

Fishery Data Series No. 98-13

**Survey of the Rainbow Trout Sport Fishery on the
Nonvianuk and Alagnak Rivers, 1996**

by

Michael J. Jaenicke

July 1998

Alaska Department of Fish and Game

Division of Sport Fish



Symbols and Abbreviations

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Weights and measures (metric)		General		Mathematics, statistics, fisheries	
centimeter	cm	All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.	alternate hypothesis	H _A
deciliter	dL			base of natural logarithm	e
gram	g	All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.	catch per unit effort	CPUE
hectare	ha	and	&	coefficient of variation	CV
kilogram	kg	at	@	common test statistics	F, t, χ^2 , etc.
kilometer	km	Compass directions:		confidence interval	C.I.
liter	L			correlation coefficient	R (multiple)
meter	m		east E	correlation coefficient	r (simple)
metric ton	mt		north N	covariance	cov
milliliter	ml		south S	degree (angular or temperature)	°
millimeter	mm		west W	degrees of freedom	df
		Copyright	©	divided by	÷ or / (in equations)
		Corporate suffixes:		equals	=
		Company	Co.	expected value	E
		Corporation	Corp.	fork length	FL
		Incorporated	Inc.	greater than	>
		Limited	Ltd.	greater than or equal to	≥
		et alii (and other people)	et al.	harvest per unit effort	HPUE
		et cetera (and so forth)	etc.	less than	<
		exempli gratia (for example)	e.g.,	less than or equal to	≤
		id est (that is)	i.e.,	logarithm (natural)	ln
		latitude or longitude	lat. or long.	logarithm (base 10)	log
		monetary symbols (U.S.)	\$, ¢	logarithm (specify base)	log ₂ , etc.
		months (tables and figures): first three letters	Jan,...,Dec	mideye-to-fork	MEF
		number (before a number)	# (e.g., #10)	minute (angular)	'
		pounds (after a number)	# (e.g., 10#)	multiplied by	x
		registered trademark	®	not significant	NS
		trademark	™	null hypothesis	H ₀
		United States (adjective)	U.S.	percent	%
		United States of America (noun)	USA	probability	P
		U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)	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
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				

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by

Michael J. Jaenicke
Division of Sport Fish, Dillingham

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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*Michael J. Jaenicke,
Alaska Department of Fish and Game, Division of Sport Fish
P.O. Box 230, Dillingham, AK 99737-0605, USA*

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ABSTRACT

The Alaska Department of Fish and Game-Division of Sport Fish and National Park Service-Katmai National Park and Preserve conducted a cooperative project to evaluate the current status of the rainbow trout stocks in the Alagnak and Nonvianuk rivers. A creel census indicated that total sport fishing effort at the headwaters of the Nonvianuk River during 8 June to 30 June 1996 was 755 angler hours, with 1,529 rainbow trout caught and released. Most anglers were guided (59%), not an Alaskan resident (58%), used air charter to access the area (80%), fished from shore (91%), and fished with fly gear (91%). Fifty-seven rainbow trout were Floy tagged during the creel census. Length and age data were collected from 620 rainbow trout from the Nonvianuk River ($n = 297$) and Alagnak River ($n = 323$) during June through September 1996. The length distribution of rainbow trout differed significantly ($p < 0.001$) between the outlet of Nonvianuk Lake and the lower 11 miles of the Nonvianuk River, while the length distribution was not significantly different ($p = 0.38$) between three zones on the upper Alagnak River. Based on age composition information from other systems in southwest Alaska, the rainbow trout stock in the Nonvianuk River and Alagnak River appears to have a smaller proportion of age-6 and age-7 year old fish than would be expected in a healthy stock. An emergency order issued in 1996 created a catch-and-release rainbow trout fishery on the Alagnak and Nonvianuk rivers. Preliminary indications from a more intensive research project started in April 1997 on the rainbow trout stock in the Alagnak River drainage by the U.S. Geological Survey-Biological Research Division indicate that the stock status may not be lacking in larger, older fish as suggested from results from this 1996 project.

Key words: Rainbow trout, *Oncorhynchus mykiss*, creel census, angler demographics, biological composition, Nonvianuk River, Alagnak River, Southwest Alaska.

INTRODUCTION

The fishing pressure on the rainbow trout *Oncorhynchus mykiss* stock within the Alagnak River drainage has been increasing with the growth of the sport fishing industry in southwest Alaska. Sport fishing effort on the Alagnak River (Mills 1982-1994, Howe et al. 1995, 1996) since 1981 has increased dramatically, from 1,947 angler days in 1981 to 13,232 angler days in 1995 (Table 1). The estimated rainbow trout harvest in the Alagnak River has remained relatively low, but the estimated number of rainbow trout caught during 1991-1995 has ranged from 11,062 in 1994 to 30,665 in 1993 (Table 1).

Growing public and department concern for the health of the rainbow trout stock in the Alagnak River resulted in a study in 1996 conducted by National Park Service-Katmai National Park and Preserve (NPS-KNPP) personnel and the Alaska Department of Fish and Game (ADF&G)-Division of Sport Fish. Previous studies on the rainbow trout fisheries of the Alagnak River drainage have been limited. In 1984, NPS-KNPP personnel

conducted a creel survey at the headwaters of the Nonvianuk River during 11 June to 15 September (Jope *Unpublished*). The days were divided into three periods (8:00 a.m. to 12:00 p.m., 12:00 p.m. to 4:00 p.m., and 4:00 p.m. to 8:00 p.m.), with a total of 288 possible periods during the 96-day season. The creel survey was conducted for 18 (6.25%) of the 288 possible periods via randomly sampling one of the three daily periods approximately every 5 days. Results from the survey indicated a catch per unit effort (CPUE) for rainbow trout of 0.5 fish per hour. A regression equation estimated that approximately 986 rainbow trout were caught, of which an estimated 67 fish were harvested, during the 1984 season. Note that the small sampling effort in this survey indicates that the 1984 results should be considered preliminary.

In addition to the NPS-KNPP creel survey in 1984, the ADF&G- Division of Sport Fish and the NPS-KNPP have conducted biological sampling of the rainbow trout population on the Nonvianuk River during 1974 and 1990, and on the Alagnak River

Table 1.-Estimated sport fishing effort (angler-days) and harvest and catch of rainbow trout on the Alagnak River during 1981-1995.

Year	Fishing Effort (Angler-days)	Harvest	Catch ^a
1981	1,947	76	
1982	2,252	157	
1983	2,348	178	
1984	5,119	187	
1985	2,473	518	
1986	7,628	340	
1987	4,786	824	
1988	1,182	18	
1989	2,717	343	
1990	6,571	423	6,057
1991	6,079	243	23,244
1992	12,323	111	18,452
1993	12,440	312	30,665
1994	10,949	74	11,062
1995	13,232	107	19,499
Average during:			
1991-1995	11,005	169	20,584
1986-1995	7,691	280	

From: Mills 1982-1994, Howe et al. 1995 and 1996.

^a Estimates of rainbow trout catch not available until 1990.

during 1965, 1989, 1993, and 1995 (Appendix A). Creel surveys were conducted by Sport Fish Division on the Alagnak River during 1988 (Brookover 1989), 1989 (Dunaway 1990), and 1993 (Dunaway 1994), but these surveys occurred in the lower section of the Alagnak River (approximately 5 km above the confluence with the Kvichak River and extending upstream 19 km) where the primary sport fish target species were chinook and coho salmon rather than rainbow trout.

Objectives of this study were twofold. First, a creel census was conducted on the rainbow trout fishery at the outlet of Nonvianuk Lake during June 1996. This census allowed calculation of recreational fishing effort (in angler-days and angler-hours), catch and

harvest of rainbow trout, the distribution of catch of rainbow trout among anglers (angler-days), and the proportion of angler-days by angler type (shore/boat, guided/unguided, local/Alaska/U.S./not U.S. residency, and adult/youth). In addition, the length and age composition of catchable rainbow trout was estimated for the Nonvianuk River and Alagnak River during June through September 1996.

METHODS

This study was conducted on the Nonvianuk River and Alagnak River. Kukaklek Lake forms the headwaters of the Alagnak River (Figure 1). The Nonvianuk River flows from the outlet of Nonvianuk Lake into the

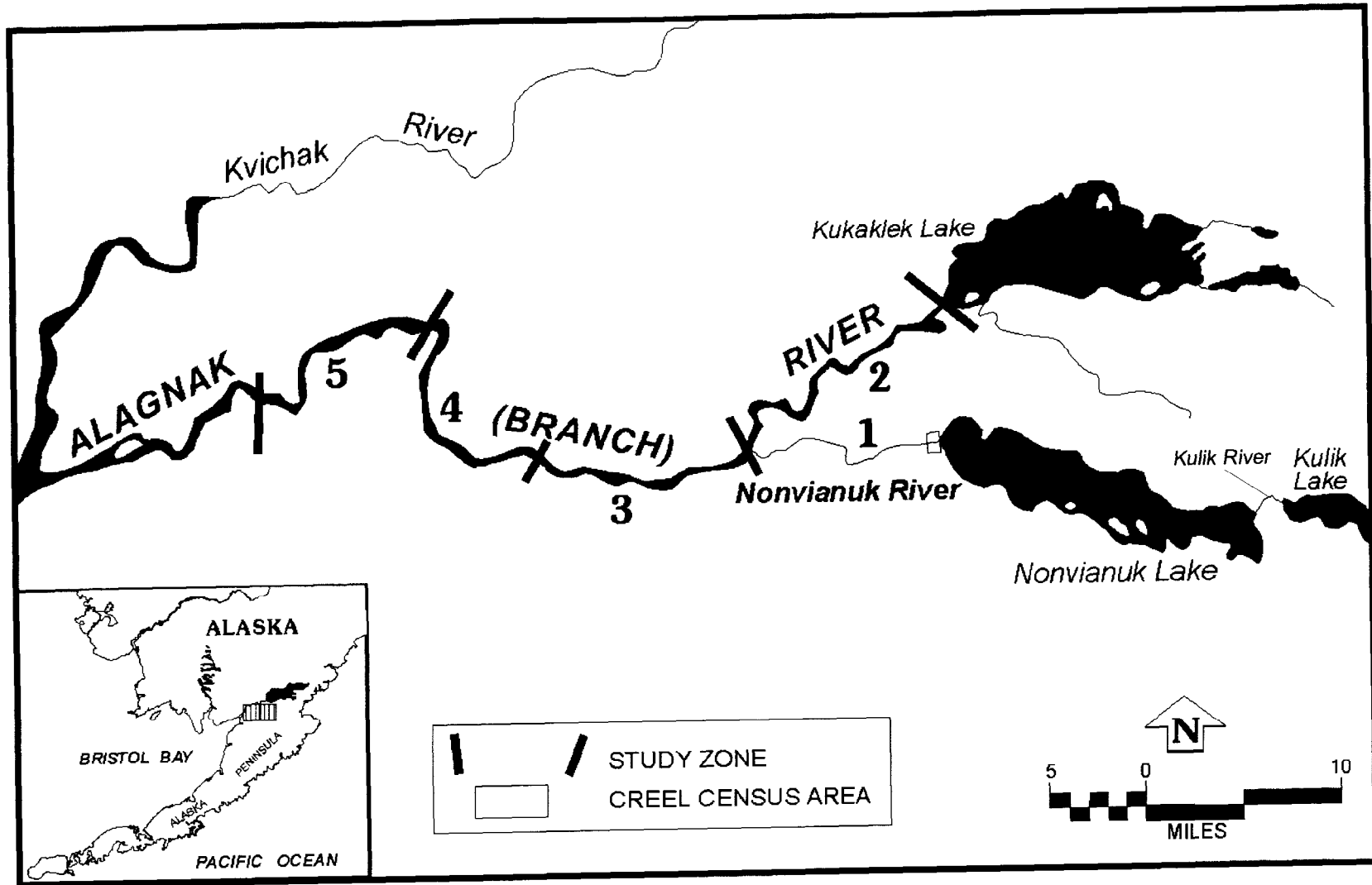


Figure 1.-Location of the 1996 creel census on the Nonvianuk River and study zones along the Nonvianuk and Alagnak rivers.

Alagnak River. The NPS-KNPP conducted the creel census at the headwaters of the Nonvianuk River, and collected biological samples from rainbow trout in the Wild River Corridor of the Alagnak River drainage which includes the upper 56 river miles of the 74-mile Alagnak River, as well as the entire 11 miles of the Nonvianuk River. The ADF&G-Sport Fish Division provided sampling equipment, data forms, and creel census training; aged the scales; and analyzed the data.

CREEL CENSUS

A direct expansion creel census was conducted at the outlet of Nonvianuk Lake from 8 June through 30 June 1996. The lake outlet is where the majority of the anglers enter and exit the rainbow trout fishery on the upper Nonvianuk River. The sampled area included the first 0.4 km (1/4 mile) of shoreline above the outlet of the lake, and continued downstream from the lake outlet approximately 0.8 km (1/2 mile) to the lower end of the first island in the river. Seven days per week, two to four NPS-KNPP field personnel interviewed all completed-trip anglers fishing at the Nonvianuk River. This level of sampling constituted a census. Completed-trip angler interview data were used to calculate effort and catch of rainbow trout, and to census the distribution of catch success and angler demographics.

Sport anglers who completed fishing for the day were interviewed to obtain fishing effort (to the nearest half hour), and catch and harvest information on the various sport fish species. In addition, the angler type (guided/unguided, air charter/private plane, and outfitting services), gear type (fly fishing/spin fishing), and residency (local SW Alaskan/Alaskan/U.S. citizen) were recorded. Counts of the number of anglers interviewed and number of missed anglers were recorded on a daily basis.

BIOLOGICAL COMPOSITION

The NPS-KNPP technicians also walked through the fishery at various times of each day and collected biological data from rainbow trout caught by anglers. This improved chances of obtaining a random sample. In addition, the field personnel used hook-and-line gear to capture and sample rainbow trout in the creel census area. Finally, in addition to sampling rainbow trout in the creel census area, two NPS-KNPP field personnel rafted or boated the remaining 18 km (11 miles) of the Nonvianuk River to the confluence with the Alagnak River and from the headwaters of the Alagnak River at Kukaklek Lake down approximately 90 km (56 miles) to the end of the Wild River Corridor (Figure 1) from mid-June through mid-September and collected lengths and scales from rainbow trout caught by sport anglers or by field personnel using hook-and-line gear.

The Alagnak River was divided into four sampling zones (Figure 1): zone 2-approximately 26 km (16 miles) in length, from the headwaters of the Alagnak River to the confluence with the Nonvianuk River; zone 3-approximately 24 km (15 miles) in length, from the confluence with the Nonvianuk River to an area with three small hills/rock outcrops (830 m, 830 m, and 971 m) on the southern bank of river; zone 4-approximately 21 km (13 miles) in length from the area with the three small hills/rock outcrops down to Estrada's campsite; and zone 5-approximately 19 km (12 miles) in length from Estrada's campsite down to the Wild River Corridor boundary. The Nonvianuk River was divided into two sampling zones: zone 1 was the lower 18 km (11 miles) of the Nonvianuk River from the edge of the creel census area to the confluence with the Alagnak River, and zone 2 was the first 1.6 km (1 mile) of the upper river where

the creel census was conducted. The above zones designated for this study utilize obvious landmarks (e.g., confluence area and Estrada's cabin) along the Alagnak and Nonvianuk rivers as zone boundaries; furthermore, zones 2-4 on the Alagnak River and zone 1 on the Nonvianuk River correspond closely with zones used on maps for recording aerial survey observations of salmon escapement on these rivers.

Rainbow trout caught by sport anglers and by the field crew were measured for fork length to the nearest millimeter; and examined for the presence of tags, fin clips, and tag scars. Scale smears of six to 12 scales was taken from the preferred area (Alvord 1954, Maher and Larkin 1955) for aging purposes. Estimation of length and age composition on the Nonvianuk River and Alagnak River required sampling a minimum of 130 rainbow trout (Thompson 1987) to attain the desired objective criteria. The smear technique minimized errors of estimating age caused by regenerated scales. Scales were placed inside coin envelopes upon which the corresponding length, tag number (if a tag was present), and other data were recorded for that particular fish. Upon completion of the sampling procedures, all rainbow trout were released unharmed.

Rainbow trout sampled during the creel census that were robust and healthy (not lethargic, no gaping wounds or scars, no bleeding gills) were also marked with a uniquely numbered Floy tag. Only rainbow trout larger than 200 mm were tagged. The Floy tag number was recorded on the coin envelope containing the scale samples. Potential future recovery of these marked fish may provide some information on fish movement within, and perhaps between, the two rivers.

At the end of the field season, the scale smears were sorted under a microscope and

the three or four best scales mounted on adhesive-coated cards. The mounted scales were pressed against acetate cards in a heated hydraulic press and the resulting scale impressions displayed on a microfiche projector for age determination (Jerald 1983). Utilizing the procedure described by Coggins (1994), the scale impressions were read three separate times, and only those readings which had at least two out of the three age determinations matching were considered as a known age. The occurrence of aging error; i.e., no modal ages, regenerated scales, inverted scales, or missing scales, was recorded.

DATA ANALYSIS

CREEL CENSUS

Sampling at the Nonvianuk River was a census of all anglers using the area. Analysis of the data amounted to summing the reported hours of effort and number of fish caught or harvested by species, and summing the number of angler-days by gear type, demographic information, and other interview data. The distribution of catch success of rainbow trout was calculated as a binomial proportion by (Cochran 1977):

$$\hat{p}_i = \frac{n_i}{n}, \quad (1)$$

where:

n_i = number of completed-trip anglers who caught zero rainbow trout for $i = 0$, 1 or more rainbow trout for $i = 1$, etc., and

n = total number of completed-trip anglers sampled.

The proportion of angler-days by angler type was calculated in a similar manner.

BIOLOGICAL COMPOSITION

Mean length and the associated variance were calculated using normal procedures. The proportion of rainbow trout of each length or

age class (p_i), was estimated as shown in equation (1). The numerator in this case was the number of rainbow trout sampled of length or age class; and the denominator was the total number of fish sampled.

The variance of this proportion was estimated by (Cochran 1977):

$$\hat{V}(\hat{p}_i) = \frac{\hat{p}_i(1-\hat{p}_i)}{n-1}. \quad (2)$$

A Kolmogorov-Smirnov test (test statistic = D , Sokal and Rohlf 1981) or an Anderson-Darling k -sample test (test statistic = T_{akn} , Scholz and Stephens 1987), at a significance level of $\alpha = 0.05$, was used to test the null hypotheses that the length distributions of sampled rainbow trout did not differ over time. To detect change over time, the data were divided into two or three groups of equal, or nearly equal, numbers of rainbow trout sampled. If no difference was detected then the sample would likely provide unbiased estimates of the length and probably the age distribution of the catchable population. If the length distribution was different between the groups, then the data were poststratified. An Anderson-Darling test also was conducted to determine if there was a significant difference in the length distribution among zones in the Alagnak River. Visual inspection of plots of the cumulative length frequency was also conducted to evaluate differences in length distributions.

RESULTS

CREEL CENSUS

The creel census was performed daily from 8 June through 30 June. During this time, 155 anglers were interviewed (Table 2). Only two anglers were not interviewed, so we considered this a census. Interviewed anglers accounted for a total of 755 hours of effort and caught 1,529 rainbow trout, of which all but two fish were released. The catch per unit

effort (CPUE) over the entire census, calculated by dividing total catch by total effort, was 2.0 rainbow trout per hour (Table 2).

Lake trout were also caught within the creel census area. During the study period, 28 lake trout were caught and released and two lake trout were harvested. The majority of these lake trout were caught in the relatively deep water (>2 m) of the pool at the outlet of Nonvianuk Lake. The only other fish species caught in the creel census area was a single whitefish (species unknown) on 11 June.

The angler demographic survey (Table 3) indicated that the typical angler was guided (59%), not an Alaskan resident (58%), used air charter to access the area (80%), fished from shore (91%), and fished with fly gear (91%).

The percent of anglers who caught one or more rainbow trout by the completion of their fishing day was quite high, approximately 94% (Figure 2). Fishing success decreased almost linearly, with 53% of the anglers catching eight or more fish, and 11% of the anglers catching 20 or more fish.

BIOLOGICAL COMPOSITION

A total of 214 rainbow trout were sampled for length and age at the creel census area and 83 were sampled from the lower 11 miles of the Nonvianuk River (Table 4). There was a significant difference ($D = 0.22$, $P = 0.007$) in the cumulative length distribution at the creel census area between fish sampled from 8 June to 18 June ($n = 107$) and those sampled from 19 June to 30 June ($n = 107$). Rainbow trout sampled later in the month tended to be smaller than those sampled earlier in the month (Figure 3). Conversely, in the lower river, there was no difference ($D = 0.29$, $P = 0.06$) in the cumulative length distribution between fish sampled from 19 June to 2 July ($n = 38$) and those sampled from 1 August to

Table 2.-Daily sampling summary at the Nonvianuk River during the 1996 creel census.

Date	Anglers Interviewed	Effort (hrs)	Catch	CPUE ^a	Number of Rainbow Trout Sampled for Length and Age Data			Number of Rainbow Trout Floy Tagged		
					Sport	Test	Total	Sport	Test	Total
					Fish	Fish		Fish	Fish	
6/08	7	56.5	153	2.7	3	11	14	0	1	1
6/09	9	44.5	134	3.0	1	23	24	0	0	0
6/10	15	44.0	183	4.2	1	0	1	0	0	0
6/11	8	38.5	73	1.9	2	2	4	1	2	3
6/12	9	32.0	77	2.4	4	0	4	0	0	0
6/13	4	26.0	47	1.8	0	4	4	0	1	1
6/14	9	40.0	86	2.2	0	12	12	0	0	0
6/15	6	42.5	75	1.8	10	8	18	5	0	5
6/16	11	54.0	80	1.5	5	4	9	0	2	2
6/17	7	47.0	104	2.2	0	1	1	0	0	0
6/18	9	50.0	75	1.5	0	15	15	0	4	4
6/19	5	44.0	72	1.6	0	7	7	0	4	4
6/20	11	40.5	93	2.3	0	3	3	0	1	1
6/21	3	16.5	18	1.1	0	12	12	0	3	3
6/22	6	21.0	20	1.0	5	26	31	0	4	4
6/23	13	29.5	67	2.3	0	6	6	0	2	2
6/24	10	64.0	94	1.5	3	9	12	1	3	4
6/25	7	53.0	72	1.4	0	10	10	0	7	7
6/26	0	0.0	0	0.0	0	14	14	0	7	7
6/27	1 ^b	3.0	2	0.7	0	5	5	0	4	4
6/28	5	8.75	4	0.5	0	3	3	0	3	3
6/29	0	0.0	0	0.0	0	0	0	0	0	0
6/30	0	0.0	0	0.0	0	1	1	0	1	1
TOTAL	155	755.25	1,529	2.0	34	169	203	8	49	57

^a CPUE is calculated by dividing total catch by total effort.

^b The only two anglers not interviewed during the creel census fished on this date.

4 August (n = 45). Therefore, length data from the creel census area had to be poststratified while that from the lower river were pooled. There was also a significant difference ($D = 0.44$, $P < 0.001$) in the length distribution between all fish sampled in the lower river and those sampled from 19 June to 30 June at the creel census area. Rainbow trout sampled later in June at the creel census area were used in this test because they were similar temporally to those sampled in the lower river.

Temporal and spatial trends in the length distribution were also apparent in the age composition (Table 5, Figure 4). Rainbow trout sampled at the creel census area from 8 June to 18 June were predominantly 5-year-old fish, followed by 4-year-old and 6-year-old fish. Nearly 50% of the fish sampled in this same area from 19 June to 30 June were 4-year-old fish, with a large, though smaller, proportion of 5-year-old fish. The predominant age group in the lower river was

Table 3.-Demographic information from anglers interviewed during the creel census on the Nonvianuk River during 8 June to 30 June 1996.

Characteristic	Angler-trips	Percent
<u>ANGLER TYPE</u>		
Guided	91	59
Unguided	64	41
<u>RESIDENCY</u>		
Alaska Residents	65	42
Local Alaskan Residents	0	0
Nonlocal Alaskan Residents	65	42
Non-Alaskan Residents	90	58
U.S. Residents	88	57
Non-U.S. Residents	2	1
<u>ACCESS</u>		
Access to Nonvianuk River		
Used air charter service	124	80
Used private plane	30	19
Unknown	1	1
<u>OUTFITTED</u>		
Outfitted ^a	44	28
Not outfitted ^b	111	72
<u>SEX</u>		
Male	138	89
Female	17	11
<u>YOUTH/ADULT</u>		
Adult	154	99
Youth	1	1
<u>BOAT/SHORE</u>		
Fished from boat	12	8
Fished from shore	141	91
Fished from shore and boat	2	1
<u>TACKLE TYPE</u>		
Spin	13	8
Fly	141	91
Unknown	1	1
TOTAL ANGLER TRIPS	155	

^a Outfitted implies that the angler was provided with gear, rental boat, or camp equipment.

^b Not outfitted implies that the angler used personal gear.

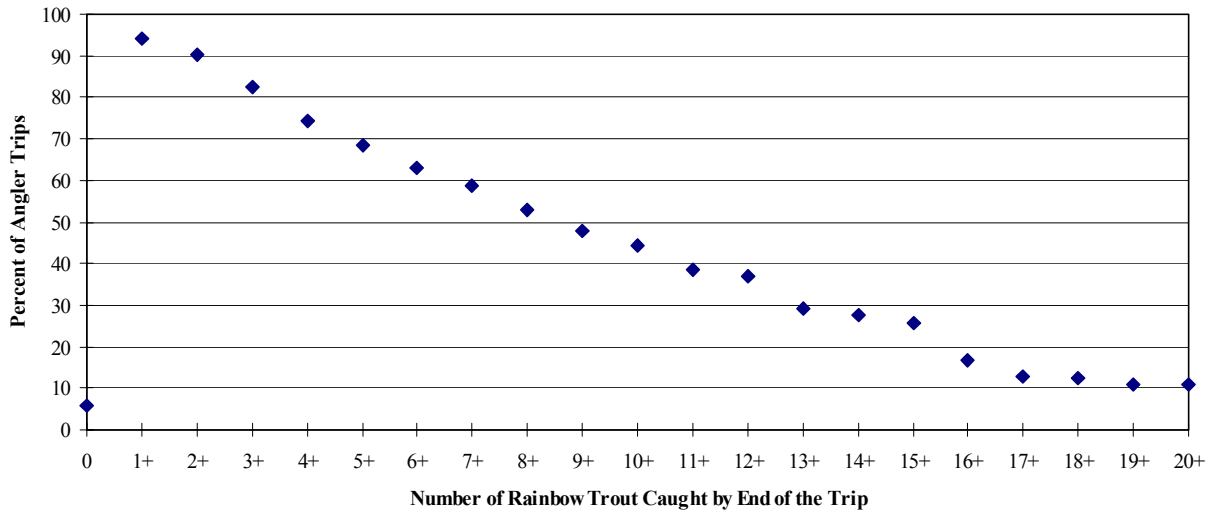


Figure 2.-Angler success for rainbow trout caught during the creel census on the upper Nonvianuk River in June 1996.

2-year-old fish, with nearly equal proportions of 3-year-old, 4-year-old, and 5-year-old fish.

Rainbow trout from the Alagnak River were sampled over an extended interval of time, from 19 June to 15 September (Table 4). An Anderson-Darling test found no temporal difference ($T_{akn} = 0.015$, $P = 0.38$) in the cumulative length distribution of rainbow trout sampled from zone 4 (Figure 5). Only fish sampled in this zone were used to explore a temporal change because this zone was sampled throughout the entire season (23 June to 13 September) and also had the most fish sampled ($n = 155$) among any of the zones (i.e., provided the best statistical power to detect a temporal difference). Zone 1 was sampled only from 19 June to 25 July and only 17 rainbow trout were sampled from zone 5 (Table 4). Based on these results it was assumed the length distribution of rainbow trout in the Alagnak River did not differ over time, so data within each zone could be pooled.

There was no dramatic difference spatially in the cumulative length distribution of rainbow trout sampled from the Alagnak River.

Although there was a marginal statistical difference ($T_{akn} = 1.93$, $P = 0.05$) in the length distributions among zones 2, 3, and 4 when all of the sample data were used, pairwise comparisons failed to detect a difference ($D \geq 0.15$, $P \geq 0.10$) and a plot of the cumulative length data showed no striking differences (Figure 6). When the data set was truncated to include samples collected over a similar interval of time (mid June to late July), there was no statistical difference ($T_{akn} = 0.92$, $P = 0.15$) in the cumulative length distribution among zones (Figure 7). This indicates the length data among zones may also be pooled. Zone 5 was not used in these comparisons because so few rainbow trout were sampled from this area.

The modal age of rainbow trout sampled from the Alagnak River was 4 years. Modal age was the same whether the data were truncated to samples collected from mid June through late July (Figure 8) or all of the data were included (Table 5). Modal age was the same among zones (Figure 8). Note that a small percentage (39 out of 323 samples; 12%) of scale samples was not mounted or aged; these

Table 4.-Rainbow trout length data collected during 1996 on the Alagnak and Nonvianuk rivers.

Location	Sample size	Length (mm)			Sampling Dates
		Mean	SE	Range	
<u>Nonvianuk River:</u>					
Creel census area					
Group 1	107	328.6	7.7	183 - 569	6/08 to 6/18
Group 2	107	302.0	7.1	162 - 534	6/19 to 6/30
Lower Nonvianuk River area					
Group 1	42	258.7	12.8	129 - 476	6/19 to 8/01
Group 2	41	246.7	11.7	135 - 532	8/01 to 8/04
Pooled (Group 1 & 2)	83	252.8	8.7	129 - 532	6/19 to 8/04
<u>Alagnak River:</u>					
Zone 2 (all)	75	320.5	15.6	158 - 672	6/19 to 7/25
Zone 3 (all)	76	309.9	11.1	94 - 630	6/21 to 9/15
Zone 4 (all)	155	305.8	7.5	119 - 624	6/23 to 9/13
Zone 5 (all)	17	387.9	26.0	199 - 587	6/25 to 9/14
Zone 3 (truncated)	62	306.8	12.8	94 - 536	6/21 to 7/26
Zone 4 (truncated)	56	302.5	12.3	119 - 522	6/23 to 7/16
Pooled Alagnak:	193	310.9	8.1	94 - 672	6/19 to 7/26
Zone 2 (all)					
Zone 3 (truncated)					
Zone 4 (truncated)					
Pooled Alagnak:	323	315	6.0	94 - 672	6/19 to 9/15
Zones 2-5 (all)					

samples were all from rainbow trout < 200 mm fork length. Thus the age data are biased slightly upward to an unknown degree.

The length distribution of rainbow trout sampled at the lower Nonvianuk River from 18 June to 4 August differed significantly ($D = 0.29$, $P < 0.001$) from that of trout sampled in zones 2-4 at the Alagnak River from mid June through late July. Rainbow trout sampled at the lower Nonvianuk River

were generally smaller than those sampled at the Alagnak River.

Fifty-seven rainbow trout were Floy tagged at the headwaters of the Nonvianuk River during the creel census (Table 2). One fish tagged (tag number: 257907) on 26 June 1996 was later recaptured on 25 August 1996 at the Kulik River, on the opposite end of Nonvianuk Lake (Figure 1). The future recovery of tagged fish will continue to

provide indications of the movement of rainbow trout in this drainage.

Three other fish species (Arctic grayling *Thymallus arcticus*, Dolly Varden/Arctic char *Salvelinus malma/Salvelinus alpinus*, and lake trout *Salvelinus namaycush*) were captured in the lower Nonvianuk River and Alagnak River during this project (Appendix B). No biological data (length, weight, scale samples) were collected from these fish. These records provide only a preliminary indication of distribution of these fish species. The majority of the Arctic grayling were captured were in zone 2 (n = 23) and zone 4 (n = 28) of the Alagnak River (Appendix B). The Dolly Varden/Arctic char were captured in zones 2 (n = 3) , 3 (n = 4) , and 4 (n = 8) of the Alagnak River, and in the lower Nonvianuk River (n = 1). The lake trout were encountered in the lower Nonvianuk River (n = 5) , and the two upper zones of the Alagnak River: zone 2 (n = 4) and zone 3 (n = 2).

Other species were present during the season in the Alagnak River, but none were captured (Dan Vos, National Park Service, Dillingham, personal communication). These included all five Pacific salmon species: chinook salmon *Oncorhynchus tshawytscha*, coho salmon *O. kisutch*, sockeye salmon *O. nerka*, chum salmon *O. keta*, and pink salmon *O. gorbuscha*. Additionally, northern pike *Esox lucius* were encountered in the warmwater, back slough areas of the lower Alagnak River (zones 3, 4, and 5).

DISCUSSION

The creel census conducted at the headwaters of the Nonvianuk River was the first full-scale creel census conducted at this location. A creel survey conducted at this area in 1984 (Joep *Unpublished*) sampled the fishery much less intensely, and over a longer period of time (11 June to 15 September). The CPUE estimate in 1984 was 0.5 fish per hour,

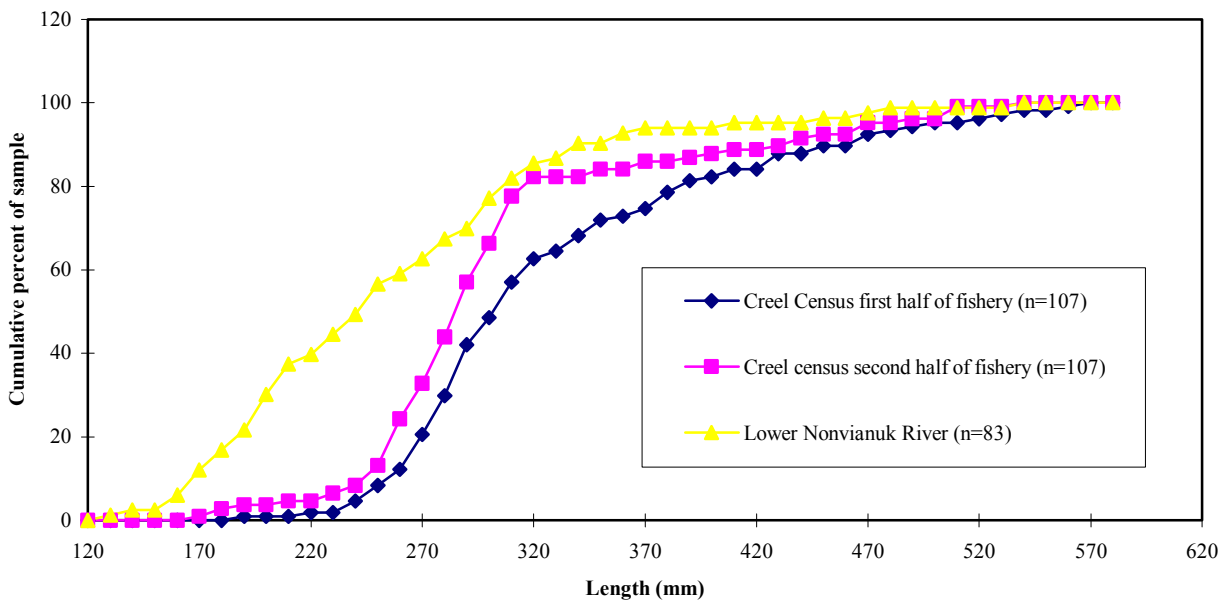


Figure 3.-Cumulative length frequencies of rainbow trout captured in the creel census area and lower Nonvianuk River in 1996.

Table 5.-Mean lengths (millimeters) of rainbow trout by age group from samples collected with hook-and-line gear on the Nonvianuk River and Alagnak River in 1996.

<u>Nonvianuk River</u>		Sample Period: 6/08/96 to 6/18/96										
Creel Census												
Period 1		Age Group										
	UNKNOWN	1	2	3	4	5	6	7	8	9	10	TOTAL
n (Known Age)		0	2	1	17	34	14	8	5	2	1	84
Percent		0	2.4	1.2	20.2	40.5	16.7	9.5	6.0	2.4	1.2	100
Standard Error			1.67	1.19	4.41	5.39	4.09	3.22	2.60	1.67	1.19	0
Mean Length	397		210	250	266	288	314	381	416	482	554	329
Standard Error	17.74		27.00	0	6.67	3.94	7.12	23.02	21.73	55.50	0	7.68
Sample Size	23		2	1	17	34	14	8	5	2	1	107

<u>Nonvianuk River</u>		Sample Period: 6/19/96 to 6/31/96										
Creel Census												
Period 2		Age Group										
	UNKNOWN	1	2	3	4	5	6	7	8	9	10	TOTAL
n (Known Age)		0	2	2	39	26	6	2	3	0	2	82
Percent		0	2.4	2.4	47.6	31.7	7.3	2.4	3.7	0	2.4	100
Standard Error			1.71	1.71	5.55	5.17	2.89	1.71	2.09		1.71	0
Mean Length	343		181	223	269	287	304	387	477		473	302
Standard Error	19.06		1.50	16.00	3.49	3.46	11.90	75.00	36.92		37.00	7.06
Sample Size	25		2	2	39	26	6	2	3		2	107

-continued-

Table 5.-Page 2 of 2.

Nonvianuk River
lower 11 mile area

Sample Period: 6/19/96 to 8/04/96

Age Group

	UNKNOWN	1	2	3	4	5	6	7	8	9	10	TOTAL
n (Known Age)		6	22	13	11	10	7	1	1	0	1	72
Percent		8.3	30.6	18.1	15.3	13.9	9.7	1.4	1.4	0	1.4	100
Standard Error		3.28	5.47	4.56	4.27	4.10	3.52	1.39	1.39		1.39	0
Mean Length	287	152	203	218	272	293	332	476	369		532	253
Standard Error	32.02	7.71	5.98	8.58	8.79	9.45	8.15	0	0		0	8.67
Sample Size	11	6	22	13	11	10	7	1	1		1	83

Alagnak River

Sample Period: 6/19/96 to 9/15/96

Age Group

	UNKNOWN	1	2	3	4	5	6	7	8	9	10	TOTAL
n (Known Age)		0	4	49	73	57	27	15	21	6	2	254
Percent		0	1.6	19.3	28.7	22.4	10.6	5.9	8.3	2.4	0.8	100
Standard Error			0.78	2.48	2.85	2.62	1.94	1.48	1.73	0.95	0.56	0.00
Mean Length	281		220	238	279	331	355	425	483	538	526	315
Standard Error	18.48		4.14	3.35	3.69	4.98	5.56	16.62	13.54	22.19	24.50	5.95
Sample Size	69		4	49	73	57	27	15	21	6	2	323

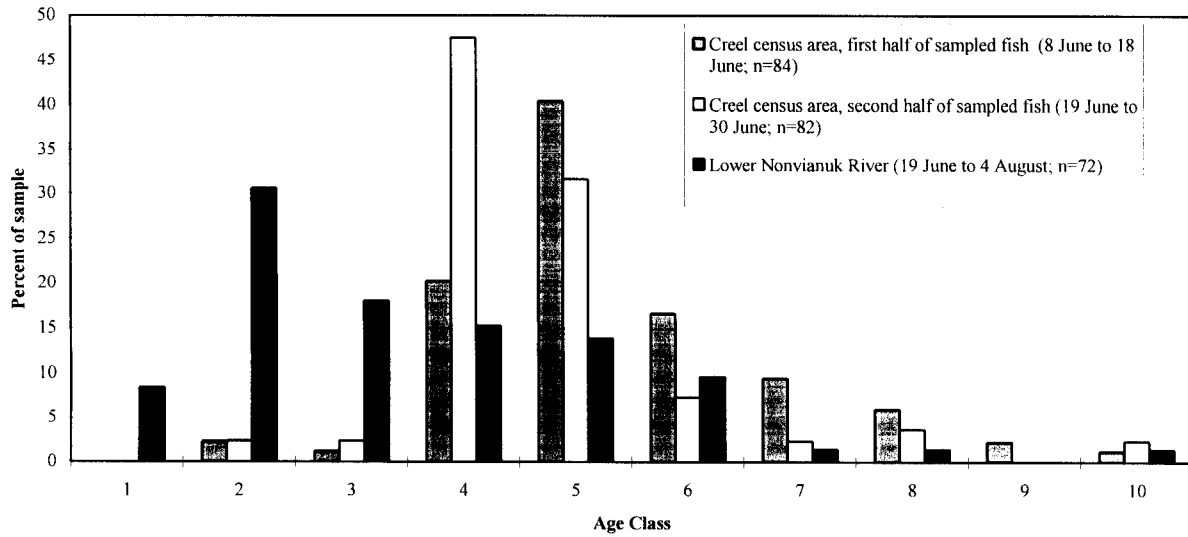


Figure 4.-Age distribution of rainbow trout captured in the creel census area and lower Nonvianuk River in 1996.

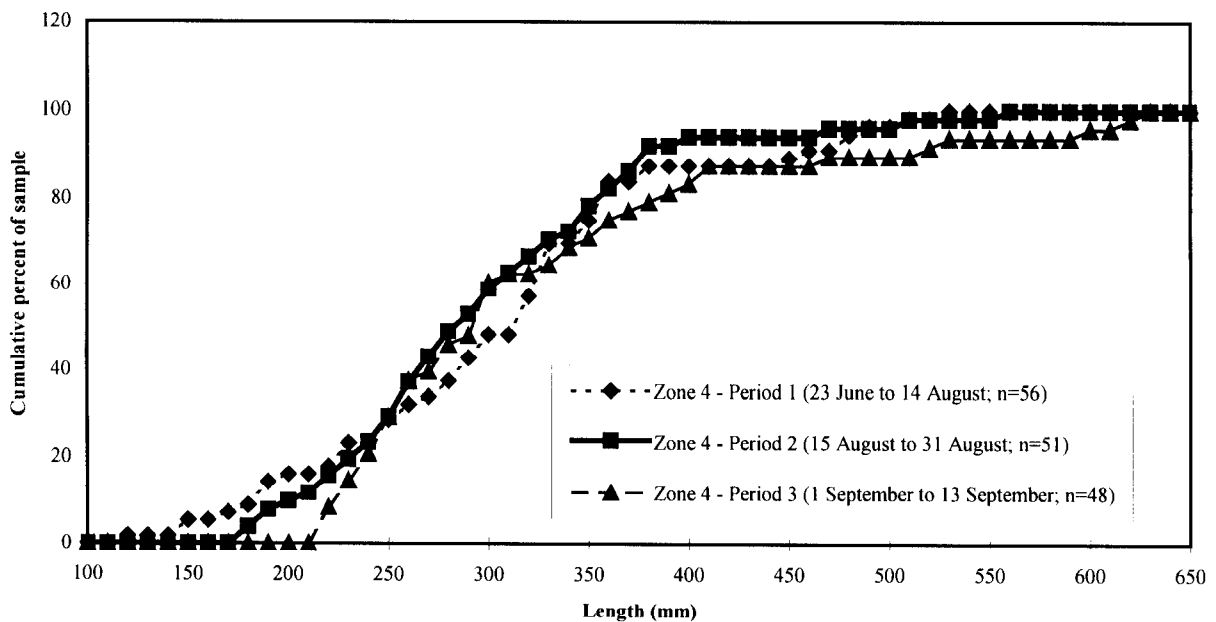


Figure 5.-Cumulative length frequencies of rainbow trout captured in zone 4 of the Alagnak River during three temporal periods in 1996.

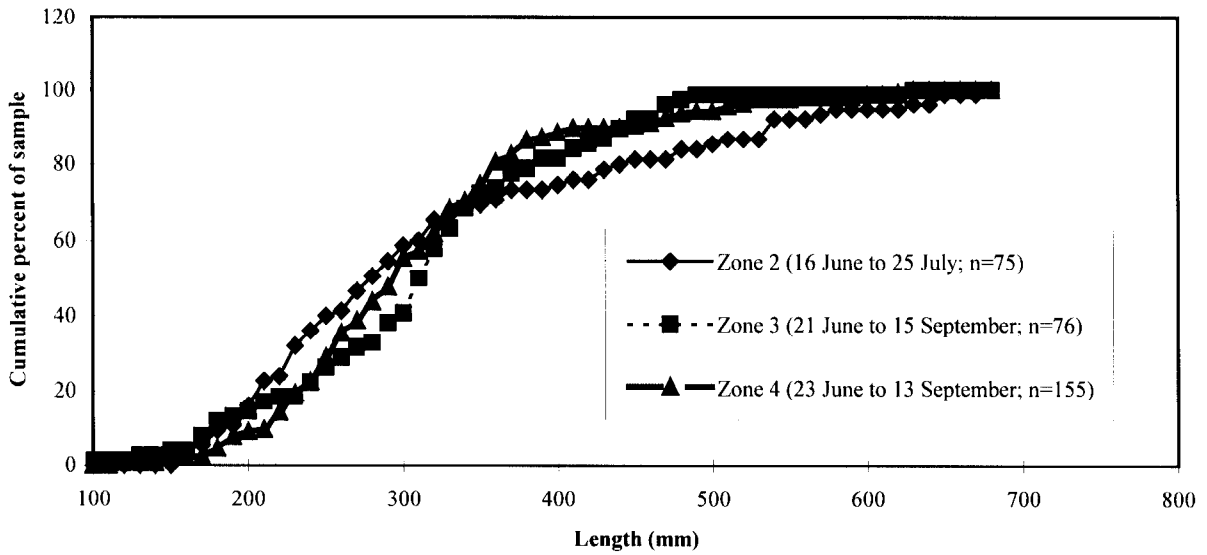


Figure 6.-Cumulative length frequencies of rainbow trout captured in zones 2, 3, and 4 of the Alagnak River during 1996.

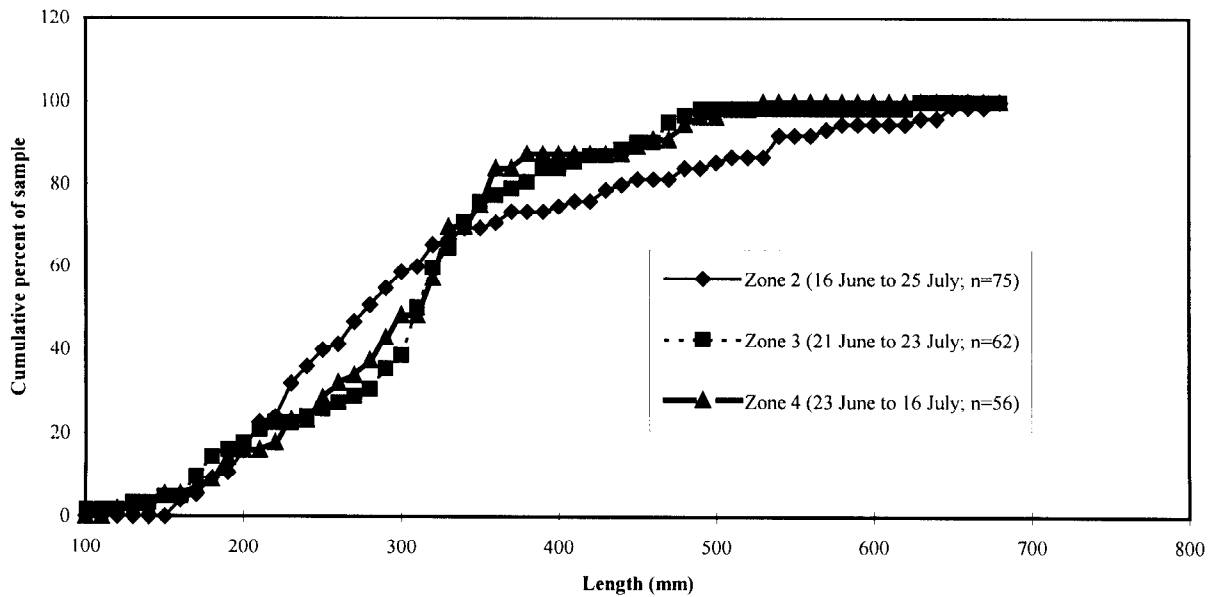


Figure 7.-Cumulative length frequencies of rainbow trout captured in zones 2, 3, and 4 of the Alagnak River during mid-June to late July 1996.

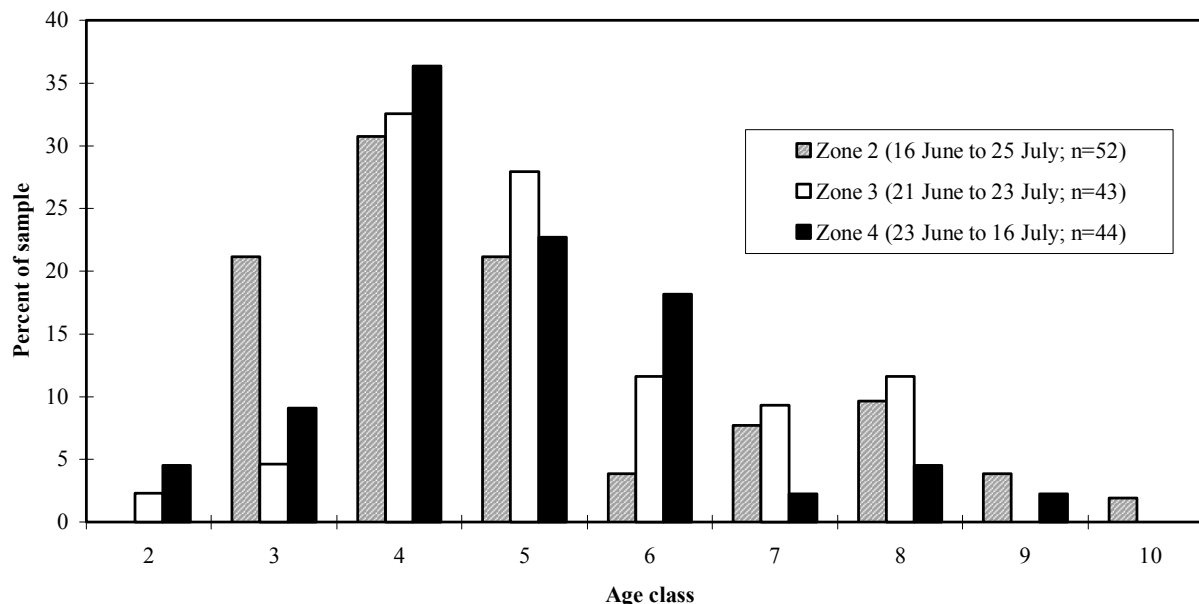


Figure 8.-Age distribution of rainbow trout sampled in zones 2, 3, and 4 of the Alagnak River during mid-June to late July 1996.

while CPUE in 1996 was 2.0 fish per hour. The difference in these two values of CPUE may result from different sample designs and/or different time intervals sampled; i.e., the CPUE may drop dramatically from July to mid-September, a period sampled in 1984 but not in 1996.

Angling success was very high during June 1996, with approximately 50% of all anglers catching eight or more rainbow trout by the end of the angling day. The high angler success is also reflected in the high value of CPUE. The fishing effort observed within the creel census area was usually less than 10 angler trips per day: the greatest number of anglers observed on any day was 15 anglers on 10 June. The expected large number of anglers on opening day (8 June) never materialized, probably due to the poor flying conditions on 8 and 9 June.

The high CPUE and angler success in the upper Nonvianuk River in June 1996 both indicate healthy numbers of fish. An informal opinion survey in 1996 of anglers (n = 34)

who had fished in June in previous years at the upper Nonvianuk River (Jaenicke *Unpublished*) indicated that the rainbow trout abundance was the same (82%), or less abundant (18%), than in previous trips. On a broader perspective, the average annual catch of rainbow trout during 1991 to 1995 in the Alagnak River drainage has been approximately 20,000 fish per year. Evaluation of the June 1996 census and the significant annual average catch on the Alagnak River suggests that the rainbow trout populations are at healthy levels of abundance.

Spatial and temporal differences in the length distribution of rainbow trout observed in 1996 indicate that these two factors are important to consider when attempting to examine changes in size among years. The length distribution(s) observed in 1996 can not be compared to length distribution of rainbow trout sampled (n = 109) in 1990 in the Nonvianuk River (Appendix A) because location of capture was not recorded in 1990. Comparison of length distributions is possible for

rainbow trout sampled in 1974 on the Nonvianuk River (Appendix A): 35 rainbow trout were sampled at the outlet of Nonvianuk Lake from 1 June to 6 June. The cumulative length distribution of these rainbow trout sampled in 1974 was not different ($D = 0.22$, $P = 0.12$) from that of rainbow trout sampled between 8 June and 18 June 1996 (Figure 9).

The age distribution of rainbow trout at the outlet of Nonvianuk Lake in early June of 1974 and 1996 is also similar (Figure 10). Rainbow trout age 4 and 5 years composed the majority of the sampled fish during both years. The small number of fish sampled in 1974 ($n = 28$) likely results in observing no fish on the lower end (age 2) and upper end (ages 8 to 10) of the age distribution.

Length and age data were collected from rainbow trout in the Alagnak River during 1965, 1989, 1993, and 1995 (Appendix A); however, only data from 1989 had a sufficient sample size and similar time interval to data collected in 1996 to conduct the test. Length distributions of 68 rainbow trout sampled during 8 August to 11 August 1989 in the lower Alagnak River were compared to that of 51 rainbow trout sampled during 17 August to 31 August 1996 in zone 4. As observed in the comparison between years at the Nonvianuk River, there was no significant difference ($D = 0.20$, $P = 0.15$) between years in length distribution of rainbow trout sampled at the Alagnak River, although rainbow trout tended to be smaller in 1996 (Figure 11).

The age distribution of rainbow trout sampled in the Alagnak River during August of 1989 ($n = 54$) and 1996 ($n = 43$; Figure 12) indicates that 3- to 5-year-old fish were the most common age classes in the lower Alagnak River.

The observed modal ages of rainbow trout in both the Alagnak and Nonvianuk rivers suggest an age structure that may not be indicative of a healthy stock. Previous

management experience with rainbow trout populations in the SW Alaska region indicates that healthy stocks consist of catchable populations of primarily 5- and 6-year-old fish and spawning populations of 6- to 7-year-old fish (R. E. Minard, ADF&G, Division of Sport Fish, Dillingham, personal communication). The age composition in 1996 of rainbow trout in both the Alagnak and Nonvianuk rivers was 4- and 5-year-old fish, and tended to be skewed toward the younger age groups.

As mentioned previously, the size frequency data from 1996 also indicates that the smaller fish dominate the population in both rivers. The informal opinion survey of anglers at the upper Nonvianuk River in June 1996 (Jaenicke *Unpublished*) also suggested that there might be a shift in size composition, with anglers either stating that the average size of the rainbow trout were the same (65%) or smaller in average size (35%).

The observed shift in length, and to a lesser extent age, composition of rainbow trout in the Alagnak (1989 data compared to 1996) and Nonvianuk (1974 compared to 1996) rivers may be erroneous due to inadequate sample size, or may be authentic and due to one or more possible biotic or abiotic factors. Evaluation of the possible causes of the observed shift provides some means of understanding what may have caused the observed shift in length and age composition.

The lack of adequate sample sizes may indeed not provide a representative sample for comparison of length and age compositions between years. While in some previous years there first appears to be adequate sample size, lack of specific sampling location being recorded results in some biological data being discarded from the analysis. An additional cause of discarding data was if sampling periods were significantly different between or within years, such as if samples were collected in June and then again in August.

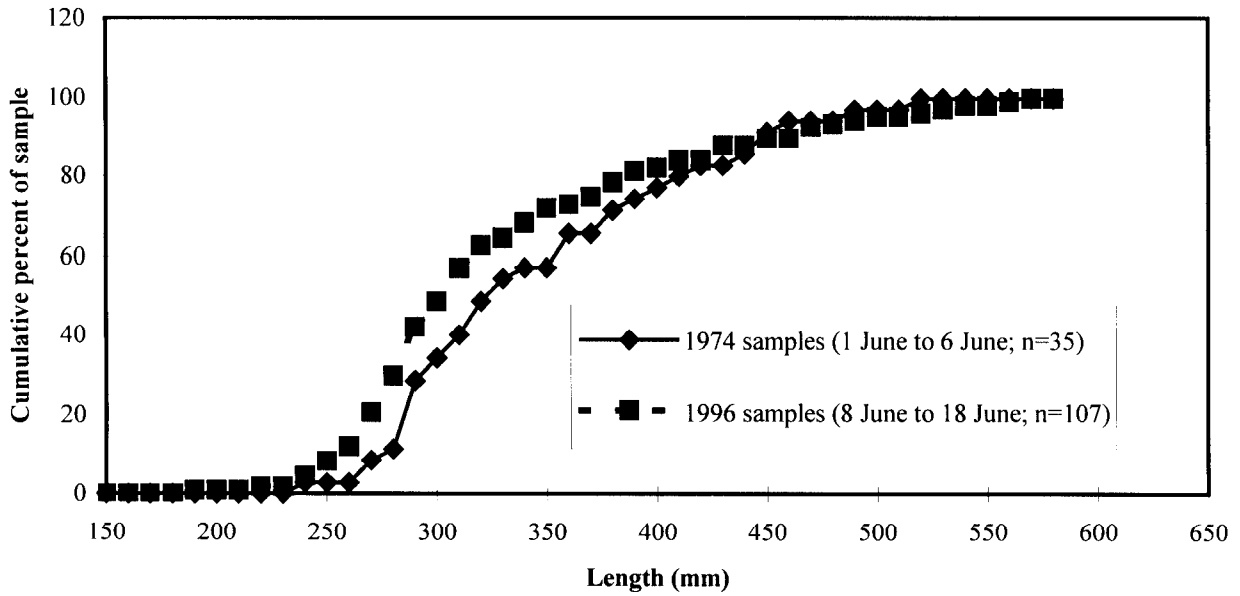


Figure 9.-Cumulative length frequencies of rainbow trout sampled at the headwaters of the Nonvianuk River during early June of 1974 and 1996.



Figure 10.-Age distribution for rainbow trout sampled at the headwaters of the Nonvianuk River during early June of 1974 and 1996.

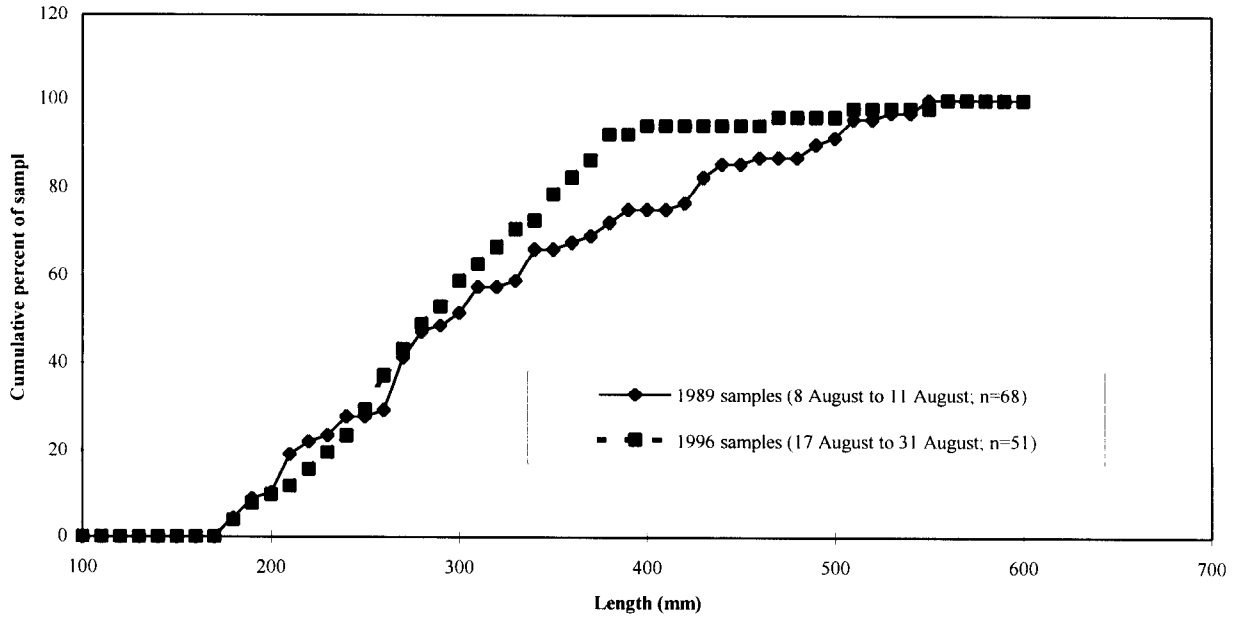


Figure 11.-Cumulative length frequencies of rainbow trout sampled in zone 4 of the Alagnak River during August of 1989 and 1996.

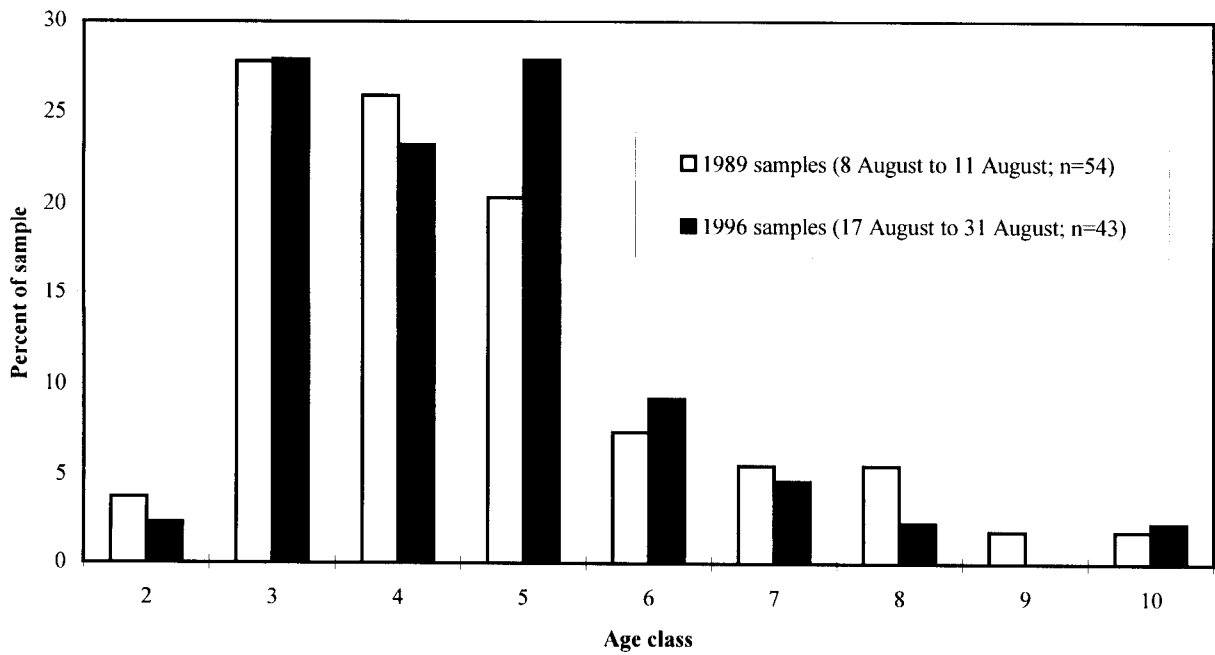


Figure 12.-Age distribution of rainbow trout sampled in zone 4 of the Alagnak River during August of 1989 and 1996.

Thus, the spatial and temporal qualities of the biological data influenced the available sample size.

Biotic changes may have influenced the population structure shifts in the rainbow trout population in the Alagnak and Nonvianuk rivers. A dramatic shift in environmental conditions, such as adverse water levels or temperatures, may have influenced the survival of the rainbow trout by reducing food availability or susceptibility to predators. While this is possible, such environmental changes would have occurred on a region-wide basis and thus influenced nearby drainages and their trout populations as well. An 11-year study (period: 1986 to 1997) of size and recruitment into the overwintering population of rainbow trout at the headwaters of the Kvichak River, a river proximal to the Alagnak drainage, has indicated that population size, survival, and recruitment has been stable over time (Minard et al. 1992, Minard and Fleischman *In prep*). Additionally, no such downward shift has been observed in the population structure in the nearby Naknek River (Fair *Unpublished*), again suggesting that no large-scale environmental change has occurred.

The potential for fishing pressure influencing the size and age composition does hold some merit. Sport fishing is closed in the Alagnak and Nonvianuk rivers during 10 April to 7 June, to provide protection for spawning rainbow trout. Prior to 1996, the open water sport fisheries during 8 June to 31 October had a bag limit of one fish per day, no size limit; the winter sport fishery during 1 November to 9 April had a bag limit of five fish per day, with only one fish over 20 inches (ADF&G 1996). The harvest potential of one large fish per day during 8 June to 9 April may have resulted in the larger fish being selectively harvested.

Based in part on results of this study, the bag and possession limits for rainbow trout were reduced to zero; i.e., catch and release, via emergency order during 1 July to 31 October 1996 and during 8 June to 31 October 1997 in the Alagnak and Nonvianuk rivers.

The U.S. Geological Survey-Biological Research Division (USGS-BRD) began a 3-year study of the genetics, abundance, and migration of rainbow trout in the Alagnak River drainage beginning in April 1997 (Eric Knudsen, USGS-BRD, Anchorage, personal communication). Examination of preliminary size composition data of rainbow trout from the more intensive USGS-BRD sampling program being initiated indicates that the rainbow trout population in the Alagnak and Nonvianuk rivers may not be lacking in larger, older fish as indicated by the result of this 1996 study.

The results of the USGS-BRD rainbow trout project in the Alagnak River drainage will provide valuable insight into the current status of the rainbow trout stocks. It is recommended that such sampling programs continue in order to monitor the rainbow trout stocks in this popular sport fishing area.

ACKNOWLEDGMENTS

The success of these projects was made possible by the field and logistic support of individuals from the National Park Service-Katmai National Park and Preserve. Special thanks go to the two key coordinators at the NPS King Salmon office for the creel census and Alagnak River biological sampling projects: Fisheries Biologist Don Bill and Resource Management Specialist Susan Savage. Deep appreciation goes to the field crews at the Nonvianuk River creel census: Fisheries Biotechnician Daniel Vos, and Student Conservation Association volunteers Michael Clark, John Dunne, Bill Hobbins,

and Andrea Earp; and to the field crew conducting the biological sampling in the Nonvianuk River and Alagnak River: Law Enforcement Ranger Brian McCullough and Daniel Vos. The field crews collected the projects' data in an efficient and accurate manner, and were able to do so while conducting their main goals of monitoring use and providing information on public use along the Alagnak River drainage. The expedient work of Jason Dye, Fisheries Technician, of mounting and aging the rainbow trout scale samples from the Nonvianuk and Alagnak rivers was greatly appreciated. Finally, the guidance on the data analysis section and text editing provided by Jim Hasbrouck, Biometrician, was a great help.

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APPENDIX A

Appendix A1.-Computer files and software used to produce this report.

<u>Data files:</u>	<u>Description</u>
S128BIA6.DTA	Nonvianuk River creel census angler interview data for 1996
S128BBA6.DTA	Nonvianuk River creel census rainbow trout AWL data for 1996
S128BCA6.DTA	Nonvianuk River creel census angler count data for 1996
S128ABA6.DTA	Nonvianuk River (below creel census area) rainbow trout AWL data (part I of 1996)
S128ABB6.DTA	Nonvianuk River (below creel census area) rainbow trout AWL data (part II of 1996)
S1280B74.DTA	Nonvianuk River rainbow trout AWL data (sample dates: 6/01/74 to 7/11/74)
S1280BA1.DTA	Nonvianuk River rainbow trout AWL data (sample dates: 6/09/90 to 7/14/90)
S008BBA6.DTA	Alagnak River rainbow trout AWL data (part I of 1996)
S008BBB6.DTA	Alagnak River rainbow trout AWL data (part II of 1996)
S0080B65.DTA	Alagnak River rainbow trout AWL data (sample dates: 6/11/65 to 9/29/65)
S0080B89.DTA	Alagnak River rainbow trout AWL data (sample dates: 7/12/89 to 8/07/89)
S0080BA3.DTA	Alagnak River rainbow trout AWL data (sample dates: 7/23/93 to 8/04/93)
S0080BA5.DTA	Alagnak River rainbow trout AWL data (sample dates: 8/21/95 to 9/24/95)
<u>Analysis programs:</u>	<u>Description</u>
KS2M.EXE	A program developed by ADF&G Sport Fish Division, Research and Technical Services staff for conducting Kolmogorov-Smirnov two sample tests.
ADK2.EXE	A program developed by ADF&G Sport Fish Division, Research and Technical Services staff for conducting Anderson-Darling K-Sample tests.
BBXP.EXE	A series of programs that uses biological files to produce tables of mean length and weight by sex and age group. The program also produces a data set which may be used in Excel (tm) to create graphs.

APPENDIX B

Appendix B1.-Summary of fish species caught by sport anglers and test fisheries in the lower Nonvianuk River and the various zones of the Alagnak River during 1996.

Zone/area	Rainbow Trout	Arctic Grayling	Dolly Varden/ Arctic char	Lake Trout	Total
lower Nonvianuk River	83	2	1	5	91
Alagnak River					
Zone 2	75	23	3	4	105
Zone 3	76	10	4	2	92
Zone 4	155	28	8	0	191
Zone 5	17	4	0	0	21
Total Alagnak River	323	65	15	6	409
Total for lower Nonvianuk and Alagnak River					
	406	67	16	11	500