Fishery Data Series No. 07-78

Koktuli River Fish Distribution Assessment

by

Craig J. Schwanke

December 2007

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. 07-78

KOKTULI RIVER FISH DISTRIBUTION ASSESSMENT

by
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ABSTRACT

Float trips were conducted on the lower 52 miles of Koktuli River in the Nushagak River drainage during June, July and August 2005 to document the size distribution of resident fish species and observe the distribution of resident fish and salmon species in the river. Water quality parameters were documented at four sites on each float trip. Hook and line sampling was conducted from two rafts on each float trip. A total of 183 rainbow trout *Oncorhynchus mykiss*, 291 Arctic grayling *Thymallus arcticus*, and 70 Dolly Varden *Salvelinus malma* were captured. The mean fork length and weight of rainbow trout was 406 mm and 880 g. The mean fork length and weight of Arctic Grayling and Dolly Varden were 311 mm and 364 g and 448 mm and 993 g, respectively. A total of 193.3 hours was spent angling. The mean catch per unit effort (fish/hour) of rainbow trout, Arctic grayling and Dolly Varden were 0.95, 1.50, and 0.55, respectively. Adult Chinook *O. tshawytscha*, chum *O. keta*, sockeye *O. nerka* and coho salmon *O. kisutsch* were observed throughout the river over the course of the study. Juvenile Chinook and coho were captured in minnow traps at most sites sampled.

Key words: Koktuli River, Nushagak River, float trips, water quality, rainbow trout, *Oncorhynchus mykiss*, Arctic grayling, *Thymallus arcticus*, Dolly Varden, *Salvelinus malma*, catch per unit effort.

INTRODUCTION

The Koktuli River flows into the Mulchatna River of the Nushagak River system in southwest Alaska (Figure 1). A lack of rapids and a diversity of anadromous and resident fish species, most notably rainbow trout *Oncorhynchus mykiss*, make the river a popular choice for float trips in the Bristol Bay Management Area (BBMA). Float and wheel equipped aircraft access the river's headwaters, and the lower river is accessible by power boat from Mulchatna River. Three float trips were conducted on Koktuli River to document the presence and distribution of anadromous and resident fish species in the drainage. In addition, water quality and aquatic habitat parameters were documented. This information will be used as a reference for evaluating the potential future impacts of development and increased use in the drainage.

The headwaters of Koktuli River are located approximately 120 miles northeast of the community of Dillingham. The Koktuli River is comprised of a north and south fork (Figure 2). The south fork is a larger, wider river conducive to float trip activities and flows approximately 75 miles to its confluence with the Mulchatna River. The Koktuli River supports all five species of Pacific salmon *Oncorhynchus*, rainbow trout, Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, Dolly Varden *Salvelinus malma*, and northern pike *Esox lucius*. Aerial index surveys to enumerate Chinook salmon *O. tshawytscha* spawning in the Nushagak River drainage indicate that Koktuli River supports approximately 24% of the drainage's spawning population (Dye and Schwanke *In prep*).

The Nushagak/Mulchatna River drainage is a popular drainage for sport fishing in the BBMA with 18,420 angler-days of effort from 1999 to 2003 (Howe et al. 2001; Jennings et al. 2004, 2006a, b; Walker et al. 2003). The average effort for the Koktuli River during the same 5-year period was 519 angler-days (Howe et al. 2001; Jennings et al. 2004, 2006a, b; Walker et al. 2003). Potential mineral resource development at the headwaters of Koktuli River may increase access and angling pressure on the river. Increased use and mineral development also have the potential to negatively affect the river's water quality to the detriment of fish populations. Documenting fish distribution, resident fish size composition and water quality in Koktuli River provides information to assess potential effects of development and increased use.

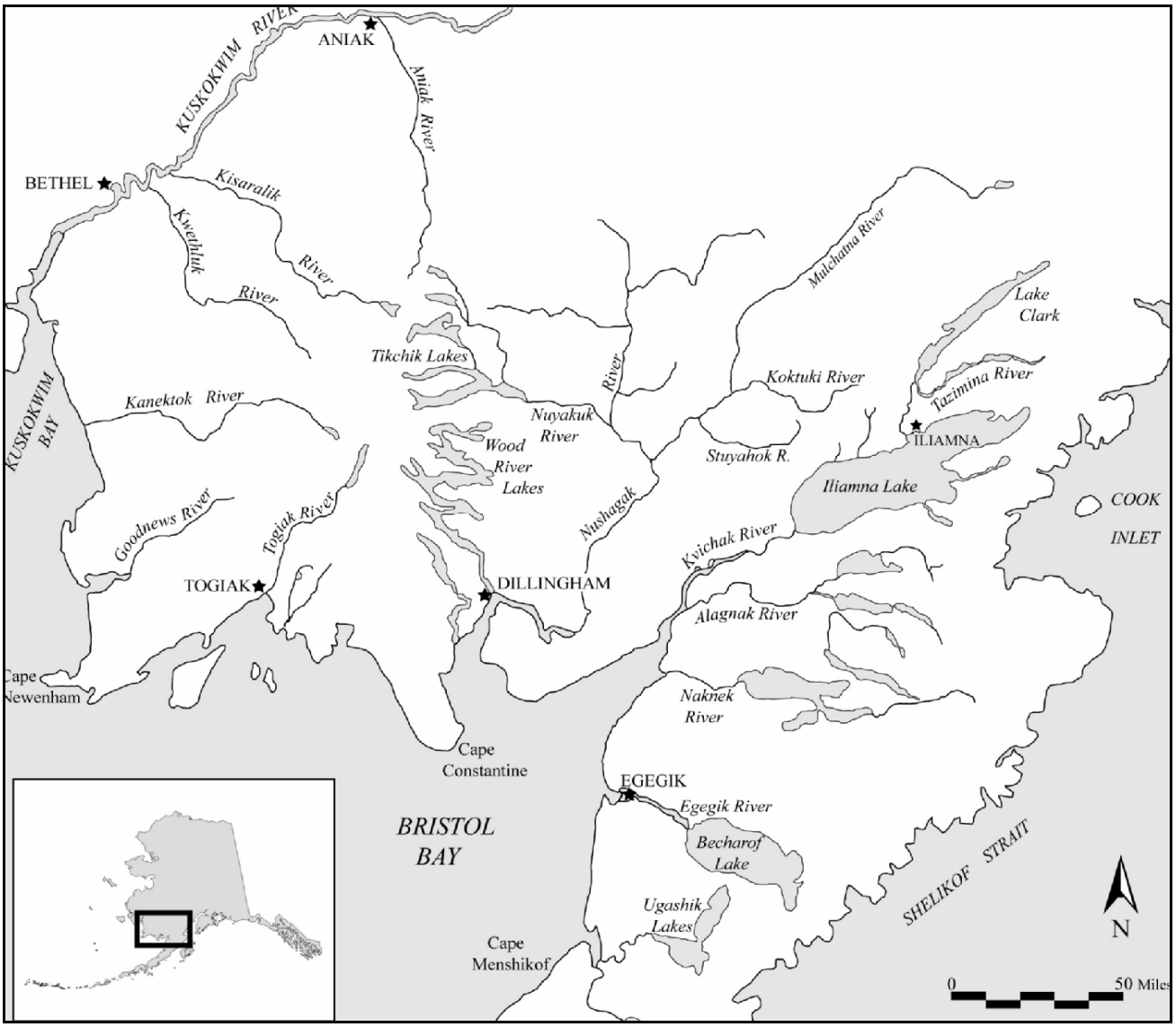

Figure 1.–Bristol Bay area showing the location of Koktuli River in Nushagak River drainage.

OBJECTIVES

The objective of this study was to:

1. Estimate the size distribution of resident fish species susceptible to hook and line sampling in the upper south fork of the Koktuli River to its confluence with Mulchatna River.

Addition project tasks were to:

1. Calculate the mean catch per unit effort (CPUE) (number of rainbow trout, Arctic grayling and Dolly Varden captured per hour) with hook and line gear in Koktuli River between the upper south fork and its confluence with Mulchatna River;

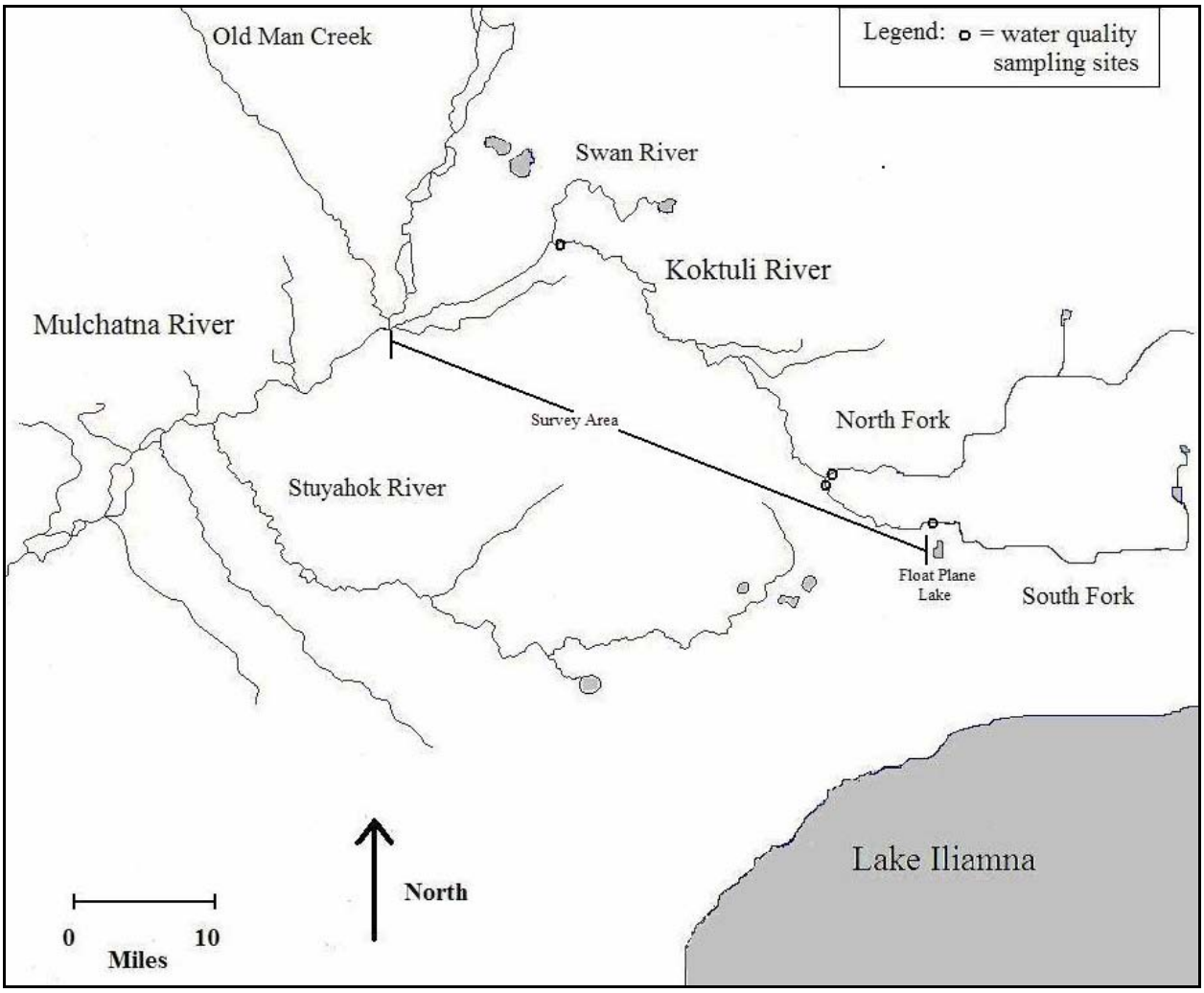

Figure 2.–Koktuli River showing the survey area, water quality sampling sites, and a float plane accessible lake near the upper end of the survey area.

2. Document water quality and aquatic habitat parameters from four locations on Koktuli River;
3. Document distribution of resident fish species in Koktuli River between the upper south fork and its mainstem confluence with Mulchatna River;
4. Document the upper reaches of the river where anadromous salmon are observed spawning; and
5. Document the upper reaches of the river where juvenile anadromous salmon are captured with minnow traps.

METHODS

STUDY DESIGN

Float trips on Koktuli River were conducted in June, July and August of 2005. A trip scheduled for September was not possible due to low water preventing float plane access. The study area was a 52-mile stretch of river from the upper south fork of Koktuli River to its mainstem confluence with Mulchatna River (Figure 2). A combination of visual observation, angling and minnow trapping was used to determine the presence and distribution of fish in the river. Water quality was assessed at four locations on each trip.

Float trips began on the upper south fork of Koktuli River near a tundra lake that was large enough to accommodate a float equipped airplane (Figure 2). Float trips were conducted by four technicians in two 10-foot rafts and took 5 days. Terminal gear used largely consisted of size two and three spinners of various colors and brands. Sampling was conducted in 2-mile stretches using a "leap frog" strategy. One raft floated (without sampling) through a 2 mile section of river as indicated by a global positioning system (GPS) while the other raft sampled the 2 miles that the previous raft floated through. Once the primary raft floated 2 miles, its occupants sampled the next 2-mile section. The start and ending location of each 2-mile river section were recorded with a global positioning system. These points defined the sections of river to be floated and fished during subsequent trips. The technician not oaring angled over the entire course of each section. The other technician angled when productive habitat (i.e. deep pools, deep runs, woody debris) was encountered and the raft was stopped. Time spent angling in each section by each technician was recorded to estimate CPUE of resident species. Each technician's independently recorded catch and effort were combined to estimate CPUE in each section.

Water quality and aquatic habitat parameters sampling sites were recorded with GPS coordinates on the first float trip and subsequent samples were taken at the same location. The locations were: the starting point of the float trip, immediately above the confluence with the north fork, on the north fork immediately above its confluence with the south fork, and on Koktuli River immediately above the confluence with the Swan River (Figure 2). Parameters measured were: water and air temperature, pH, specific conductivity, turbidity, dissolved oxygen level, water color, stream stage, substrate type, channel width, water depth and riparian plant community. In addition, wire mesh minnow traps baited with salmon eggs were set at each location and soaked while water quality data were gathered (approximately 1 hour). After the water quality data were collected the minnow traps were retrieved and the number of each species captured was recorded.

DATA COLLECTION AND REDUCTION

All resident fish species captured with hook and line gear were measured for fork length (FL) to the nearest millimeter and weighed to the nearest 10 grams. The terminal gear used to capture the fish was recorded. Each rainbow trout over 250 mm FL received an individually numbered Floy-T-Anchor™ tag placed on the left side near the posterior base of the dorsal fin. No secondary mark was used. All fish captured in minnow traps were identified and counted. The first encounter of any resident or anadromous species was documented with GPS to indicate the upper range of that species' distribution within the survey area. Each technician recorded the number of hours fished per 2-mile section and the number of fish caught in each section.

At each of the water quality and habitat assessment sites a transect was selected crossing a straight section of the river channel. Channel width and thalweg depth were measured at the ordinary high water level and wetted levels. A YSI[1] 556 MPS multi- parameter meter was used to measure several water quality parameters. Measurements were taken in slow water by inserting the probe directly in the channel near the thalweg, or 12 liters of stream water were collected in a bucket and immediately analyzed. The probe was gently agitated to ensure proper mixing and the water chemistry readings were allowed to stabilize before recording values. Specific conductivity, pH, turbidity, dissolved oxygen and temperature were measured with the meter.

Water color (clear, ferric, humic or muddy), stream stage (dry, low, medium, high), three dominant substrate classes (Wentworth scale, Wentworth 1922), and Rosgen channel type (Rosgen 1996) were visually assessed. The dominant riparian vegetation community along each bank was visually assessed (Viereck et al. 1982). A photograph of an upstream and downstream view was taken along the banks connecting a transect.

A log was maintained to summarize data collected each day. The log summarized the daily catch of all fish species, weather conditions, estimated number of each salmon species observed spawning, water temperature, observations of any subsistence and sport fish activity, and miles of river covered.

DATA ANALYSIS

Biological Composition

Mean length and weight and their associated variances were calculated for each resident fish species caught. The proportion of a particular species *s*, in weight or length class *i* (p_{si}), was estimated as:

$$\hat{p}_{si} = \frac{x_{si}}{n_s}, \tag{1}$$

with x_{si} being the number of fish of species *s* in weight category *i* and n_s being the total number of fish species *s* sampled for length or weight.

The associated variance was estimated as:

$$\hat{V}(\hat{p}_{si}) = \frac{\hat{p}_{si}(1-\hat{p}_{si})}{n_s - 1}. \tag{2}$$

In addition, Anderson-Darling tests (Scholz and Stephens 1987) were used to assess differences in the length frequency distributions for each resident species captured among float trips.

Catch per Unit Effort

CPUE was estimated by river section to provide an impression of relative fish density in Koktuli River.

[1] YSI Incorporated, Yellow Springs, Ohio. Use of this company name does not constitute endorsement, but is included for scientific completeness.

Average CPUE for the study area was estimated as a ratio (Thompson 1992):

$$\overline{CPUE} = \sum_{i=1}^{n} c_i \Big/ \sum_{i=1}^{n} e_i \,, \tag{3}$$

and its variance estimated as:

$$\hat{V}(\overline{CPUE}) = \frac{\sum_{i=1}^{n}\left(c_i - \overline{CPUE} \times e_i\right)^2}{\bar{e}^2 n(n-1)} \,, \tag{4}$$

where:

c_i = catch of each fish species in section i;

e_i = effort expended in section i;

n = number of sections in study area;

and

$$\bar{e} = \sum_{i=1}^{n} \frac{e_i}{n} \,.$$

RESULTS

Float trips were conducted from 13-16 June, 11-15 July and 16-19 August. A total of 183 rainbow trout were captured on the three float trips, of which 181 were measured for length and 177 were weighed. Two hundred and ninety-one Arctic grayling were captured of which 290 were measured for length and 272 were weighed. Seventy Dolly Varden were captured, all of which were measured for length and 65 were weighed.

The length distribution of rainbow trout captured during the float trips ranged from 269 to 557 mm FL (Figure 3) with a mean length of 406 mm (SE = 5.01) and fish in the 350 to 450 mm range dominated the sample (Table 1). No significant difference (D = 1.32, n_{trip1} = 55, n_{trip2} = 67, n_{trip3} = 59, P = 0.10) was detected in the cumulative length frequency distributions of rainbow trout captured among float trips. The weight distribution ranged from 100 to 2,200 g with a mean of 880 g (SE = 33.96).

The length distribution of Arctic grayling captured ranged from 210 to 405 mm FL (Figure 4) with a mean length of 311 mm (SE = 2.53) and fish in the 250 to 350 mm range dominated the sample (Table 1). There was a significant difference (D = 6.01, n_{trip1} = 114, n_{trip2} = 95, n_{trip3} = 81, P < 0.001) in the cumulative length frequency distributions of Arctic grayling captured among float trips. The weight distribution of Arctic grayling ranged from 100 to 805 g with a mean weight of 364 g (SE = 9.08).

The length distribution of Dolly Varden ranged from 181 to 571 mm FL (Figure 5) with a mean length of 448 mm (SE = 8.01) and fish in the 400 to 500 mm range dominated the sample (Table 1). No significant difference (D = 0.553, n_{trip2} = 25, n_{trip3} = 45, P = 0.573) was detected for the cumulative length frequency distributions of Dolly Varden on the two trips they were captured.

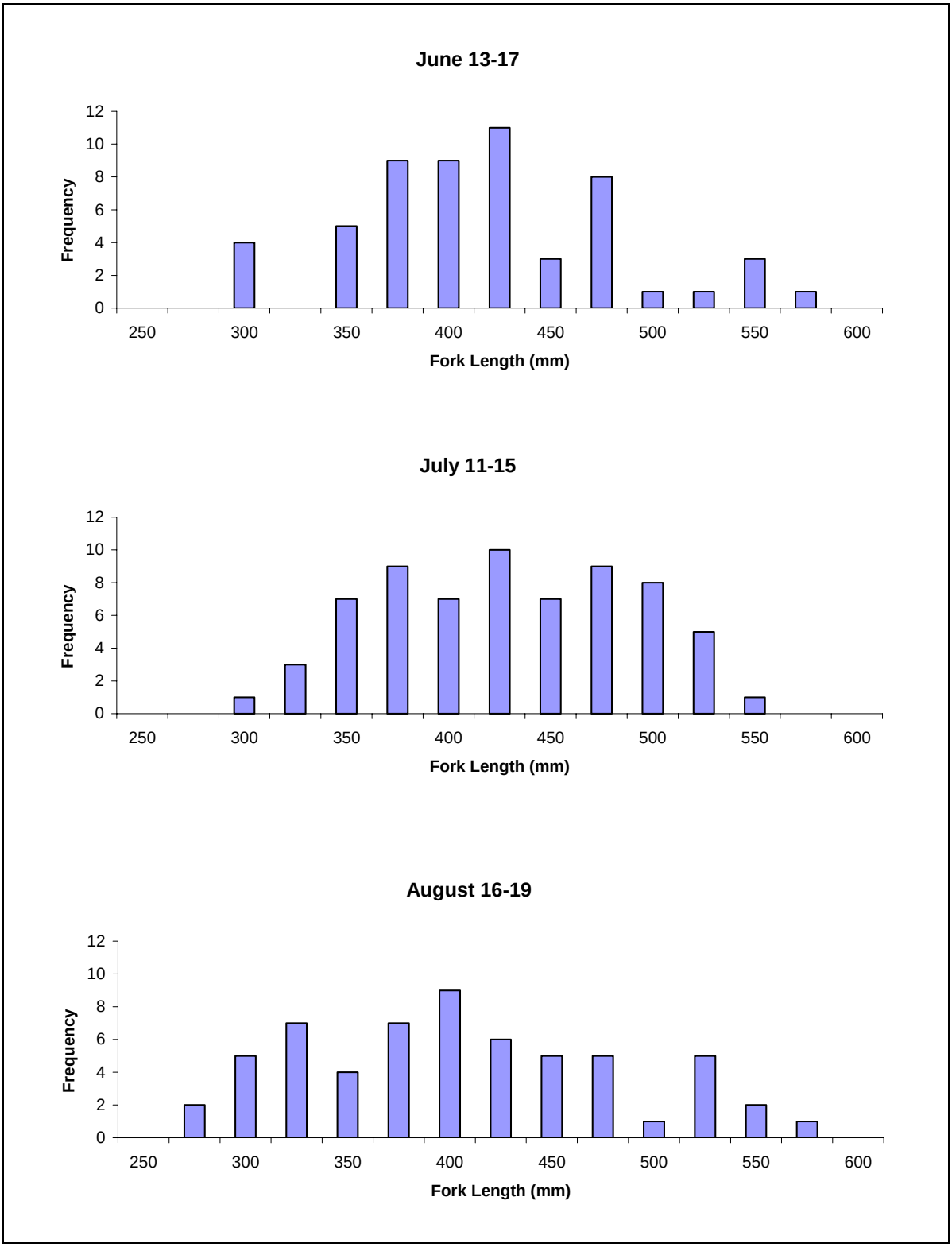

Figure 3.–Length frequency distribution of rainbow trout captured during each of three float trips on Koktuli River, 2005.

Table 1.–Proportions of resident fish species by length with estimated standard error from Koktuli River, 2005.

		Length (FL, millimeters) [a]								
		150-199	200-249	250-299	300-349	350-399	400-449	450-499	500-549	550-599
Rainbow Trout										
	Proportion	0	0	0.07	0.14	0.27	0.24	0.18	0.09	0.01
	Standard Error	0	0	0.019	0.026	0.033	0.032	0.029	0.022	0.008
Arctic Grayling										
	Proportion	0	0.08	0.32	0.38	0.21	0.01	0	0	0
	Standard Error	0	0.016	0.027	0.028	0.024	0.006	0	0	0
Dolly Varden										
	Proportion	0.03	0	0	0.01	0.07	0.37	0.36	0.11	0.04
	Standard Error	0.020	0	0	0.014	0.031	0.058	0.058	0.038	0.024

[a] FL = fork length

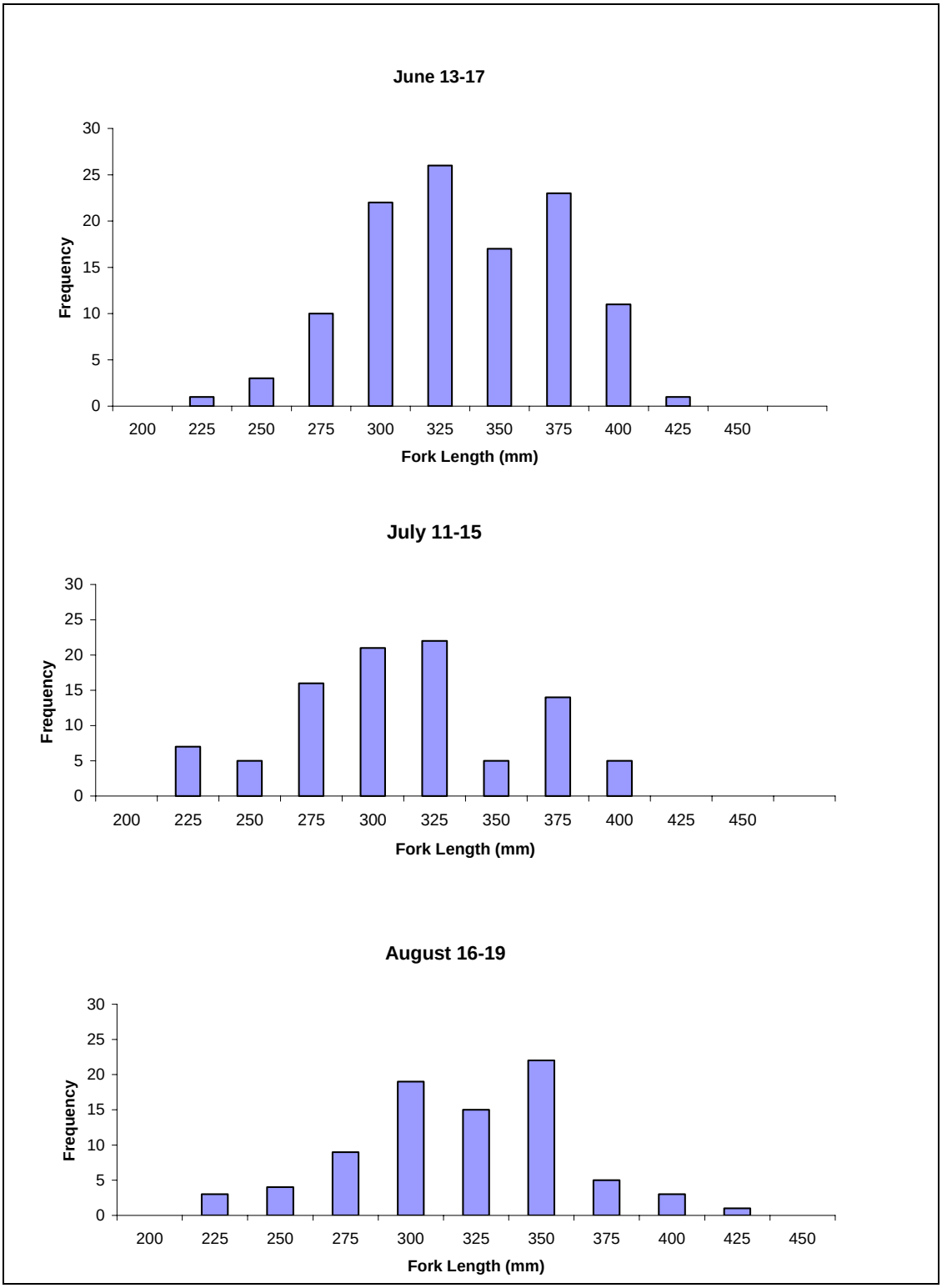

Figure 4.–Length frequency distribution of Arctic grayling captured during each of three float trips on Koktuli River, 2005.

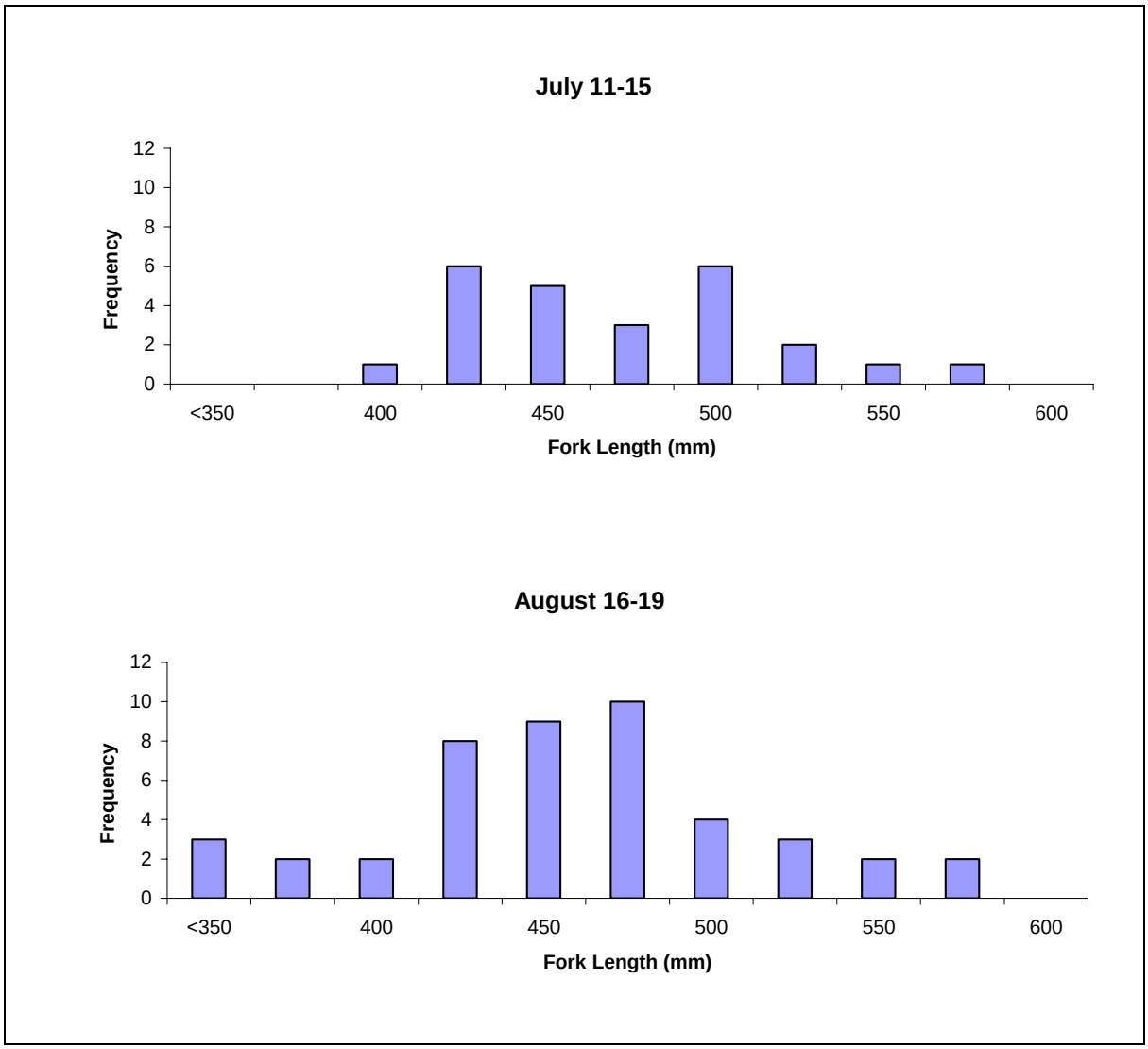

Figure 5.–Length frequency distribution of Dolly Varden captured during float trips on Koktuli River, 2005.

The weight distribution of Dolly Varden ranged from 100 to 2,080 g with a mean weight of 993 g (SE = 43.12).

A total of 193.3 hours was spent rod and reel sampling during the three float trips with a mean time spent angling of 64.4 hours (SE = 1.65) (Table 2). The total catch from the three float trips was 544 resident fish with a mean of 181 (SE = 6.17) fish caught per float trip. The average CPUE of rainbow trout per float trip fluctuated between 0.82 and 1.11 fish/hour with a mean average CPUE of 0.95 fish/hour (SE = 0.12) (Table 2). The average CPUE of Arctic grayling decreased each subsequent trip from 1.70 to 1.26 fish/hour with a mean average CPUE of 1.50 fish/hour (SE = 0.15) (Table 2). The average CPUE of Dolly Varden increased from zero in June to 0.69 fish/hour in August with an average CPUE of 0.55 fish/hour (SE = 0.11) for the two trips they were captured (Table 2).

Table 2.–Summary of hours sampled with hook and line, the number and catch per unit effort (CPUE) of resident fish species during each of three float trips on Koktuli River, 2005.

			Catch [a]				Mean CPUE [b]		
Trip	Dates	Hours sampled	Rainbow Trout	Arctic Grayling	Dolly Varden	Total	Rainbow Trout	Arctic Grayling	Dolly Varden
1	13-17 June	67.0	55	114	0	169	0.82	1.70	0.00
2	11-15 July	61.4	68	95	25	188	1.11	1.40	0.26
3	16-19 August	64.9	60	82	45	187	0.93	1.26	0.69
	Total:	193.3	183	291	70	544			
	Mean (SE):	64.4 (1.65)	61 (3.8)	97 (9.29)	23 (13.02)	181 (6.17)	0.95 (0.12)	1.50 (0.15)	0.55 (0.11)

[a] Number of fish.
[b] CPUE = catch per unit effort (fish/hour).

Water quality information was collected at the four designated sampling sites on each of the float trips. The location of each site was recorded with GPS coordinates and all water quality data were collected with the exception of turbidity during the June float trip (Table 3). All sampling sites were sampled at the medium stream stage and had clear, well oxygenated water. Minnow traps were set at each water quality sampling site during the first float trip and only at site four during the rest of the float trips. Forty-nine juvenile Chinook and coho salmon *O. kisutsch* were captured at three of the four water quality and habitat assessment sites (Table 3).

Hours spent angling and the catch and CPUE of resident species in addition to the number of adult salmon observed in each river section for each float trip are summarized in Appendices A1-A3. Rainbow trout were found throughout the river on each of the float trips, but were most concentrated in sections 14 through 22 with 65% of the total catch therein and a mean average CPUE of 1.65 fish/hour (SE = 0.20). Arctic grayling were most concentrated in the upper half of each float trip. Sections 1 through 14 comprised 81% of the total catch and an average CPUE of 2.24 fish/hour (SE = 0.19). In July, the majority of Dolly Varden (76%) was captured in the lower sections 14 through 26. In August, Dolly Varden were captured with a higher frequency (62%) in the upper sections 1 through 13.

Four adult species of Pacific salmon (Chinook salmon, chum salmon *O. keta*, sockeye salmon *O. nerka* and coho salmon) were observed over the course of the three float trips (Appendices A1-A3). In June, only two Chinook salmon were observed in the lower river. In July, approximately 3,354 Chinook salmon were observed throughout the majority of sections. Chum and sockeye salmon were also observed in most sections throughout the river in July. In August the majority of Chinook and chum salmon had completed spawning and carcasses were common throughout the float trip. Sockeye salmon were also present throughout the river in August with the majority of the fish in the upper sections either spawning or dead. The remaining sockeye salmon in the lower sections were in prespawning aggregations. The first coho salmon was captured in section 2 during the August trip. Seven additional coho salmon were subsequently captured in other sections.

Biological data files are archived with ADF&G, Research and Technical Services (Appendix B1).

DISCUSSION

The float trips provided documentation of the size distributions, presence, and distribution of resident fish species in the lower 52 miles of the river. Size distributions of fish captured with hook and line can be used for future comparisons of samples collected in a similar manner. The similarity of rainbow trout length distributions during the 3 months of the project provides evidence that there may be a resident population in the river during the summer. However, this observation must be considered with caution since no life history studies of rainbow trout have been conducted in Mulchatna River drainage and the extent of movement between tributaries is unknown. The length distributions of Arctic grayling were significantly different due to slightly larger fish captured in June. Another research project on Arctic grayling in Koktuli River found Arctic grayling to be common upriver of the survey area during the summer (P. McLarnon, Fishery Biologist, HDR Inc., Anchorage, personal communication). With Arctic grayling present upstream of the float trip survey area, the difference in length distributions may be explained by the larger grayling being located farther upriver later in the summer. Arctic grayling have been found to segregate by size within a drainage during the summer with the

Table 3.–Location, vegetation and substrate dominant classification, dates, water quality data and juvenile salmon minnow trapped during float trips on Koktuli River, 2005.

											Channel					
											Width (m)		Depth (m)			
				Water	Specific	Dissolved									Minnow Trap Catch [d]	
				Temp	Conductivity	Oxygen		Turbidity	Water	Stream				Wetted		
			Date	(°C)	(muS/cm)	(% & mg/L)	pH	(NTU)[a]	Color	Stage	OHW [b]	Wetted	OHW [b]	Thalweg [c]	Chinook	Coho
Site 1																
	General Location:	Start of float trip.	13-Jun	13.4	45	95%, 9.93	6.30	ND	Clear	Medium	19.0	17.4	1.3	0.8	4	3
	GPS Coordinates:	59° 48.254 N latitude														
		155° 35.600 W longitude	11-Jul	15.0	38	76%, 7.65	7.88	1.19	Clear	Medium	19.0	17.2	1.3	0.6	ND	ND
	Vegetation Classification:															
	Right bank:	IIIA2d (Tussock tundra)	16-Aug	11.1	37	104%, 11.25	7.20	0.55	Clear	Low, continuous	19.0	16.2	1.3	0.5	ND	ND
	Left bank:	IIC1b (Closed low willow shrub)								surface flow						
	Dominant Substrates:	Small cobble, large pebble, coarse gravel														
	Rosgen Channel Code, Stream Type:	E3 (slightly entrenched channel, cobble dominated substrate, with a low width to depth ratio and high sinousity)														
Site 2																
	General Location:	South fork above														
		confluence with North fork.	14-Jun	16.6	41	90%, 8.87	6.80	ND	Clear	Medium	31.1	24.7	1.0	0.6	0	0
	GPS Coordinates:	59° 50.030 N latitude														
		155° 46.534 W longitude	12-Jul	12.1	31	70%, 7.55	7.58	1.26	Clear	Medium	31.1	31.9	1.0	0.6	ND	ND
	Vegetation Classification:															
	Right bank:	IC2 (Open mixed forrest)	17-Aug	10.7	45	93%, 10.34	6.40	0.95	Clear	Low, surface	31.1	23.8	1.0	0.5	ND	ND
	Left bank:	IIC1b (Closed low willow shrub)								flow discontinuous						
	Dominant Substrates:	Small cobble, large pebble, coarse gravel														
	Rosgen Channel Code, Stream Type:	E4 (slightly entrenched channel, gravel dominated substrate, with a low width to depth ratio and high sinousity)														
Site 3																
	General Location:	North fork above														
		confluence with South fork.	14-Jun	15.5	42	86%, 8.58	6.70	ND	Clear	Medium	33.8	31.1	1.5	0.9	4	8
	GPS Coordinates:	59° 50.036 N latitude														
		155° 46.350 W longitude	12-Jul	12.3	34	71%, 7.43	7.46	2.73	Clear/slightly	Medium	33.8	32.2	1.5	0.9	ND	ND
									humic							
	Vegetation Classification:															
	Right bank:	IC2a (Open spruce-paper birch forest)	17-Aug	11.2	66	94%, 10.37	6.40	1.35	Clear/slightly	Low, continuous	33.8	ND	1.5	0.6	ND	ND
	Left bank:	IIC1b (Closed low willow shrub)							humic	surface flow						
	Dominant Substrates:	Large pebble, small cobble, coarse gravel														
	Rosgen Channel Code, Stream Type:	E4 (slightly entrenched channel, gravel dominated substrate, with a low width to depth ratio and high sinousity)														
Site 4																
	General Location:	Above confluence														
		with Swan River.	17-Jun	12.9	43	85.4%, 9.03	6.90	ND	Clear	Medium	51.2	29.3	2.1	1.0	4	1
	GPS Coordinates:	59° 59.826 N latitude														
		156° 12.902 W longitude	15-Jul	13.7	37	68.4%, 7.09	7.48	1.37	Clear	Medium	51.2	32.1	2.1	1.2	17	4
	Vegetation Classification:															
	Right bank:	IIC1b (Closed low willow shrub)	19-Aug	11.5	48	97%, 10.55	7.30	2.83	Clear	Medium	51.2	31.9	2.1	1.1	4	0
	Left bank:	IC2a (Open spruce-paper birch forest)														
	Dominant Substrates:	Coarse sand, small pebble, small cobble														
	Rosgen Channel Code, Stream Type:	E5 (slightly entrenched channel, sand dominated substrate, with a low width to depth ratio and high sinousity														

[a] Nephelometric turbidity unit.
[b] OHW = ordinary high water level.
[c] Thalweg = the deepest channel in the river bed, almost always the area with the fastest flowing water.
[d] Numbers of juvenile salmon. ND = no data, minnow traps not set.

largest fish migrating to the upper reaches of the drainage (Armstrong 1986; Vincent-Lang and Alexandersdottir 1990).

Although not an index of abundance, the CPUE of resident species does provide a means of documenting fish distribution in the survey area. Rainbow trout were most common in the lower half of the survey area and Arctic grayling were more common in the upper half of the survey area and are common above the survey area. Very little additional insight regarding the life history and movements of rainbow trout and Arctic grayling was obtained during this study. The distribution of rainbow trout throughout the river did not appear to change significantly over the course of the three float trips. Only one rainbow trout was recaptured. It was tagged during June in section 15 and recaptured approximately 10 miles upriver in July. Dolly Varden appeared in the lower half of the river between June and July and exhibited an upstream movement between July and August. This is likely an anadromous population, similar to those observed in the Togiak River drainage west of the Nushagak River, that enter the system to feed on salmon spawn during late summer and to spawn in the fall (M. Lisac, Fishery Biologist, USFWS, Dillingham, personal communication). Although spawning locations are unknown, some of the Dolly Varden sampled in August were developing sexual characteristics such as spawning colors.

Water quality data were collected over the course of the project to document a number of parameters. Turbidity was not collected during the June float trip due to a malfunction with sampling equipment. The location of each of the four sites that data were documented allow for the direct comparison of future samples from the same sites at the medium stream stage. Koktuli River water quality appears to be relatively pristine and supports a healthy diversity of salmonid species.

Adult salmon were present throughout the survey area seasonally and appeared abundant. Spawning was observed by Chinook, chum and sockeye salmon beginning in the upper section of the float, and aerial surveys indicate that spawning occurs above this location as well. Juvenile Chinook and coho salmon were captured at three of the four water quality sampling sites and salmon fry were commonly observed throughout the survey area.

In light of potential mineral resource development, additional studies are occurring in Koktuli River drainage by other research entities to document environmental parameters and assess fish populations. This study in conjunction with these other studies provides a means of documenting current conditions to assist in monitoring the impacts of potential development in the drainage. A basic understanding of fish distribution throughout the survey area was garnered from this research. However, very little information is available regarding the life history of rainbow trout or other resident species in the Nushagak and Mulchatna River drainages. Future research should examine the life history of the drainages' resident species for the documentation of spawning and other seasonal critical habitat areas.

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APPENDIX A. HOURS FISHED, CATCH, EFFORT, AND OBSERVATIONS

Appendix A1.–The number of hours angled by 2-mile river sections with the number and catch per unit effort of each resident fish species captured and the number of adult salmon observed on the June 13-17 float trip, 2005.

			Catch [a]			CPUE [b]			Adult Salmon Observed/Present			
2-Mile Section	Date	Hours Angled	Rainbow Trout	Arctic Grayling	Dolly Varden	Rainbow Trout	Arctic Grayling	Dolly Varden	Chinook	Chum	Sockeye	Coho
1	13-Jun	4.37	0	16	0	0	3.66	0	0	0	0	0
2	13-Jun	5.72	0	3	0	0	0.52	0	0	0	0	0
3	14-Jun	5.78	0	16	0	0	2.77	0	0	0	0	0
4	14-Jun	5.50	1	13	0	0.18	2.36	0	0	0	0	0
5	14-Jun	3.98	1	8	0	0.25	2.01	0	0	0	0	0
6	14-Jun	1.97	1	6	0	0.51	3.05	0	0	0	0	0
7	15-Jun	1.42	0	2	0	0	1.41	0	0	0	0	0
8	15-Jun	1.67	1	3	0	0.60	1.80	0	0	0	0	0
9	15-Jun	1.55	1	2	0	0.65	1.29	0	0	0	0	0
10	15-Jun	1.88	0	2	0	0	1.06	0	0	0	0	0
11	15-Jun	1.53	1	4	0	0.65	2.61	0	0	0	0	0
12	15-Jun	1.83	1	1	0	0.55	0.55	0	0	0	0	0
13	15-Jun	1.52	2	0	0	1.32	0	0	0	0	0	0
14	15-Jun	1.45	2	4	0	1.38	2.76	0	0	0	0	0
15	16-Jun	2.77	4	11	0	1.45	3.98	0	0	0	0	0
16	16-Jun	2.08	2	4	0	0.96	1.92	0	0	0	0	0
17	16-Jun	2.02	3	0	0	1.49	0	0	0	0	0	0
18	16-Jun	3.02	2	3	0	0.66	0.99	0	0	0	0	0
19	16-Jun	4.32	8	4	0	1.85	0.93	0	0	0	0	0
20	16-Jun	1.13	4	2	0	3.53	1.76	0	0	0	0	0
21	17-Jun	5.45	12	6	0	2.20	1.10	0	0	0	0	0
22	17-Jun	0.83	0	2	0	0	2.40	0	0	0	0	0
23	17-Jun	1.58	4	0	0	2.53	0	0	2	0	0	0
24	17-Jun	1.67	2	2	0	1.20	1.20	0	0	0	0	0
25	17-Jun	1.28	3	0	0	2.34	0	0	0	0	0	0
26	17-Jun	0.70	0	0	0	0	0	0	0	0	0	0
	Total	67.02	55	114	0				2	0	0	0

[a] Number of fish.

[b] CPUE = catch per unit effort (fish/hour).

Appendix A2.–The number of hours angled by 2-mile river sections with the number and catch per unit effort of each resident fish species captured and the number of adult salmon observed on the July 11-15 float trip, 2005.

			Catch [a]			CPUE [b]			Adult Salmon Observed/Present [c]			
2-Mile Section	Date	Hours Angled	Rainbow Trout	Arctic Grayling	Dolly Varden	Rainbow Trout	Arctic Grayling	Dolly Varden	Chinook	Chum	Sockeye	Coho
1	11-Jul	2.28	1	5	0	0.44	2.19	0	180	5	ND	0
2	12-Jul	1.78	0	8	0	0	4.49	0	80	21	35	0
3	12-Jul	2.17	1	2	0	0.46	0.92	0	67	20	100	0
4	12-Jul	2.40	1	5	0	0.42	2.08	0	105	20	20	0
5	12-Jul	1.80	2	8	0	1.11	4.44	0	ND	ND	ND	0
6	13-Jul	2.62	3	5	3	1.15	1.91	1.15	300	35	110	0
7	13-Jul	2.13	1	8	1	0.47	3.75	0.47	381	80	ND	0
8	13-Jul	1.87	0	7	0	0	3.75	0	225	25	50	0
9	13-Jul	2.15	0	6	0	0	2.79	0	ND	ND	ND	0
10	13-Jul	1.88	1	9	0	0.53	4.78	0	255	80	50	0
11	13-Jul	2.12	0	5	0	0	2.36	0	371	ND	ND	0
12	13-Jul	2.18	1	0	1	0.46	0	0.46	141	60	40	0
13	13-Jul	2.00	1	6	1	0.50	3.00	0.50	79	ND	ND	0
14	14-Jul	2.10	3	7	0	1.43	3.33	0	23	60	5	0
15	14-Jul	2.92	10	2	6	3.43	0.69	2.06	200	160	ND	0
16	14-Jul	2.98	3	2	0	1.01	0.67	0	201	265	97	0
17	14-Jul	2.08	2	2	2	0.96	0.96	0.96	ND	ND	ND	0
18	14-Jul	3.00	6	2	4	2.00	0.67	1.33	201	100	147	0
19	14-Jul	2.40	4	0	1	1.67	0	0.42	105	ND	ND	0
20	15-Jul	3.08	6	0	3	1.95	0	0.97	10	50	3	0
21	15-Jul	3.67	8	1	2	2.18	0.27	0.55	167	ND	ND	0
22	15-Jul	2.58	3	2	0	1.16	0.77	0	90	135	200	0
23	15-Jul	1.98	0	1	0	0	0.50	0	123	ND	ND	0
24	15-Jul	2.18	2	0	0	0.92	0	0	50	30	20	0
25	15-Jul	2.42	7	2	1	2.90	0.83	0.41	ND	ND	ND	0
26	15-Jul	2.60	2	0	0	0.77	0	0	ND	ND	ND	0
	Total	61.38	68	95	25				3354	1146	877	0

[a] Number of fish.

[b] CPUE = catch per unit effort (fish/hour).

[c] ND = no data, not counted by field staff.

Appendix A3.–The number of hours angled by 2-mile river sections with the number and catch per unit effort of each resident fish species captured and the number of adult salmon observed on the August 16-19 float trip, 2005.

			Catch [a]			CPUE [b]			Adult Salmon Observed/Present [c]			
2-Mile Section	Date	Hours Angled	Rainbow Trout	Arctic Grayling	Dolly Varden	Rainbow Trout	Arctic Grayling	Dolly Varden	Chinook	Chum	Sockeye	Coho
1	16-Aug	3.1	1	9	0	0.32	2.90	0	12	ND	ND	0
2	16-Aug	2.8	1	9	2	0.36	3.20	0.71	ND	ND	Yes	1
3	16-Aug	2.4	1	4	2	0.41	1.66	0.83	ND	ND	ND	0
4	16-Aug	2.7	0	4	0	0	1.51	0	ND	ND	Yes	0
5	16-Aug	1.9	0	3	0	0	1.57	0	ND	ND	Yes	0
6	17-Aug	3.3	3	4	11	0.91	1.22	3.35	ND	ND	ND	2
7	17-Aug	3.5	4	5	5	1.16	1.45	1.45	Yes	ND	ND	0
8	17-Aug	2.1	0	7	1	0	3.39	0.48	ND	ND	ND	0
9	17-Aug	1.9	1	5	0	0.52	2.61	0	ND	ND	ND	0
10	17-Aug	1.8	0	5	1	0	2.75	0.55	ND	ND	ND	0
11	17-Aug	1.9	2	4	0	1.06	2.12	0	5	ND	100	1
12	17-Aug	2.2	1	5	1	0.45	2.27	0.45	ND	ND	ND	0
13	18-Aug	2.5	2	8	5	0.80	3.20	2	ND	ND	Yes	0
14	18-Aug	3.3	3	2	5	0.90	0.60	1.5	ND	ND	ND	0
15	18-Aug	3.7	4	0	0	1.10	0	0	ND	ND	500	0
16	18-Aug	2.5	3	4	3	1.22	1.63	1.22	ND	ND	ND	1
17	18-Aug	2.3	4	1	2	1.74	0.43	0.87	ND	ND	ND	30
18	18-Aug	3.1	1	2	2	0.33	0.65	0.65	ND	ND	ND	0
19	18-Aug	1.7	4	0	1	2.35	0	0.59	ND	ND	ND	0
20	19-Aug	2.4	0	1	0	0	0.43	0	ND	ND	ND	0
21	19-Aug	2.2	4	0	0	1.79	0	0	ND	ND	200	1
22	19-Aug	3.1	14	0	1	4.47	0	0.32	ND	ND	ND	0
23	19-Aug	2.2	0	0	0	0	0	0	ND	ND	ND	0
24	19-Aug	2.3	5	0	3	2.22	0	1.33	ND	ND	ND	0
25	19-Aug	2.8	2	0	0	0.71	0	0	ND	ND	ND	0
26	19-Aug	1.4	0	0	0	0	0	0	ND	ND	ND	0
	Total	64.9	60	82	45				17	ND	800	36

[a] Number of fish.

[b] CPUE = catch per unit effort (fish/hour).

[c] ND = no data, not counted by field staff.

APPENDIX B. LIST OF ARCHIVED BIOLOGICAL DATA FILES

Appendix B1.–List of archived biological data files for resident fish species captured by hook and line sampling at Koktuli River, 2005.

File Name [a]	Description (location, species, captured technique, data collected, dates sampled)
t-000500b012005	Koktuli R; rainbow trout; hook & line; sex, length, weight & tag data, 13-17 Jun
t-000500b032005	Koktuli R; rainbow trout; hook & line; sex, length, weight & tag data, 11-15 Jul
t-000500b062005	Koktuli R; rainbow trout; hook & line; sex, length, weight & tag data, 16-19 Aug
t-000500b022005	Koktuli R; Arctic grayling; hook & line; sex, length, weight & tag data, 13-17 Jun
t-000500b042005	Koktuli R; Arctic grayling; hook & line; sex, length, weight & tag data, 11-15 Jul
t-000500b072005	Koktuli R; Arctic grayling; hook & line; sex, length, weight & tag data, 16-19 Aug
t-000500b052005	Koktuli R; Dolly Varden; hook & line; sex, length, weight & tag data, 13-17 Jun
t-000500b082005	Koktuli R; Dolly Varden; hook & line; sex, length, weight & tag data, 11-15 Jul

Note: Archived at the Alaska Department of Fish and Game (ADF&G), Division of Sport Fish, Research and Technical Services at 333 Raspberry Road, Anchorage, AK 99518-1565.

[a] Text files of data scanned from mark-sense forms (ADF&G, Standard Age Weight Length, Form Version 1.2).