction.

Boulder	Clear Creek	Douglas
Antelope Creek	Barbour Fork	Bear Creek
Arapahoe Creek	Bear Track Creek	Cook Creek
Bell Gulch	Beaver Dam Creek	Dry Gulch
Beaver Creek	Cottonwood Gulch	Jenny Gulch
S. Fk. Mid. Boulder	Devils Canyon	Spring Gulch
Central Gulch	Ethel Creek	Star Canyon
Chipmunk Gulch	Indian Creek	
Colorado Creek	Lake Fork Creek	Jefferson
Dry St. Vrain	Lost Creek	Bear Gulch
Ellsworth Creek	Melvine Creek	Beaver Creek
Hawkins Gulch	Nott Creek	Brush Creek
Jasper Creek	Ralston Creek	
Keystone Gulch	Rose Creek	Gilpin
Mammoth Gulch	Ruby Creek	Arbuckle Gulch
Mitchell Creek	Soda Creek	Cottonwood Gulch
Pennsylvania Gulch	Truesdale Creek	Elk Creek
Rattlesnake Gulch	Tumbling Creek	Jenny Creek
	Warren Gulch	Macy Gulch
Larimer	Watrous Gulch	Pecks Gulch
Cedar Creek	West Fork Creek	
Dry Creek	Woods Creek	
Fall Creek		
Fox Creek	Park	
Lewstone Creek	Deep Gulch	
Poverty Gulch	Gibson Gulch	
Swamp Creek	Holmes Gulch	
Willow Creek	Jefferson Lake Fork	
	Lake Fork	
	Mill Gulch	
	Slaughterhouse Gulch	

Rating	Criteria
Class A	Pure greenback cutthroat trout are present.
Class B	Hybrid greenback cutthroat trout are present.
Class C	1) Excellent to good trout habitat. 2) Low use area. 3) Barrier or barrier site present. 4) Good reclamation potential.
Class D	1) Good to marginal trout habitat. 2) Low to moderate use area. 3) Barrier site present or no site found. 4) Good to moderate reclamation potential.
Class E	1) Marginal to poor trout habitat. 2) Moderate to high use area. 3) No barrier site found. 4) Moderate to poor reclamation potential.

This stream classification system is not to be confused with Binns population rating system. This classification system classifies streams not greenback populations based on relative genetic purity.

A total of 79 streams were surveyed during 1977-1984 (Table 2), and stream classifications were based on the above classification system. A and B classified streams, which contained pure A type greenback cutthroat trout or B and C type hybrid greenbacks, were not considered for reintroduction. Streams classified C, D, or E were evaluated based on potential for greenback cutthroat trout reintroduction. Class C streams were given high priority as reintroduction sites, class D streams were considered if no class C streams were available. Class E streams were not considered for reintroduction.

Habitat with no greenback cutthroat trout were classified based on a qualitative evaluation of habitat, area use, barrier site, and reclamation potential. Each rating criteria were categorized and defined as follows:

Table 2. List of habitat evaluated from 1977 to 1984 in the Northeast Region.

Habitat	County	Location	Rating	Rating Criteria				Species
				Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	
Bard Creek	Clear Creek	R75W,T4S, sec 1-4	A	Good	Mod. rec.	Waterfall	--	A-Greenback
Black Hollow Creek	Larimer	R74W,T8N, sec 2,10,11,14	A	Good	Low	Man-made	--	A-Greenback
Como Creek	Boulder	R73W,T1N, sec 22-26	A	Good	Mod. rec.	Waterfall	--	A-Greenback
Cornelius Creek	Larimer	R73W,T11N, sec 22-30	A	Good	Mod. graz.	Man-made	--	A-Greenback
George Creek	Larimer	R73W,T11N, sec 22-30	A	Good	Mod. graz.	Man-made	--	A-Greenback
Hourglass Creek	Larimer	R79W,T7N, sec 13,14	A	Marginal	Low	Waterfall	--	A-Greenback
May Creek	Larimer	R75W,T7N, sec 1-3	A	Good	Low	Waterfall	--	A-Greenback
E.&W. Fork Sheep Creek	Larimer	R74W,R75W,T8N, sec 12-23	A	Good	Low	Waterfall	--	A-Greenback
Little S. Fk. Poudre River	Larimer	R73W,T7N, sec 29,30	A	Good	Low	Waterfall	--	A-Greenback
Williams Gulch	Larimer	R75W,T9N,sec 21,22,26,27,36	A	Good	Mod. graz.	Waterfall	--	A-Greenback
West Creek	Larimer	R72W,T6W, sec 31,32	A	Good	Low	Man-made	--	A-Greenback, brook

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Bear Creek	Douglas	R68W,T9S,sec 22,28,29,31,32 R68W,T10S,sec 5,6,7	B	Marginal	Low	Waterfall	--	B-Greenback
Goose Lake	Boulder	R73W,T1N, sec 19	B	Good	Low	Waterfall	--	B-Greenback
Island Lake	Boulder	R73W,T1N, sec 20	B	Good	Low	Waterfall	--	B-Greenback
Roaring Creek	Larimer	R75W,T9N, sec 13,14,24	B	Good	Low	Waterfall	--	B-Greenback
Sawmill Creek	Larimer	R76W,T7N,sec 10,11,13,15	B	Marginal	Heavy logging	Waterfall	--	B-Greenback
Bruno Gulch	Park	R75W,T6S, sec 13-17	C	Good	Low	Man-made	Good	Brook
Craig Creek	Park	R72W,T8S,sec 19,20 R73W,T8S,sec 5,6,9,14,15, 23,24 R74W,T7S, sec 35,36	C	Excellent	Low	Waterfall	Good	Brook
E. Plum Creek	Douglas	R68W,T11S, sec 5 R68W,T10S,sec 24,26,27,28,32	C	Good	Low	Waterfall	Good	Barren

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Pennock Creek	Larimer	R73W,T7N,sec 11,14,23,26	C	Good	Low	Man-made	Good	Brook
Wigwam Creek	Jefferson	R71W,T9S,sec 10,11,12,13 R72W,T9S,sec 18-20	C	Good	Low	Waterfall	Moderate	Brook
Zinn Ranch Ponds	Douglas	R69W,T9S, sec 22	C	Good	Low	Standpipe	Good	Barren
Beaver Creek	Park	R75W,T7S,sec 3,4,7,8,9	D	Marginal	Mod. rec.	Potential site	Moderate	Brook
Boston Peak Creek	Larimer	R74W,T9N,sec 33,34,35	D	Marginal	Low	Waterfall	Good	Barren
Bluestem Draw	Park	R72W,T8S, sec 29	D	Marginal	Low	No site	Good	Brook
Caribou Creek	Boulder	R73W,T1S, sec 4,5	D	Marginal	Heavy 4WD	Potential site	Poor	Brook
Chicago Creek	Clear Creek	R74W,T5S,sec 1,12,13,14	D	Good	Low, private property	Reservoir	Moderate	Brook & cutthroat
Coney Creek	Boulder	R73W,T2N, sec 17,19,20	D	Good	Mod. rec.	Waterfall	Poor	Brook
Cow Creek	Larimer	R72W,T5N, sec 5,6	D	Good	Private property graz.	No site	Moderate	Brook

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Deer Creek	Park	R73W,T6S,sec 18-20 R74W,T6S,sec 11,13,14	D	Marginal	Low	Potential site	Good	Brook
Eagle Creek	Douglas	R69W,T10S, sec 4,8,9 R69W,T9S, sec 3,4	D	Marginal	Low	Waterfall	Good	Barren
Elk Creek	Park	R73W,T6S, sec 9,10,15	D	Marginal	High rec.	No site	Good	Brook
Fourmile Creek	Boulder	R72W,T1N,sec 15,23,24	D	Marginal	Low	Potential site	Good	Brook
French Creek	Park	R77W,T7S, sec 24 R76W,T7S, sec 19,20	D	Good	Low	No site	Good	Brook
Gove Creek	Douglas	R68W,T10S,sec 10,11,15,21	D	Marginal	Low	Waterfall	Good	Brook
Goose Creek	Jefferson	R72W,T10S,sec 1,2,12,13 R71W,T10S, sec 3,4,9	D	Good	Mod. rec.	No site	Moderate	Brook
Gunbarrel Creek	Jefferson	R70W,T8S, sec 32-34	D	Good	Low	Potential site	Moderate	Brook,brown, rainbow
Kirby Creek	Park	R75W,T6S, sec 4,9,10	D	Marginal	Low	Potential site	Good	Brook

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Little Beaver Creek	Larimer	R73W,T8N, sec 28-36	D	Good	Low	Potential site	Good	Brook,brown
Lost Creek	Park	R73W,T8S, sec 19-33 R73W,T9S,sec 4,11,12,13 R72W,T9S, sec 16-34	D	Good	Low	Waterfall	Poor	Brook
Mill Creek	Clear Creek	R74W,T3S,sec 7-10,14,15	D	Good	Private property	No site	Moderate	Brook, cutthroat
Mad Creek	Clear Creek	R75W,T3S, sec 13 R74W,T3S, sec 19,20	D	Marginal	Mining	Waterfall	Good	Barren
N. Fk. N. Elk Creek	Park	R72W,T6S, sec 8,9,16	D	Good	Graz., private property	Potential site	Good	Brook
Trib. N. Fk. N. Elk Creek	Park	R72W,T6S, sec 4,9,15	D	Good	Mod. rec.	Potential site	Good	Brook
Panhandle Creek	Larimer	R74W,T10N, sec 2-5	D	Good	Private property	Potential site	Moderate	Brook
E. Fork Roaring Creek	Larimer	R74W,T9N,sec 16,17,19,20,30	D	Marginal	Low	Waterfall	Good	Barren
Vance Creek	Clear Creek	R73W,T4S,sec 1-3,5,8,34,35	D	Good	Private property	No site	Good	Brook

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Acme Creek	Larimer	R74W,T11N, sec 13,14	E	Marginal	Mod. rec.	No site	Good	Brook
Beaver Creek	Larimer	R74W,T11N, sec 11,15,21	E	Marginal	Logging	No site	Good	Brook
Blue Creek	Clear Creek	R75W,T3S, sec 14,23	E	Poor	Low	No site	Poor	Barren
Camp Creek	Park	R73W,T6S,sec 21,29,30	E	Marginal	Mod. rec.	No site	Good	Brook
Church Fork	Park	R73W,T6S,sec 15,16,21,22	E	Poor	High rec.	No site	Moderate	Brook
Trib. of Craig Creek	Park	R72W,T8S, sec 28	E	Marginal	Low	No site	Moderate	Brook
Cumberland Gulch	Clear Creek	R75W,T3S, sec 1,12	E	Poor	Low	No site	Good	Barren
Dry Gulch	Clear Creek	R76W,T4S, sec 15-17	E	Poor	Low	No site	Good	Barren
Fall River	Clear Creek	R74W,T3S, sec 4,10	E	Marginal	Mod. rec., private property	No site	Moderate	Brook
Middle Garber Creek	Douglas	R69W,T8S, sec 24-26	E	Poor	Mod. rec.	No site	Good	Barren
North Garber Creek	Douglas	R69W,T8S, sec 13,14	E	Poor	Low	No site	Good	Cutthroat x rainbow

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria				Species
				Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	
Geneva Creek	Park	R75W,T5S, sec 32,33 R75W,T6S, sec 2,3,11	E	Poor	Mining, mod. rec.	Waterfall	Good	Barren
Grizzly Gulch	Clear Creek	R75W,T4S, sec 29,31	E	Poor	Mining	Waterfall	Good	Barren
Hill Canyon Creek	Larimer	R71W,T4N, sec 7-9	E	Poor	Low	Potential site	Good	Brook
Herman Gulch	Clear Creek	R76W,T4S, sec 9-11	E	Poor	Mining	Waterfall	Good	Barren
Hoop Creek	Clear Creek	R75W,T3S, sec 16,21	E	Poor	Low	No site	Good	Barren
Killpecker Creek	Larimer	R74W,T10N, sec 32	E	Marginal	Logging	Potential site	Good	Barren
Jackwacher Gulch	Clear Creek	R75W,T5S, sec 28,33	E	Poor	Low	Waterfall	Good	Barren
Leavenworth Creek	Clear Creek	R75W,T5S, sec 2,11 R75W,T4S, sec 24,25	E	Poor	Mining	Waterfall	Good	Barren
N. Fork Little Thompson	Larimer	R71W,T5N,sec 27-30	E	Poor	Low	No site	Poor	Longnose sucker
W. Fork Little Thompson	Larimer	R72W,T3N, sec 3,4,9	E	Good	Private property	No site	Good	Brook
Long Hollow Creek	Douglas	R69W,T10S,sec 10,11,16,17	E	Poor	Low	No site	Good	Barren

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Miller Fork Creek	Larimer	R72W,T6N,sec 4,5,9,15,23	E	Marginal	Private property	Waterfall	Good	Brook
Qualye Creek	Clear Creek	R75W,T4S, sec 20,29	E	Marginal	Low	Waterfall	Moderate	Barren
Pendergrass Creek	Larimer	R72W,T8N,sec 15,22,27	E	Poor	Low	No site	Poor	Barren
Scott Gomer Creek	Park	R74W,T5S,T6S	E	Marginal	Low	Waterfall	Poor	Brook
Smelton Gulch	Park	R75W,T5S, sec 27,34	E	Poor	Low	Waterfall	Good	Barren
Stark Creek	Douglas	R68W,T10S, sec 3,4,9,16	E	Poor	Low	Waterfall	Good	Barren
Stevens Creek	Clear Creek	R75W,T4S, sec 28,33	E	Poor	Low	Waterfall	Good	Barren
Stove Prairie Creek	Larimer	R71W,T7N, sec 3,4,10,15	E	Poor	Private property	No site	Good	Barren
Trail Creek	Larimer	R72W,R73W,T11N, T12N,sec 7-35	E	Good	Private property	Potential site	Poor	Brook,brown
West Chicago Creek	Clear Creek	R74W,T5S, sec 3,9	E	Marginal	Mod. rec.	Waterfall	Good	Brook

Table 2 (Cont'd).

Habitat	County	Location	Rating	Rating Criteria: Trout Habitat Quality	Area Use	Barrier	Reclamation Potential	Species
Wildcat Creek	Jefferson	R71W,T10S, sec 27-29	E	Poor	Low	No site	Good	Barren
Woods Creek	Clear Creek	R76W,T4S, sec 2,3 R76W,T3S, sec 36	E	Marginal	Mining	Reservoir	Good	Brook
Youngs Gulch	Larimer	R71W,T8N,sec 9,15,16,22	E	Good	Private property Mod. rec.	No site	Poor	Brook,brown

HABITAT

Category	Definition
excellent	Trout habitat is superior in quality. Cover, flow, substrate, and pool/riffle ratio are optimal for trout population stability.
good	Trout habitat will support a stable trout population. Cover, flow, substrate and pool/riffle ratio are ideal for all trout life stages. Successful reproduction will occur, even under extreme conditions such as drought or flood.
marginal	Habitat will support a trout population but not at levels considered stable. Environmental conditions are not ideal for all life stages from year to year.
poor	Habitat will not support all trout life stages.

AREA USE

Category	Definition
high	Area use, such as logging, mining, grazing, and recreation, has significant negative impact on trout populations.
moderate	Area use has a slight negative impact on trout populations.
low	Area use has no impact on trout populations.
private property	Permission from landowners is required before stream reclamation can be considered.

BARRIER

Category	Definition
natural	Naturally occurring, waterfall, steep cascade or other impassable barrier which prevents upstream fish migration.
man-made	Any man-made structure that prevents upstream fish migration.
potential site	Good site where a man-made improvement would create an impassable fish barrier. A stream site typically has steep banks and narrow stream channel.
no site	Fish barrier or potential barrier site was not found during survey.

RECLAMATION POTENTIAL

Category	Definition
good	Stream is barren or removal of nonnative salmonids with a piscicide could be done with relative certainty of a complete kill.
moderate	Removal of fish may be difficult because of beaver ponds, swampy areas, or isolated waters. Possibility that all fish would be removed is fair.
poor	Removal of fish would be very difficult because of beaver ponds, swampy areas, dense vegetation and isolated pools. High probability that all fish would not be removed.

Evaluating habitat for reintroduction of greenback cutthroat trout was not always as simple as Table 2 appears. Much thought went into weighting the different evaluation factors before selecting reclaimable habitat. One factor not included in the table was economics, streams with natural barriers and barren of fish were selected over superior trout streams because of the lower costs. Habitat classifications did not always reflect the corresponding evaluation factors; in some cases, habitat quality outweighed the other rating factors.

In the future, if no class C streams are available for reclamation, the following class D streams should be reevaluated:

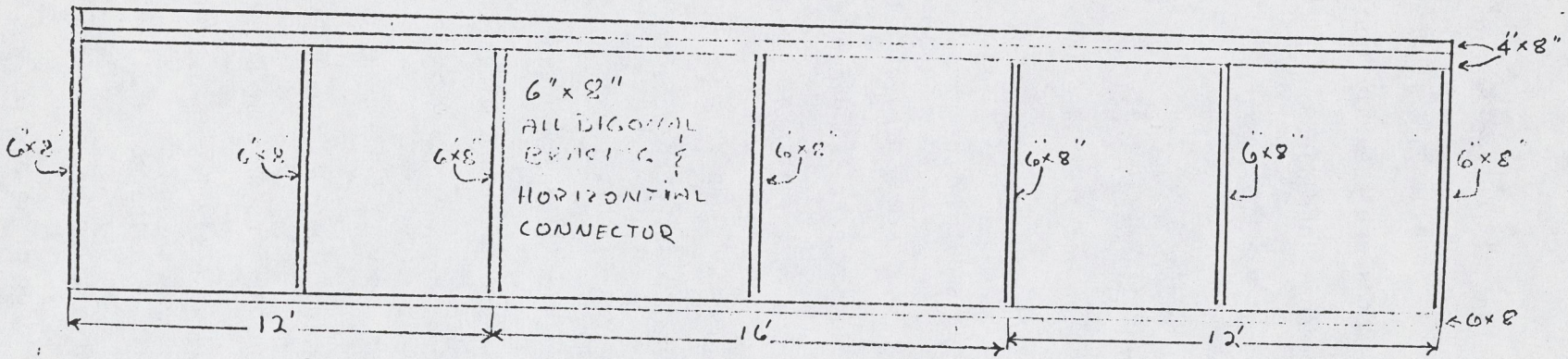
1. North Fork, North Elk Creek
2. Chicago Creek
3. Mill Creek
4. Deer Creek
5. Little Beaver Creek
6. French Creek
7. Gunbarrel Creek

These 7 streams have the highest potential for reclamation of all class D streams. Future habitat evaluations should shift from streams to lakes for reclamation. Zinn Ranch Ponds are the only lentic habitat scheduled for A-type greenback cutthroat introduction in the Northeast Region outside Rocky Mountain National Park.

RECLAMATION OF HABITAT 1977-1984

When a particular habitat had been accepted as a potential restoration site several agencies were notified. If a man-made barrier was necessary, a design was developed and then the proposed project was approved by the following agencies: U.S. Army Corps of Engineers, Colorado Historical Society, Colorado State Health Department, and USFWS Endangered Species Office. In 1981, a rock-filled gabion barrier was built on George Creek. The barrier has held up well during the last two high-water years (1983-1984). Minor repairs were necessary in 1983. Inspection of the barrier in 1984 revealed that the barrier had completely silted in on the upstream side increasing the stability of the barrier. In 1984, two barriers were built and materials for an additional barrier were ordered. One barrier on Pennock Creek was built by a private firm, the other barrier, on West Creek, was built by personnel from the U.S. Forest Service, Colorado Division of Wildlife and Trout Unlimited. The design for the barriers on West Creek and Bruno Gulch, which is to be built in 1985, were similar (Figs. 4 and 5). The barrier on Pennock Creek was constructed using rock-filled gabion baskets. The design of the barrier was similar to the design in Figure 6.

After the barrier had been built or if no barrier was necessary, the fish removal aspect began. First, the following agencies were



PLAN VIEW

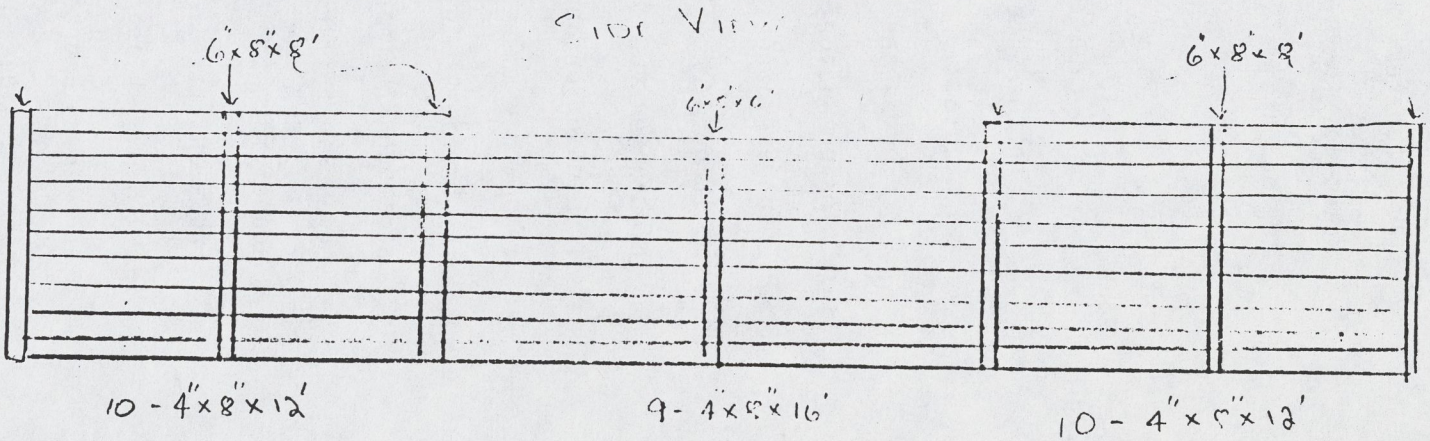


Figure 4. Schematic view of barrier used on West Creek, Pennock Creek and Bruno Creek (plan and side view).

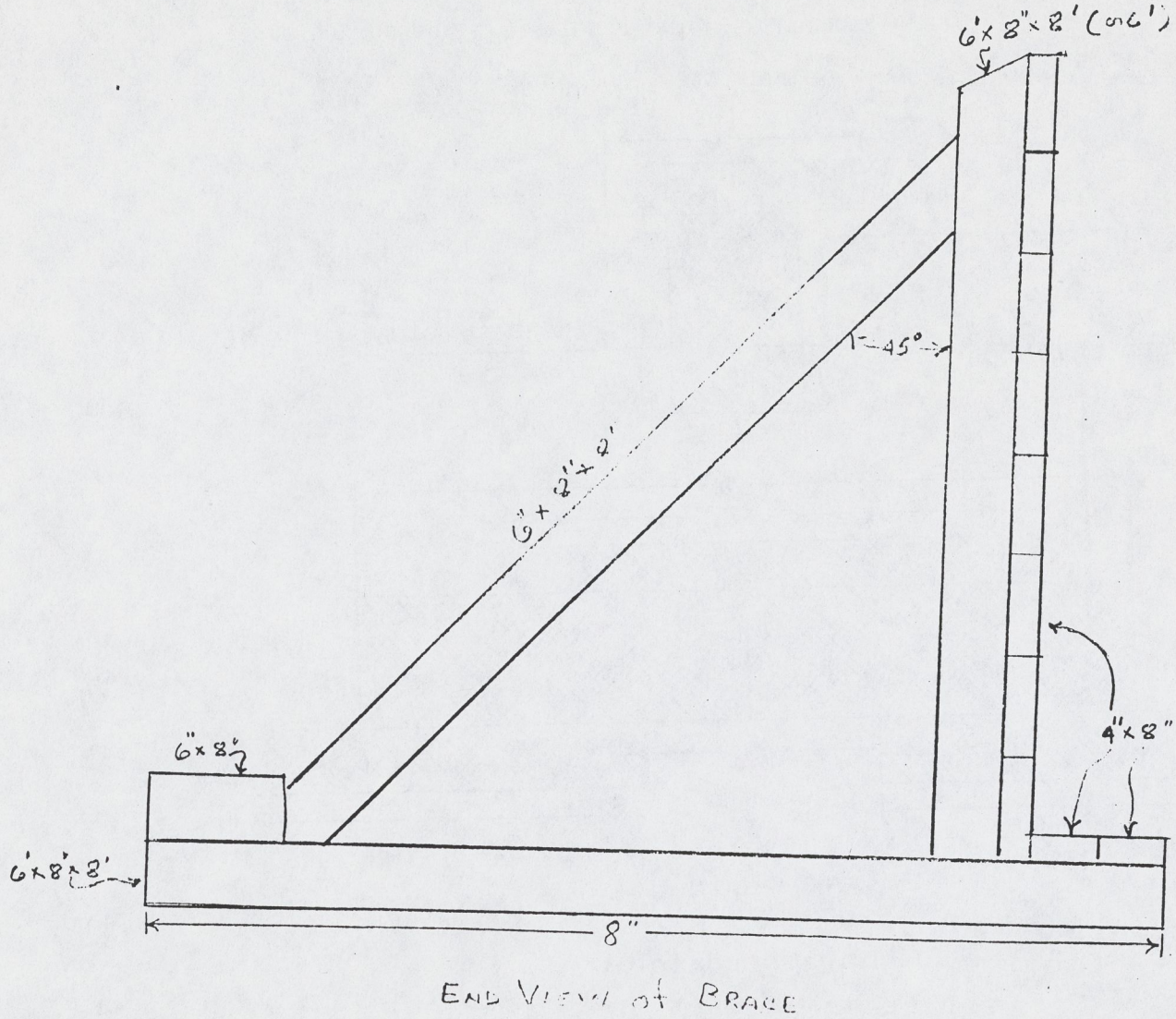


Figure 5. Schematic view of barrier used on West Creek, Pennock Creek and Bruno Gulch (end view).

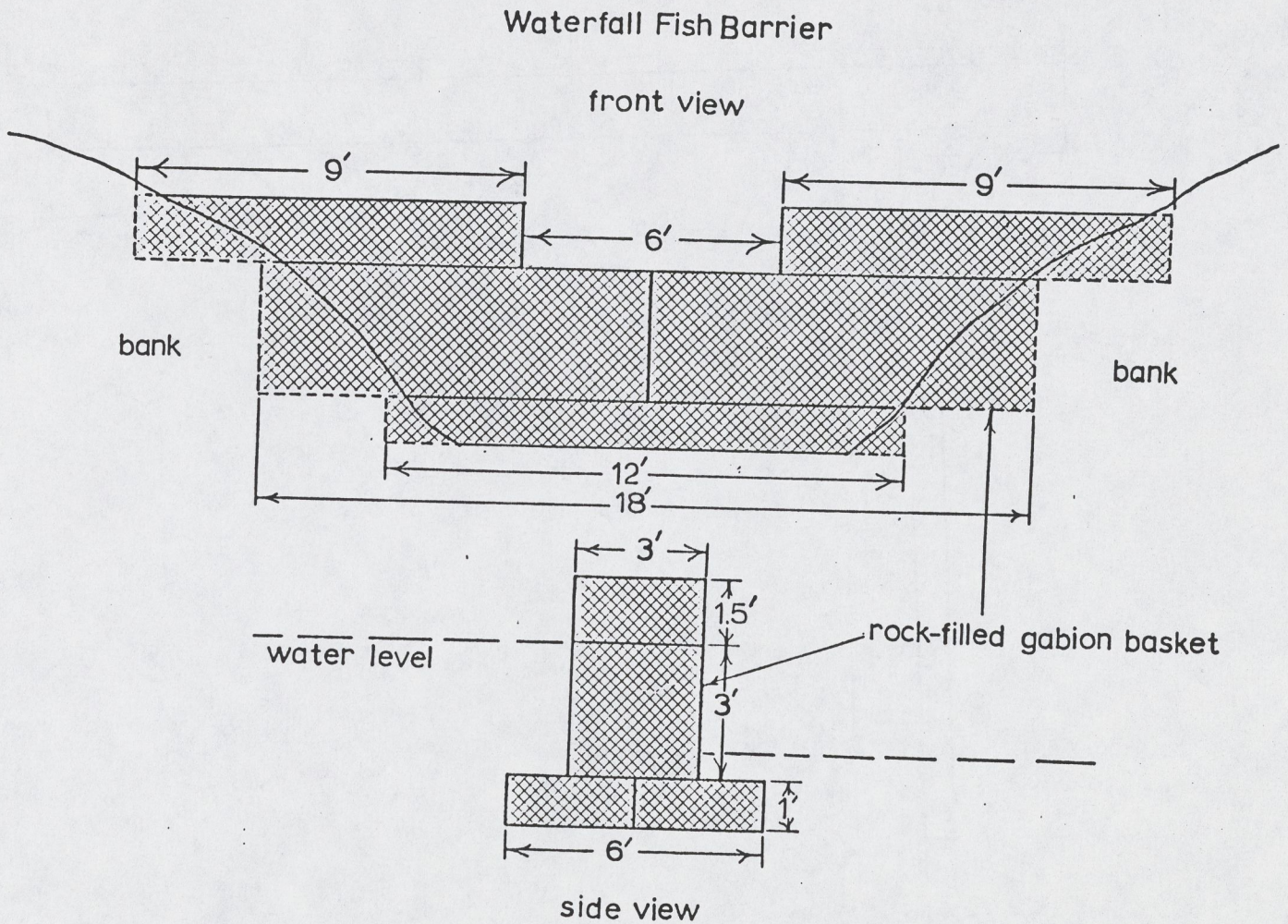


Figure 6. Design of gabion barrier on Pennock Creek.

notified: Colorado Division of Wildlife, U.S. Forest Service, Colorado State Health Department and downstream landowners and water users. Stream flows (m^3/sec) or pond volumes (m^3) were measured to determine the amount of piscicide and oxidizer needed. Prior to 1984, 4 streams were poisoned: Black Hollow Creek 1979; East and West Forks Sheep Creek 1981; and George and Cornelius Creeks 1982. In 1984, only one habitat area was reclaimed, Zinn Ranch Ponds at the headwaters of Jackson Creek, Douglas County, Pike National Forest. There were 6 ponds totaling 0.71 hectares (Table 3). Five of the ponds contained brook trout. The fish were removed using 2.5% synergized rotenone at 4 ppm. A total of 46 liters of piscicide was used (Table 3). The rotenone was dispensed into ponds with portable chemical sprayers and 2 animal waterers were used to "drip" rotenone into the inlet streams. It was necessary to use more piscicide than originally calculated because large amounts of the aquatic vascular plants potamogeton and myriophyllium prevented thorough mixing. Rotenone was detoxified with $KMnO_4$ (potassium permanganate) at 3 ppm concentration located at the outlet of the lowest pond. $KMnO_4$ was dissolved in a 55 gallon drum of water at approximately 3% concentration. The solution was released at a constant 2 liters/hour. A fish kill extending 1.3 km downstream occurred. Initial inspection revealed a complete irradication of all fish. An additional survey will be made in spring 1985.

The Craig Creek fish removal project originally scheduled for August 1984 was postponed because of high water. Rotenone calculations were based on 2.5% synergized formula at 5 ppm for a period of 4-5 hours continuous dispensing (Table 4). A total of 190 liters was estimated to complete the project. Five drip stations were selected (Fig. 7). The

Table 3. Zinn Ranch Ponds fish removal project: rotenone calculations 1984.

Pond #	Surface Area (m^2)	Mean Depth (m)	Volume (m^3)	Amount Rotenone (l)
1	1971	0.87	1715	7.6
2	450	0.9	405	3.8
3	846	0.5	423	3.8
4	959	0.45	432	3.8
5	1288	0.48	618	7.6
6	1575	0.99	1559	7.6
2 drip stations				11.4

Table 4. Craig Creek fish removal project: rotenone calculation 1984.

Drip Station	CFS	Amount Rotenone (l)
Site 1	8.5	22
Site 2	8.5	22
Site 3	10.5	27
Site 4	13.5	34
Site 5	17.5	46
Backpack Sprayers		38

Figure 7. Locations of rotenone drip stations on Craig Creek.

detoxification station, using $KMnO_4$ at a concentration of 3 ppm was to drip continuously for 14 hours at a rate of 5.4 liters/hour. This project has been rescheduled for August 1985. Bruno Gulch has also been scheduled for August 1985. Pennock and Wigwam Creeks are still being considered as potential restoration sites.

INTRODUCTION OF GREENBACK CUTTHROAT TROUT 1980-1984

Stocking of reclaimed habitat began one year after fish removal had been completed. This was done for two reasons: 1) allowed time for recovery of aquatic invertebrate populations and 2) prevented introduction of greenback cutthroat trout if fish removal was not 100% successful. Poisoning of a stream was not necessary if the stream was barren of fish and stocking could begin immediately. Four streams were barren, Bard Creek, May creek, Williams Gulch, and Hourglass Creek.

Originally, stocking was done by transferring adult greenback cutthroat trout from Como Creek. Three streams were stocked by this method: in 1965, 56 greenback cutthroat trout were transferred into Hourglass Creek; in 1980 Black Hollow, May and Hourglass Creeks received 37, 54, and 34 greenback cutthroat trout, respectively. The Como Creek strain of greenback cutthroat trout, established at the USFWS Bozeman Fish Technology Center in Bozeman, Montana, was used for stocking in 1981 (Table 5). To maintain the "wildness" of stocked fish, milt from wild male fish in Como Creek was packed in ice and sent to Bozeman to fertilize the hatchery reared females. Each reclaimed stream was stocked for 3 consecutive years. Black Hollow, George and Cornelius Creeks have received 2 consecutive years of stocking (Table 5). The remainder of the streams have received 3 consecutive years of stocking,

Table 5. Greenback cutthroat trout stocking history 1980-1984.

	1980		1981		1982		1983		1984	
	Date	#	Date	#	Date	#	Date	#	Date	#
Bard Creek					10-5 11-16	6900 (fry) 1150 (fry)	9-28	2243 (fry)	7-11 9-11	400 (140mm) 2896 (fry)
Black Hollow Creek	7-31	37					9-26	935 (fry)	7-11 9-11	75 (140mm) 1086 (fry)
Cornelius Creek							9-26	2243 (fry)	7-11 9-11	310 (140mm) 3620 (fry)
George Creek							9-26	2243 (fry)	7-11 9-11	200 (140mm) 3620 (fry)
May Creek	8-5	54			10-5	2000 (fry)	9-27	701 (fry)	7-11 9-11	90 (140mm) 1448 (fry)
E. Fork Sheep Creek					10-5	3600 (fry)	9-27	1100 (fry)	7-11 9-11	150 (140mm) 905 (fry)
W. Fork Sheep Creek					10-5	3600 (fry)	9-27	1000 (fry)	7-11 9-11	150 (140mm) 905 (fry)
Williams Gulch			7-16	48 (127mm)	10-6	2000 (fry)	9-29	421 (fry)	9-11	230 (140mm) 1448 (fry)
Hourglass Creek	8-15	34	7-15	158 (127mm)	10-5	1500 (fry)		0		0

Bard, Hourglass, May, East and West Forks Sheep Creeks, and Williams Gulch (Table 5). Stocking was discontinued after 3 years to allow for natural reproduction.

Fry arrived from Bozeman early in the morning during September. They were stocked the same day to reduce stress and put the fry into a natural environment as soon as possible. Most streams had to be reached on foot; this required the development of a manageable technique to haul fish. One technique used required cold water to be placed into double-lined, heavy-duty plastic bags. The ratio of fish to water was 1:10. The bag was filled approximately 1/3 of its capacity with water, the fish were added and the remainder of the bag was filled with O_2. The sealed bags were placed in backpacks and carried to the stream. In 1984 a better method was used. Plastic jars, 33 cm high and 22 cm in diameter, were filled with cold water and sealed under pressure of 3-5 psi of pure O_2. This design allowed more fish and less water per container than the plastic bag method. Care must be taken to maintain a constant pressure or upon rapid release of pressure, especially at high altitudes, gas bubble disease will develop. When the stream had been reached, the fry were tempered and carefully distributed in pools throughout the stream. This year fry and fingerlings were stocked into various streams (Table 5). The fingerlings that were stocked in July 1984 were held at the Bozeman hatchery over the previous winter and marked with an adipose fin clip. An evaluation of survival is still in progress. Preliminary observations indicated good survival and growth. The mean length increase of 13 of marked greenbacks collected in September was 19 mm.

An attempt was made to establish a second strain of greenback cutthroat trout brood stock from Little South Fork, Cache La Poudre River. The eggs that were collected did not develop. Another attempt to gather eggs for this source will be made in July 1985. This strain of greenback cutthroat trout will be stocked into new habitat reclaimed since 1984. These will include Zinn Ranch Ponds, Bruno Gulch, Craig Creek, Pennock Creek and Wigwam Creek.

MONITORING OF INTRODUCED POPULATIONS OF GREENBACK CUTTHROAT TROUT 1981-1984

Habitat Evaluation

Evaluation of habitat quality and quantity is a necessary aspect of any management plan. A baseline of habitat parameters must be established so changes can be detected. There is a myriad of habitat models to evaluate habitat quantity and quality. In 1982 a combination of models was used to evaluate trout habit on Como Creek and Black Hollow Creek (Culver and Bestgen 1982), USFWS Habitat Evaluation Procedures (HEP), Habitat Qualty Index (HQI) (Binns and Eisermann 1979), and Instream Flow Methods. This combination of models was abandoned because of the complexity and time required to collect and evaluate data. In 1984, the HQI model was adopted to evaluate stream habitat that supported existing greenback cutthroat trout populations and potential greenback cutthroat trout restoration sites. The simplicity of the HQI model was the main reason for selecting this model.

A 100 m section of typical habitat for each stream was selected and identified by yellow flagging. Many of the selected study areas were similar (Table 6). Evaluation and rating of each habitat attribute

Table 6. Descriptions of study sections for streams containing introduced greenback cutthroat trout 1984.

Stream	Section Length	Gradient	Substrate Composition	Vegetation	Comments
Bard Creek	100 m	7.5%	Boulders, cobble, gravel	Willow, alders, spruce, aspen, pine	Section begins 0.9 mi above stone cottage (Whispering Pines). Beaver activity.
Black Hollow Creek	100 m	7.0%	Cobble, gravel, sand	Pine, spruce, alder, aspen, willows	Section begins 50 m above barrier. Stream is heavily shaded. Not very many pools.
Cornelius Creek	100 m	5.0%	Small gravel, silt, some cobble	Willows, aspens, pine, spruce, alders	Section begins at exclosure. Grazing in the area. Beaver ponds and undercut banks.
George Creek	100 m	2.0%	Small gravel, silt, sand	Willows, pine, spruce, grasses	Section begins 0.8 mi downstream of road crossing. Mainly series of long pools, some riffles. Grazing.
May Creek	100 m	8.0%	Boulders, cobble, gravel, sand	Pine, spruce, aspen	Heavily shaded, small pools. Some undercut banks.
W. Fork Sheep Creek	100 m	4.8%	Silt, sand, small gravel	Grasses	Section begins mid-meadow. Several large pools, sloughing streambank, not much cover.
E. Fork Sheep Creek	100 m	4.8%	Cobble, gravel, sand, silt	Pine, spruce, aspen, willows	Section begins at edge of trees. Large pools, brush dams, beaver activity.
Williams Gulch	100 m	3.0%	Some gravel, mostly silt	Grasses, willows, pine, spruce	Section begins at southern end of last meadow. Small pools, extensive undercut banks. Severe grazing, trampled streambanks.

(Table 7) in the HQI model was aided by the procedures manual (Binns 1982). The attribute ratings were manipulated to estimate the standing crop of fish (kg/ha) in the study section (Table 7). This value may actually estimate the carrying capacity as the standing crop may be affected by attributes not considered in the model, i.e. fishing or toxic substances. The estimated kg/ha (Table 7) ranged from 14.5 - 139.5 kg/ha with a mean of 66 kg/ha; this value includes potential restoration sites. The range for streams containing only introduced greenback cutthroat trout was 14.5 - 82.2 kg/ha (Table 7). The HQI estimated standing crop value for Williams Gulch (Table 7) appears to be very low. The reason for this was the "0" rating for water velocity which gives the food factor in the model a "0" value. This stream may be an exception to the model. Numerous plecoptera, emphemeroptera, and coleoptera were collected with a surber sampler. Growth and survival of the stocked greenback cutthroat trout in Williams Gulch appears to be very good. If the velocity rating in this stream was increased to "1" the HQI standing crop estimate would be 82.1 which was about the same as the estimated standing crop calculated from weights of collected greenback cutthroat trout (Table 8). The remainder of the estimated standing crop values (Table 8) for streams with introduced greenback cutthroat trout, with the exception of May Creek, were far below the standing crop value estimated by HQI.

Population Estimates

Population estimates are essential for proper management, especially in the streams containing introduced greenback cutthroat trout. It is a major "tool" to describe the population dynamics. There are two main types of population estimation, mark and recapture, and

Table 7. HQI attribute ratings and estimate of standing crop (carrying capacity) 1984.

Stream	Section Length (m)	Length of Stream (m)	$\overline{W}$ (m)	Late Summer Flow	Annual Flow Variation	Max. Summer Temp.	NO_3-N	Cover	Eroding Banks	Stream Width	H_2O Vel.	Substrate	Standing Crop Estimate (kg/ha)
Bard Creek	100	8000	3.1	4	2	2	3	1	4	2	2	2	58.4
Black Hollow Creek	100	3200	3.1	4	2	3	3	0	4	2	2	1	46.7
Cornelius Creek	100	8000	1.8	3	2	4	4	2	4	2	1	1	81.0
George Creek	199	14400	2.0	4	2	4	4	2	4	1	1	1	82.2
May Creek	100	4800	2.3	4	2	2	3	0	4	2	2	1	24.8
E. Fork Sheep Cr.	100	6400	3.9	4	2	3	3	2	4	3	2	1	84.4
W. Fork Sheep Cr.	100	4800	4.2	4	2	3	2	2	3	3	1	1	42.4
Williams Gulch	100	4800	1.4	4	2	4	2	3	4	1	0	2	14.5
Hourglass Creek	100	1600	3.1	4	2	1	3	1	4	2	2	1	14.6
East Plum Creek	100	8000	1.1	2	2	4	4	1	4	1	2	1	78.1
Wigwam Creek	100	7200	2.1	4	2	4	2	1	3	2	2	2	126.0
Craig Creek	100	10400	2.9	4	2	3	4	1	3	2	3	1	139.5

Table 8. Estimated carrying capacity of streams with greenback trout 1984.

Stream	Kg/ha (HQI)	# ha	Potential carrying capacity (kg)	Estimated standing crop 1984 (kg)
Bard Creek	58.4	2.8	163.5	15.8
Black Hollow Creek	46.7	0.99	46.2	29.6
May Creek	24.8	1.1	27.3	40.6
East Fork Sheep Creek	84.4	2.5	211.0	59.5
West Fork Sheep Creek	42.4	2.0	84.8	18.7
Williams Gulch	14.5	1.0	14.5	81.3
Hourglass Creek	14.6	0.5	7.3	4.0
Cornelius Creek	81.0	1.4	113.4	*
George Creek	82.2	2.9	238.0	*
Wigwam Creek	126.0	1.5	189.0	*
Craig Creek	139.5	3.0	418.5	*
East Plum Creek	78.1	0.9	70.3	*

* Population estimates not conducted.

removal methods. Each has its advantages and disadvantages. In 1982, the total removal method of population estimation was used on Como Creek (Culver and Bestgen 1982). This particular method required many man-hours. The estimate was 1450 greenback cutthroat trout for the entire stream. In 1983, a Petersen's mark and recapture population estimate was done on Little South Fork, Cache La Poudre River (Culver 1983). The estimate was 539 ± 205 greenback cutthroat trout. This method also required many man-hours because two trips to the study section were required. In 1984, two removal methods of population estimation were evaluated, Seber and LeCren (1967) and Zippin (1958) using 3 passes. A Colfelt BP-3 backpack shocker capable of providing a maximum of 200 volts was used. Each study section was the same as the one used for habitat evaluation. All passes with the electrofishing unit in each study section was made by the same person. All collected greenback cutthroat trout were weighed and measured for total length. Population estimates were completed for streams that had 3 years of stocking prior to the estimate. These streams were May Creek, Black Hollow Creek, Williams Gulch, East and West Forks, Sheep Creek and Bard Creek (Table 9).

Seber-LeCren population estimation model was used on Bard and Black Hollow Creeks (Table 9). The low estimate for Bard Creek was due to stocking procedures; all greenback cutthroat trout were stocked into beaver ponds. The study section was located below one pond and the fish collected probably emigrated from this pond. Zippin's population estimation model was used on the remainder of the streams. A 95% confidence interval was calculated for each estimate. Population

Table 9. Population estimates and mean lengths and weights for greenback cutthroat trout 1984.

Stream	No. Collected	$\bar{L}$ (mm)	L Range	$\bar{W}g$	W Range	$\hat{N}$	S.D. ($\hat{N}$)	95% CI	Total Population Estimate
Bard Creek[1]	8	124	72-160	22	3-44	9	2	5-13	720±360
Black Hollow Creek[1]	31	118	35-180	21	4-56	44	15	14-74	1408±240
May Creek[2]	46	118	73-163	18	4-48	47	1.3	44-50	2256±125
E. Fork Sheep Creek[2]	86	100	70-150	10	2-33	93	3.4	86-100	5952±435
W. Fork Sheep Creek[2]	22	121	46-164	17	1-40	23	1.4	20-26	1104±134
Williams Gulch[2]	75	126	65-220	22	3-95	77	1.6	74-80	3696±154
Hourglass Creek	7	141	102-210	36	10-91	7	0	7	112
George Creek[3]	20	123	87-183	20	5-59				
Cornelius Creek[3]	17	115	93-144	15	8-29				
Como Creek[3]	36	140	8-168	32	6-80				
S. Fork Poudre River[3]	12	200	132-236	80	51-140				

[1]Seber-LeCren population model.

[2]Zippin population model (3 passes).

[3]No population estimates available for 1984.

estimates were not done on George and Cornelius Creeks because this was the second year of the 3-year stocking schedule.

Both of these population estimation methods were less time consuming than the mark and recapture method used in 1983 and the total removal method used in 1982. The Zippin population estimation method using 3 passes allowed a smaller confidence interval (Table 9) to be calculated than the Seber-LeCren method, therefore, the Zippin method was thought to be superior.

There was no significant difference in the mean lengths and mean weights (Table 9) of greenback cutthroat trout collected from reclaimed streams. This would be expected as all streams were stocked with the same size fry for the same length of time.

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