Proposed Research

Spatial Variation and Physical Habitat Limitation of Cutthroat Trout in Headwater Streams

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Introduction

The greenback cutthroat trout (Salmo clarki stomias) is one of four subspecies of trout native to Colorado. Historically it is the sole trout species of the South Platte River drainage and occupied the Arkansas River system with the yellowfin cutthroat (Salmo clarki macdonaldi). Extirpation of the yellowfin around the turn of the century leaves the greenback the only extant, native trout on the east slope of the Colorado Rocky Mountains.

Detrimental impacts imposed by man on the environment were particularly devastating to the greenback. As early as the 1880's, poor logging and mining practices and overgrazing by livestock prompted degradation of habitat and resultant reduction in the distribution of this native salmonid. The emergence of the art of fish culture was probably the most significant cause of the precipitous decline in greenback populations. Introduced brook trout (Salvelinus fontinalis) and brown trout (Salmo trutta) compete with and are able to eliminate cutthroat trout in sympatric populations (Behnke and Zarn, 1976). Congeneric rainbow trout (Salmo gairdneri) and other subspecies of cutthroat trout readily hybridize with S. c. stomias, destroying its genetic purity. Because of these factors, pure populations were extremely rare and the greenback cutthroat was placed on the endangered species list and was afforded the protection of the Endangered Species Act of 1973.

The Greenback Cutthroat Trout Recovery Team was organized through a cooperative effort of the Colorado Division of Wildlife (CDOW), the United States Fish and Wildlife Service (USFWS), the National Park Service (NPS) and the United States Forest Service (USFS) to facilitate recovery of the species. Initially, the recovery effort was to determine the state of this endangered salmonid and taxonomically describe it. A comprehensive

survey, collection and taxonomic evaluation of cutthroat trout from possible pure populations by the CDOW and Dr. Robert Behnke revealed only three populations that conformed to ideal specifications for S. c. stomias. These remnant populations were found in the headwaters of Como Creek (Boulder County), the Little South Poudre River (Larimer County), and Cascade Creek (Heurfano County), Colorado. Due to progress in recovery efforts, a recommendation was made by the recovery team to elevate the status of the greenback to threatened and in 1978 became reality. This change in status facilitated recovery work by removing the stringent regulations imposed on species classified as endangered. The recovery process is relatively simple, involving introduction of genetically pure fish into suitable waters. Requirements for an introduction site include the presence of a barrier (natural or man-made) to upstream fish movement and the absence of other trout species to prevent competition and hybridization. To date, eleven additional populations have been established raising the total to fourteen.

The Colorado cutthroat trout management plan has several requisite criteria to accommodate the eventual delistment of the greenback from threatened status. One of the prerequisites states that fifteen stable populations in several selected watersheds will be established in each management region. When this and other standards are met, the species will be recommended for delistment and upon approval, will then be considered a game species and managed under the provisions of a wild trout fishery. Because of the relative paucity of populations and numbers of individuals within them, monitoring will be done at appropriate intervals to determine the response of these fish to limited harvest regulations and ensure that adequate numbers of fish are present to maintain viable populations.

Problems and Rationale for Research

The requirements of a barrier and waters barren of other trout initially restricts the greenback to habitation of headwater streams. These streams are usually shallow, high in elevation, low in temperature and have a highly variable annual flow regime. All these factors contribute to create a harsh environment for fish. Allen (1969) stated production in streams to be limited by a variety of processes including density dependent and density independent factors. Allen further believed limiting factors to include biological, chemical and physical processes that vary greatly from stream to stream because of the heterogeneity of stream ecosystems. Larkin (1956) also found that many factors can limit fish production, but indicated that biological factors are often superseded by climatic conditions in controlling population size. Trout become lethargic in winter and search out deep water areas with cover to overwinter (Bjornn 1971, Chapman and Bjornn 1969). Here trout escape natural, climatic phenomenon like anchor ice and dewatering of shallow water areas. The importance of adequate overwintering habitat to survival of stream salmonids has been well documented for all age classes. Mason (1976) found production of juvenile coho salmon (Onchorynchus kisutch) could be increased several fold through supplemental feeding but lack of sufficient overwintering area resulted in population numbers equal to the natural carrying capacity of the stream. Chapman and Knudsen (1980) report that channelization and livestock impacts significantly reduced winter habitat quality and numbers of cutthroat trout longer than 70 mm in length. Habitat modifications to increase pool area and bank cover in Wisconsin increased biomass of Age II+ brook trout by 141%, primarily because of increased over-winter survival (Hunt 1971). Chapman (1966) speculated that due to the territorial nature of stream salmonids, a minimum amount of living space

is required and that space available to escape the rigors of winter may regulate the density of fish populations. Because of the harsh nature of the high mountain streams available for greenback introductions, it is believed that habitat, particularly overwinter habitat, is one of the most important population regulation mechanisms.

The habitat evaluation work proposed will attempt to quantitatively define the physical habitat variables that impose limitations on a population of trout in headwater streams. Recent years have seen a variety of predictive models and assessments produced that can be used with varying success to correlate fish population parameters with habitat quality. A method developed by the Instream Flow Group of the USFWS and another by Hooper (1973) equate changes in flow regime to fish populations, so the effects of water development projects can be quantified. The Habitat Quality Index developed by Binns and Eisermann (1979) has been used in the same manner and can also be used as a survey technique when conventional fish sampling methods prove ineffective. Platts (1974) devised a scheme to evaluate stream ecosystems by geomorphic classification. Oswood and Barber (1982) have developed a method of habitat evaluation using diagramatic mapping of stream features important to a salmonid population. The underlying purpose of these methodologies is to accurately predict how production or standing crop levels of fish are controlled by a variety of biological, chemical and physical variables and how changes in these variables impart changes (positive or negative) to the productive capacity of a stream, group of streams or ecosystems.

Despite a plethora of habitat evaluation work, relatively little data has been collected on small, headwater streams. It would be erroneous to assume habitat parameters that limit trout population biomass and numbers in headwater streams are the same, or can be compared on a proportional

basis to limiting parameters in larger, downstream reaches. Many methods use qualitative, subjective measurements that reduce the predictive capabilities of the method. Also, studies limited to one stream may not represent enough of a range of stream environments to reveal true limiting factors. Rinne (1982) expressed this and other concerns in a critique of his habitat evaluation work on headwater trout streams.

It is generally agreed that physical variables are the most predictive of habitat quality and spatial variation of populations of stream salmonids (Hall and Knight 1981). Although biological and chemical parameters are undoubtedly important in the production scheme, exhibition of gross daily, seasonal and annual changes reduce predictive capability. Binns and Eiserman (1979) stated, "In reality, any investigation of limiting factors on a trout stream is controlled more by man's ability to measure than by theoretical considerations as to the true, dominant limiting factors." Thus, physical variables are favored because of relative ease of accurate measurement and exhibition of the least amount of change. Important habitat variables to be measured or calculated are listed below (see also data sheets).

Temperature
Elevation
Length of stream
Gradient
Canopy cover
Flows (maximum, minimum)
Pool-riffle ratio
Meander factor
Pool and riffle area
Pool and riffle volume
Cover (%, area, volume)

Objectives

1) Determine the relationship of fish resource factors (biomass, mean size, maximum size, numbers) to physical habitat variables.
2) Develop an evaluation techniques to monitor greenback population stability.
3) Develop a simple model or rating system for habitat measurements that can predict trout biomass in headwater streams.

Null Hypotheses

1) Fish resource factors are not correlated with habitat quality as measured by physical characteristics of streams.

Fulfillment of said objectives should yield much useful information for the management of greenback cutthroat trout. Evaluation of a large number of variables may yield a combination of a few that are highly predictive for good trout habitat. Variables such as elevation, gradient, watershed size and temperature will guide future selection of introduction sites for greenbacks. Definition of microhabitat preferences will also facilitate introduction site selection and identify reasons for spatial variation of stream salmonids. Limiting habitat such as overwinter cover can be quantitatively determined and remedial measures (habitat improvements) taken to improve both existing populations and enhance marginal habitat. Fish collection data will describe age and size structure of naturally equillibrated trout populations. Sampling in subsequent years should provide data to assess natural, temporal variation in salmonid populations and alert management biologist when a population is being impacted by anthropogenic influences. Eventual delistment of the species and subsequent subjection to fishing will require that regulation recommendations be made. A large data base of fish population statistics will determine the fishery potential of greenback streams and generate effective management decisions.

Methods

High correlations obviate the need for careful measurement of both the fish resource and its habitat. A number of stream reaches (1-3) 100 m in length will be selected within the stream to be evaluated. Location and number of stream reaches will depend primarily on length of the stream and

complexity and diversity of the habitat. Each pool and riffle in all study sections will be coded with numbered flagging tape and electrofished three times. Block-nets will be used where necessary to prevent fish movement from a given pool or riffle. In the streams to be evaluated, effective sampling is facilitated by small size and will be assumed to be 100% effective. Fish will be held in live cages until electrofishing is completed. Fish Age I and older will be weighed and measured and this information recorded for the fish from each coded pool and riffle. When fish data are collected for each study section, habitat measurements will ensue using modifications of methodologies from Stewart (1970) and Wesche (1976). Transects will be taken perpendicular to flow and equidistant along the length of each pool or riffle and will measure width, depth, maximum depth and substrate types. The number of transects taken per pool or riffle depend upon length and complexity of the section and will follow the guidelines listed below.

Pools (P)	Riffles (R)
$P \leq 5$ ft. = 2 transects	$R \leq 10$ ft. = 2 transects
5th $\leq P \leq 10$ ft. = 3 transects	10 ft. $\leq R \leq 20$ ft. = 3 transects
10 ft $\leq P \leq 20$ ft. = 4 transects	20 ft. $\leq R \leq 40$ ft. = 4 transects
$P \geq 20$ ft. = 5 transects	$R \geq 40$ ft. = 5 transects

Readings across transects less than 10 ft. wide will be taken every foot and at 10% of total width for transects greater than 10 ft. wide.

The importance of cover to stream trout populations has been well documented (Boussu 1954, Hunt 1969, Lewis 1969, Bjornn 1980) and will be critically analyzed. Cover is defined as anything that provides overhead protection and/or a resting place for fish. Instream cover measurements will consist of structure such as underwater, overhanging rock cover, debris jams and survace turbulence.

Bank cover will primarily be overhanging banks caused by water undercutting and vegetation close to the surface of the water. All measurements will be taken in three dimensions to allow calculation of both areal and volumetric cover space. Once data is collected the fish resource factors (maximum size, mean size, biomass and numbers) will be correlated with the physical habitat variables in a stepwise multiple regression analysis (Draper and Smith 1966) to determine what combination of physical habitat variables are indicative of resource factors.

In order to be an effective evaluation technique, correlations must be consistent not only within study sections of the same stream, but between all streams studied. This will require study streams to have populations that have reached natural equillibrium (e.g. not recently stocked) and have little artificial perturbation (e.g., fishing pressure). This should ensure that fish are present in the sizes and numbers that will yield accurate correlations with habitat parameters. An effort will be made to examine streams and study sections that exhibit extremes in environmental conditions such as high vs. low elevation and fluctuating flow and temperature regimes so that true habitat preferences and limitations will be exhibited and measured. Ideally, measurement of limiting habitat factors should be performed during the entire year, but resources and climatic conditions do not permit this type of sampling. Both fish populations and habitat parameters will be measured during low flow conditions (August-October). Although it may be argued that this does not adequately represent periods of high stress, it is a time when sampling is facilitated and low flows limit the amount of physical habitat available.

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Equipment List

(2) Backpack electroshocker

(1) Flow meter

(1) 150 ft. tape reel

(6) 20 ft. block nets

(6) collapsible fish cages

(2) dip nets

(1) water chemistry kit

(2) measuring boards

(2) scale to weigh fish

(1) collapsible ruler

(1) clinometer

(1) densitometer

flagging tape

waders

maps

miscellaneous camping equipment

scale envelopes

Appendix B: Field forms

STUDY SECTION DATA SHEET

Stream _____ County _____ Location _____

Date(s) _____

Time _____ Photo No's _____ Section No. _____

Team _____

_____

WATERSHED DESCRIPTION

Area _____ Vegetation _____

Condition _____

_____

CHEMICAL ANALYSIS

DO _____ppm ALK _____mg/l PH _____ Turbidity _____

Other _____

_____

BIOTA

Reparian spp, extent (% shade) _____

Aquatic plant spp. _____

_____

PHYSICAL CHARACTERISTICS

Section length _____ Stream length _____ Temp (F°) _____

Grad.(Sect.) _____ Grad.(Whole) _____ Stream order _____

Discharge _____ Barrier _____

Elevation(Sect.) _____ Elevation(Whole) _____to_____ Meander factor _____

_____

NOTES (beaver dams, tribs., barrier dams (size, location)):

COVER ANALYSIS DATA SHEET

DATE __/__/__ STREAM _____ PICTURE NO. _____ TEAM _____

LENGTH OF SECTION _____ CODE NO. _____

Bank or Instream	Type	Dimensions (1)(w^n)(d^n)	% Shade	Flow data

LENGTH OF SECTION _____ CODE NO. _____

Bank or Instream	Type	Dimensions (1)(w^n)(d^n)	% Shade	Flow data

TRANSECT DATA SHEET

DATE __/__/__ STREAM _____ TEAM _____ PICTURE NO. _____

CODE _____ Transect No. _____ of _____ Length site ___ ___ ___

Distance ( )	Width ( )	Depth ( )	Substrate	Flow Data

CODE _____ Transect No. _____ of _____ Length site ___ ___ ___ .

Distance ( )	Width ( )	Depth ( )	Substrate	Flow Data

Appendix C: Transect habitat data summary for Como Creek and Black Hollow Creek

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PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
TRANSECT DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	LENGTH OF STATION	WIDTH OF STATION	DEPTH OF STATION	MAXIMUM DEPTH FT	SURFACE AREA FT 2	VOLUME FT 3	BOULDER %	RUBBLE %	GRAVEL %	SAND %	SILT %	VEGE-TATION %	DEBRIS %
BLACK HOLLOW - B -	POOL	POOL 1													
		AVERAGE	7.00	11.50	.36	1.00	80.50	28.91	54.35	32.63	10.88	2.17	0	0	0
		POOL 2													
		AVERAGE	9.00	9.30	.91	1.55	83.67	77.03	38.89	38.89	16.67	3.70	1.85	0	0
		POOL 3													
		AVERAGE	12.00	9.22	.67	1.40	110.67	73.91	32.71	45.06	17.28	1.23	3.70	0	0
		POOL 4													
		AVERAGE	13.00	9.16	.67	1.40	119.09	79.23	42.45	38.81	13.13	3.74	1.87	0	0
		POOL 5													
		AVERAGE	8.50	13.60	.46	.80	115.58	53.22	38.43	34.48	14.80	4.96	7.32	0	0
		POOL 6													
		AVERAGE	8.50	9.51	.56	.90	80.84	45.24	15.90	51.32	24.85	5.33	2.62	0	0
		POOL 7													
		AVERAGE	6.00	15.80	.49	1.20	94.78	46.93	20.64	50.42	20.83	4.97	0	0	0

PREPARED ON 83/05/28.

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BLACK HOLLOW - B -	POOL	(CONT.) (CONT.) POOL 8													
		AVERAGE	7.00	9.74	.61	1.00	68.16	40.86	25.44	44.74	25.44	1.75	2.63	0	0
		POOL 9													
		AVERAGE	5.00	9.50	.59	.90	47.50	28.25	39.17	47.50	11.66	1.66	0	0	0
	AVERAGE		8.58	11.18	.59	1.55	93.05	54.27	34.65	41.97	16.94	3.47	2.54	0	0
	RIFFLE	RIFFLE 1													
		AVERAGE	61.00	7.74	.40	.85	471.95	187.25	33.34	32.34	19.65	14.66	0	0	0
		RIFFLE 2													
		AVERAGE	188.00	10.44	.34	1.15	1962.13	605.82	51.34	24.01	11.99	10.38	1.75	0	0
		RIFFLE 3													
		AVERAGE	81.00	9.25	.36	1.40	749.25	270.01	36.96	38.48	22.49	.70	1.38	0	0
		RIFFLE 4													
		AVERAGE	95.00	11.39	.39	.70	1082.17	422.81	23.91	36.91	25.95	10.40	2.84	0	0

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BLACK HOLLOW - B -	RIFFLE	(CONT.) (CONT.) RIFFLE 5													
		AVERAGE	24.00	12.47	.26	.55	299.35	78.00	46.01	31.85	18.47	2.32	1.35	0	0
	AVERAGE		98.94	10.31	.35	1.40	1014.36	343.72	38.89	32.11	19.27	8.05	1.54	0	0
AVERAGE			51.57	10.76	.47	1.55	531.39	191.98	36.67	37.28	18.05	5.65	2.07	0	0
COMO CREEK - A -	POOL	POOL 1													
		AVERAGE	4.50	2.68	.34	.65	12.07	4.05	0	72.00	5.45	5.45	0	0	0
		POOL 2													
		AVERAGE	3.00	14.00	.36	.90	42.00	15.30	5.36	5.36	23.21	50.00	16.07	0	0
		POOL 3													
		AVERAGE	24.00	14.41	.40	1.15	345.88	125.33	10.29	4.41	8.82	79.41	70.59	0	0
		POOL 4													
		AVERAGE	36.00	8.04	.39	1.00	289.42	106.80	3.95	8.92	28.66	46.64	11.84	0	0
		POOL 5													
		AVERAGE	9.00	6.80	.35	.75	61.20	20.79	23.33	33.33	25.00	18.33	0	0	0

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COMO CREEK - A -	POOL	(CONT.) (CONT.) POOL 6													
		AVERAGE	12.00	4.83	.63	1.30	58.00	36.31	18.15	23.82	37.15	21.60	0	0	0
		POOL 7													
		AVERAGE	7.00	8.69	.65	1.35	60.85	38.94	17.31	23.08	25.00	34.62	0	0	0
		POOL 8													
		AVERAGE	19.00	7.19	.50	1.00	136.69	69.91	5.56	15.91	38.26	33.33	1.39	0	0
		POOL 9													
		AVERAGE	28.00	8.13	.48	.95	227.50	107.33	11.03	18.34	30.69	22.70	17.22	0	0
	AVERAGE		18.80	9.01	.46	1.35	168.40	70.87	10.00	17.59	25.85	38.83	16.29	0	0
	RIFFLE	RIFFLE 1													
		AVERAGE	32.00	5.93	.24	.60	189.79	44.76	18.97	27.87	20.98	11.49	0	0	0
		RIFFLE 2													
		AVERAGE	14.00	3.73	.36	1.00	52.27	18.48	6.35	23.34	31.07	21.81	1.27	0	0

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COMO CREEK - A -	RIFFLE	(CONT.) (CONT.) RIFFLE 3													
		AVERAGE	29.00	6.36	.23	.60	184.44	40.69	33.87	34.93	25.86	5.33	0	0	0
		RIFFLE 4													
		AVERAGE	31.00	7.16	.26	.55	221.98	61.00	10.71	32.69	42.16	14.42	0	0	0
		RIFFLE 5													
		AVERAGE	40.00	7.00	.19	.55	280.00	55.84	15.57	35.18	39.86	1.96	0	0	0
		RIFFLE 6													
		AVERAGE	15.00	8.91	.24	.75	133.61	31.84	25.85	46.44	19.21	8.50	0	0	0
		RIFFLE 7													
		AVERAGE	37.00	5.72	.21	.33	211.54	44.03	18.39	28.76	28.43	19.73	0	0	0
	AVERAGE		29.12	6.60	.24	1.00	190.50	44.14	19.16	33.40	29.60	11.11	.11	0	0
AVERAGE			23.06	8.02	.37	1.35	177.51	59.85	13.78	24.11	27.40	27.40	9.62	0	0
COMO CREEK - C -	POOL	POOL 1													
		AVERAGE	29.00	6.01	.54	1.30	174.39	90.71	0	3.33	51.26	41.51	3.89	0	0

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COMO CREEK - C -	POOL	(CONT.) (CONT.) POOL 2													
		AVERAGE	12.00	4.39	.72	1.73	52.71	37.38	0	36.40	52.89	10.71	0	0	0
		POOL 3													
		AVERAGE	9.00	6.90	.73	1.35	62.14	45.79	0	19.68	43.96	36.34	0	0	0
		POOL 4													
		AVERAGE	5.00	5.55	.41	.65	27.73	11.41	0	27.27	50.00	22.73	0	0	0
		POOL 5													
		AVERAGE	6.00	6.27	.84	1.73	37.62	31.77	22.47	49.40	28.10	0	0	0	0
		POOL 6													
		AVERAGE	27.50	8.60	.72	1.67	236.50	170.34	1.51	35.82	49.30	11.94	1.43	0	0
		POOL 7													
		AVERAGE	9.00	8.58	.39	.75	77.25	28.18	8.33	22.22	59.72	9.72	0	0	0
	AVERAGE		17.15	7.00	.62	1.73	122.97	76.91	3.68	25.35	49.16	20.67	1.13	0	0

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
TRANSECT DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	LENGTH OF STATION	WIDTH OF STATION	DEPTH OF STATION	MAXIMUM DEPTH FT	SURFACE AREA FT 2	VOLUME FT 3	BOULDER %	RUBBLE %	GRAVEL %	SAND %	SILT %	VEGE-TATION %	DEBRIS %
COMO CREEK - C -	(CONT.) (CONT.) RIFFLE	RIFFLE 1													
		AVERAGE	22.00	7.13	.28	.60	156.77	43.63	2.32	7.02	82.48	8.19	0	0	0
		RIFFLE 2													
		AVERAGE	9.00	3.29	.25	.40	29.57	7.30	0	0	53.04	46.91	0	0	0
		RIFFLE 3													
		AVERAGE	68.00	6.64	.29	.55	451.27	128.84	3.03	37.88	47.68	11.41	0	0	0
		RIFFLE 4													
		AVERAGE	60.00	6.22	.28	.55	373.00	107.26	1.67	43.84	49.36	5.13	0	0	0
		RIFFLE 5													
		AVERAGE	65.00	5.95	.26	.50	386.75	100.70	6.67	32.95	48.46	10.13	1.79	0	0
	AVERAGE		53.36	6.27	.28	.60	337.38	93.86	3.28	30.20	55.09	10.98	.44	0	0
AVERAGE			33.58	6.67	.46	1.73	220.29	84.61	3.50	27.55	51.85	16.28	.81	0	0
COMO CREEK - B -	POOL	POOL 1													
		AVERAGE	13.00	6.58	.40	.75	85.53	33.29	5.26	30.70	35.96	22.81	5.26	0	0

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
TRANSECT DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	LENGTH OF STATION	WIDTH OF STATION	DEPTH OF STATION	MAXIMUM DEPTH FT	SURFACE AREA FT 2	VOLUME FT 3	BOULDER %	RUBBLE %	GRAVEL %	SAND %	SILT %	VEGE-TATION %	DEBRIS %
COMO CREEK - D -	POOL	(CONT.) (CONT.) POOL 2													
		AVERAGE	7.00	6.18	.56	1.00	43.29	24.03	4.38	64.30	15.99	8.29	7.02	0	0
		POOL 3													
		AVERAGE	8.00	3.55	.66	1.87	28.36	20.03	0	55.26	11.21	22.94	10.61	0	0
		POOL 4													
		AVERAGE	8.00	1.75	.41	.55	14.00	5.79	0	0	50.00	50.00	0	0	0
		POOL 5													
		AVERAGE	5.50	6.08	.35	.70	33.46	12.03	0	8.97	31.67	58.53	0	0	0
		POOL 6													
		AVERAGE	32.00	5.20	.40	1.07	166.40	63.70	0	0	64.45	35.56	0	0	0
		POOL 7													
		AVERAGE	18.00	4.79	.56	1.25	86.29	46.06	0	11.76	49.76	38.45	0	0	0
		POOL 8													
		AVERAGE	14.00	7.07	.69	1.05	99.00	71.10	0	30.39	32.77	36.83	0	0	0

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
TRANSECT DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	LENGTH OF STATION	WIDTH OF STATION	DEPTH OF STATION	MAXIMUM DEPTH FT	SURFACE AREA FT 2	VOLUME FT 3	BOULDER %	RUBBLE %	GRAVEL %	SAND %	SILT %	VEGE-TATION %	DEBRIS %
COMO CREEK - B -	POOL	(CONT.) (CONT.) POOL 9													
		AVERAGE	7.00	2.75	.34	.45	19.25	6.56	16.67	32.22	30.55	20.55	0	0	0
		POOL 10													
		AVERAGE	3.50	4.56	.56	.85	15.94	8.91	0	61.11	27.78	11.11	0	0	0
		POOL 11													
		AVERAGE	14.00	4.04	.29	.50	56.54	16.10	0	4.39	54.04	41.58	0	0	0
		POOL 12													
		AVERAGE	26.00	4.97	.40	.70	129.35	50.62	0	24.72	40.28	35.00	0	0	0
	AVERAGE		15.10	5.29	.48	1.87	79.95	37.24	1.66	27.21	37.75	31.27	2.05	0	0
	RIFFLE	RIFFLE 1													
		AVERAGE	2.50	8.00	.18	.23	20.00	3.65	0	175.00	25.00	0	0	0	0
		RIFFLE 2													
		AVERAGE	59.00	5.42	.19	.45	319.96	61.55	6.07	44.67	9.62	18.05	4.14	0	0

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
TRANSECT DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	LENGTH OF STATION	WIDTH OF STATION	DEPTH OF STATION	MAXIMUM DEPTH FT	SURFACE AREA FT 2	VOLUME FT 3	BOULDER %	RUBBLE %	GRAVEL %	SAND %	SILT %	VEGE-TATION %	DEBRIS %
COMO CREEK - B -	RIFFLE	(CONT.) (CONT.) RIFFLE 3													
		AVERAGE	3.50	6.00	.28	.45	21.00	5.95	0	16.67	58.33	25.00	0	0	0
		RIFFLE 4													
		AVERAGE	24.00	4.12	.27	.50	99.00	26.63	0	0	70.98	29.01	0	0	0
		RIFFLE 5													
		AVERAGE	13.00	6.33	.16	.33	82.33	12.66	0	30.76	42.94	2.78	0	0	0
		RIFFLE 6													
		AVERAGE	59.00	4.65	.28	.80	274.10	75.58	13.20	50.00	25.30	13.82	0	0	0
		RIFFLE 7													
		AVERAGE	14.00	4.00	.20	.30	56.00	11.20	0	54.16	29.16	16.66	0	0	0
	AVERAGE		36.89	5.27	.22	.80	185.93	41.85	4.84	42.33	32.30	15.13	1.10	0	0
AVERAGE			23.04	5.28	.39	1.87	118.56	38.92	2.82	32.72	35.76	25.39	1.70	0	0

Appendix D: Cover data summary for Como Creek and Black Hollow Creek

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
COVER DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	BANK COVER %	IN-STREAM COVER %	UNDER-CUT BANK %	OVER-HANG-VEG. %	SUR-FACE TURB. %	DEBRIS COVER %	ROCK COVER %	LOG COVER %	VEGE-TATION %	COVER AREA FT 2	DEPTH OF COVERED AREA	VOLUME COVERED FT 3	COVER AREA/ TOT AREA RATIO	COVER VOL./ TOT VOL. RATIO
COMO CREEK - D -	RIFFLE	(CONT.)														
		(CONT.)														
		RIFFLE 5														
		AVERAGE	50.00	50.00	50.00	0	0	0	0	0	50.00	8.30	.20	1.66	.101	.131
		PCTGT.5										50.00	0	50.00		
		PCTGT1.0										50.00		50.00		
		PCTGT2.0										50.00		0		
		PCTGT3.0										50.00		0		
		RIFFLE 6														
		AVERAGE	75.00	25.00	75.00	0	0	0	12.50	0	12.50	10.96	.29	3.32	.040	.044
		PCTGT.5										87.50	0	25.00		
		PCTGT1.0										37.50		12.50		
		PCTGT2.0										25.00		0		
		PCTGT3.0										0		0		
		RIFFLE 7														
		AVERAGE	0	100.00	0	0	0	50.00	50.00	0	0	1.82	.20	.36	.032	.032
		PCTGT.5										50.00	0	0		
		PCTGT1.0										50.00		0		
		PCTGT2.0										0		0		
		PCTGT3.0										0		0		
	AVERAGE		51.85	48.15	51.85	0	0	3.70	11.11	18.52	14.81	65.05	.29	18.28	.417	.548
	PCTGT.5											66.67	0	37.04		
	PCTGT1.0											48.15		22.22		
	PCTGT2.0											29.63		3.70		
	PCTGT3.0											18.52		3.70		
AVERAGE			57.33	42.67	52.00	2.67	0	10.67	8.00	17.33	9.33	139.1	.41	58.65	1.969	2.423
PCTGT.5												70.67	20.00	44.00		
PCTGT1.0												48.00		26.67		
PCTGT2.0												30.67		9.33		
PCTGT3.0												17.33		[illegible]		

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
COVER DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	BANK COVER %	IN-STREAM COVER %	UNDER-CUT BANK %	OVER-HANG-VEG. %	SUR-FACE TURB. %	DEBRIS COVER %	ROCK COVER %	LOG COVER %	VEGE-TATION %	COVER AREA FT 2	DEPTH OF COVERED AREA	VOLUME COVERED FT 3	COVER AREA/ TOT AREA RATIO	COVER VOL./ TOT VOL. RATIO
COMO CREEK - B -	(CONT.) (CONT.)															
	RIFFLE	RIFFLE 1														
		AVERAGE	100.0	0	100.00	0	0	0	0	0	0	.30	.50	.15	.015	.041
		PCTGT.5										0	0	0		
		PCTGT1.0										0		0		
		PCTGT2.0										0		0		
		PCTGT3.0										0		0		
		RIFFLE 2														
		AVERAGE	37.50	62.50	37.50	0	0	0	12.50	50.00	0	35.30	.31	9.84	.110	.160
		PCTGT.5										75.00	0	62.50		
		PCTGT1.0										75.00		37.50		
		PCTGT2.0										50.00		12.50		
		PCTGT3.0										37.50		12.50		
		RIFFLE 3														
		AVERAGE	50.00	50.00	50.00	0	0	0	0	50.00	0	.90	.25	.22	.043	.037
		PCTGT.5										0	0	0		
		PCTGT1.0										0		0		
		PCTGT2.0										0		0		
		PCTGT3.0										0		0		
		RIFFLE 4														
		AVERAGE	50.00	50.00	50.00	0	0	0	0	0	50.00	7.46	.33	2.73	.075	.102
		PCTGT.5										75.00	0	50.00		
		PCTGT1.0										50.00		25.00		
		PCTGT2.0										25.00		0		
		PCTGT3.0										25.00		0		

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
COVER DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	BANK COVER %	IN-STREAM COVER %	UNDER-CUT BANK %	OVER-HANG-VEG. %	SUR-FACE TURB. %	DEBRIS COVER %	ROCK COVER %	LOG COVER %	VEGE-TATION %	COVER AREA FT 2	DEPTH OF COVERED AREA	VOLUME COVERED FT 3	COVER AREA/ TOT AREA RATIO	COVER VOL./ TOT VOL. RATIO
COMO CREEK - B -	POOL	(CONT.)														
		(CONT.)														
		POOL 10														
		AVERAGE	0	100.00	0	0	0	66.67	0	33.33	0	1.34	.43	.73	.084	.082
		PCTGT.5										33.33	33.33	33.33		
		PCTGT1.0										0		0		
		PCTGT2.0										0		0		
		PCTGT3.0										0		0		
		POOL 11														
		AVERAGE	80.00	20.00	80.00	0	0	20.00	0	0	0	12.81	.46	7.06	.227	.439
		PCTGT.5										100.0	40.00	80.00		
		PCTGT1.0										80.00		40.00		
		PCTGT2.0										40.00		40.00		
		PCTGT3.0										40.00		20.00		
		POOL 12														
		AVERAGE	100.0	0	100.00	0	0	0	0	0	0	11.75	.57	6.69	.091	.132
		PCTGT.5										*	66.67	100.00		
		PCTGT1.0										*		100.00		
		PCTGT2.0										*		66.67		
		PCTGT3.0										*		0		
	AVERAGE		60.42	39.58	52.08	4.17	0	14.58	6.25	16.67	6.25	74.06	.48	40.37	1.552	1.875
	PCTGT.5											72.92	31.25	47.92		
	PCTGT1.0											47.92		29.17		
	PCTGT2.0											31.25		12.50		
	PCTGT3.0											16.67		4.17		

PREPARED ON 83/05/28.

GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
COVER DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	BANK COVER %	IN-STREAM COVER %	UNDER-CUT BANK %	OVER-HANG-VEG. %	SUR-FACE TURB. %	DEBRIS COVER %	ROCK COVER %	LOG COVER %	VEGE-TATION %	COVER AREA FT 2	DEPTH OF COVERED AREA	VOLUME COVERED FT 3	COVER AREA/ TOT AREA RATIO	COVER VOL./ TOT VOL. RATIO
COMO CREEK - B -	POOL	(CONT.)														
		(CONT.)														
		POOL 6														
		AVERAGE	100.0	0	60.00	0	0	20.00	0	20.00	0	5.75	.50	3.07	.035	.048
		PCTGT.5										80.00	40.00	20.00		
		PCTGT1.0										40.00		20.00		
		PCTGT2.0										20.00		0		
		PCTGT3.0										0		0		
		POOL 7														
		AVERAGE	25.00	75.00	25.00	0	0	25.00	0	0	50.00	8.55	.68	6.19	.099	.134
		PCTGT.5										100.0	50.00	75.00		
		PCTGT1.0										75.00		50.00		
		PCTGT2.0										50.00		25.00		
		PCTGT3.0										25.00		25.00		
		POOL 8														
		AVERAGE	75.00	25.00	75.00	0	0	12.50	0	12.50	0	7.75	.49	3.95	.078	.056
		PCTGT.5										100.0	25.00	37.50		
		PCTGT1.0										37.50		12.50		
		PCTGT2.0										12.50		0		
		PCTGT3.0										0		0		
		POOL 9														
		AVERAGE	66.67	33.33	66.67	0	0	0	33.33	0	0	7.21	.33	2.66	.375	.405
		PCTGT.5										66.67	0	66.67		
		PCTGT1.0										66.67		33.33		
		PCTGT2.0										66.67		0		
		PCTGT3.0										33.33		0		

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GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
COVER DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	BANK COVER %	IN-STREAM COVER %	UNDER-CUT BANK %	OVER-HANG-VEG. %	SUR-FACE TURB. %	DEBRIS COVER %	ROCK COVER %	LOG COVER %	VEGE-TATION %	COVER AREA FT 2	DEPTH OF COVERED AREA	VOLUME COVERED FT 3	COVER AREA/ TOT AREA RATIO	COVER VOL./ TOT VOL. RATIO
COMO CREEK - D -	POOL	(CONT.)														
		(CONT.)														
		POOL 2														
		AVERAGE	50.00	50.00	50.00	0	0	0	0	50.00	0	5.60	.55	3.10	.129	.129
		PCTGT.5										100.0	50.00	100.00		
		PCTGT1.0										100.0		100.00		
		PCTGT2.0										100.0		0		
		PCTGT3.0										0		0		
		POOL 3														
		AVERAGE	100.0	0	100.00	0	0	0	0	0	0	4.44	.87	4.04	.157	.202
		PCTGT.5											100.00	100.00		
		PCTGT1.0										66.67		66.67		
		PCTGT2.0										33.33		33.33		
		PCTGT3.0										0		0		
		POOL 4														
		AVERAGE	50.00	50.00	0	50.00	0	0	25.00	0	25.00	1.50	.38	.60	.107	.104
		PCTGT.5										0	0	0		
		PCTGT1.0										0		0		
		PCTGT2.0										0		0		
		PCTGT3.0										0		0		
		POOL 5														
		AVERAGE	25.00	75.00	25.00	0	0	0	0	75.00	0	4.66	.33	1.44	.139	.120
		PCTGT.5										25.00	0	25.00		
		PCTGT1.0										25.00		0		
		PCTGT2.0										25.00		0		
		PCTGT3.0										25.00		0		

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GREENBACK CUTTHROAT TROUT
HABITAT ANALYSIS
COVER DATA SUMMARY

COLORADO DIVISION OF WILDLIFE

STREAM/ SECTION	HABITAT	HABITAT ID	BANK COVER %	IN-STREAM COVER %	UNDER-CUT BANK %	OVER-HANG-VEG. %	SUR-FACE TURB. %	DEBRIS COVER %	ROCK COVER %	LOG COVER %	VEGE-TATION %	COVER AREA FT 2	DEPTH OF COVERED AREA	VOLUME COVERED FT 3	COVER AREA/ TOT AREA RATIO	COVER VOL./ TOT VOL. RATIO
COMO CREEK - C -	RIFFLE	(CONT.)														
		(CONT.)														
		RIFFLE 5														
		AVERAGE	30.00	70.00	30.00	0	0	30.00	10.00	0	30.00	13.70	.27	3.79	.035	.038
		PCTGT.5										90.00	0	10.00		
		PCTGT1.0										30.00		10.00		
		PCTGT2.0										10.00		0		
		PCTGT3.0										10.00		0		
	AVERAGE		40.32	58.06	32.26	12.90	0	25.81	24.19	4.84	16.13	66.13	.27	22.79	.197	.266
	PCTGT.5											48.39	3.23	11.29		
	PCTGT1.0											24.19		8.06		
	PCTGT2.0											11.29		6.45		
	PCTGT3.0											8.06		1.61		
AVERAGE			45.71	53.33	38.10	18.10	.95	24.76	20.95	4.76	14.29	149.0	.33	59.90	1.525	1.133
PCTGT.5												57.14	8.57	23.81		
PCTGT1.0												35.24		15.24		
PCTGT2.0												20.00		7.62		
PCTGT3.0												11.43		4.76		
COMO CREEK - D -	POOL	POOL 1														
		AVERAGE	25.00	75.00	25.00	0	0	25.00	25.00	25.00	0	2.70	.30	.83	.032	.025
		PCTGT.5										50.00	0	0		
		PCTGT1.0										25.00		0		
		PCTGT2.0										0		0		
		PCTGT3.0										0		0		