Fishery Data Series No. 98-29

Status of the Arctic grayling fishery in the upper Chatanika River during 1997

by

Douglas F. Fleming

November 1998

Alaska Department of Fish and Game

Division of Sport Fish

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
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

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

Spell out acre and ton.

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour (spell out for 24-hour clock)	h
minute	min
second	s

Spell out year, month, and week.

Physics and chemistry

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

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
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
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

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	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
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.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
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
standard length	SL
total length	TL
variance	Var

FISHERY DATA SERIES NO. 98-29

STATUS OF THE ARCTIC GRAYLING FISHERY IN THE UPPER CHATANIKA RIVER DURING 1997

by

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ABSTRACT

In response to public concern, the status of the Arctic grayling *Thymallus arcticus* fishery in the upper Chatanika River was examined using a fishing survey through nearly all areas of river accessible to anglers driving the Steese Highway. The fishing survey consisted of a crew of three anglers with varied experience that conducted composition (age- and length) and CPUE sampling in 10 adjacent sections comprising the 72 km study area.

Ages 4, 6 and 7 years predominated in the uncorrected sample. More than half of the fish caught (57%, N= 405 fish) had attained at least 12 inches TL (305 ≥ mm TL), which is presently the minimum size for sport harvest. Catches in the upper sections of the study area included larger Arctic grayling, while greater numbers of small fish contributed to the catches in downstream sections.

A total of 151 h of angling yielded a total catch of 423 Arctic grayling in the 10 days of sampling. While the overall CPUE estimate was 2.80 Arctic grayling per hour fished (SD = 1.39), CPUE varied in the 10 sections between 0.95 and 4.44 fish per hour. Additionally, CPUE was estimated in reference to Arctic grayling large enough for sport harvest. This estimate was 1.58 fish (SD = 0.77). For a subsample of 397 captures, an average of 19 min (SD = 23 min) angling was required to catch an Arctic grayling in the 72 km study area. Angling times ranged between 1 and 115 min. Higher catch rates and shorter angling times occurred in the middle and downstream sections which may relate to higher numbers of smaller Arctic grayling resident in those areas.

The results of this study do not indicate a conservation concern exists for Arctic grayling in the upper Chatanika River. The variation in CPUE supports opinions of earlier researchers that productivity may be lower in the upper Chatanika River than in other nearby drainages.

Key Words: Arctic grayling, Chatanika River, age composition, length composition, CPUE, fishery status.

INTRODUCTION

Each year anglers travel along the Steese Highway to fish for Arctic grayling *Thymallus arcticus* in the upper Chatanika River. The Steese Highway, which is largely an unsealed road, parallels the upper 76 km of river. Access points and trails (developed and undeveloped), and several developed recreational areas and campgrounds allow anglers a unique opportunity to fish nearly all of the headwater area of an interior Alaska river close to Fairbanks (Figure 1).

The Chatanika River is formed by the confluence of Faith, McManus, and Smith creeks and flows southwest out of the White Mountains (Figure 2). Including McManus Creek, the Chatanika River flows 270 km before its confluence with the Tolovana River in Minto Flats. Its drainage pattern is not dendritic like other runoff rivers in the Interior, such as the Chena or Salcha rivers. Along its course a number of small tributary streams enter until its confluence with Goldstream in the Minto Flats Complex.

The upper Chatanika River has had a long history of placer mining. Placer mines have operated in Faith, Smith, Sourdough, Flat, and Cleary creeks which include the largest tributaries to the Chatanika River (Townsend 1987, Wojcik 1953a). A diversion dam, located approximately 1.6 km below Faith Creek, diverted headwater flows into the Davidson Ditch to operate hydraulic giants in gold mines, and run a power plant near Cleary Creek, located 75 km downstream (Wojcik 1953a, Reed 1964).

The Chatanika River Arctic grayling fishery has a long history. During the 1950's the fishery occurred only upstream of Cleary, because of turbidity generated from mining activity downstream (Wojcik 1953a). Fishing in the clear waters was often interrupted by turbidity from

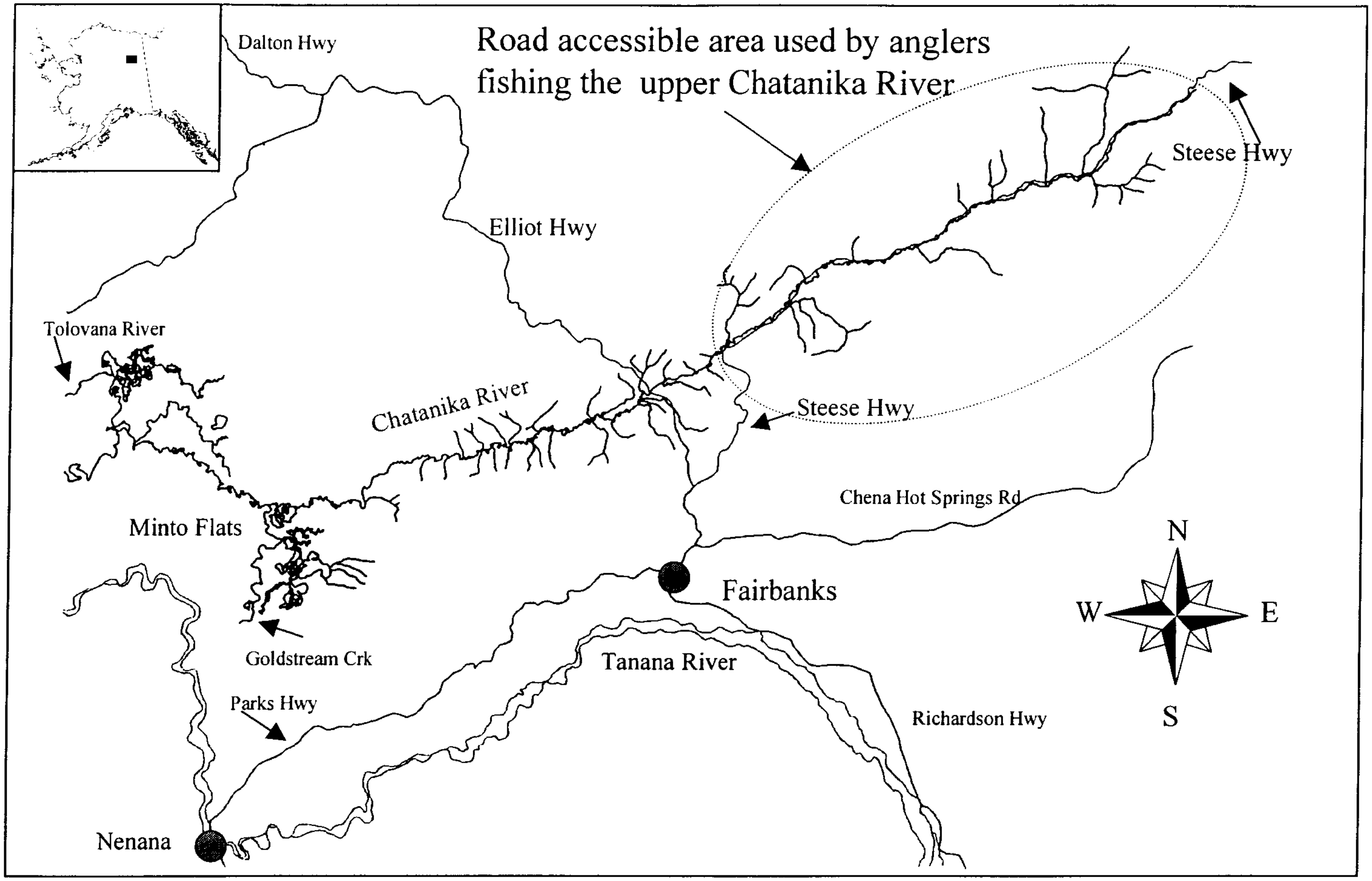

Figure 1.-Map of the Chatanika River drainage including the upper river area accessed by anglers driving the Steese Highway.

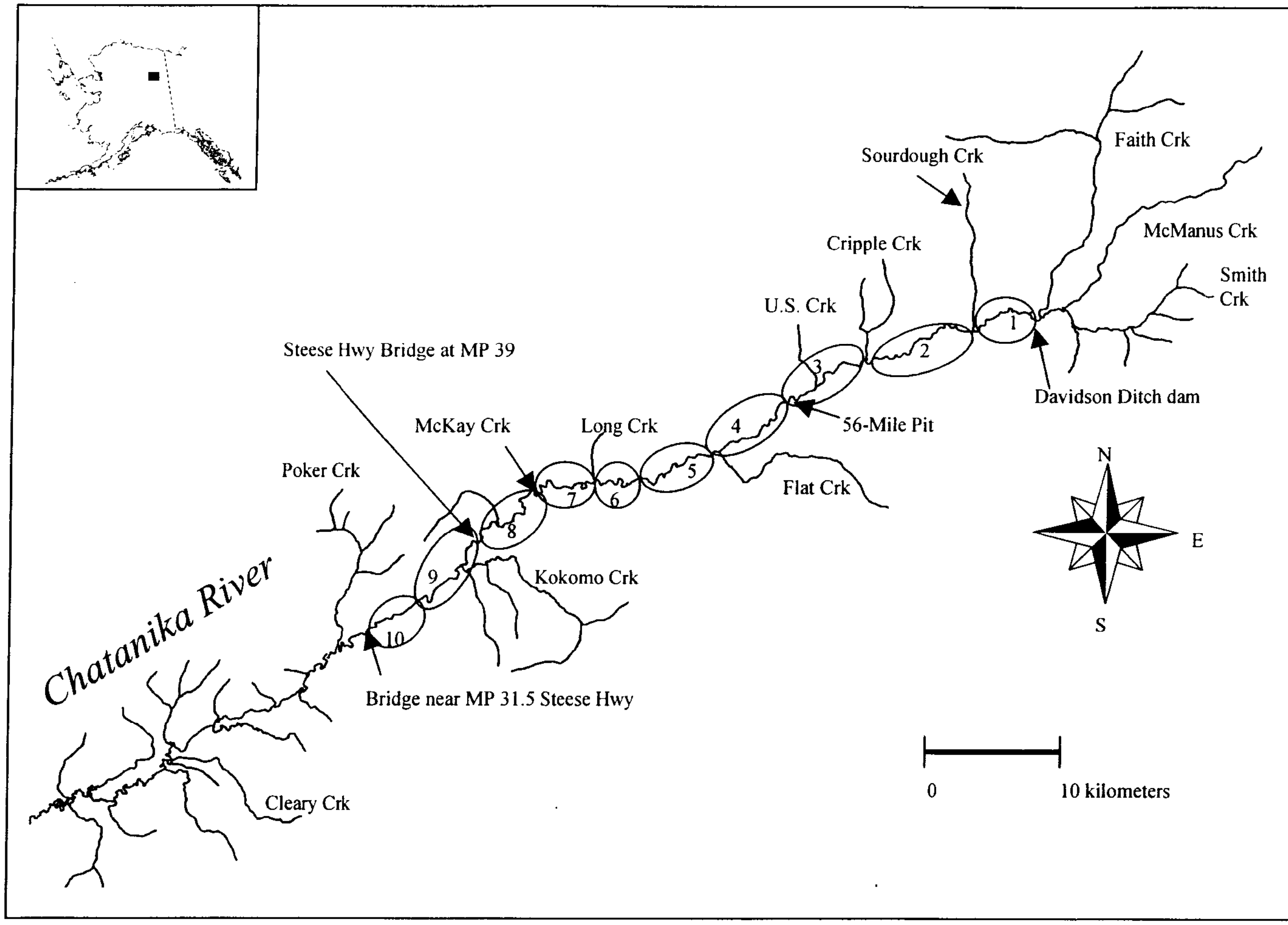

Figure 2.-Map of the study area encompassing 72 km of the upper Chatanika River divided among 10 sections, sampled June 16 – 27, 1997.

upstream placer mines during the hours of their operation (Wojcik 1953a). Nevertheless, Wojcik (1953b) found that anglers ranked the Chatanika River their favorite fishery, with the Big Delta Clearwater, Salcha River, and the Paxson-Summit area following. At the same time the small average size of harvested Arctic grayling was believed to be due to heavy angling pressure. With declining angler catch rates (and assumed declines in abundance), fishery managers imposed a 305 mm TL (12 in) minimum length limit between 1955 and 1958. After a slight increase in the angling catch rate (1958) the regulation was removed in 1959 (Warner 1959). Multiple-use conflicts continued in the upper Chatanika River through the early 1980's as placer gold mining activities increased, and as a result, recreational use declined during several summers of poor water quality (Townsend 1987). These conflicts declined after intensified efforts to improve water quality and fish and wildlife habitat were implemented. Improvements in water quality occurred in 1986, following the cooperative efforts of the industry and resource agencies.

Since the 1950's, studies on the Chatanika River Arctic grayling fishery have included tagging and migration studies, life history studies, on-site creel surveys, harvest estimates, and stock assessments. Tagging studies concluded definite seasonal migrations and high levels of fidelity between release and recovery locations within and between years (Reed 1961). Additionally, tag returns by anglers suggested high exploitation levels. Wojcik (1954) reported that anglers returned tags from 31% of the fish released with tags in 1953.

Life history studies have examined growth rates, and sexual maturity of Arctic grayling in the Chatanika River population. Reed (1964) found the growth of Chatanika River fish to be the poorest among other rapid runoff stocks (Goodpaster and Salcha rivers). Later, Clark (1992) estimated that the age- and size of maturity (Am_{50} and Lm_{50}) was five years and 243 mm FL, respectively (Clark 1992).

On-site creel surveys in 1953 to 1958 estimated catch rates from 0.13 to 0.78 Arctic grayling per hour, but did not estimate harvest or effort for the fishery (Warner 1959). A creel survey conducted in 1974 (Kramer 1975) estimated the catch rate was 1.02 Arctic grayling per hour, and 13 years later the estimated catch rate was 0.02 per angler hour (Baker 1988). Beginning in 1977, the harvests of Arctic grayling along the entire Chatanika River have been estimated by the statewide harvest survey (Mills 1979-1994). Beginning in 1995, harvests were stratified into the upper and lower river. Estimates of Arctic grayling harvest range from 1,751 fish in 1992 (Mills 1993) to 9,766 fish in 1983 (Mills 1984). In the upper Chatanika River, harvest estimates from 1995-1997 have been less than 1,000 fish (Howe et al. 1996, 1997, *In prep*). In 1991, fishing effort was estimated for three different segments of the upper Chatanika River which border the Steese Highway (Hallberg and Bingham 1992). The results indicated anglers fished proportionally more in the segments closer to Fairbanks, and most effort occurred in July.

Stock assessments of Arctic grayling in the Chatanika River have included abundance, size, and age sampling (Tack 1973; Holmes 1983, 1985; Holmes et al. 1986; Clark et al. 1991; Fleming et al. 1992; Ridder et al. 1993; Roach 1994, 1995; and, Fish 1996). Most were conducted in an area extending downstream from 10 km above the Elliot Highway Bridge to Any Creek, between river kilometers 110 and 148 (river kilometers from the confluence of Faith and McManus creeks). In 1991, stock assessment sampling also occurred along the upper Chatanika River, in selected locations between river km 30 and km 69 (Fleming et al. 1992). In that study abundance was not estimated and the size composition was similar to the composition of Arctic grayling in the lower Chatanika River during the same year. Since that time, results from periodic stock assessments conducted downstream of the Elliot Highway have been considered representative for all exploited areas of the Chatanika River.

In 1992, regulation changes were implemented in an attempt to conserve more of the Chatanika River Arctic grayling stock:

1. harvest of Arctic grayling was closed between April 1 and the first Saturday in June (spawning period);
2. terminal gears were restricted to single-hook artificial lures during the spring closure; and,
3. a 305 mm TL (12 in) minimum size limit was imposed in all areas upstream of a point 1.6 km above the Elliot Highway bridge.

In 1994, the Board of Fisheries extended the minimum size limit to all areas and tributaries of the Chatanika River.

The last five stock assessments conducted near the Elliot Highway have indicated that densities of Arctic grayling ≥ 150 mm FL (1991 through 1995) have remained statistically similar (Fish 1996). However, the proportion of fish ≥ 305 mm TL has increased from 16% to as high as 43% (last at 37%; Fish 1996). In spite of these findings, conservation concerns were brought forward by the public in 1996. Anglers reported that very few larger Arctic grayling were available in the upper portions of the Chatanika River. In 1997 it was proposed that the status of this fishery be investigated. The following report is on that investigation.

OBJECTIVES

The research objective for 1997 was to:

1. test the null hypothesis that catch rates of large (or small) Arctic grayling are ≥ 1 fish per day in the upper Chatanika River;

In addition:

1. the length and age distribution of the sample is reported;
2. data was collected to estimate CPUE in a way that can be related to particular sections and anglers; and,
3. fish were marked with tags so that the relative exploitation rate may be proxied by monitoring angler tag returns, and to provide a means for identifying fish.

METHODS

STUDY AREA AND SAMPLING

Sampling of Arctic grayling in the Chatanika River has primarily been conducted using electrofishing boats in navigable areas since the early 1980's. These efforts have focused on waters adjacent to, and downstream of the Elliot Highway (Figure 1). In the upper Chatanika

River, past researchers used hook and line gears (hereafter referred to as H&L) because of its channel characteristics. While the higher stream gradient and low stream discharges preclude the use of electrofishing from boats (unnavigable), the depth and velocity characteristics of the channel also discouraged backpack electrofishing for wading crews (unsafe). In 1991, a crew tried to use backpack electrofishing gears to sample the Arctic grayling population, but switched to H&L gear (Fleming et al. 1992). Mark-recapture data collected in a smaller study area near the upper boundary indicated immigration occurred during early- to mid-June, and precluded attempts to estimate abundance (Fleming et al. 1992). Based on these findings, sampling in 1997 occurred later, between June 16 and 27 to allow fish time to reach summer feeding areas.

In 1997, a crew of three members assessed the angling CPUE and composition during a single downstream sampling pass through 72 river km of the upper Chatanika River (Figure 2). The upstream boundary of the sampling area was the Davidson Diversion Dam, located near Milepost 68 on the Steese Highway. The lower sampling boundary was located at the Poker Creek Bridge at MP 31.5 Steese Highway. The study area fell within the portion of the upper Chatanika River that earlier researchers used for creel- and biological sampling studies, and represented as much as 95% of the river accessible to anglers travelling the Steese Highway.

The 72 km area was sampled systematically over 10 days, beginning at the upstream boundary. During each day the crew traveled on foot and sampled a section of the river between two access points. The 10 sections were accessed by road, trail or from the Steese Highway at the beginning and end-points (Figure 2). Lengths of the sections ranged from 5.6 to 10.6 km:

Sample Reach	Location	Access (in, out)	Length
1	Diversion Dam to Sourdough Creek	trail, trail	5.5 km
2	Sourdough Creek to Cripple Creek	trail, road	10.6 km
3	Cripple Creek to MP 55 access road	road, road	7.2 km
4	To MP 55 access road to Flat Creek	road, road	7.4 km
5	Flat Creek to Camp Creek area	road, overland	6.8 km
6	Camp Creek area to Long Creek	overland, trail	6.1 km
7	Long Creek to McKay Creek	trail, overland	7.6 km
8	McKay Creek to Chatanika River bridge	overland, road	7.9 km
9	Chatanika River bridge to MP 35 access	road, trail	7.1 km
10	MP 35 access to MP 31.5 access road	trail, road	5.6 km

To ensure that longer sections were sampled within time constraints, downstream progress by the crew was monitored by the time and location relative to checkpoints. Checkpoints were selected geographic features such as landmarks, tributary creeks, trails, or topographic features such as ridges or ravines identified from maps. The crew captured fish for sampling with a variety of occasion. Hook and lure sizes were purposely kept small to minimize size selectivity. Lures commonly included silver, blue, and prismatic colored spinners and lightweight (1/64 to 1/16 ounce) plastic or feather single hook jigs. Flies included Caddis- and Mayfly imitations as well as various attractor patterns, all on size 12 hooks.

Two crew members walked and fished while the other crew member fished, but also tended a canoe carrying all sampling and safety gear. In order to reduce any angler bias, canoe-tending duties were rotated among crew members during each day. All angling was done while wading, and captured fish were briefly held in 25 liter plastic buckets before transfer into a 60 liter cooler prior to sampling. Each crew member recorded times into water resistant notebooks that corresponded to stop and start times of fishing, and the time of each capture. Time fished included time spent walking or wading and time spent changing lures or gears, but not when extensive walking was needed. Total handling time (time in bucket plus cooler transport and sampling times) was limited to no more than 30 min, and crew members changed holding water often to reduce holding stress.

All fish greater than 149 mm FL were measured to the nearest millimeter FL, tagged with an individually numbered Floy™ FD-67 internal anchor tag, and three scales were taken from an area approximately six scale rows above the lateral line, just posterior to the insertion of the dorsal fin (W. Ridder, Alaska Department of Fish and Game, Delta Junction, unpublished information on refinement of methods described by Brown 1943). The anchor tags were gray colored and the tagging number series ranged from 69,000 to 69,388. Scales were mounted directly on gum cards. The gum cards were later used to make triacetate impressions of the scales (30 s at 137,895 kPa, at a temperature of 97°C). Ages were determined by counts of annuli from impressions of scales magnified to 40X with the aid of a microfiche reader. Criteria for determining the presence of an annulus were: 1) complete circuli cutting over incomplete circuli; 2) clear areas or irregularities in circuli along the anterior and posterior fields; and, 3) regions of closely spaced circuli followed by a region of widely spaced circuli (Kruse 1959). All data except recorded angling times were recorded on Alaska Department of Fish and Game Tagging Length Form, Version 1.0.

AGE AND SIZE COMPOSITION

Apportionment of the assessed stock among age or size groupings generally depends on the extent of sampling biases, if known. During the upper Chatanika River investigation, the single sampling pass through the study area precluded the use of mark-recapture methodologies to determine, and correct for sampling biases. In an attempt to minimize effects of size selectivity of the capture gear (H & L), the crew utilized the smallest artificial lures that were effective, flies that were size 12 or 14, and exceptionally light monofilament lines (2-4 lb test). Since no adjustments were possible for length selectivity or geographic differences in capture probability, the proportion of fish at age $_j$ (or length class $_j$) in 1997 was estimated by:

$$\hat{p}_j = \frac{y_j}{n} \qquad (1)$$

where: $\hat{p}_j$ = the proportion of fish that are age or length class j;

where: $\hat{p}_j$ = the proportion of fish that are age or length class j;

y_j = the number of fish sampled that are age or length class j; and,

n = the total number of fish sampled.

The unbiased variance of this proportion was estimated as:

$$\hat{V}[p_j] = \left[\frac{\hat{p}_j(1-\hat{p}_j)}{n-1}\right]. \tag{2}$$

Stock assessment categories for the 1996 and 1997 studies utilized the same approach, where substitutions for class were: age classes and 10 mm FL incremental size groupings. Incremental size composition categories for Arctic grayling were 10 mm FL groupings with mid-points 155 to 395 mm FL.

CATCH PER UNIT EFFORT

Catch per unit effort was estimated in a similar manner:

$$CPUE_k = \frac{y_k}{t_k} \tag{3}$$

where: $CPUE_k$ = the catch per unit effort through angling of Arctic grayling in area or section k;

y_k = the number of fish captured in area or section k; and,

k = the section ranging from 1 to 10, or the overall 72 km study area.

t_k = time spent angling in area or section k.

The standard deviation of CPUE was estimated as the sample standard deviation of the independent estimates of CPUE by section.

RESULTS

FIELD SAMPLING

A total of 423 Arctic grayling were caught by angling and sampled throughout the 72 river km study area between June 16 and 27, 1997. The three-member crew logged a total of 151 h of angling during the study. A total of 413 Arctic grayling (≥ 150 mm FL) were released bearing individually numbered Floy™ anchor tags. Throughout the study, water conditions remained low and clear on all but one day, when the river briefly rose after an evening thunderstorm in the headwater areas. Weather conditions were typically clear, sunny, and hot with air temperatures to 30 °C on all but two days. The minimum and maximum water temperatures during the latter half of June were 9.5°C and 16 °C, respectively, but generally daily water temperatures ranged between 13°C and 15 °C during the time of day when angling and sampling occurred. The overall acute mortality rate from sampling was five out of 423 individual grayling handled, or 1.1 %.

Members of the angling public voluntarily reported information on the capture of 10 of the tagged fish following the field investigations. Of these fish, all were known to be at a legal size for harvest (≥ 260 mm FL), and all but two fish were believed to have been harvested. This represents a minimum relative exploitation rate of approximately 2%. Locations of nine of the 10 tagged-fish returns indicated that all fish were recaptured within the same area[1] as where they were released 5 to 45 days before. Based on these results, the lack of post-tagging movement indicated the population had completed post-spawning movements, and the Arctic grayling were distributed for summer feeding.

AGE AND SIZE COMPOSITION

Scale samples were collected from 413 Arctic grayling, of which 362 were aged due to an incidence of 12% regenerated or illegible scales. Estimated ages observed from the sample of angler-caught Arctic grayling ranged from 2 to 14 years. The predominant age class present was age 4 (27%; Table 1) followed by ages 6 and 7 fish (each 15%). The sizes of angled Arctic grayling in the upper Chatanika River tended to be bimodally distributed, with modes corresponding to year-class strengths of age-4 and combined strengths of age-6 and 7 fish (Figure 3, Table 1). Within the study area, 57% of the Arctic grayling captured by angling were at or above the minimum size (12 in TL) for harvest (≥ 270 mm FL, or, ≥ 305 mm TL). The median sized Arctic grayling captured was 274 mm FL, and fish ranged from 145 to 377 mm FL. The largest Arctic grayling were captured in the upstream sections of the study area, while the smaller fish were captured in downstream sections. The median lengths of Arctic grayling decreased with increased distance from the headwater areas (Figure 4).

CATCH PER UNIT EFFORT

The total angling time for the three-person crew was 151 h, which corresponded to the summation of the time spent fishing less the time spent travelling or sampling. Crew members recorded all instances when not actively fishing, which included time used for sampling fish or when extensive foot or canoe travel was necessary. The overall estimated CPUE for the 72 km study area was 2.80 fish per angling-hour (SD = 1.39). I also estimated the CPUE of Arctic grayling that had reached the minimum length for sport harvest - this estimate was 1.58 fish per angling-hour (SD = 0.77). The tabulations of section-specific angling time and CPUE were as follows:

[1] For the purpose of this study the "same area" refers to the section of the upper Chatanika River bounded between known access points along the Steese Highway, which are often referenced by mileposts.

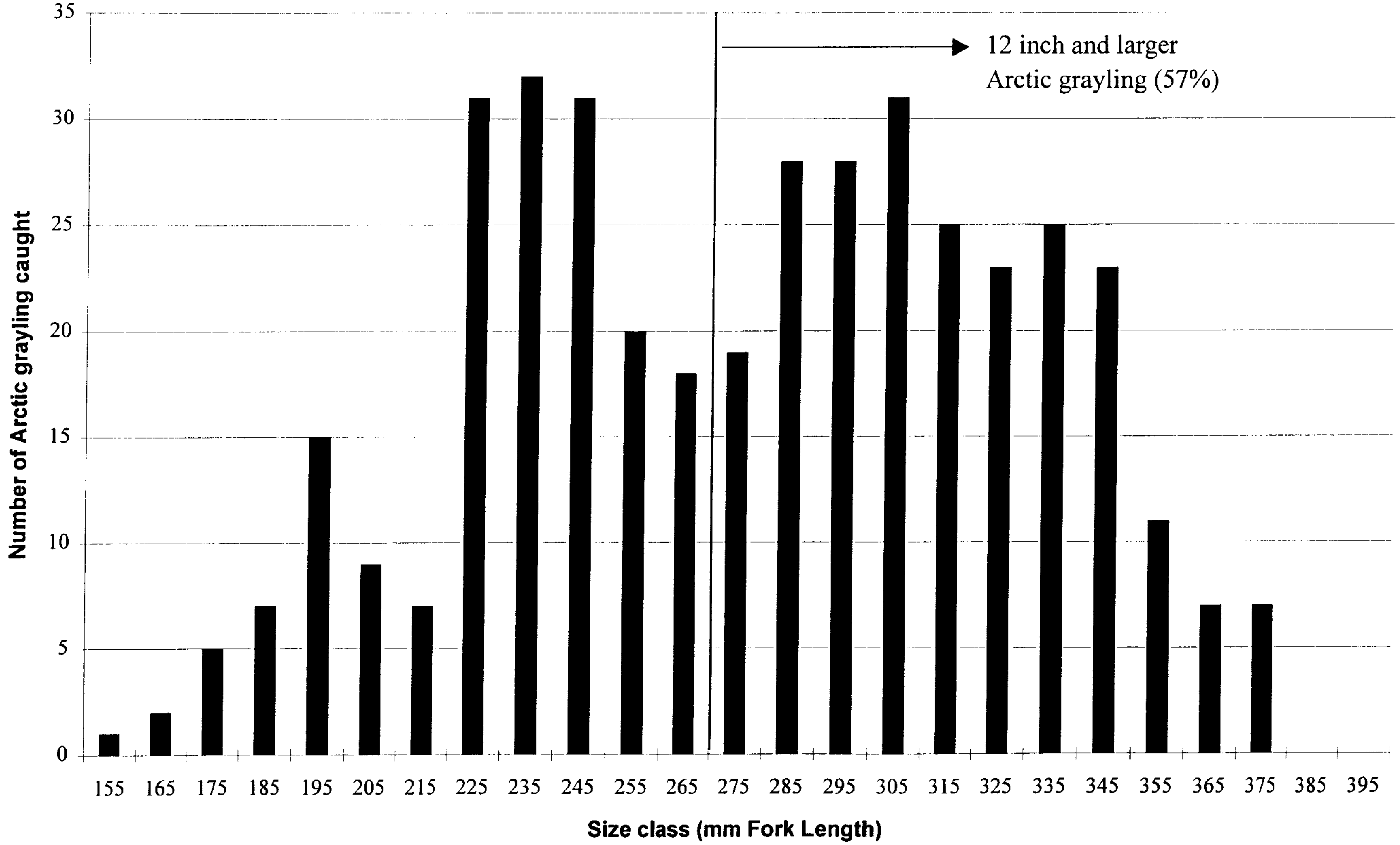

Figure 3.-Number of Arctic grayling caught by length (≥ 150 mm FL) in the upper Chatanika River, June 16 – 27, 1997.

Table 1.-Estimates of the sampled contributions by each age class and 10 mm FL incremental size groupings for Arctic grayling (≥150 mm FL) captured by angling in the upper Chatanika River, June 16 – 27, 1997.

Age	Count[a]	$\hat{p}$[b]	SE[c]	Length	Count[a]	$\hat{p}$[b]	Se[c]
1	0	0.00	----	155	1	< 0.01	<0.01
				165	2	< 0.01	<0.01
2	2	<0.01	<0.01	175	5	0.01	<0.01
				185	7	0.02	0.01
3	27	0.07	0.01	195	15	0.04	0.01
				205	9	0.02	0.01
4	98	0.27	0.02	215	7	0.02	0.01
				225	31	0.08	0.01
5	41	0.11	0.02	235	32	0.08	0.01
				245	31	0.08	0.01
6	56	0.15	0.02	255	20	0.05	0.01
				265	18	0.04	0.01
7	56	0.15	0.02	275	19	0.05	0.01
				285	28	0.07	0.01
8	34	0.09	0.01	295	28	0.07	0.01
				305	31	0.08	0.01
9	20	0.05	0.01	315	25	0.06	0.01
				325	23	0.06	0.01
10	16	0.04	0.01	335	25	0.06	0.01
				345	23	0.06	0.01
11	6	0.02	0.01	355	11	0.03	0.01
				365	7	0.02	0.01
12	4	0.01	0.01	375	7	0.02	0.01
>12	2	<0.01	<0.01				
Total	362	1.00	----	Total	405	1.00	----

[a] Number of sampled individuals which yielded age or size information in each age or 10 mm FL incremental size class.

[b] $\hat{P}$ = estimated proportions of Arctic grayling.

[c] SE = standard error of the proportional contribution.

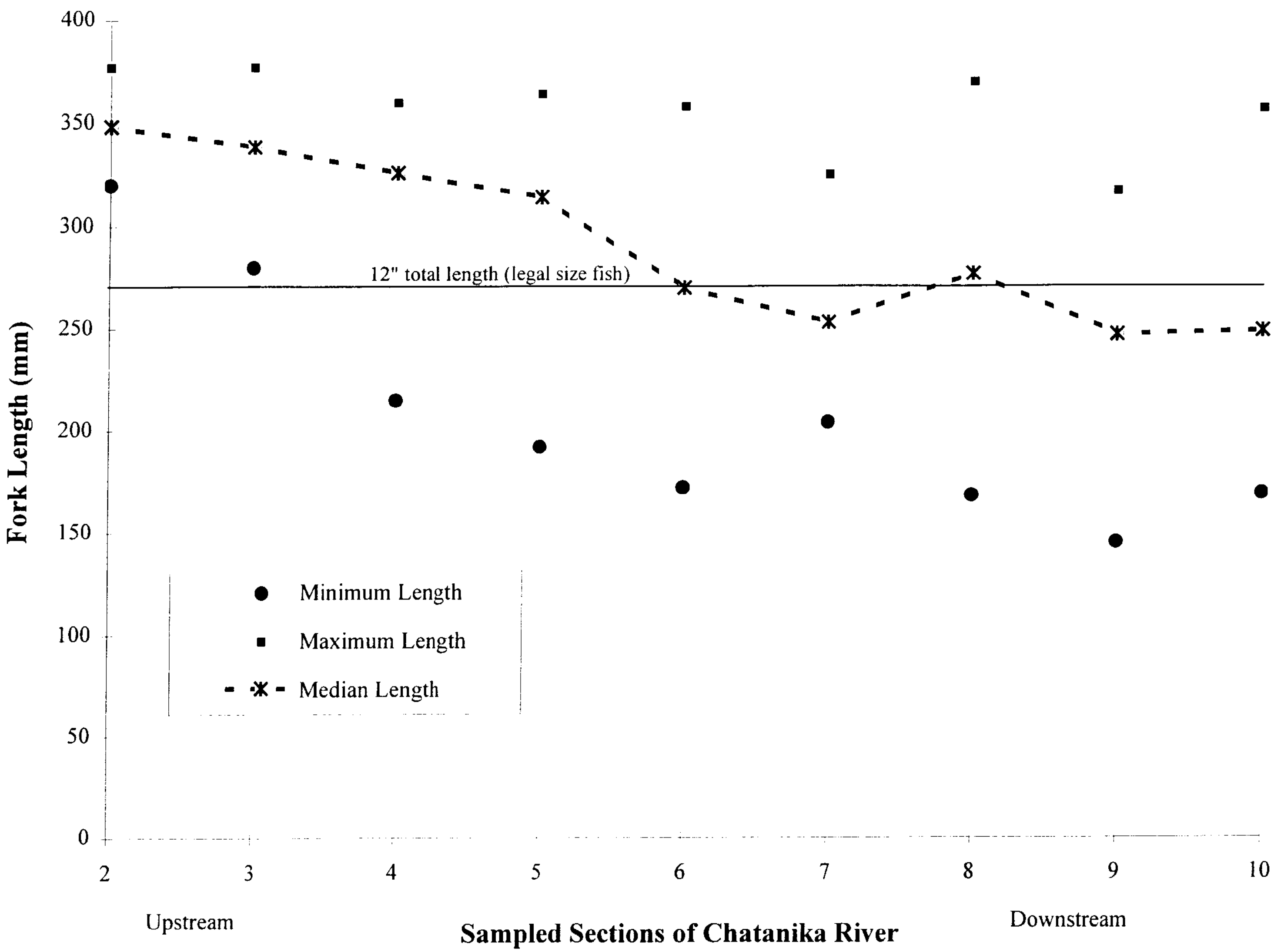

Figure 4.-Minimum, maximum and median lengths of Arctic grayling caught by angling in sections 2-10 of the upper Chatanika River, June 16 – 27, 1997. Fish sampled in section 1 were only examined to determine if they exceeded the 12 in TL size limit.

Section	Location	Time Fished (h)	Catch	CPUE	CPUE (12"+)
1	Diversion Dam to Sourdough Creek	11.3	14	1.24	0.97
2	Sourdough Creek to Cripple Creek	14.8	14	0.95	0.95
3	Cripple Creek to MP 55 access road	14.6	22	1.51	1.51
4	to MP 55 access road to Flat Creek	13.8	34	2.47	1.74
5	Flat Creek to Camp Creek area	15.8	57	3.62	2.97
6	Camp Creek area to Long Creek	15.6	41	2.63	1.35
7	Long Creek to McKay Creek	15.7	27	1.73	0.76
8	McKay Creek to Chatanika River bridge	15.3	73	4.77	2.88
9	Chatanika River bridge to MP 35 access	15	57	3.81	1.27
10	MP 35 access to MP 31.5 access road	19	84	4.44	1.26

The elapsed fishing time between subsequent captures of fish was tabulated for each crew member to more closely examine underlying patterns of fishing effort and successes throughout the study area. The crew collectively tabulated information on 397 capture events. The time to capture Arctic grayling ranged between 1 and 115 min. The average angling times by section varied (Figures 5 and 6). The estimated overall mean time fished between captures of Arctic grayling in the 72 km study area was 19 min (SD = 23 min) while the median time was 10 min. Angling time was also used to construct graphical timelines which visually reflected the distribution of angling catches of Arctic grayling by cumulative fishing time in each section (Figure 7). The combined plots of the three anglers (seen as vertically offset circles) within each sampling reach indicate variation in angling success.

In order to test the null hypothesis concerning a daily catch rate, the estimates were recalculated using an 8-h time unit. As a result, the mean 8-h CPUE (ave=12.528, SE = 6.16) was greater than 1 ($t = 5.914$, $df = 9$, $p = 0.00001$).

Among the sections, two had high CPUEs for fish 12 in or larger. CPUEs for sections 5 and 8 were considered outliers when compared to the other sections (t-tests, $p \leq 0.001$). Assuming that the remaining estimates of CPUE are normally distributed (mean = 9.81, variance = 6.603) the estimated probability that an angler would not catch a fish in 8 h of fishing is 0.003. This estimate is more conservative than if the outlier CPUEs remained in the analysis.

DISCUSSION

In the course of angling Arctic grayling on the upper portions of the Chatanika River, sufficient captures of fish indicate that the CPUE was higher than previously reported. It is likely that some fish failed to utilize adjacent tributaries during the summer because of record low water conditions in 1997, and remained in the Chatanika River. As a result, catchability of Arctic

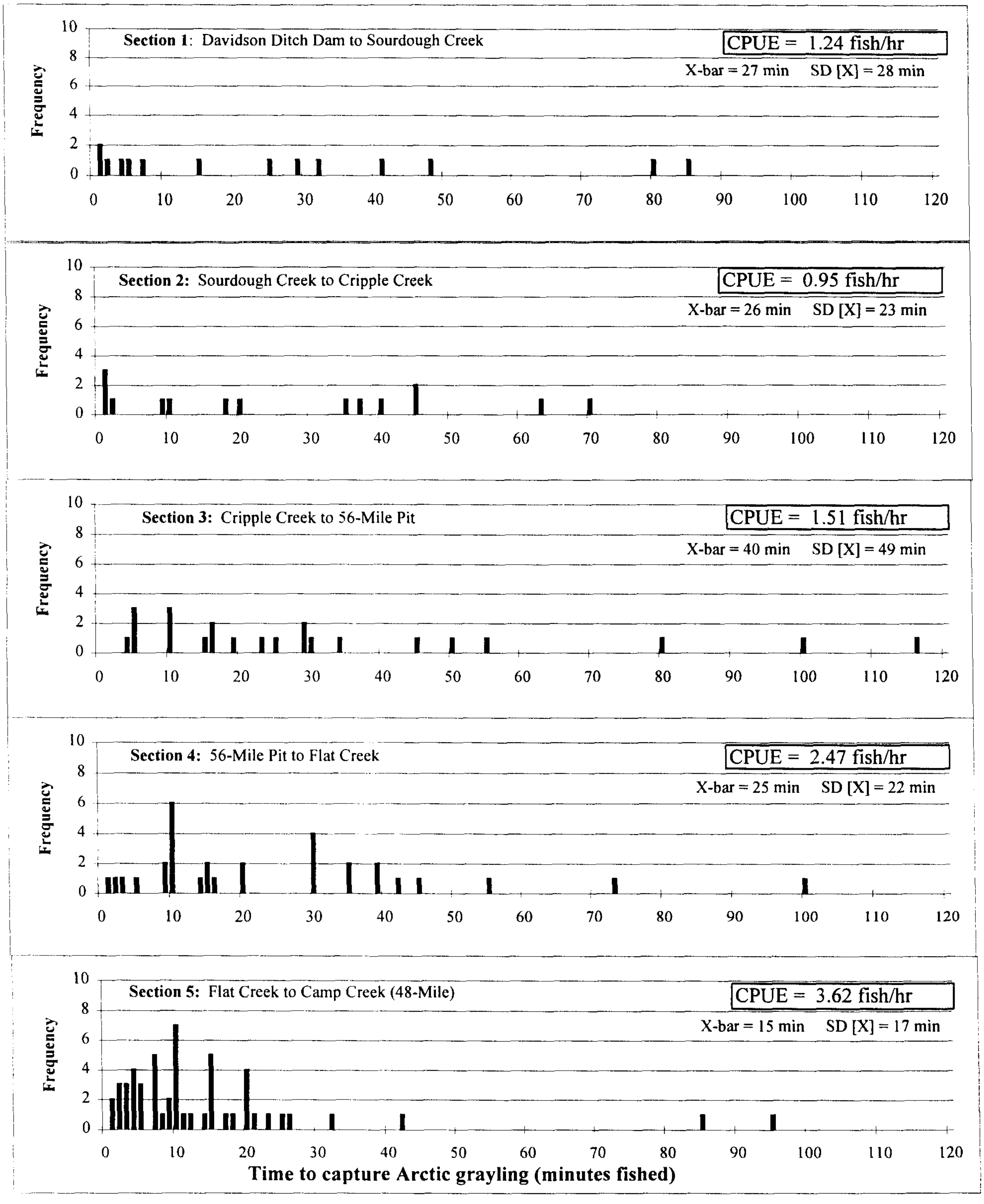

Figure 5.-Frequency distributions of tabulated angling times to capture Arctic grayling in sections 1-5 of the upper Chatanika River, June 16 – 27, 1997.

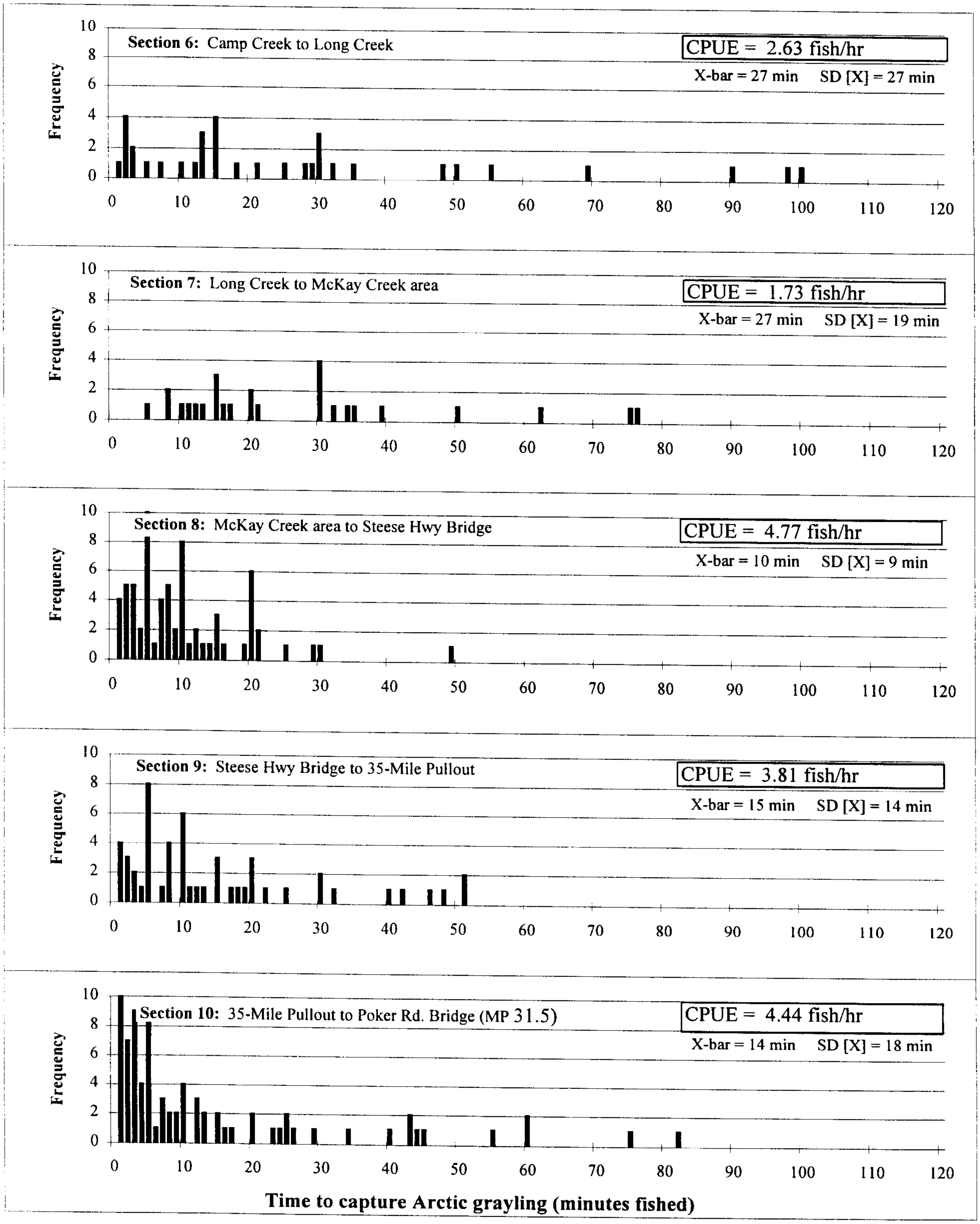

Figure 6.-Frequency distributions of tabulated angling times to capture Arctic grayling in sections 6-10 of the upper Chatanika River, June 16 – 27, 1997.

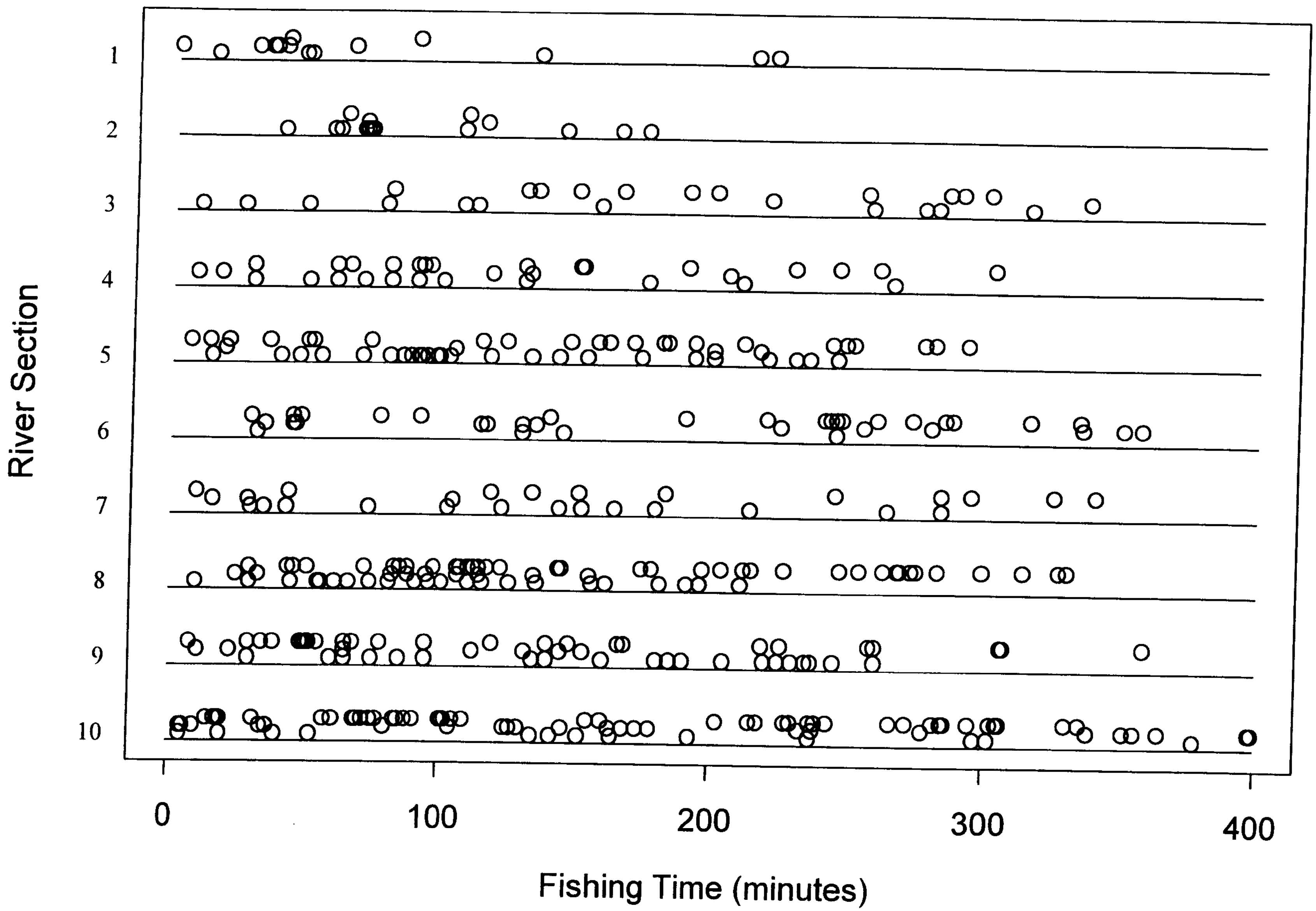

Figure 7.-Angler cumulative timelines for captured Arctic grayling in sampled sections of the upper Chatanika River, June 16 – 27, 1997 (within each river section the vertical offset of circles represents captures by each of three anglers).

grayling may have been higher than on average, and this could have influenced our CPUE results to be higher.

The majority of fish (57%) were at or above the minimum size allowable for harvest. The resulting high overall estimates of CPUE (2.80 per hour fished, or 1.58 fish ≥ 12 in TL) and the availability of fish for harvest do not indicate that immediate conservation problems exist for this fishery. When the CPUE data was further examined in context of the 10 sections that made up the 72 km study, it became apparent that some areas may offer better fishing to anglers. For some anglers better fishing may relate to higher catch rates, while for others the presence of larger fish may be more important. These two angling preferences may be realized by anglers fishing in different sections of the upper Chatanika River. In sections with predominantly larger fish and lower CPUE estimates, such as the upper three sections, it is likely that overexploitation could occur on the relatively few larger fish present. Alternatively, the low catch rates in these sections may prevent over harvest. In the lower sections where catches included greater numbers of smaller Arctic grayling and higher catch rates, the potential for over exploitation on the smaller fish is low due to the 12 in minimum size limit.

Since the early 1950's researchers have noted that the Steese-accessed portion of the Chatanika River is unproductive and subject to overexploitation (Wojcik 1953a). Creel surveys between 1953 and 1958 indicated catch rates ranged between 0.13 and 0.78 Arctic grayling per hour averaging 0.43 (Warner 1959, Wojcik 1954). During the same or similar years, creel studies indicated similar average catch rates at the Delta Clearwater River (0.42) and higher rates at the Chena (0.83) and Salcha (0.84) rivers (Warner 1959). Later creel surveys estimated catch rates of 1.02 Arctic grayling per hour (Kramer 1975) and 0.02 Arctic grayling per hour (Baker 1988). Estimates of CPUE in 1997 were considerably higher and could have been influenced by angling efficiency of the crew members. It is likely that the varied experience levels among the sampling crew possibly reduced some of this effect. Moreover, to remove this effect, a more costly approach such as creel surveys would be required.

During sampling we found reaches of habitat within the study area where we did not see or angle any Arctic grayling, while similar habitats in other rivers have been found to host many actively feeding Arctic grayling. While the present study was not designed to determine patterns of habitat utilization by Arctic grayling, this topic may be considered in the future as a step towards proactive management of the Chatanika River. Since it is known that mining activity impacted the river prior to 1986, it is reasonable to suspect problems with production may relate to habitat impacts, nutrient limitations, or food resources, i.e. invertebrates.

Road access has allowed anglers to reach most areas where Arctic grayling reside. In other rapid runoff rivers such as the Chena, Goodpaster, and Salcha, remote headwater forks and tributaries are not often road accessible and allow fish refugia where harvest levels are likely to be low or non-existent. The combination of refugia encompassing summer feeding areas and spring spawning closures by regulation may provide substantially higher protection to these spawning stocks.

While the Chatanika River offers a minimum of 25 additional stream kilometers to fishermen compared to the Chena River, and is equally distant from Fairbanks, there are fewer angler days spent on the Chatanika River than the Chena River:

	Upper Chatanika River			Upper Chena River	
Year	Angler days	Catch	Harvest	Angler days	Catch
1995	5,709	8,964	963	13,319	23,429
1996	4,867	6,113	234	15,228	26,805
1997	3,312	9,968	680	14,838	42,572

Comparisons of angling effort, catch and harvest estimates (Howe et al. 1996, 1997, and *In prep*) for these two upstream areas may be confounded by harvest regulations, and the existence of differing recreational opportunities. The apparent difference in angling use is large between the upper areas of the Chena and Chatanika rivers and to some degree may be influenced by differences in fishery performance.

In the future, management actions might alter the fishery's performance by consideration of differing regulation packages, such as a slot limit, in conjunction with proactive steps toward understanding and even improving biological production of the Chatanika River. Studies have shown that nutrient levels can be altered to improve production and growth of salmonids, including Arctic grayling (Johnson et al. 1990, Deggan and Peterson 1992). Examination and comparison of several abiotic and biotic factors with results from the nearby Chena River could determine whether fertilization may be successful in boosting production for short-term or long-term gains to salmonids including Arctic grayling. Sources of nutrients could include natural sources such as hatchery-waste salmon carcasses, or various prepared fertilizers and chemicals. If the examination does not indicate nutrient limitations, then focus should be placed on habitat status, habitat use, and localized improvements.

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Appendix A

Appendix A.- Data File.

Data file[a]	Description
U004ALCA.DTA	Data file listing

[a] Data files were archived at and are available from the Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage, Alaska 99518-1599.