Fishery Data Series No. 05-62

Copper River Delta Trout Assessment

by

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December 2005

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 05-62

COPPER RIVER DELTA TROUT ASSESSMENT

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ABSTRACT

As part of a trout assessment project initiated in 2000, cutthroat *Oncorhynchus clarkii* and rainbow trout *O. mykiss* were sampled from the Copper River Special Management Area for Trout (CRSMT) on the Martin River Delta of Southcentral Alaska in 2001-2003. The objectives of the study were to assess length at age for trout in the CRSMT, observe trout movements, and gather information on the distribution of anadromous fish species in the area. Trout sampled in streams of the Clear Martin River in the southern half of the CRSMT were larger and older than trout from the northern streams. Recaptures of tagged trout showed movements within sub-drainages, but not movements between major northern and southern drainages. Cutthroat, rainbow, and cutthroat/rainbow hybrid trout were identified in the Clear Martin River, but cutthroat trout dominated the samples in the northern streams of the Glacial Martin River. Dolly Varden *Salvelinus malma* were common in all sampled streams, but Arctic grayling *Thymallus arcticus* and whitefish *Coregonus spp*. were found in only a few locations. Additionally, coho *O. kisutch*, sockeye *O. nerka*, chum *O. keta* and pink salmon *O. gorbuscha* were observed throughout the CRSMT.

Keywords: Cutthroat trout *Oncorhynchus clarkia*, rainbow trout *O. mykiss*, hybrid trout, Dolly Varden *Salvelinus malma*, Copper River Special Management Area for Trout (CRSMT), recapture, tagged trout, trout assessment project, Martin River Delta, Clear Martin River, and Southcentral Alaska.

INTRODUCTION

Chugach Alaska Corporation (CAC) has requested the construction of an access road to develop resources on their land near Carbon Mountain (Figure 1). The proposed road corridor extends approximately 72 km from the Copper River Highway at Clear Creek to the Bering River area, and crosses 47 km of U.S. Forest Service (USFS) land, 5 km of Eyak Village Corporation land, and about 14 km of CAC land. Road construction began in 1998 on the southeastern side of the Copper River near Clear Creek along the Copper River Highway, and it currently extends for 1.8 km, ending at Sheep Creek (Figure 2).

The proposed road corridor crosses over 250 streams and rivers, 48 of which have been identified as anadromous streams (Johnson et al. 2004). Other studies (Dirk Lange, USFS, Cordova, personal communication) and fish surveys documented in the Alaska Department of Fish and Game (ADF&G) Anadromous Stream Catalog (Johnson et al. 2004) show the presence of coho salmon *Oncorhynchus kisutch*, pink salmon *O. gorbuscha*, sockeye salmon *O. nerka*, Chinook salmon *O. tshawytscha*, chum salmon *O. keta*, rainbow trout *O. mykiss*, cutthroat trout *O. clarkii*, Dolly Varden *Salvelinus malma*, Arctic grayling *Thymallus arcticus*, longnose suckers (*Catostomus catostomus*), whitefish (*Coregonus* spp.), and hybrids of rainbow and cutthroat trout.

At the 1999 Alaska Board of Fisheries meetings, concerns over the road construction and the impact of recreational anglers on stocks of cutthroat trout in the pristine Martin River drainage of the eastern Copper River Delta prompted the establishment of the Copper River Special Management Area for Trout (CRSMT, Figure 1). This management plan (5 AAC 55.033) stipulates that only unbaited, single-hook, artificial lures are allowed in all fresh waters south of Miles Glacier, and east of the Copper River (excluding the Clear Creek drainage), and all waters draining into the Gulf of Alaska west of Cape Suckling. These waters are also designated as catch-and-release only for all trout species. The proposed road corridor falls within this area (Figure 2).

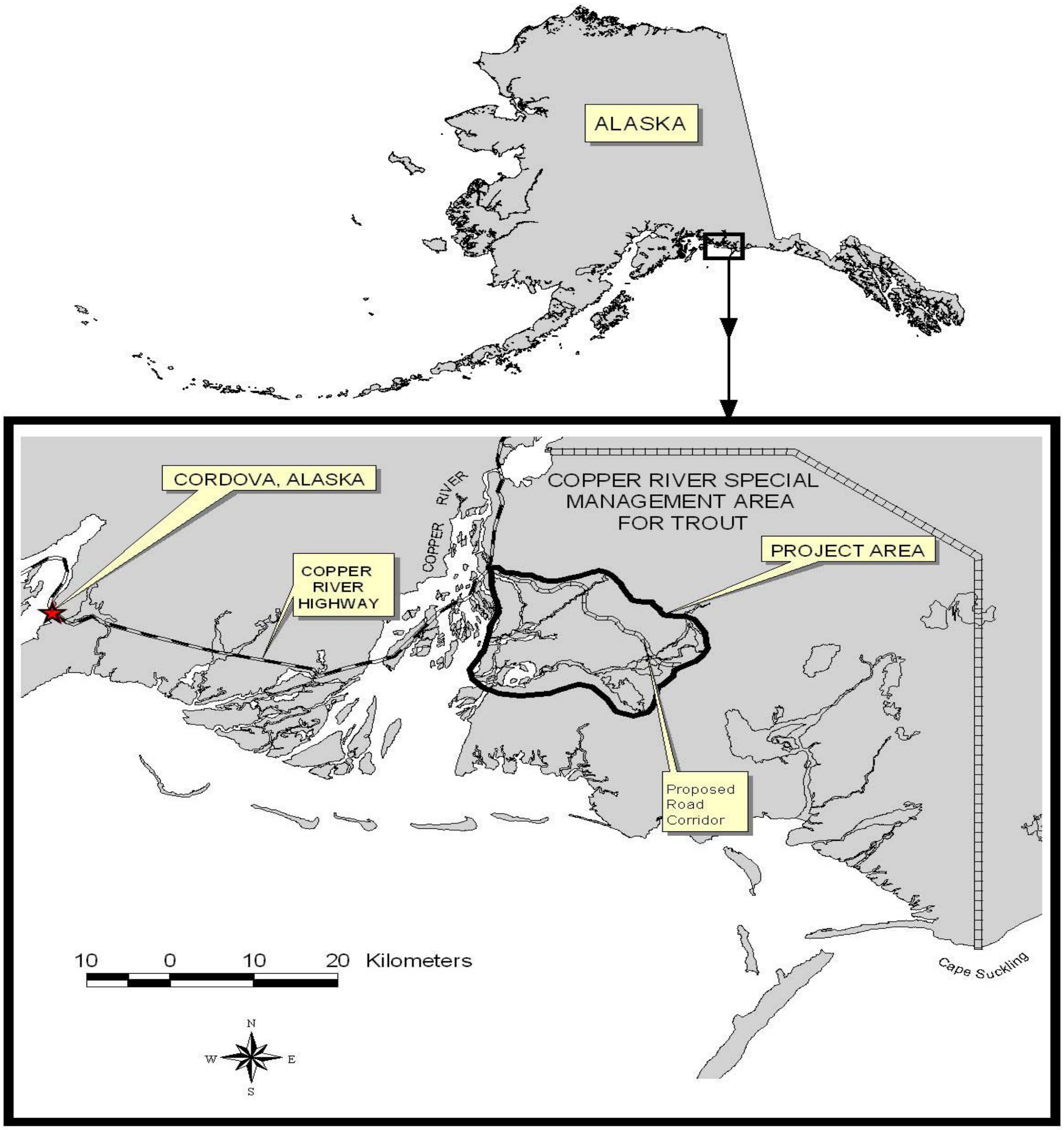


Figure 1.-Copper River Special Management Area for Trout, and project area.

A small preliminary sample of rainbow and cutthroat trout (n = 26) was captured in fall 2000 in the Martin Lake area and the study was then designed and continued in 2001-2003. Cutthroat and rainbow trout within the CRSMT were sampled to help understand the distribution, size, and movements of trout found in the area. Dolly Varden were also sampled, and all species seen were recorded in order to update the ADF&G Anadromous Stream Catalog. This information will help fishery managers craft regulations that provide for sustainable fisheries in the survey area.

OBJECTIVES

Objectives of the 2001-2003 study were to:

1. Sample trout among the drainages of the CRSMT and estimate length at age of the trout found in three strata within the area.
2. Floy™ tag all captured trout over 250 mm with a unique number to determine movement patterns from repeat captures.
3. Update the ADF&G Anadromous Stream Catalog with observations of all fish seen in the area.

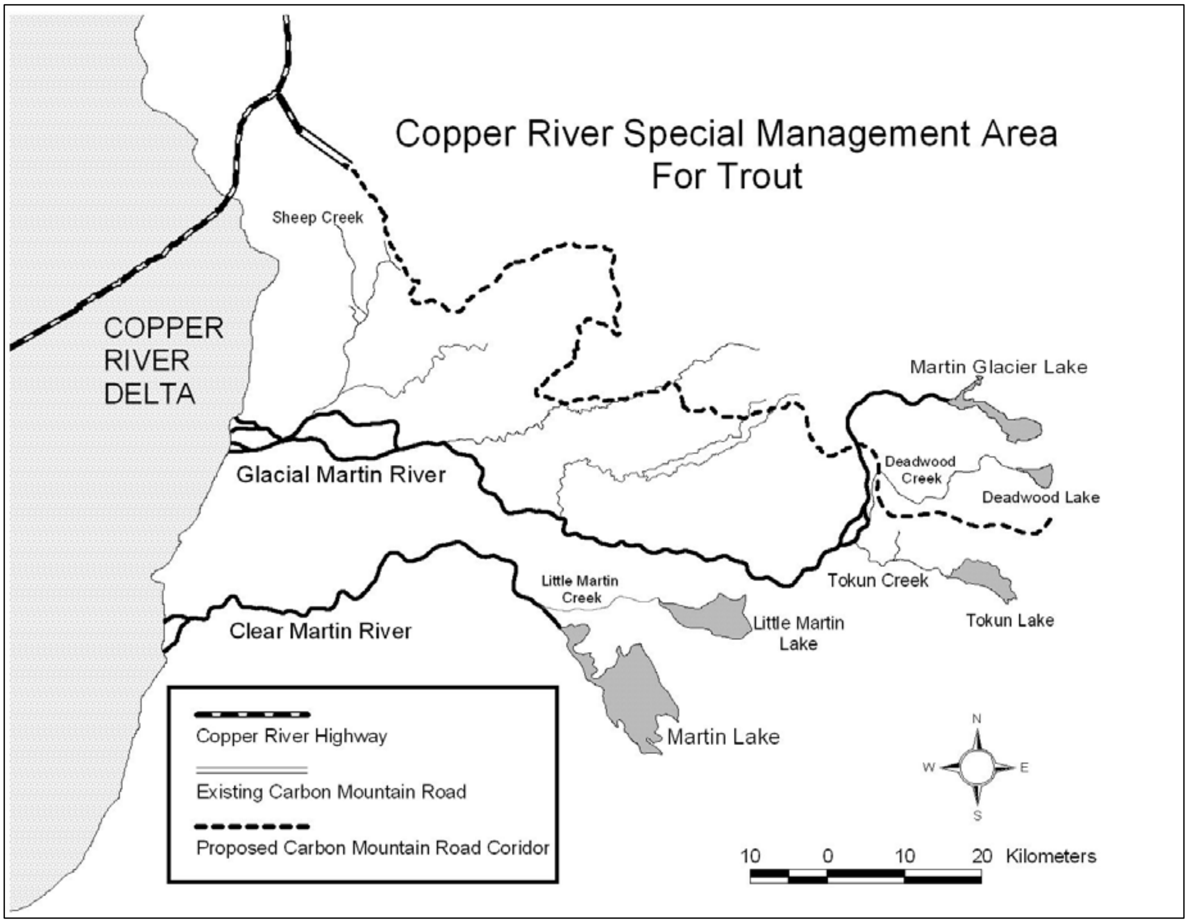


Figure 2.-Existing and proposed road corridor in relation to project area.

METHODS

The study area is located on the northeast side of the Copper River Delta in Southcentral Alaska (Figure 1). The Copper River flows across its delta into the Gulf of Alaska near Prince William Sound. Two main drainages flow through the CRSMT, the Glacial Martin River on the north side, and the Clear Martin River on the south. The Glacial Martin River originates from a lake at the terminus of the Martin Glacier, and has two large tributaries, Johnson and Sheep creeks. Many smaller clearwater creeks also drain from the northern mountains, cross open marshes of beaver dam-complex bottomlands, and flow into the Glacial Martin River. The Glacial Martin River flows into the Copper River 28 km from the sea and is 6 km north of the Clear Martin River mouth. The Clear Martin River originates from two lakes, Martin Lake and Little Martin Lake, on the south side of the study area. Both lakes are clear with little glacial melt-water. Little Martin Lake Creek flows into the Clear Martin River 2 km below the Martin Lake outlet. The Clear Martin River flows directly into the Copper River 22 km from the sea.

The study was conducted from 2001-2003. Sampling in 2001 consisted of one 4-day trip to Martin Lake. In 2002 multiple trips were made to all strata of the study area. In 2003 the study area was divided into three geographic sampling strata (Figure 3), and sampling trips were conducted with the objective of obtaining discrete samples from these strata for comparison. These geographic strata were: the northwestern tributaries of the Glacial Martin River (Stratum A); the northeastern tributaries and lakes of the Glacial Martin River (Stratum B); and the Clear Martin River and its associated lakes and tributaries (Stratum C; Figure 3).

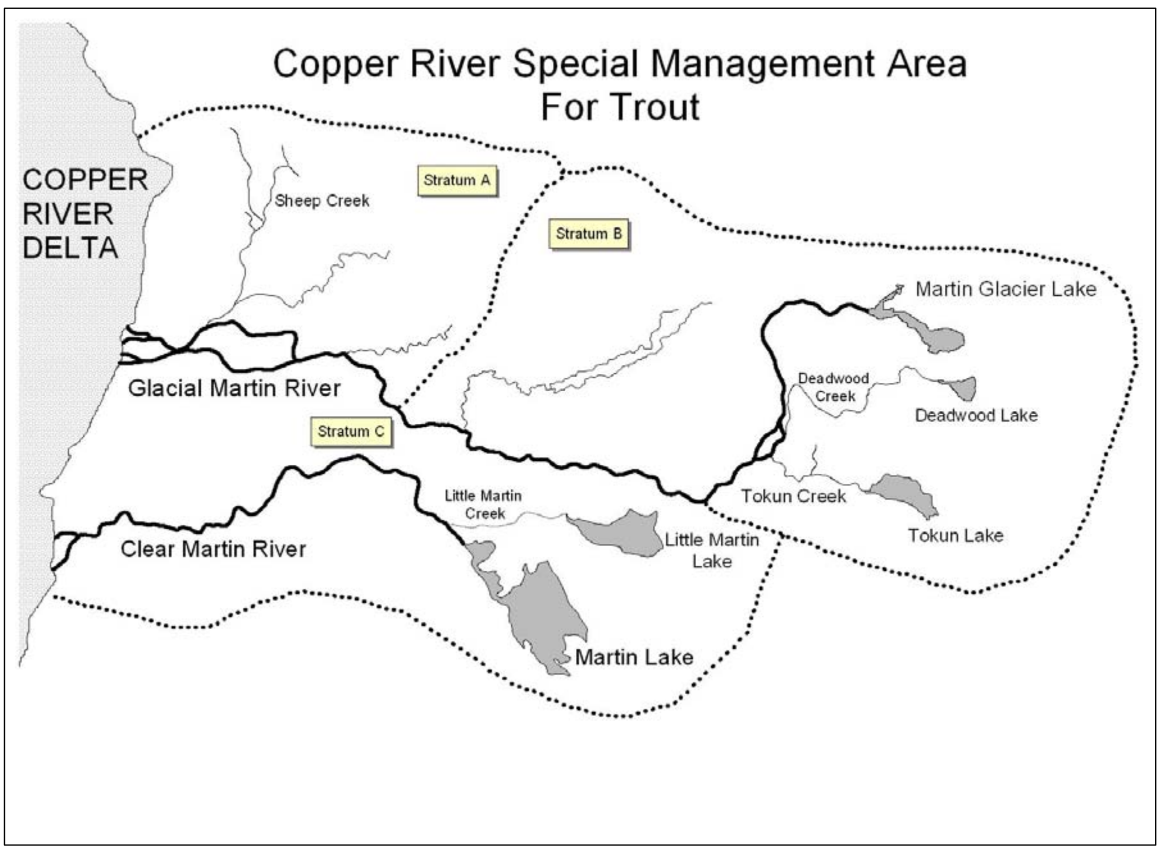


Figure 3.-Geographic sampling strata for trout in the CRSMT in 2003.

Sport fishing gear (hook and line), and baited hoop traps were used to sample trout. Preliminary studies identified woody debris structures, cut-bank holes, and small stream mouths as productive sample sites. Sampling locations within these habitats were chosen to maximize sample size in each stratum and were dispersed throughout the accessible portions of each stratum. Traps were baited with salmon roe and set in the beginning of a sample day, and then pulled at the end of the day. Hook-and-line samplers were instructed to move to new location if the site became unproductive while using hook-and-line gear, but traps were left in one location each day. In each case one sampler used spinning gear and one used fly gear. The same two crew members were used throughout the study with occasional help from an additional volunteer. Volunteers always used a combination of spinning and fly gear. Trout captured with traps were differentiated from hook-and-line capture in the database.

All captured trout were measured to the nearest millimeter FL, sampled for scales, and examined for obvious signs of sexual maturity (i.e., fish exuding mature gametes during handling). All trout ≥250 mm FL were marked with a uniquely numbered Floy™ tag if the fish were not overstressed during capture. All fish were examined for tags from previous captures or scars indicating that a tag may have been lost. Sampling locations were documented with GPS readings, notes and markings on field maps, and photography, in such a way that a specific location could be associated with each unit of effort or fish sampled. Movement distances of recaptured fish were measured with mapping software (National Geographic Topo™) from the GPS points and tracks created along each stream during sampling. For mean movement distance, two values were calculated, all movements were pooled for an overall mean of all recaptures, and a mean was calculated using the averages of individual fish when multiple recaptures occurred. Species specific means were also calculated.

Scales were collected from the left side of the caudal peduncle (Brown and Bailey 1952; Laakso and Cope 1956) of each trout sampled. Prior to taking a scale sample, each fish was wiped with the blunt side of the knife to remove excess mucus at the scale collection site. A sample of 15-20 scales was removed from each fish and spread out on clear glass slides. The glass slides were stored inside a coin envelope and labeled with the date, species, and sample number. The large number of scales necessary is due to the high proportion of regenerated scales in cutthroat trout (Ericksen 1999; Moring et al. 1981).

Trout scale collection, preparation, and aging were done similar to methods described by Ericksen (1999). Each slide was examined by two readers. The scale with the most visible annuli on the slide was selected and its annuli counted. Disagreements between readers were discussed until a consensus was reached.

Additionally, in 2003 effort (hours of sampling for hook and line, hours fished for hoop traps) was recorded for each sampling day, and daily water temperatures were recorded at each sample site prior to sampling. Catch per unit effort (CPUE) was calculated as the number of fish caught per hour of sampling for each sample day. Sampling time began when hook-and-line fishing began or a trap was set, and ended when angling stopped or the trap was pulled. Time spent measuring fish was excluded from CPUE. Mean CPUE was calculated as the average of all daily CPUE for each stratum and capture method. Water temperature was sampled from the middle of the water column with a thermometer. If two or more sites were sampled in one day then a mean was used for that day's temperature. All sample sites for a particular day were within the same stratum. A yearly mean of the daily temperatures at capture sites per stratum was also calculated.

Analysis of variance (Neter et al. 1990) was used to test for differences in trout mean length between locations, gear types, years, and ages. For visual comparisons of size at age data between species and geographic strata, von Bertalanffy growth curves (LVB) were fitted with additive errors, where length at age *t* follows

$$L(t) = L_\infty \left[1 - e^{-\kappa(t-t_0)}\right],$$

and where L_∞, κ, and t_0 are the von Bertalanffy growth parameters (Quinn and Deriso 1999, p. 135).

RESULTS

Over the course of the 3-year study, all accessible stream habitats in the area were visited. In some cases headwater areas could not be visited due to the remoteness of the area, but some part of every stream was sampled. In June 2001, one sample trip of 4 days was conducted to Martin Lake. In July-August 2002, nine sampling trips, for a total of 16 days, were conducted to Sheep Creek, Johnson Creek, Tokun Lake, Little Martin Lake, Martin Lake, the Clear Martin River and several unnamed tributaries. During May-September 2003, 27 sampling trips for 51 sample days totaling 885 sampling hours were made to three separate geographic strata of the CRSMT (Table 1). Most of the northeastern portion of the study area (Stratum B) was inaccessible, or had little suitable trout habitat, so effort was concentrated on the other two strata.

Table 1.-CPUE for trout sampling in the CRSMT in 2003.

Gear	Stratum	Total Hours Fished	Total [a] Trout Caught	Mean [a] Trout CPUE
Trap	A	182	24	0.10
Trap	B	82	0	0.00
Trap	C	34	6	0.17
Trap Total		298	30	0.09
Hook-and-Line	A	369	126	0.76
Hook-and-Line	B	10	1	0.08
Hook-and-Line	C	208	141	0.88
Hook-and-Line Total		587	268	0.81
Grand Total		**885**	**298**	**0.55**

[a] Cutthroat, rainbow and hybrids; includes recaptures and escaped fish that were not measured.

In 2003, daily CPUE for trout ranged from 0 to 5.3 in Stratum A, 0 to 0.3 in Stratum B, and 0 to 6.0 in Stratum C. Mean CPUE per stratum for trout ranged from 0 to 0.88 (Table 1). Mean CPUE of the hook-and-line capture method for cutthroat trout ranged from 0.08 in Stratum B to 0.73 in Stratum A (Figure 4).

Species composition differed between fish captured by hoop trap versus those captured by hook and line ($\chi^2 = 9.5$, df = 3, P = 0.02, Table 2). Hoop traps captured relatively more Dolly Varden and fewer rainbow trout than were captured by hook and line. A total of 64 cutthroat and 19 rainbow trout were captured in hoop traps, and 207 cutthroat and 93 rainbow trout by hook and line.

A total of 29 cutthroat trout, 11 rainbow trout, and 1 Dolly Varden was captured in 2001 at Martin Lake; 50 cutthroat trout, 30 rainbow trout, 3 cutthroat-rainbow hybrids, 115 Dolly Varden, and 2 whitefish in 2002; and 192 cutthroat trout, 71 rainbow trout, 9 cutthroat-rainbow hybrids, 110 Dolly Varden, 2 whitefish, and 1 arctic grayling in 2003. Altogether, a total of 101 cutthroat and 109 rainbow trout in the Clear Martin River and associated lakes, and 169 cutthroat and 3 rainbow trout were captured in the tributaries of the Glacial Martin River (Figure 5). Only one cutthroat trout was sampled in the habitat-limited northeastern Stratum B. Species composition differed between samples from geographic strata (χ^2 = 12.8, df = 3, P < 0.0001). The Glacial Martin tributaries samples had very few rainbow and hybrid trout (Table 2).

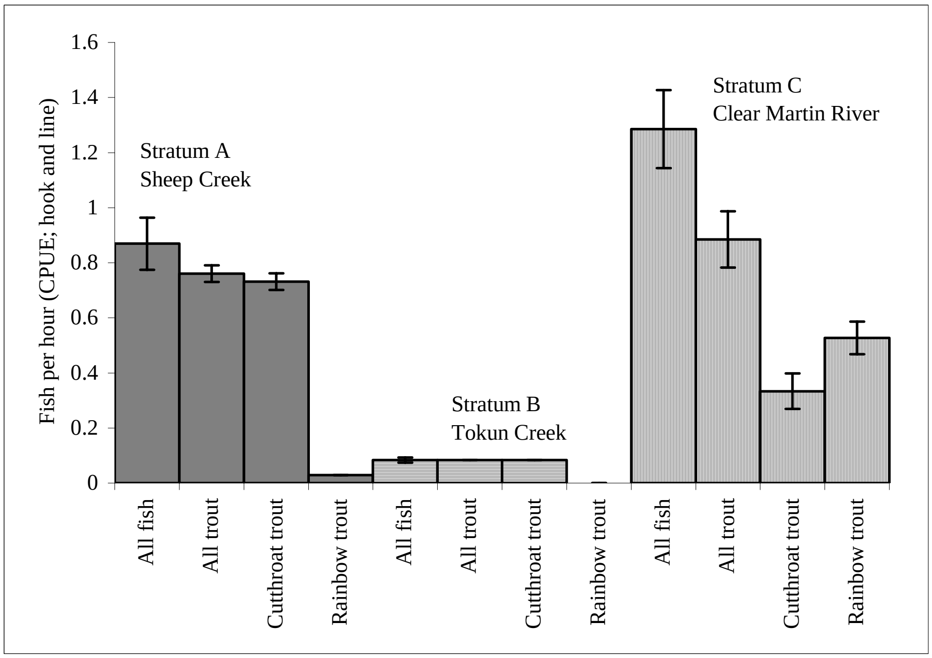
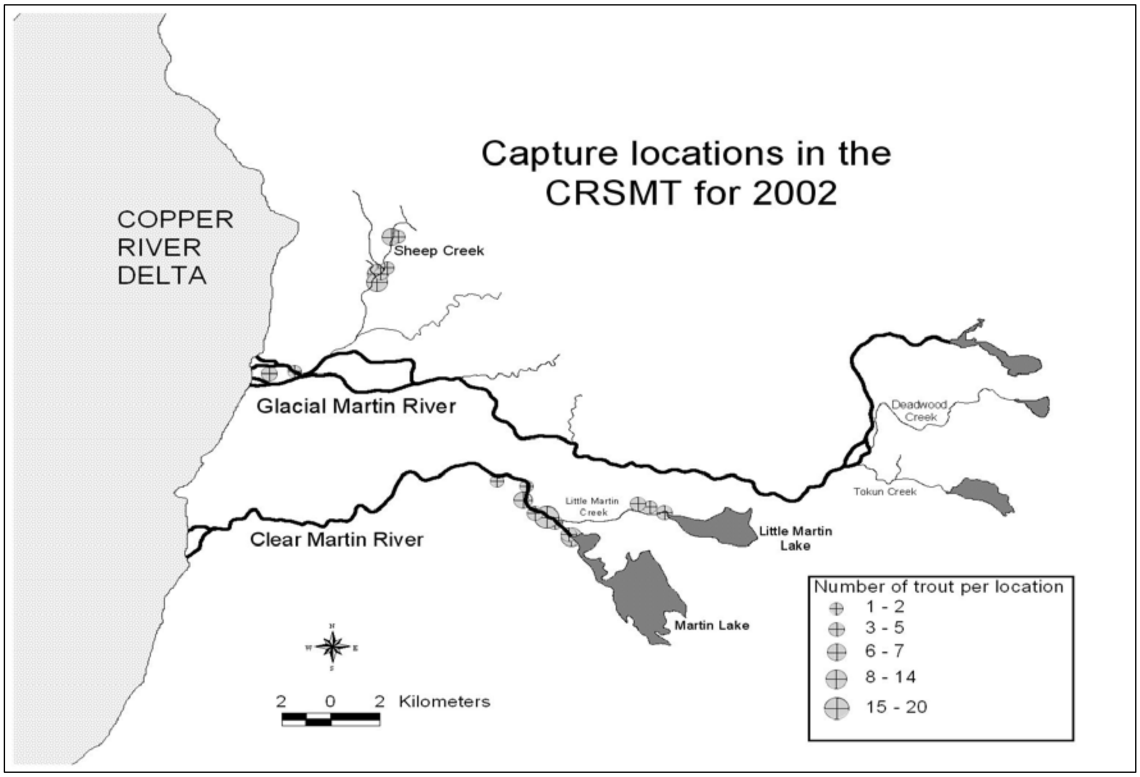


Figure 4.-CPUE by geographic stratum and species during sampling in 2003.

Table 2.-Number of fish captured by species and capture method, Copper River Delta study area, 2001-2003.

	Clear Martin River			Glacial Martin Tributaries		
	Hook and Line	Hoop Trap	Both	Hook and Line	Hoop Trap	Both
Cutthroat Trout (CT)	90	11	101	116	53	169
Rainbow Trout (RT)	90	19	109	3	0	3
CT/RT Hybrid	9	1	10	1	1	2
Dolly Varden	76	17	93	79	48	127
Total[a]	266	50	316	199	104	303

[a] Column sums include a total of 1 Arctic grayling and 4 whitefish.



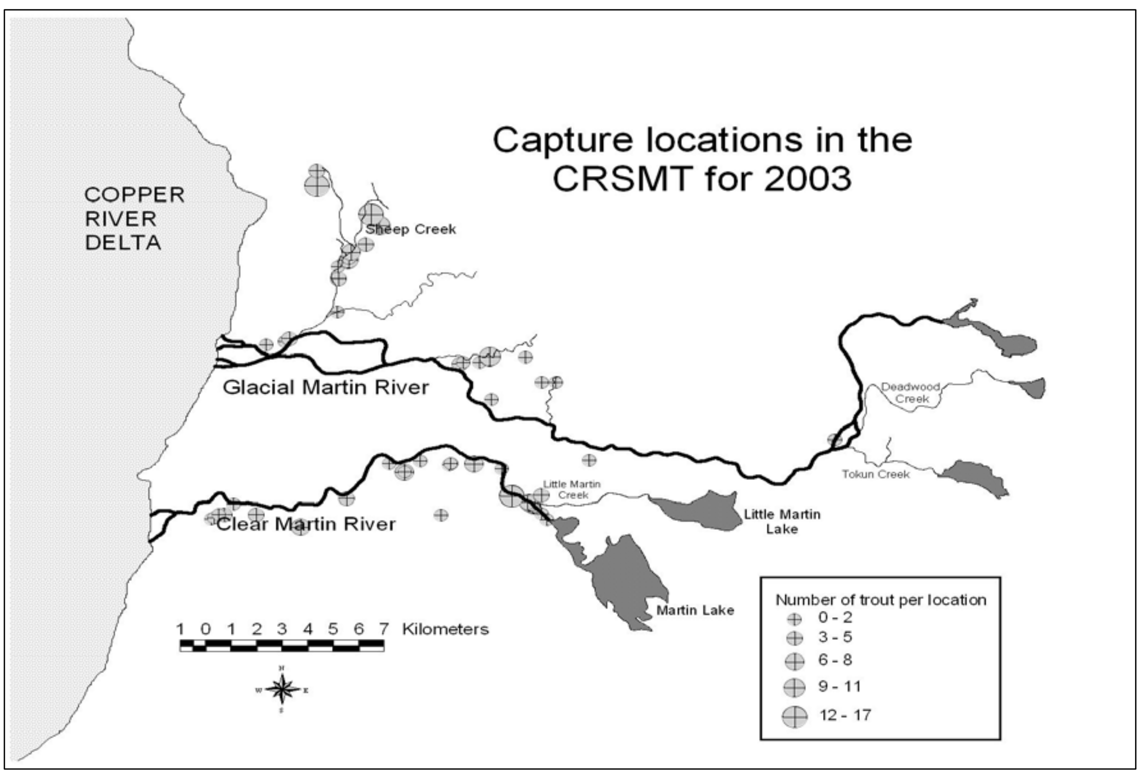


Figure 5.-Trout capture locations in 2002 (top) and 2003 (bottom) in the CRSMT.

Mean size (fork length) of cutthroat trout differed between samples from geographic strata (ANOVA, F = 21.5; df = 1, 264; P < 0.0001), and gear type (F = 6.2; df = 1, 264; P = 0.014), but not among years (P > 0.05). The effect of gear type differed by geographic stratum (F = 4.5; df = 1, 264; P = 0.036). Cutthroat trout from the Clear Martin stratum were larger than those from the Glacial Martin tributaries; and those caught by hook and line were larger than those caught with hoop traps, especially in the Glacial Martin tributaries stratum (Table 3). Cutthroat trout caught in the Clear Martin stratum were older than those from the Glacial Martin tributaries (F = 21.5; df = 1, 251; P < 0.0001; Tables 3 and 4), but there were no differences in mean age between gear types or among years (P > 0.05). Cutthroat trout size at age differed between samples from geographic strata (ANOVA, F = 83.3, df = 1, 237; P < 0.0001). Fish of most ages (except age 3) from the Clear Martin River stratum samples were larger than their counterparts from the Glacial Martin River tributary samples. Length at age curves for trout per each stratum are plotted in Figure 6. The graph of cutthroat trout from the Glacial Martin River strata (middle plot) shows few trout over 7 years old, whereas the other two graphs for the Clear Martin strata have proportionately more fish of age 8 years or more. The lack of older cutthroat trout in the Glacial Martin River system results in a flatter length-age curve for cutthroat trout as compared to cutthroat and rainbow trout in the Clear Martin system.

Table 3.-Mean fork length and age of cutthroat trout, by geographic region and capture method.

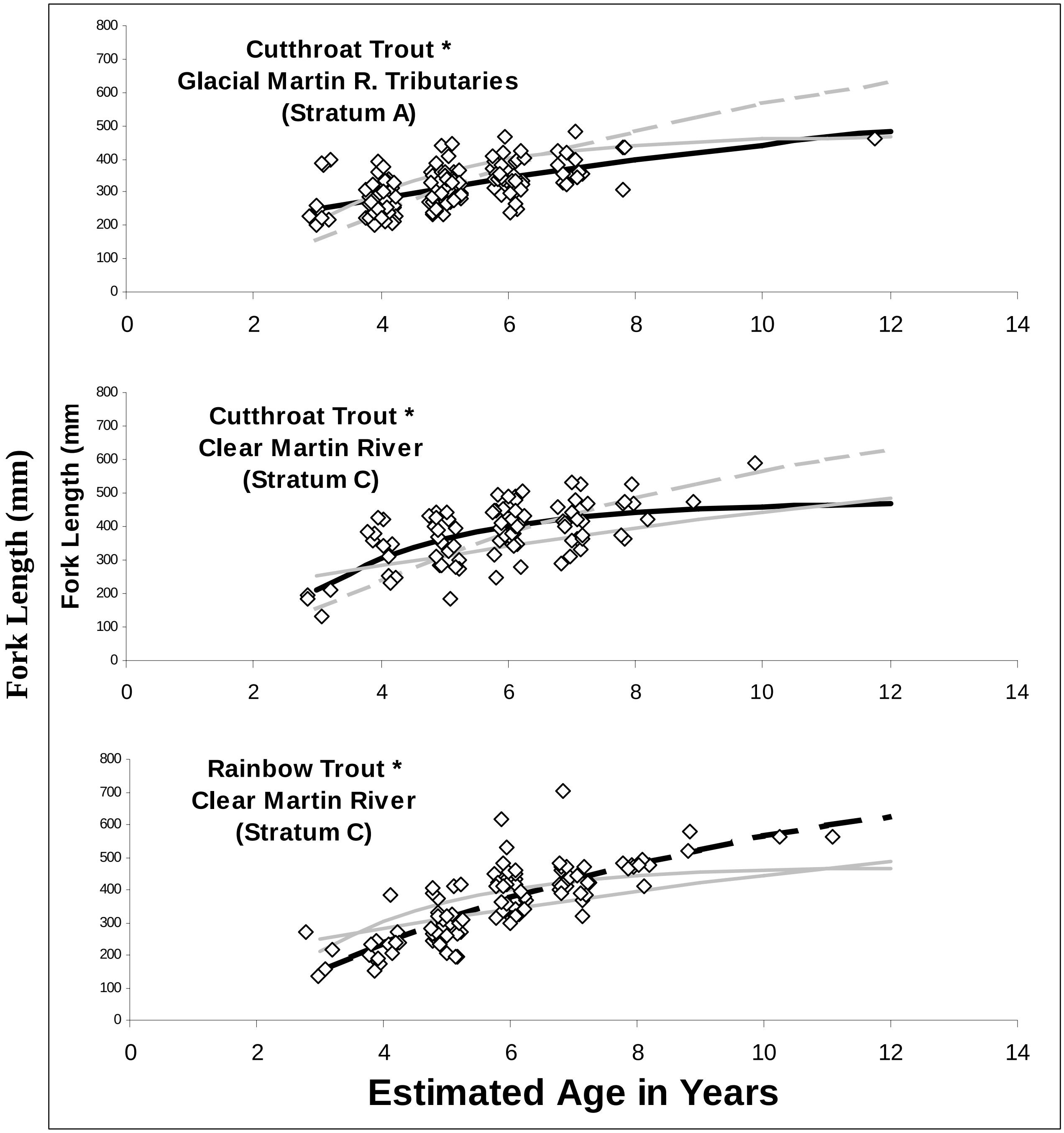
	Geographic Region	
Capture Method	Clear Martin River	Glacial Martin Tributaries
Fork Length		
Hook and Line	384 (83)	333 (54)
Hoop Trap	379 (114)	274 (59)
Age		
Both Methods	5.9 (1.4)	5.1 (1.2)

[a] Standard deviation in parentheses.

Table 4.-Number of cutthroat trout by geographic region and estimated age.

	Estimated Age in Years							
Geographic Region	3	4	5	6	7	8+	unknown	Total
Clear Martin River	4	11	19	29	19	9	10	101
Glacial Martin Tributaries	9	45	57	34	13	4	7	169

Mean fork length of rainbow trout differed between gear types (F = 5.5; df = 1, 108; P = 0.02), and years (F = 4.4; df = 2, 108; P = 0.02). Mean age of rainbow trout differed between years (F = 4.0; df = 2, 103; P = 0.02). Rainbow trout caught by hook and line were larger than those caught with hoop traps, and those captured in 2001 were smaller/younger than those caught during 2002 and 2003 (Tables 5 and 6). There were too few rainbow trout caught in the Glacial Martin tributaries region (n = 3) to test for differences by stratum.



*Black line is the fitted LVB curve for each group; gray lines are the LVB curves from other groups for comparison. Solid lines = cutthroat trout, dashed line = rainbow trout. Actual estimated ages are integers, but they were jittered (random variation added) for presentation in this plot.

Figure 6.-LVB growth curves for length at age of trout in the CRSMT**.**

Table 5.-Mean fork length and age of rainbow trout captured, by capture method and year of capture.

Capture Method	Year 2001	2002	2003
Fork Length			
Hook and Line	277 (101)	376 (104)	377 (113)
Hoop Trap		319 (80)	267 (91)
Age			
Both methods	4.5 (1.3)	5.8 (1.3)	6.0 (1.5)

[a] Standard deviation in parentheses.

Table 6.-Number of rainbow trout captured by year, and estimated age.

	Estimated Age in Years							
Year	3	4	5	6	7	8+	unknown	Total
2001	2	3	0	3	0	0	3	11
2002	0	6	6	8	7	3	0	30
2003	2	5	21	18	13	9	3	71

Mean size (FL) of Dolly Varden showed no clear effects or trends. Size differed between samples from geographic strata (F = 3.6; df = 2, 212; P = 0.03) and years (F = 7.7; df = 2, 212; P = 0.0006), but the effect of geography depended upon year (stratum*year interaction; F = 5.2; df = 2, 212; P = 0.006), and the effect of year depended on gear type (gear*year interaction; F = 9.3; df = 1, 212; P = 0.003) (Table 7).

Table 7.-Mean of fork length (millimeters) of Dolly Varden, by geographic region, capture method, and year.

		Year		
Region	Capture Method	2001	2002	2003
Clear Martin	Hook-and-Line	304 (NA)	349 (51)	349 (100)
Clear Martin	Hoop Trap		302 (68)	368 (15)
Glacial Martin	Hook-and-Line	401 (75)	359 (72)	248 (48)
Glacial Martin	Hoop Trap		318 (85)	393 (68)

[a] Standard deviation in parentheses.

In 2003, 24 trout were recaptured with tags intact. No attempts were made to assess tag retention. Mean movement distance noted from these recaptures was 1,036 meters (SD = 2,136), and movements ranged from 0 to 9 kilometers. When multiple recaptures of individual fish were averaged, mean movement distance was 1,210 meters (SD = 2,309). Of these, rainbow trout (n = 7) moved a mean of 444 meters (SD = 541) and cutthroat (n = 9) moved a mean of 2,064 meters (SD = 3,172). One fish recaptured in 2003 was initially captured in 2001 and three were initially captured in 2002. Additionally, of the 15 trout captured and recaptured in 2003, one fish was recaptured three times and two were recaptured two times. Mean days between capture was 49 days. No fish were captured in more than two different years. Three trout recaptures were classed as hybrids and these movement distances were excluded from species means but included in the overall trout mean.

From May through September 2003 daily water temperatures at capture sites ranged from 5.5 to 16^{o} C in Stratum A, and from 8 to 20^{o} C in Stratum C (Figure 7). The temperature of both strata peaked in July and the lowest temperatures were recorded in September. Mean temperature in Stratum A was 11^{o} C, (SD = 3.1, n = 20); mean temperature in Stratum C was 14^{o} C, (SD = 2.9, n = 16).

New information was collected to update the ADF&G Anadromous Stream Catalog on 26 streams in the study area. Resident or anadromous cutthroat trout were found in all streams and whitefish and Arctic grayling were found in two streams. Additionally, steelhead trout were noted in one drainage as were suckers, and resident rainbow trout were noted in two drainages. Sockeye salmon adults were newly documented during the spawning season in three streams of the Glacial Martin River.

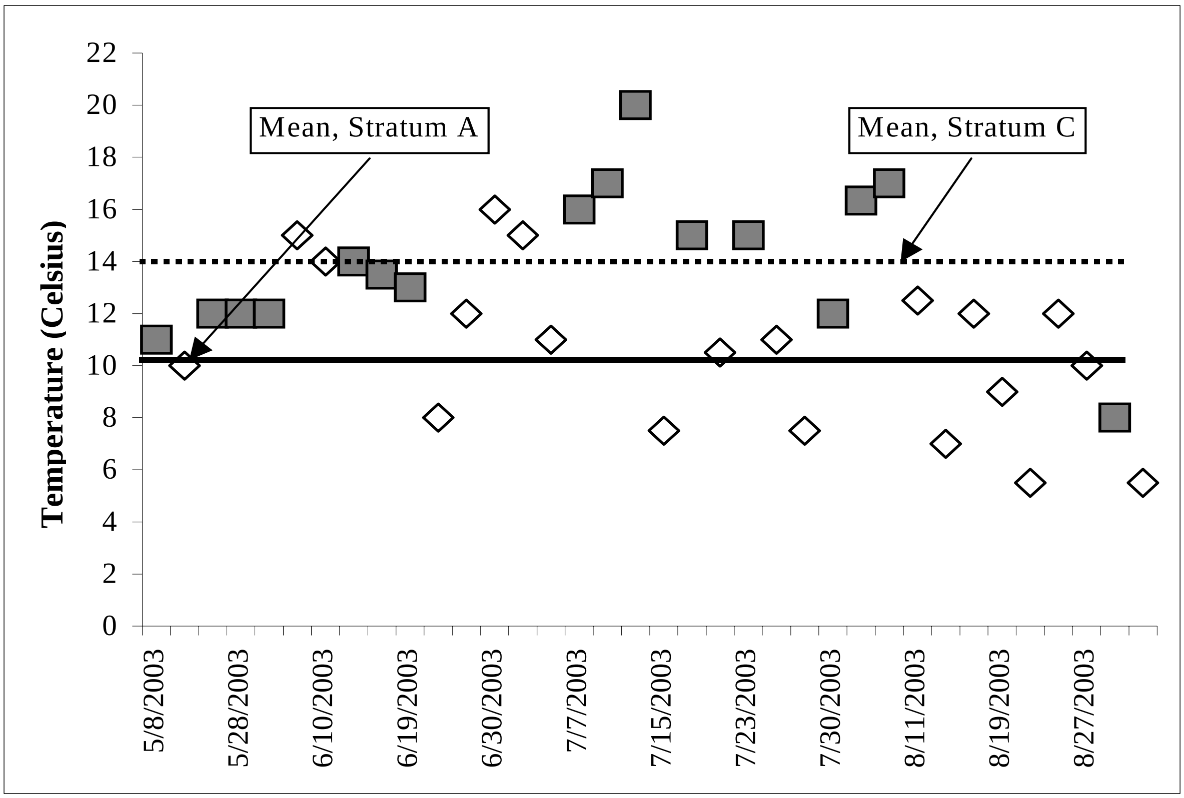


Figure 7.-Water temperatures at capture sites for Stratum A (diamonds) and Stratum C (squares) in the CRSMT, 2003.

DISCUSSION

Cutthroat trout were larger and older in the Clear Martin (Stratum C) samples than in the Glacial Martin tributary (Stratum A) samples. Habitat within the Clear Martin area consisted of a relatively swift middle order stream originating from non-glacial lakes. This contrasted with the Glacial Martin tributaries which were smaller, slower, driven by snowmelt, and greatly modified by beaver activity. Additionally, Clear Martin streams flowed north and west, while Glacial Martin tributary streams flowed south and west. Other studies have documented differences in cutthroat trout growth and physiology that were related to stream conditions. Length at maturation was positively correlated to stream order and width, but negatively correlated to gradient in Idaho cutthroats (Meyer et al. 2003). Trotter (1989) found that cutthroat trout in small streams were younger, smaller and matured earlier than those from larger streams. Larger cutthroat trout were found to be associated with river basins with northwestern aspects near Yellowstone Lake (Gresswell et al. 1997).

Aging of cutthroat trout from scale patterns can be a subjective process (Ericksen 1999). Age estimates from CRSMT samples are best viewed for the comparative results within the area and should not be extrapolated to other populations. Any potential age bias in the estimates from CRSMT samples should have been consistent among all samples as methods were consistent.

Samples from tributary streams of the Glacial Martin River were dominated by cutthroat trout, but in the Clear Martin River rainbow trout were proportionately more abundant. Additionally in Stratum C, fish that appeared to be hybrids were observed, and hybridizing has also been noted in the past between rainbow and cutthroat trout in the Clear Martin River (G. Reeves, USFS, Corvallis, Oregon, personal communication). Several observations at capture sites as well as water temperature data indicate that habitats in Stratum A may be more favorable to cutthroat trout than in Stratum C. Cutthroat trout have slower swimming abilities than rainbow trout and their hybrids which could lead to niche differentiation between species (Hawkins and Quinn 1996). Other studies have shown that habitat variables such as elevation, velocity, and lower temperatures can alter cutthroat trout competitive abilities against other trout species (De Staso and Rahel 1994; Kershner et al. 1997). Additionally, juvenile cutthroat trout generally occupy slower water velocities than rainbow trout (Bisson et al. 1988). In Stratum A of the CRSMT study area, large woody debris structure in slow water habitats was seen at all of the most productive capture sites. Stratum A also had more areas of slow-water beaver dam marsh habitat than did Stratum C. Large woody debris blockages were not found in most Stratum C capture sites, river velocities and water temperatures were higher, and stream order is larger than Stratum A. In the CRSMT the habitats found in Stratum A may have been more conducive to cutthroat trout and excluded rainbow trout, or the habitats of Stratum C allowed rainbow trout to persist with cutthroat.

Among the rainbow trout of Stratum C, three fish appeared to be postspawning anadromous steelhead; larger size, thin body structure, less body spotting, distinct red band along midline and no red throat slash. These fish were found in the same areas as the resident rainbow and cutthroat trout that were caught in the Clear Martin River. Some evidence exists that shows resident rainbow trout can have a steelhead maternal parent (Zimmerman and Reeves 2000). Additionally, sympatric steelhead and resident rainbow trout populations in a tributary of the upper Copper River were genetically similar, whereas steelhead and resident rainbow trout separated by 15 km in another Copper River tributary had significant genetic differences (Wuttig et al. 2004). Resident and anadromous forms of rainbow trout in section C may not be genetically distinct, and that along with observations of migratory cutthroat trout (unpublished data), as well as rainbow-cutthroat trout hybrids suggests that the life history attributes of trout in the Clear Martin River may be notably complex.

Little is known about the movements, especially for overwintering, of trout in the CRSMT, and the influence of anadromous or fluvial trout on the resident trout of the area is unknown. Although only a few recaptures were observed, there were no recaptured fish which had crossed between geographic strata. Recaptured fish tended to be within 2 km of the original capture site, and some fish were recaptured in exactly the same pool, months or years later. These results suggest that the fish sampled in the CRSMT were resident and there may be separate populations of trout in the CRSMT that do not mix. Additionally, Reeves (USFS, Corvallis, Oregon, personal communication) found that cutthroat trout of the Clear Martin River were genetically dissimilar to cutthroat trout from the surrounding area, also suggesting that the population does not migrate. On the other hand, captures occurred only after spawning during summer, so movements in late fall through early spring would have been undetected. Also, very few fish were recaptured, suggesting either the overall number of unmarked trout is high thus making recapture probability low, or many fish left the sample areas after initial capture. Although the sampling sites were well distributed, the capture times were mainly in summer after spawning, anadromy or fluvial migration behaviors may have resulted in longer movements that went undetected.

Cutthroat and rainbow trout have been documented with diverse migratory behaviors. In Alaska cutthroat trout have been traced from overwintering lakes through salt waters and into spawning creeks up to 20 km away (Jones and Yanusz 1998). In Alberta, Brown and Mackay (1995) found that cutthroat trout can make two-stage movements up to 7.6 km from summer aggregations, to staging areas, and then to wintering habitats beginning in September. Additionally, Schmetterling (2001) noted migrations by cutthroat trout in Montana of up to 72 km (mean 31 km) throughout a year, and that most cutthroats returned in spring to specific spawning streams. In the CRSMT study, two cutthroat trout showed within-drainage movements from one sub-tributary to another in Stratum A, and the physical distance of these longest movements places all strata within the potential range of these fish. Additionally, radiotagging studies of spawning cutthroat trout in 2004-2005 in the CRSMT showed long postspawning movements of cutthroat trout that crossed strata (unpublished data). Rainbow trout in the Copper River basin have been observed to have sympatric populations exhibiting multiple migration behaviors (Fleming 2004; Wuttig et al. 2004). Rainbow trout seemed to display shorter movements than cutthroat trout in the Clear Martin River samples but sufficient sample sizes were not obtained to test for differences among species, and the short movement distances noted seemed to depict only resident behaviors.

The data from this study are primarily useful for planning purposes in regards to future efforts to monitor and describe trout populations of the CRSMT. The results shown from the samples may not directly infer to trout population(s) found in the study area, as sampling methods were not randomized in time or space. Sampling was focused to areas of woody debris log jams, cut-bank holes, or stream inlets in order to maximize sample size. This may have biased the samples to represent trout from only productive sample locations. However, sample site choice was consistent throughout the study area, as was capture method. The comparative tests and movement data from the CRSMT do no support a hypothesis that the study area contains one population of trout. Future management efforts that attempt to quantify size at age, or movement patterns of the trout population(s) in this area should attempt a more comprehensive sampling regime stratified to habitats, drainages, and seasons within the area. Additionally, radiotelemetry studies could better describe the complexity of trout migration behaviors and essential habitats.

Ten percent of the cutthroat trout that were captured in Stratum C of the CRSMT would be classed as trophy fish (>20 in), and the current fishery is a remote roadless experience. The hook-and-line CPUE for trout was similar for strata A and C, although cutthroat trout were smaller in Stratum A, and rainbow trout were almost absent. Currently, the CRSMT is managed as a catch-and-release fishery for trout and as such increased angler effort should have little effect on the fish population. If the proposed road is developed, improved accessibility could result in increased sport fishing for trout in strata A and B. Additionally, potential habitat impacts might include altered stream dynamics and migration barriers at culverts associated with road and recreation development. Stratum C may also receive more use due to the proximity of the road, and increased boat access points. Steelhead trout spawning areas in Stratum C could be disturbed by increased air and jet boat traffic since low flows during early spring spawning times are characteristic of this area for anadromous trout.

Preplanning to reduce or prevent potential negative affects of development within strata A and B should occur with special reference to culvert and bridge design at stream crossings, minimization of added silt, and monitoring of fishery effort and recreation changes. Potential migration barriers, woody debris blockage, or stream water chemistry changes from the road itself or road construction activities can be minimized by identifying important habitat areas above the proposed road corridor, and constructing stream crossings at these sections that do not limit fish migration or overly constrict natural stream dynamics. Within the CRSMT riverine characteristics that do not impede trout migrations, natural woody debris flow and deposition and pristine water quality should be protected whenever possible, as has been suggested for cutthroat trout management in other studies (Kershner et al. 1997; Schmetterling 2001).

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REFERENCES CITED

Bisson, P., K. Sullivan, and J. L. Nielson. 1988. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead, and cutthroat trout in streams. Transactions of the American Fisheries Society 117:262-273.

Brown, C. D. J., and J. E. Bailey. 1952. Time and pattern of scale formation in Yellowstone cutthroat trout, *Salmo clarkii lewisii*. Transactions of the American Microscopic Society 71:120-124.

Brown, R. S., and W. Mackay. 1995. Fall and winter movements of and habitat use by cutthroat trout in the Ram River, Alberta. Transactions of the American Fisheries Society 124:873-885.

De Staso, J., and F. J. Rahel. 1994. Influence of water temperature on the interactions between juvenile Colorado River cutthroat trout and brook trout in a laboratory stream. Transactions of the American Fisheries Society 123:289-297.

REFERENCES CITED (Continued)

Ericksen, R. P. 1999. Scale aging manual for coastal cutthroat trout from Southeast Alaska. Alaska Department of Fish and Game, Special Publication No. 99-4, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp99-04.pdf

Fleming, D. F. 2004. Seasonal habitat use and experimental video enumeration of rainbow trout within the Gulkana River drainage. Alaska Department of Fish and Game, Fishery Data Series No. 04-04, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-04.pdf

Gresswell, R. E., J. Liss, G. L. Larson, and P. J. Bartlein. 1997. Influence of basin scale physical variables on life history of cutthroat trout in Yellowstone Lake. North American Journal of Fisheries Management 17:1046-1064.

Hawkins, D. K., and T. P. Quinn. 1996. Critical swimming velocity and associated morphology of juvenile coastal cutthroat trout (*Oncorhynchus clarki clarki*), steelhead trout (*Oncorhynchus mykiss*), and their hybrids. Canadian Journal of Fisheries and Aquatic Science 53:1487-1496.

Johnson, J., E. Weiss, and S. Maclean. 2004. Catalog of waters important for spawning, rearing, or migration of anadromous fishes - Southcentral Region, Effective January 15, 2005. Alaska Department of Fish and Game, Special Publication No. 04-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/sp04-05.pdf

Jones, J. D., and R. Yanusz. 1998. Distribution of mature sea-run cutthroat trout from Sitkoh Creek, Alaska in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 98-17, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-17.pdf

Kershner, J. L., C. M. Bischoff, and D. L. Horan. 1997. Population, habitat, and genetic characteristics of Colorado River cutthroat trout in wilderness and nonwilderness stream sections in the Uinta Mountains of Utah and Wyoming. North American Journal of Fisheries Management 17:1134–1143.

Laakso, M., and O. B. Cope. 1956. Age determination in Yellowstone cutthroat trout by the scale method. Journal of Wildlife Management 20(2):138-153.

Meyer, K. A., D. J. Schill, F. S. Elle, and J. A. Lamansky, Jr. 2003. Reproductive demographics and factors that influence length at sexual maturity of Yellowstone cutthroat trout in Idaho. Transactions of the American Fisheries Society 132:183–195.

Moring, J. R., K. J. Anderson, and R. L. Youker. 1981. High incidence of scale regeneration by Potamodromous coastal cutthroat trout: analytical implications. Transactions of the American Fisheries Society 110:621–626.

Neter, J., W. Wasserman, and M. H. Kutner. 1990. Applied linear statistical models. *Third edition*. Irwin Publishing Company. Homewood, IL.

Quinn, T. J., II, and R. B. Deriso. 1999. Quantitative fish dynamics. Oxford University Press, New York.

Schmetterling, D. A. 2001. Seasonal movements of fluvial westslope cutthroat trout in the Blackfoot River Drainage, Montana. North American Journal of Fisheries Management 21(3):507–520.

Trotter, P. C. 1989. Coastal cutthroat trout: a life history compendium. Transactions of the American Fisheries Society 118:463–473.

Wuttig, K., D. Fleming, and J. Olsen. 2004. Stock status and population biology of the Copper River steelhead. Alaska Department of Fish and Game, Fishery Data Series No. 04-18, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-18.pdf

Zimmerman, C. E., and G. H. Reeves. 2000. Population structure of sympatric anadromous and nonanadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences 57:2152-2162.