Fishery Data Series No. 97-2

Lower Kenai Peninsula Dolly Varden Studies during 1995

by

Larry L. Larson

February 1997

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. 97-2

LOWER KENAI PENINSULA DOLLY VARDEN STUDIES DURING 1995

by

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ABSTRACT

From 4 July to 12 August 1995, abundance, composition, and selected fishery statistics were estimated for Dolly Varden *Salvelinus malma* (Walbaum) on the Anchor River. A total of 10,994 Dolly Varden were counted through a weir located 1.5 km upstream from salt water on the Anchor River. This Dolly Varden immigration is the fifth highest total adult return documented since this study was begun in 1987. Although anglers appear to be practicing more hook and release fishing when pursuing Dolly Varden, they continue to select fish larger than 350 mm for harvest.

This is the completion of 9 consecutive years of studying Dolly Varden on the Anchor River. Based on a review of all study years, the number of fish deaths due to angling is much lower than from "natural" causes. In the one year when fishing was closed during spawning (1990), the survival rate from 1990-1991 for age 6-7 was 0.652, whereas in other years it ranged from 0.216 to 0.419.

Key words: Anchor River, Kenai Peninsula, anadromous, Dolly Varden, weir, age composition, sex composition, maturity index, *Salvelinus malma*, population dynamics, mortality, survival.

INTRODUCTION

The Anchor River on the lower Kenai Peninsula (Figure 1) supports recreational fishing for chinook salmon *Oncorhynchus tshawytscha*, coho salmon *O. kisutch,* pink salmon *O. gorbuscha*, Dolly Varden *Salvelinus malma*, and anadromous (steelhead) and resident rainbow trout *O. mykiss*. The downstream section of this stream is crossed by the Sterling Highway making it easily accessible to anglers. Much of the river frontage along the lower 3 km of this stream is publicly owned, providing ample camping and parking areas. Due to the relatively small size of this stream, all fishing is conducted from the bank. The Anchor River has provided an average of 30,198 recreational fishing days (angler-days) annually from 1977 through 1995 (Mills 1979-1994; Howe et al. 1995, 1996). The fisheries targeting chinook salmon, coho salmon, steelhead, and Dolly Varden are of major importance to recreational anglers on the Anchor River, whereas the fisheries targeting resident rainbow trout and pink salmon are of lesser importance.

The recreational fishery for Dolly Varden in the Anchor River was one of the largest in Alaska and is of particular concern to resource managers. The recreational harvest has decreased since the late 1970s, in part through more restrictive regulations and as the result of a declining Dolly Varden population. From 1977 to 1983, the harvest from this fishery averaged nearly 15,000 fish annually (Mills 1979-1984). In 1984, regulations for this fishery became more restrictive, bag and possession limits were reduced from 10 to five fish, and the use of bait was prohibited after 16 September. While these regulations were in effect (1984-1990), the harvest of Dolly Varden averaged approximately 3,800 fish (Table 1).

Although a marked decline was observed in the harvest of Dolly Varden after initiation of the new regulations, the decline could be due to a depressed population rather than restrictive regulations (Larson 1990). During 1990, the use of bait was prohibited from 15 August through 31 December (ADF&G 1990). In 1991, regulations further restricted the daily bag limit from five to two fish and the use of bait was prohibited from 1 September through 31 December (ADF&G 1991). The reduction in bag limit from five to two Dolly Varden was implemented on the Anchor River, Deep Creek, Stariski Creek, and the Ninilchik River to protect the Dolly Varden spawning stocks of the lower Kenai Peninsula. While these regulations were in effect (1991-1995), the harvest of Dolly

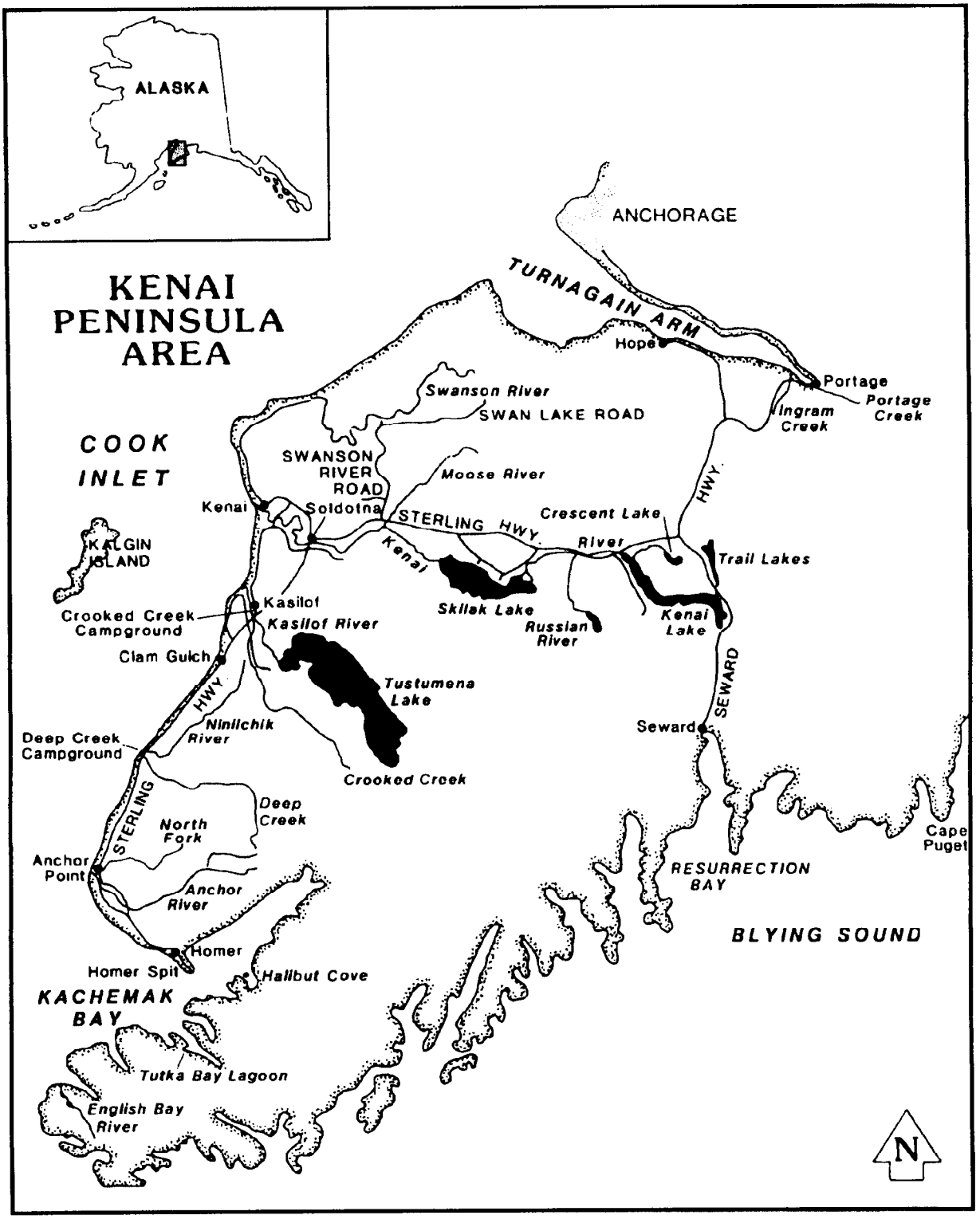

Figure 1.-Map of Kenai Peninsula.

Table 1.-Historical catch and harvest data from the Anchor River Dolly Varden sport fishery, 1977-1995.

	Creel Survey[a]		Statewide Harvest Survey[b]	
Year	Catch	Harvest	Catch	Harvest
1977				9,222
1978				17,357
1979				21,364
1980				10,948
1981				15,271
1982				10,375
1983				17,277
1984				5,560
1985				7,720
1986				3,910
1987	9,414	2,653		2,735
1988	11,992	2,915		2,746
1989	5,605	1,615		1,476
1990	5,391	2,124 [c]	11,441	2,821
1991	5,995	1,520 [d]	14,433	1,409
1992			18,303	2,532
1993			9,719	1,031
1994			13,305	1,574
1995			10,957	1,534

[a] Larson et al. 1988; Larson and Balland 1989; Larson 1990-1992.

[b] Mills 1979-1994; Howe et al. 1995, 1996.

[c] Fishing for Dolly Varden was closed by emergency order after 7 August 1990.

[d] The daily Dolly Varden bag limit was reduced from five to two fish beginning in 1991.

Varden averaged approximately 1,600 fish (Table 1). These same regulations remained in effect during 1995.

The Anchor River Dolly Varden population seems to follow a life history model similar to those described for Kodiak and Southeast Alaskan Dolly Varden (Sonnichsen 1990; Armstrong 1965, 1984). In this hypothetical model, the Anchor River is a spawning stream inhabited by juveniles (presmolt) and adults. The adults that spawn in the Anchor River remain there over winter and those that survive return to salt water the following spring (Larson 1990). Subadults forage in Cook Inlet and migrate to an overwintering area possibly other than the Anchor River for 1 or 2 years after smolting. Major coastal overwintering areas that have been described for Dolly Varden are lakes and occasionally large streams (Armstrong 1965 and 1984); thus, likely areas for the Anchor River population might be English Bay Lakes, Packers Lake, or the Kenai and Kasilof rivers, among others. Upon maturing, these fish return to the Anchor River as spawners. Results from 1989 (Larson 1990) indicate that the immigration of mature females peaks earlier in the season than males and the size range at which 100% of Dolly Varden are mature is

narrow, but changes over time. Postspawners have been documented entering the Anchor River during September (Larson 1993) and may overwinter in the Anchor River as well. Although the origin(s) of postspawners are unknown, nearby Stariski Creek is one likely stream.

This study provides information to test this model by censusing immigrating and emigrating Dolly Varden through the Anchor River weir.

This is the ninth and final year of a long-term study of lower Kenai Peninsula Dolly Varden populations. This study provides information necessary to manage the Dolly Varden spawning stocks. The acquisition of basic Anchor River and non-Anchor River population data such as a total census, length and age composition, relative maturity, and exploitation and contribution rates to the fishery provides the means to manage the sport harvest within acceptable levels of sustained yield. Since this fishery is complicated by concurrent fisheries for other species, it is also necessary to acquire specific fisheries information on all species so that additional regulatory measures (if necessary) can be effectively implemented.

The specific research objectives for 1995 were to:

1. Census the immigration and emigration of Dolly Varden through a weir on the Anchor River from 1 July to 15 August;
2. Estimate the length frequency of immigrating Dolly Varden at the weir by weekly intervals from 1 July to 15 August;
3. Estimate the sex ratio, relative maturity, percent spawners, and age composition of immigrant Dolly Varden at the weir by biweekly periods during 1 July through 15 August; and
4. Estimate the sex ratio, relative maturity, percent spawners, and age composition of Dolly Varden harvested downstream of the weir in the Anchor River sport fishery by biweekly periods during 1 July through 15 August.

This report includes historical data pertaining to Dolly Varden of the Anchor River that have been compiled and analyzed from the following sources: Allin (1954, 1957), Balland (1985, 1986), Nelson et al. (1987), Larson et al. (1988), Larson and Balland (1989), Larson (1990-1994), Wallis and Balland (1981-1984) and Wallis and Hammarstrom (1979-1982). Harvest and effort estimates have been reported by Howe et al. (1995 and 1996) and Mills (1979-1994).

METHODS

STUDY DESIGN

A floating weir was installed in the Anchor River at the upstream limit of tidal influence to assess the immigration and emigration of all Dolly Varden over 200 mm in fork length between 4 July and 12 August. A random sample of immigrant Dolly Varden was collected at the weir and assessed for length during weekly periods and sex, age, and maturity during biweekly periods. Gonad development, as described by Blackett (1968), was used to determine the relative maturity of female Dolly Varden collected at the weir, whereas subjective observations of gonad size and coloration was used to determine male relative maturity. There is currently no standard for determining the sexual maturity of male Dolly Varden and these subjective observations are a first attempt to develop a relative maturity standard for males. A random sample of sport harvested Dolly Varden was examined for length, age, sex, and relative maturity during biweekly periods from 4 July through 12 August.

ANCHOR RIVER WEIR

A weir was installed approximately 1.5 km upstream from the saltwater terminus of the Anchor River (Figure 2). The weir structure was constructed almost entirely of floating weir panels, with rigid panels connecting the floating panels to the embankments. The rigid panel pickets were 1.25 cm diameter solid aluminum rods placed in an aluminum channel framework having a 1.25 cm gap between pickets. Channel frames were 3.6 m long by 1.05 m high. The aluminum frames rested against 1.05 m high vertical weir panels at the outer extremities of the floating weir panels and sandbag abutments along the shoreline. The floating panel pickets were 2.5 cm diameter hollow PVC tubing, capped at each end to provide buoyancy, having a 1.5 cm gap between pickets. Each panel, 4.5 m long, was anchored at one end to a cable and railroad track hinge system laid perpendicular to the stream flow and along the stream bottom. A resistance board fastened to the downstream end of each panel provided the necessary lift to the panels as river water depth varied. Traps were installed to capture both upstream and downstream migrating fish. A second downstream trap was installed on the near shore to accommodate a new stream channel configuration. This provided a downstream trap to be located on each bank of the stream during 1995. The weir prevented passage of fish approximately 200 mm and larger.

Stream depth and temperature characteristics were obtained on a daily basis at the weir site. Depth and temperature readings were recorded daily at 2200 hours from 5 July through 15 August and additional temperature readings were recorded continually with a thermograph from 6 July through 15 August.

All fish passing through the upstream and downstream traps were counted by species and examined for evidence of angler hook wounds. Fish sampled from the upstream trap were chosen by randomly selecting a trap load and sampling all fish from that trap load, whereas as many fish as possible were sampled in the downstream trap. Dolly Varden that were difficult to handle were anesthetized in a CO_2 water bath prior to being measured, otherwise a tagging cradle was used (Larson 1995a).

Approximately 8% of the immigrating Dolly Varden were sampled for length (nearest millimeter fork length). Approximately 4% of the Dolly Varden immigration was sampled for age, sex, relative maturity and weight. These fish were sacrificed, weighed, and measured to the nearest millimeter fork length; and otoliths were removed for age determination (Williams and Bedford 1973). Each female Dolly Varden sampled for relative maturity was given a maturity index code of 1 to 5 according to the following criteria (Blackett 1968):

1. Immature female with egg diameter less than 0.90 mm;
2. Mature female with egg diameter greater than 1.75 mm;
3. Completely mature female, eggs easily stripped;
4. Completely spawned female; and
5. Immature female but showing development, egg diameter greater than 0.90 mm and less than 1.75 mm.

Dolly Varden given maturity index codes of 2, 3, or 4 were categorized as spawners, those with index code 1 were categorized as nonspawners, and those with index code 5 were potential spawners. Males were classified as either spawners or nonspawners. Male spawners displayed gonads that were

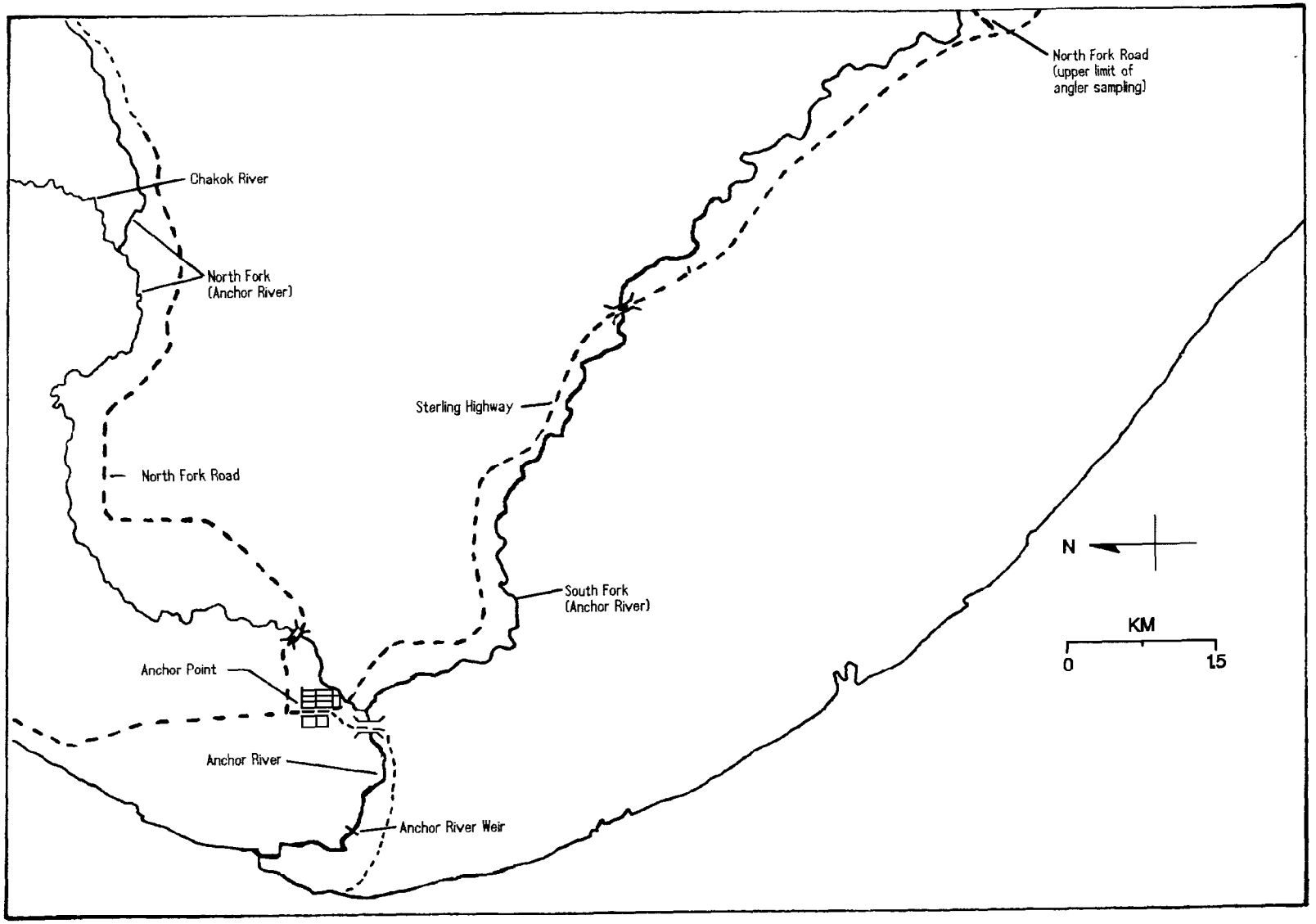

Figure 2.-Map of the Anchor River.

enlarged and of a milky-white appearance while nonspawners lacked any noticeable development. Male gonads were extracted and weighed to the nearest tenth of a gram; gonad weight was compared to total body weight.

Mortalities deposited on the upstream side of the weir face and in the downstream trap were sampled for age (by removal and examination of otoliths), sex, relative maturity, and length (nearest millimeter fork length). Mortalities were also examined for injuries. The purpose of sampling mortalities was to assess the different types of injuries which may be affecting Dolly Varden of various age, length and sexual maturity, in particular hook wounds. These observations are subjective in nature and do not necessarily constitute the cause of death but could have management implications depending on frequency.

SPORT FISHERY

Estimates of recreational harvest of Anchor River Dolly Varden and effort were provided through the postseason statewide harvest survey (Howe et al. 1996); inseason creel survey interviews of anglers at the Anchor River have not been conducted since 1991. Prior to 1992, these two independent estimates of harvest did not differ substantially (Table 1) and an inseason estimate was not considered necessary to manage the sport fishery. Estimates of catch from the creel survey for the 2 years with a corresponding statewide harvest survey were substantially lower than those from the statewide harvest survey.

To obtain a maturity index of the harvest, biological samples were collected from the sport fishery from 11 July through 7 August by a part-time creel clerk and weir personnel. The creel clerk worked a random schedule and weir personnel assisted on a time available basis.

During 1995, biological sampling of Dolly Varden was conducted throughout the lower 10 miles of the Anchor River but concentrated downstream of the weir structure where the majority of sport fishing occurred. Fork length to the nearest millimeter was recorded, otoliths were removed for age determination, and sex and relative maturity were recorded for noneviscerated fish. Dolly Varden were also examined for injuries.

STOCK STRUCTURE AND DYNAMIC RATES

The proportions of fish in each age and sexual maturity component from 1989-1995, and their respective variances, were estimated as simple proportions (Cochran 1977:50-52). Sexual maturity of females was categorized three ways by maturity index codes 1-5: by spawners (codes 2-4 combined), nonspawners (code 1), and potential spawners (code 5); sexual maturity of males (1994-1995) was categorized as either spawners or non-spawners. The inclusion of 1987 and 1988 data was based on 1989 maturity index and length frequency data (Larson 1990). Based on 1989 length frequency data, Dolly Varden less than 300 mm fork length were considered nonspawners; fish 300-349 mm, potential spawners; and fish greater than 349 mm, spawners. Males and females were assumed to have the same proportions in the different maturity categories from 1987 through 1993.

The number of Dolly Varden (sexes combined) by sexual maturity or age component was estimated for biweekly time periods by:

$$\hat{N}_{il} = \hat{P}_{il} N_i, \quad (1)$$

where:

$\hat{N}_{il}$ = estimated number of fish in length range or age class l during period i,

$\hat{P}_{il}$ = proportion of fish in length range or age l during period i, and

N_i = weir count during period i.

The variance was estimated as:

$$V(\hat{N}_{il}) = N_i^2 V(\hat{P}_{il}), \quad (2)$$

where:

$$V(\hat{P}_{il}) = \frac{\hat{P}_{il}(1-\hat{P}_{il})}{n_i - 1}. \quad (3)$$

The length frequency of immigrating Dolly Varden changes over time (Larson et al. 1988), therefore the estimated population of each sexual maturity component was stratified temporally in three, 2-week periods from July through mid-August. The time frame, July through mid-August, encompasses most of the Dolly Varden immigration and was common to all 9 years of weir operation.

Annual survival to the weir and instantaneous dynamic rates were computed from estimates of numbers by age of the immigration through the weir from 1991-1994 (Larson 1992-1994, 1995b) and 1995. These data were used to compute estimates of annual survival ($\hat{S}$) by age (Ricker 1975):

$$\hat{S} = \frac{\hat{N}_{[t+1,l+1]}}{\hat{N}_{[t,l]}}, \quad (4)$$

where:

$\hat{N}$ = immigration through the weir,

t = year, and

l = age.

Annual mortality ($\hat{A}$) was computed for each age class by subtraction:

$$\hat{A} = 1 - \hat{S}. \quad (5)$$

Annual fishing mortality or exploitation ($\hat{E}$) was defined as mortality due to fishing which occurs in the Anchor River. Nearly all of the harvest from 1988 through 1992, and 1994, occurred downstream of the weir. However, during 1993 the harvest occurred primarily upstream of the weir. Exploitation was computed from estimates of harvest ($\hat{H}$) from the Statewide Harvest Survey and immigration ($\hat{N}$) from weir counts by age:

$$\hat{E} = \frac{\hat{H}_{[t,l]}}{(\hat{H}_{[t,l]} + \hat{N}_{[t,l]})}. \quad (6)$$

The instantaneous rate of total mortality ($\hat{Z}$) was computed as (Ricker 1975):

$$\hat{Z} = -\ln(\hat{S}). \quad (7)$$

Instantaneous annual fishing mortality was computed from the Baranof catch equations:

$$\hat{H} = \hat{N} * \left(\frac{\hat{F}}{\hat{Z}}\right) * (1 - e^{-\hat{Z}}), \quad (8)$$

$$\hat{F} = \left(\frac{\hat{H}}{1 - e^{-\hat{Z}}}\right) * \left(\frac{\hat{Z}}{\hat{N}}\right).$$

Instantaneous natural mortality was computed by subtraction:

$$\hat{M} = \hat{Z} - \hat{F}. \quad (9)$$

RESULTS

ANCHOR RIVER WEIR AND SPORT FISHERY

The Anchor River weir was in continuous operation from 4 July through 12 August 1995. The weir installation was delayed a day, relative to past years, due to high water and a modified river channel at the weir site. Dismantling of the weir was begun on 13 August, 3 days earlier than scheduled. On 13 August, high water surpassed the physical limitations of the weir and fish were no longer impeded by the weir.

River water levels were relatively high (Appendix A1) throughout the duration of the weir operation and, on occasion, created small cavities along the rail substrate and rigid weir structures. On four occasions, 16, 19, 21 July and 10 August, erosion of the stream bed may

have allowed some fish to pass through the weir undetected. Due to the small size of these openings and regular inspection by weir personnel to locate openings soon after their formation, it is unlikely that the magnitude of undetected fish could alter significantly the results presented in this report.

Water depth and temperature recorded at the upstream trap location varied from 25.0 cm to 101.3 cm and 8.6°C to 17.8°C, respectively (Appendix A1). Daily water temperature readings varied from 0.9°C to 6.0°C within a 24-hour period. In comparison, water depths were higher and water temperatures lower than in previous years (Nelson et al. 1987; Larson et al. 1988; Larson and Balland 1989; Larson 1990-1994, 1995b).

A total of 10,994 Dolly Varden 200 mm or greater in length were counted passing upstream of the Anchor River weir from 4 July through 12 August (Appendix A2). The peak of the immigration occurred on 24 July (Figure 3), with 50% of the run having passed the weir by 20 July (Figure 4).

Samples collected from fish harvested in the sport fishery were insufficient to satisfy the biweekly sampling goal of 130 fish (Appendix A3). A total of 183 samples were collected from the sport fishery throughout the 6-week sampling period; these 183 samples were pooled for specific data analysis.

Dolly Varden immigrating through the weir and sampled in the sport fishery ranged in age from 3 to 9 years (Tables 2 and 3; Appendices A5 and A6). The age composition between weir and sport fishery samples was significantly different ($\chi^2 = 8.07$, df = 3, P = 0.045) (Table 2 and Figure 5). Anglers tended to harvest mainly age-4 and age-5 Dolly Varden. These fish are the most prominent during the peak of the sport fishery and are generally large enough to be preferred for harvesting. This is similar to the 1990-1992 and 1994 findings but contrary to findings in 1989 and 1993.

The age distribution of immigrating Dolly Varden sampled at the weir changed significantly ($\chi^2 = 166.36$, df = 4, $P < 0.001$) (Table 3) over biweekly periods. The proportion of younger fish increased from 12 July through 9 August (Appendix A4). Samples collected from fish harvested in the sport fishery (Appendix A5) were insufficient to determine age composition by biweekly periods.

Immigrating male and female Dolly Varden were predominantly age 4 (Figure 5). Few fish were older than age 6 and the combined year-classes from 7 through 9 accounted for less than 5% of the run. These results are consistent with those observed from 1990-1994 (Larson 1991-1994, 1995b) and suggest a low frequency of repeat spawning due to high natural or fishing mortality.

Of the 418 fish sampled at the weir for sex composition (Table 2; Appendix A4), 65% were females; of the 175 fish sampled in the sport harvest, 58% were females. These ratios did not change significantly ($\chi^2 = 0.247$, df = 2, P = 0.884) over time when compared in biweekly periods. These results are similar to 1991-1994 (Larson 1992-1994, 1995b) findings but contradictory to 1990 (Larson 1991).

One-way analysis of variance (Snedecor and Cochran 1967) was used to test the null hypothesis that there was no change in mean length of fish by age class across three biweekly periods at the weir. The mean length changed significantly for age-4 ($F = 9.3$, df = 2, 167, $P < 0.001$) and age-5 ($F = 67.2$, df = 2, 114, $P < 0.001$) fish. The mean length of age-4 fish decreased over

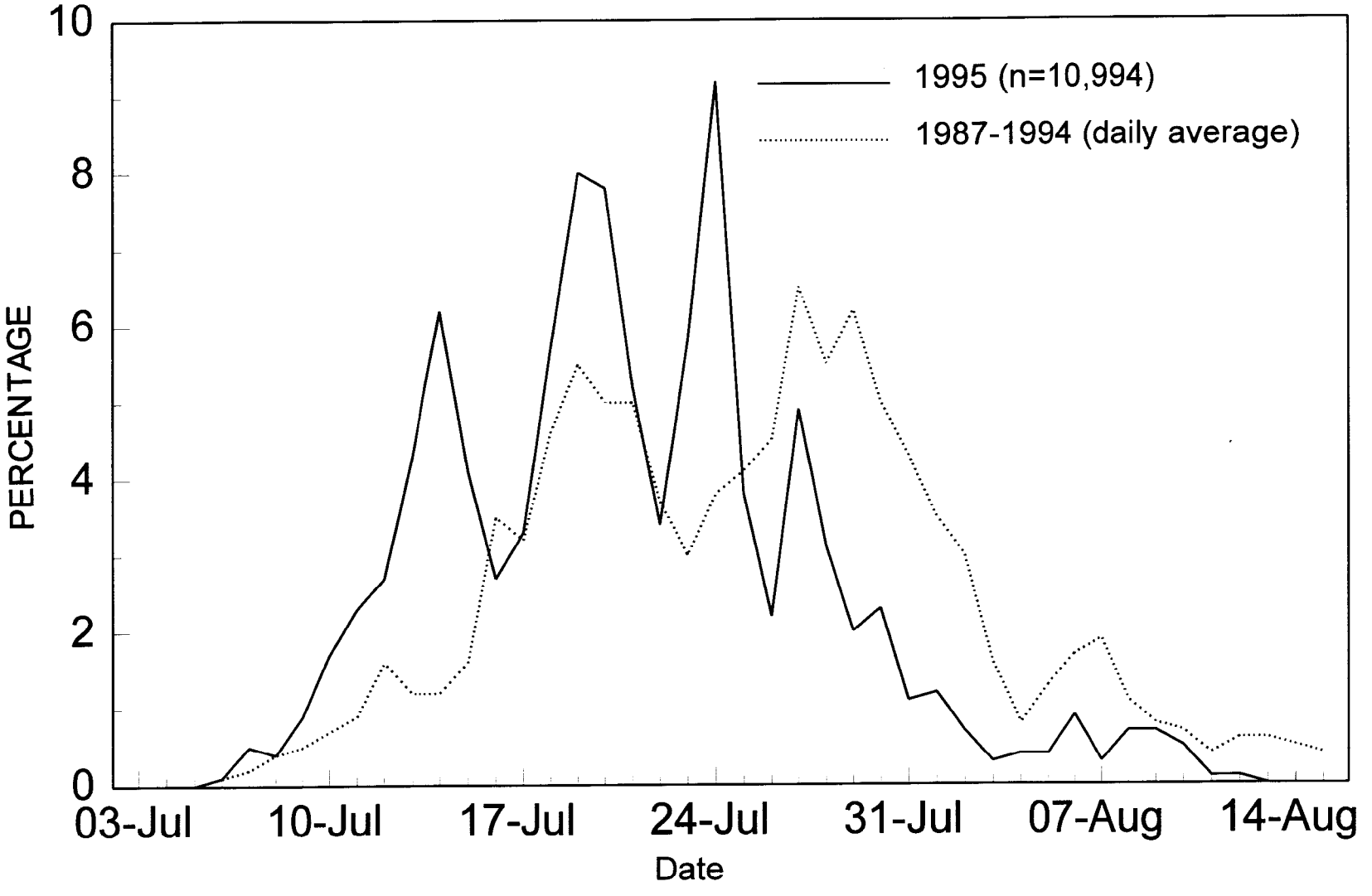

Figure 3.-Daily run timing of Dolly Varden entering the Anchor River, 3 July-15 August. Fish were counted while passing upstream through the Anchor River weir, 1987-1995.

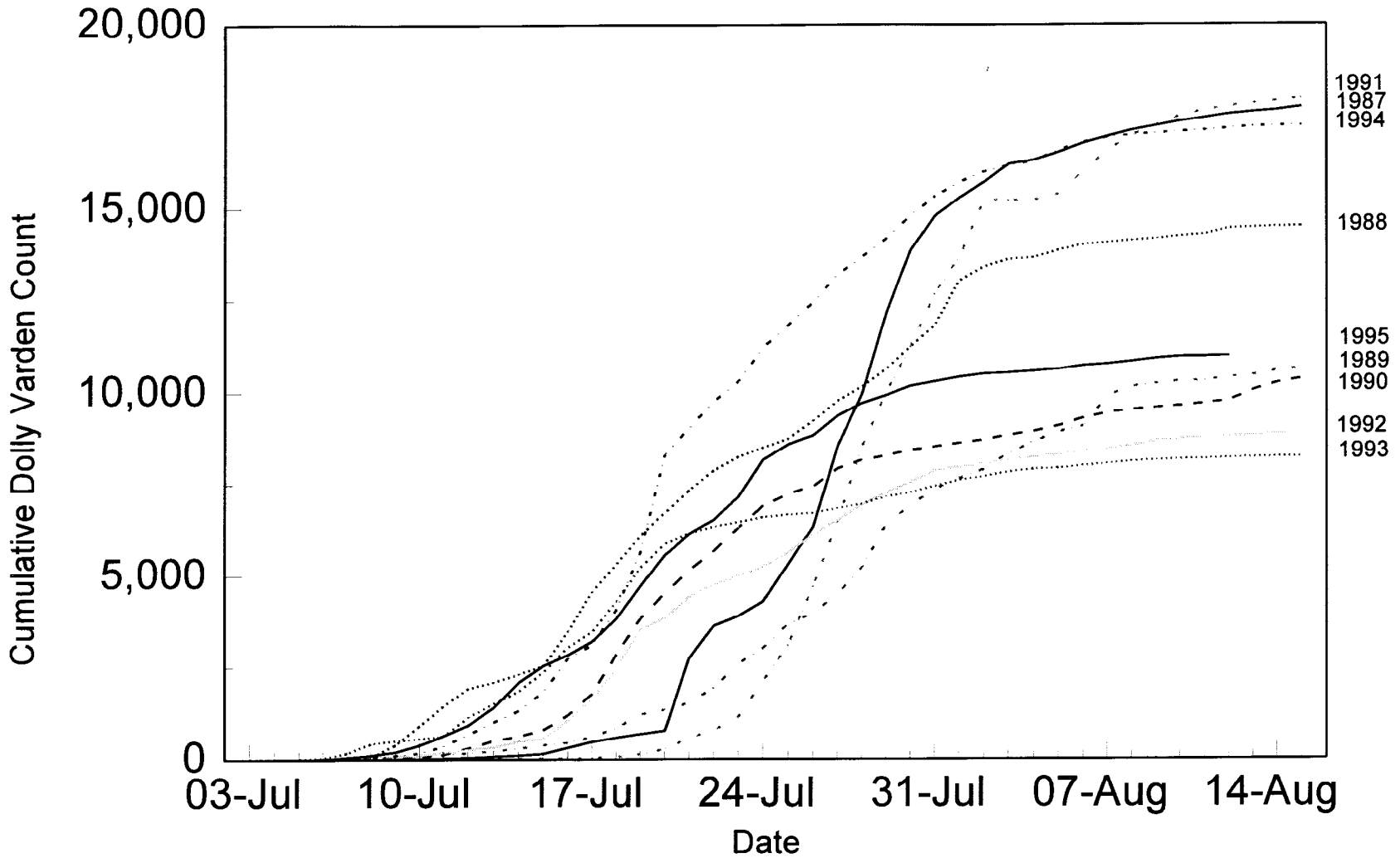

Figure 4.-Cumulative run timing of Dolly Varden entering the Anchor River weir site, 3 July-15 August. Fish were counted while passing upstream through the Anchor River weir, 1987-1995.

Table 2.-Age, sex and length (millimeters) compositions of Dolly Varden collected at the weir site and in the sport harvest on the Anchor River during 1995.

	Age Group[a]							
Component	3	4	5	6	7	8	9	Total
Weir Samples (Upstream Trap)								
Male								
Average Length	241	290	365	436	469			
Standard Error	5.3	4.7	11.9	11.7	27.6			
Percent	15.0	47.6	23.8	10.9	2.7			35.2
Sample Size	22	70	35	16	4			147
Female								
Average Length	147	288	364	426	474	462	478	
Standard Error	5.3	4.6	8.2	10.9	9.2	27.5		
Percent	11.8	36.9	30.3	12.9	5.9	1.8	0.4	64.8
Sample Size	32	100	82	35	16	5	1	271
Sexes Combined								
Average Length	236	289	362	419	471	462	478	
Standard Error	3.8	3.3	6.7	8.5	8.9	27.5		
Percent	12.9	40.7	28.0	12.2	4.8	1.2	0.2	100.0
Sample Size	54	170	117	51	20	5	1	418
Sport Harvest								
Male								
Average Length	244	308	347	377				
Standard Error	13.5	6.0	13.6	35.2				
Percent	7.8	54.7	28.1	9.4				42.1
Sample Size	5	35	18	6				64
Female								
Average Length	249	306	363	368	491			
Standard Error	12.5	6.9	8.6	18.5	19.8			
Percent	6.8	37.5	39.8	11.4	4.5			57.9
Sample Size	6	33	35	10	4			88
Sexes Combined[b]								
Average Length	261	308	355	371	491			
Standard Error	11.7	4.4	6.6	16.9	19.8			
Percent	8.6	45.7	34.3	9.1	2.3			100.0
Sample Size	15	80	60	16	4			175

[a] Age groups 6 through 9 were combined for Chi-square analysis.

[b] The combined sex category contains additional samples than the sum of the individual male and female categories. This is due to age but not sex being determined on some biological samples.

Table 3.-Estimated age and sex composition of Anchor River Dolly Varden sampled biweekly from the weir site, 1995.

		Age Group[a]							
		3	4	5	6	7	8	9	Total
4-18 July									
Male	Est. Dolly Varden	28	138	524	248	110	0	0	1,047
	SE	27	61	112	80	54	0	0	145
	Percent	0.7	3.6	13.7	6.5	2.9	0.0	0.0	27.3
	Sample Size	1	5	19	9	4	0	0	38
Female	Est. Dolly Varden	28	248	1,158	772	413	138	28	2,784
	SE	27	80	149	130	101	61	27	145
	Percent	0.7	6.5	30.2	20.1	10.8	3.6	0.7	72.7
	Sample Size	1	9	42	28	15	5	1	101
Total	Est. Dolly Varden	55	386	1,681	1,020	524	138	28	3,831
	SE	39	98	162	144	112	61	28	0
	Percent	1.4	10.1	43.9	26.6	13.7	3.6	0.7	100.0
	Sample Size	2	14	61	37	19	5	1	139
19-31 July									
Male	Est. Dolly Varden	515	1,686	234	187				2,622
	SE	150	242	103	93				271
	Percent	8.0	26.1	3.6	2.9				40.6
	Sample Size	11	36	5	4				56
Female	Est. Dolly Varden	515	2,154	890	234	47			3,840
	SE	150	260	190	103	47			271
	Percent	8.0	33.3	13.8	3.6	0.7			59.4
	Sample Size	11	46	19	5	1			82
Total	Est. Dolly Varden	1,030	3,840	1,124	421	47			6,462
	SE	202	271	209	136	47			0
	Percent	15.9	59.4	17.4	6.5	0.7			100.0
	Sample Size	22	82	24	9	1			138
1-12 Aug.									
Male	Est. Dolly Varden	50	144	55	15				263
	SE	15	24	16	9				29
	Percent	7.1	20.6	7.8	2.1				37.6
	Sample Size	10	29	11	3				53
Female	Est. Dolly Varden	99	224	104	10				438
	SE	21	28	21	7				29
	Percent	14.2	31.9	14.9	1.4				62.4
	Sample Size	20	45	21	2				88
Total	Est. Dolly Varden	149	368	159	25				701
	SE	24	30	25	11				0
	Percent	21.3	52.5	22.7	3.5				100.0
	Sample Size	30	74	32	5				141

[a] Age groups 6 through 9 were combined for Chi-square analysis.

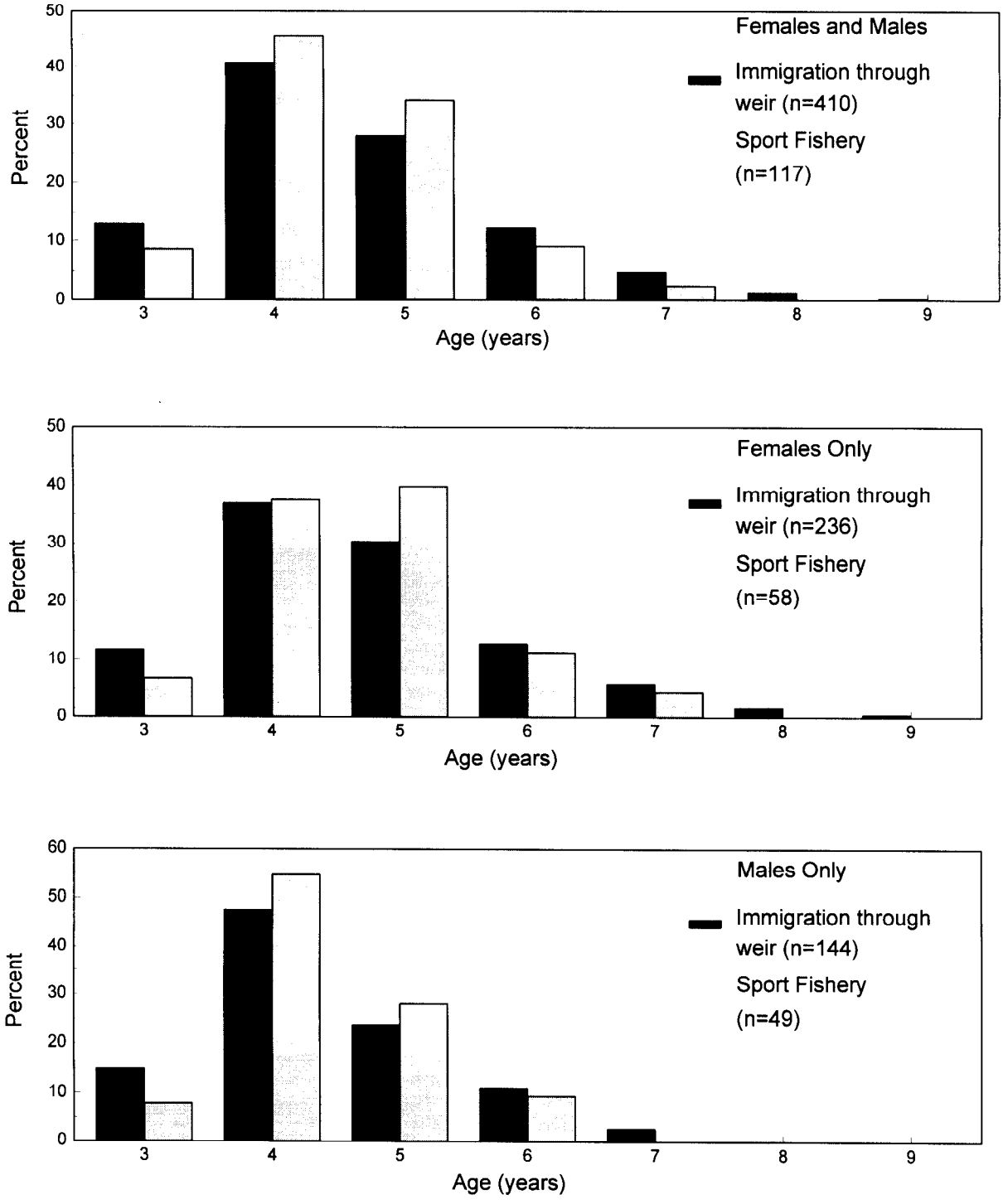

Figure 5.-Age and sex composition of Dolly Varden sampled at the Anchor River weir site and in the sport fishery, 1995.

biweekly periods, with a significant difference in mean length occurring between the first and second periods, but not between the second and third periods. The mean length of age-5 fish decreased over biweekly periods, with a significant difference in mean length between all three periods. These results are similar to 1994 results but differ from 1993 when significant differences in mean length were found within age-4, age-6, and age-7 fish (Larson 1994, 1995b).

The overall mean length decreased over a 6-week period from 4 July through 12 August (Figure 6). This general trend is consistent with all observations made since 1989 (Larson 1990-1994, 1995b).

Dolly Varden harvested in the sport fishery had a tendency to be slightly larger than those sampled at the weir (Tables 4 and 5, Figure 7), thus indicating a tendency by anglers to harvest larger fish. However, the difference in mean length between the sport fishery and fish sampled at the weir was only significant for age-4 ($F = 7.12$, df = 1, 141, $P = 0.009$) and age-5 ($F = 17.33$, df = 1, 48, $P < 0.001$) nonspawners; there was no significant difference in the mean lengths of spawners.

The cumulative length distribution between immigrating spawners and nonspawners differed significantly at age group 4 ($D_{max} = 0.48$; n = 48, 106; $P < 0.001$), age group 5 ($D_{max} = 0.81$; n = 63, 28; $P < 0.001$), and age group 6 ($D_{max} = 0.72$; n = 43, 5; $P = 0.0032$), spawners being larger than nonspawners (Table 4). These results are consistent with those observed from 1989 through 1994 (1990-1994, 1995b).

Maturity estimates of the Dolly Varden immigration through the weir from 4 July through 12 August (Table 6, Figure 8) indicate that about 48% were spawners, 10% potential spawners, and 42% nonspawners. The proportion of immigrating Dolly Varden nonspawners (maturity index code 1) and spawners (maturity index code 2) changed significantly at the weir ($\chi^2 = 119$, df = 2, $P < 0.001$) over time, but not in the sport fishery ($\chi^2 = 3.95$, df = 2, $P = 0.139$). At the weir, nonspawners increased in abundance while spawners decreased biweekly through 12 August. These results are consistent with those observed from 1989-1994, with the exception of 1991 (Larson 1990-1994, 1995b).

A total of 50 Dolly Varden were found dead in the downstream trap or along the upstream side of the weir face (Table 7). A subjective examination for possible causes of death (Table 8) revealed 25 fish (50%) with no apparent injuries, 10 (20%) fish with apparent hook wounds, 7 (14%) fish with predator injuries, 4 (8%) fish with unknown injuries, and 4 (8%) fish with net injuries. Injuries which resulted in lesions to the skin generally had topical evidence of a bacterial infection resembling furunculosis (a necrotic lesion which ulcerates to release lightly infectious reddish fluid), but empirically, the incidence of this disease was reduced from previous years.

A total of 91 live Dolly Varden passed through the downstream trap from 4 July through 12 August (Table 7). The majority (68%) of these fish were less than 300 mm in fork length. Apparent hook wounds (45.1%) and predator injuries (28.6%) were the most prevalent injuries, with 17.6% of the fish exhibiting no apparent injuries (Table 8).

STOCK STRUCTURE AND DYNAMIC RATES

The historical spawner component of immigrating Dolly Varden sampled at the Anchor River weir from 3 July through 15 August has varied between an estimated 4,861 fish in 1992 to 10,763 fish in 1987 (Table 9 and Figure 8). The estimated 1995 spawner

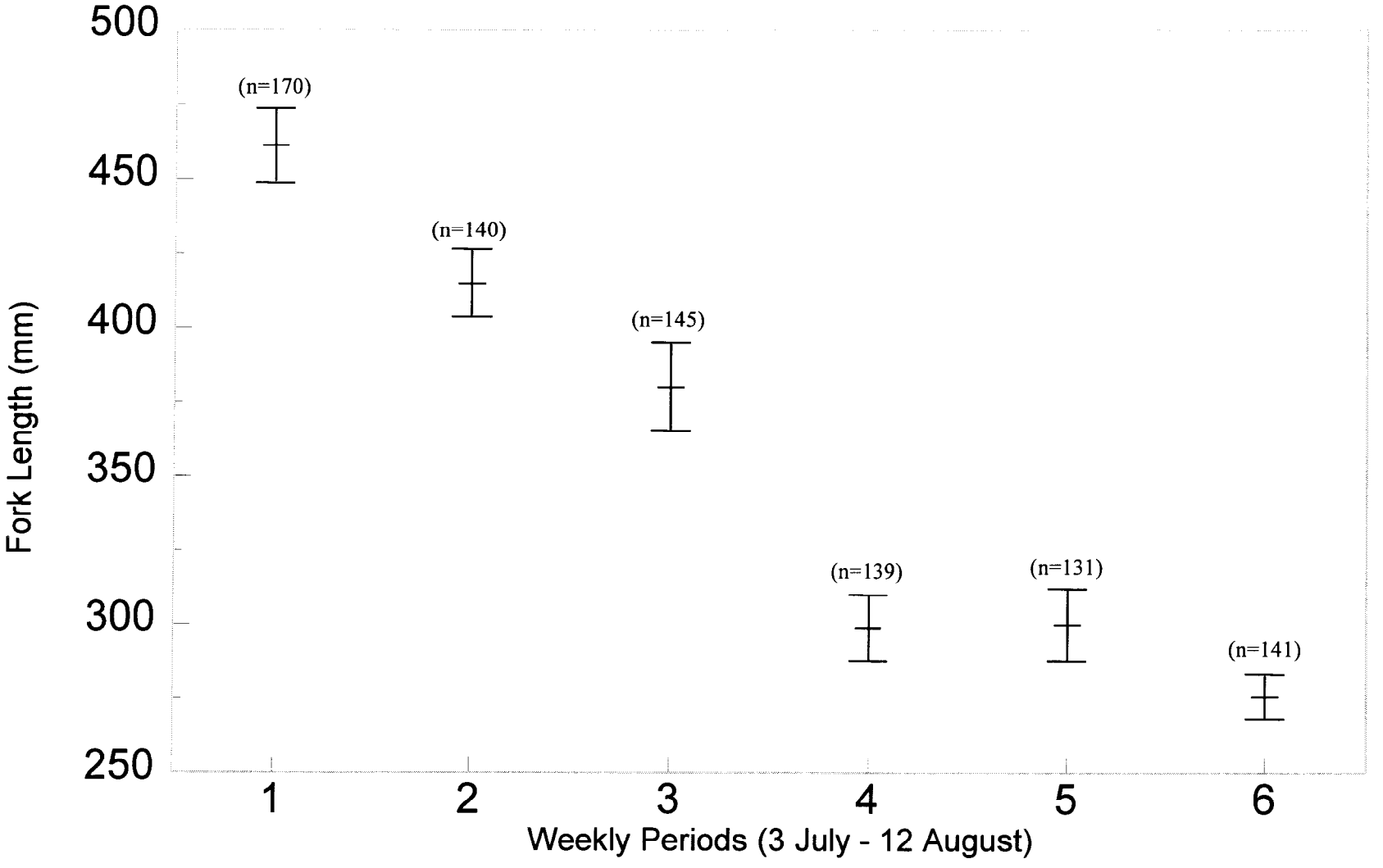

Figure 6.-Mean length by weekly period with 95% confidence intervals from Dolly Varden sampled moving upstream through the Anchor River weir, 1995.

Table 4.-Mean length (millimeters) by age group and sexual maturity of Dolly Varden collected at the Anchor River weir upstream trap, 1995.

Component		Age Group 3	4	5	6	7	8	9
Nonspawners[a]								
Males								
	Mean Length	236	276	300	388			
	Standard Error	6.1	6.2	14.8	17.1			
	Sample Size	17	42	11	3	0	0	0
Females								
	Mean Length	233	271	273	233			
	Standard Error	5.3	4.9	8.8	22.5			
	Sample Size	32	64	17	2	0	0	0
Total								
	Mean Length	234	273	283	326			
	Standard Error	4.0	3.9	8.2	39.9			
	Sample Size	49	106	28	5	0	0	0
Potential Spawners[b]								
Females								
	Mean Length		310	350	341	459	417	
	Standard Error		8.1	10.0	35.0		48.5	
	Sample Size	0	16	25	2	1	2	0
Spawners[c]								
Males								
	Mean Length	256	310	382	404	458		
	Standard Error	7.2	5.3	13.5	15.1	27.6		
	Sample Size	5	28	23	12	4	0	0
Females								
	Mean Length		325	411	445	475	492	478
	Standard Error		10.2	9.0	6.5	9.8	24.2	
	Sample Size	0	20	40	31	15	3	1
Total								
	Mean Length	256	316	400	433	471	492	478
	Standard Error	7.2	5.3	7.7	6.8	9.4	24.2	
	Sample Size	5	48	63	43	19	3	1

[a] Immature males displaying no evidence of gonad development (maturity index code 1).

Immature females with egg diameter less than 0.90 mm (maturity index code 1).

[b] Immature females showing development, egg diameter greater than 0.90 mm and less than 1.75 mm (maturity index code 5).

[c] Mature males with gonads showing signs of development, e.g., milky white coloration (maturity index code 2).

Mature females with egg diameter greater than 1.75 mm, or completely mature females (eggs easily stripped), or completely spawned females (maturity index codes 2-4).

Table 5.-Mean length (millimeters) by age group and sexual maturity of Dolly Varden collected in the sport fishery, 1995.

Component		Age Group 3	4	5	6	7
Nonspawners[a]						
Males						
	Mean Length	244	294	337	320	
	Standard Error	13.5	9.9	15.4		
	Sample Size	5	17	10	1	0
Females						
	Mean Length	249	293	325	310	
	Standard Error	12.5	9.5	5.5	11.5	
	Sample Size	6	20	12	3	0
Total						
	Mean Length	247	293	331	313	
	Standard Error	8.7	6.7	7.5	8.5	
	Sample Size	11	37	22	4	0
Potential Spawners[b]						
Females						
	Mean Length		325	352	363	
	Standard Error		11.9	16.2	33.7	
	Sample Size	0	10	11	4	0
Spawners[c]						
Males						
	Mean Length		322	358	388	
	Standard Error		6.0	24.4	40.8	
	Sample Size	0	17	8	5	0
Females						
	Mean Length		328	413	433	491
	Standard Error		18.2	14.1	31.3	19.8
	Sample Size	0	3	11	3	4
Total						
	Mean Length		323	390	405	491
	Standard Error		5.6	14.2	27.7	19.8
	Sample Size	0	20	19	8	4

[a] Immature males with no evidence of gonad development (maturity index code 1).

Immature females with egg diameter less than 0.90 mm (maturity index code 1).

[b] Immature females showing development, egg diameter greater than 0.90 mm and less than 1.75 mm (maturity index code 5).

[c] Mature males with gonads showing signs of development, e.g., milky white coloration (maturity index code 2).

Mature females with egg diameter greater than 1.75 mm, or completely mature females (eggs easily stripped), or completely spawned females (maturity index codes 2-4).

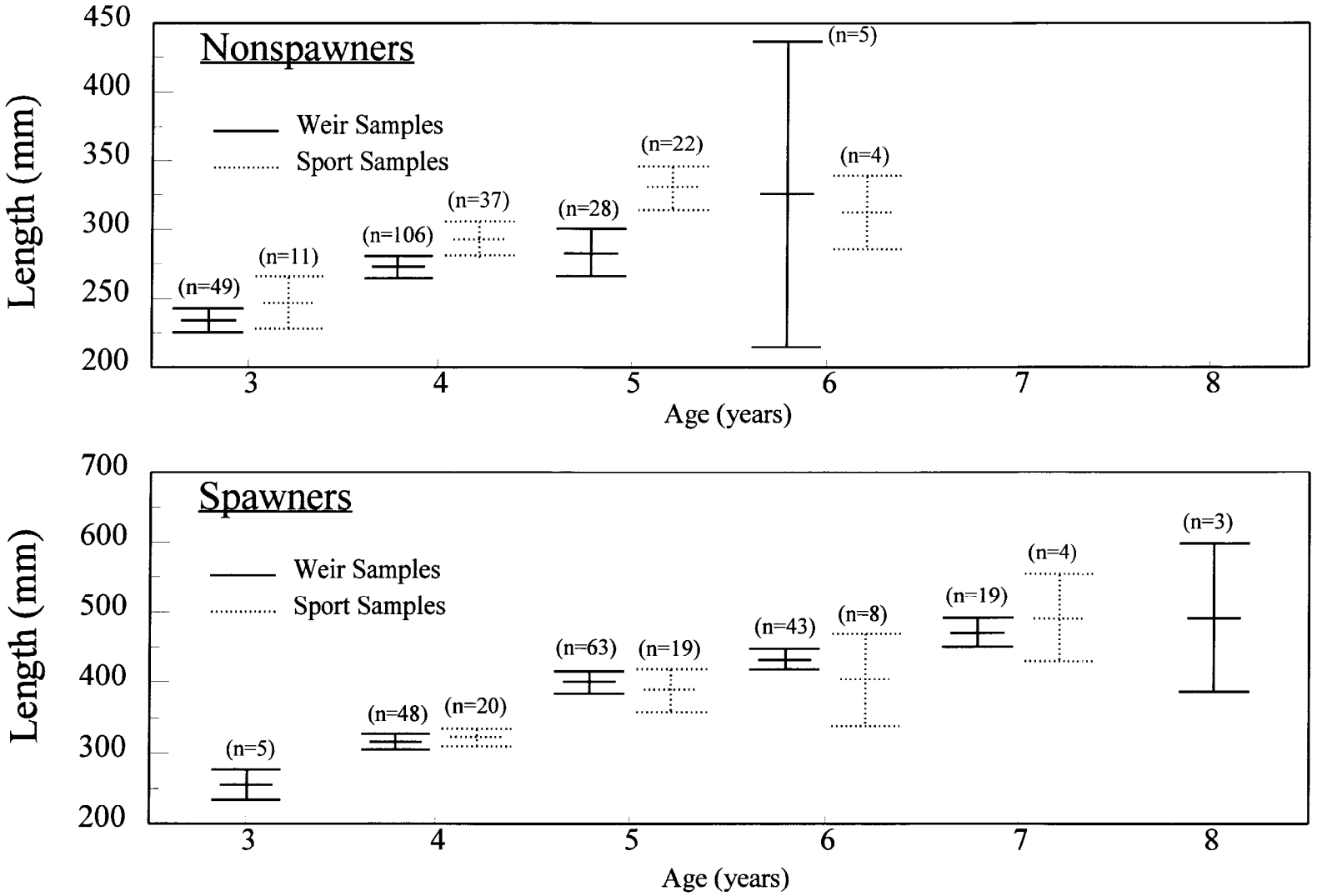

Figure 7.-Mean length by age with 95% confidence intervals from nonspawner and spawner Anchor River Dolly Varden sampled at the weir and in the sport fishery, 1995.

Table 6.-Relative maturity and sex ratios of Dolly Varden sampled at the Anchor River weir and in the sport fishery by period, 1995.

				Maturity Index[a]																
				1					2					3	4	5				
Period	N	Sex	n_i	n	%	Mean Length	$\hat{N}$	SE	n	%	Mean Length	$\hat{N}$	SE			n	%	Mean Length	$\hat{N}$	SE
Weir																				
7/4-7/18	3,831	F	102	5	3.6	271.0	139	358	73	52.9	449.8	2,026	225	0	0	24	17.4	373.1	666	303
		M	36	5	3.6	354.2	139	358	31	22.5	434.9	861	292			0	0.0	0	0	0
7/19-7/31	6,462	F	82	54	38.8	269.0	2,511	433	21	15.1	382.8	976	517	0	0	7	5.0	316.0	325	577
		M	57	29	20.9	261.7	1,348	496	28	20.1	327.6	1,302	499			0	0.0		0	0
8/1-8/12	701	F	88	56	39.7	249.8	277	46	17	12.1	318.8	85	57	0	0	15	10.6	302.0	75	58
		M	53	39	27.7	274.5	194	51	14	9.9	301.8	70	58			0	0.0		0	0
Total	10,994		418		41.9	265.6	4,608	833		48.4	391.8	5,319	812	0	0		9.7	341.2	1,066	654
Sport																				
7/4-7/18		F	36	5	8.8	310.4			14	24.6	445.6			0	0	17	29.8	349.2		
		M	21	9	15.8	318.8			12	21.1	339.7					0	0.0			
7/19-7/31		F	44	28	35.9	297.1			9	11.5	391.7			0	0	7	9.0	321.4		
		M	34	18	23.1	294.4			16	20.5	343.1					0	0.0			
8/1-8/12		F	13	10	45.5	283.0			0	0.0				0	0	3	13.6	293.2		
		M	9	6	27.3	290.0			3	13.6	336.0					0	0.0			
Total	SWHS		157	76	48.4	297.5	742		54	34.4	376.6	528		0	0	27	17.2	341.3	264	

[a] Female maturity index: 1 = immature female with egg diameter less than 0.90 mm; 2 = mature female with egg diameter greater than 1.75 mm; 3 = completely mature female (eggs easily stripped); 4 = completely spawned female; and 5 = immature female but shows development, egg diameter greater than 0.90 mm and less than 1.75 mm.

Male maturity index: 1 = no gonad development; 2 = gonads showing signs of development (milky-white coloration).

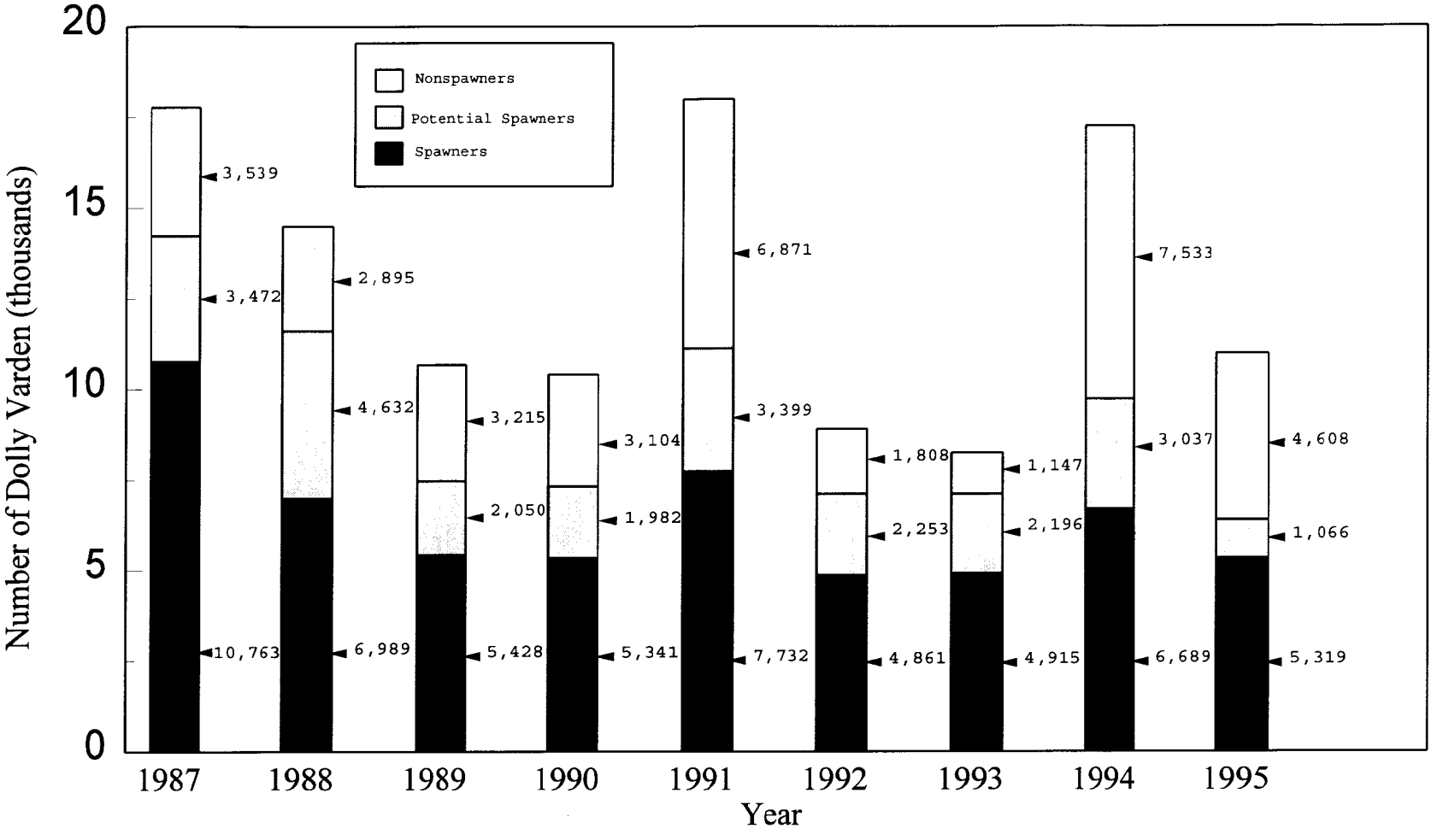

Figure 8.-Estimated sexual maturity component of immigrating Dolly Varden sampled at the Anchor River weir from 3 July through 15 August, 1987-1995.

Table 7.-Number of Dolly Varden sampled from the upstream trap, sport harvest, mortalities recovered at the weir site, and downstream trap, by length range, Anchor River, 4 July-12 August 1995.

Length	Upstream		Sport Harvest		Mortalities		Downstream	
Range	Count	%	Count	%	Count	%	Count	%
(millimeters)								
<200	11	1	0	0	1	2	6	7
200-249	111	13	20	11	6	12	42	46
250-299	151	17	29	16	12	24	14	15
300-349	202	23	86	47	14	28	23	25
350-399	75	9	26	14	6	12	5	5
400-449	102	12	12	7	7	14	1	1
450-499	124	14	5	3	0	0	0	0
500>	90	10	5	3	4	8	0	0
Total	866	100	183	100	50	100	91	100

return of 5,319 fish is the fifth highest return in the 9 consecutive years of this study.

Fish younger than age 5 were incompletely recruited to the spawning population during most years. Annual survival tended to decrease with older fish (Table 10). Based on maturity sampling, fish beyond age 5 are virtually all spawners and are believed to return annually to spawn. These estimates support that belief. While age 9 and older fish should fit the same pattern, annual survival has varied widely from 0 to 1.5 and is likely attributed to rare event sampling; age classes beyond age 8 are found in only trace levels (less than 1%) (Table 10).

Table 11 indicates that since 1994 anglers have harvested a greater percentage (>50%) of age classes 3 and 4 than in previous years. During both 1994 and 1995, age 4 was the prominent age class available for harvest. Instantaneous rates of total mortality (Z) generally increased with age for all years (Table 12).

No trends were evident in instantaneous annual fishing mortality (F) (Table 12) and the values are variable across years and ages. The years 1994 and 1995 stand out as years with some of the lowest values of annual fishing mortality in fish older than age 5 (Tables 11 and 12). Although anglers tend to select older and larger fish to harvest, approximately 11% of the harvest was from fish older than age 5, which represented approximately 18% of the run during 1994 and 1995 (Table 10).

Instantaneous natural mortality (M) (Table 12) was much higher than from the values for F for ages 4 through 9, demonstrating that the number of deaths due to harvest in the sport fishery was much lower than from natural causes. These results are consistent with previous years and support the literature which indicates mortality due to spawning is high.

DISCUSSION

DOLLY VARDEN

The scope of this study has focused on recreational angling impacts to the Dolly Varden spawning population. The decline of

Table 8.-Injuries observed by length range from Dolly Varden sampled in the emigration and immigration through the Anchor River weir and from mortalities collected at the weir site, 1995.

Length Range	No Injuries	%	Hook Wound	%	Net Wound	%	Unknown Injuries	%	Predator Injuries	%	Total
Live Emigration											
<200 mm	2	2.2	2	2.2	0	0.0	1	1.1	1	1.1	6
200-249 mm	8	8.8	18	19.8	0	0.0	3	3.3	13	14.3	42
250-299mm	3	3.3	8	8.8	1	1.1	0	0.0	2	2.2	14
300-349 mm	2	2.2	12	13.2	0	0.0	3	3.3	6	6.6	23
350-399 mm	1	1.1	1	1.1	0	0.0	0	0.0	3	3.3	5
400-449 mm	0	0.0	0	0.0	0	0.0	0	0.0	1	1.1	1
450-499 mm	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
500> mm	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Total	16	17.6	41	45.1	1	1.1	7	7.7	26	28.6	91
Downstream Mortalities											
<200 mm	0	0.0	0	0.0	0	0.0	0	0.0	1	2.0	1
200-249 mm	2	4.0	2	4.0	0	0.0	1	2.0	1	2.0	6
250-299 mm	6	12.0	4	8.0	1	2.0	1	2.0	0	0.0	12
300-349 mm	6	12.0	3	6.0	2	4.0	1	2.0	2	4.0	14
350-399 mm	4	8.0	1	2.0	1	2.0	0	0.0	0	0.0	6
400-449 mm	3	6.0	0	0.0	0	0.0	1	2.0	3	6.0	7
450-499 mm	4	8.0	0	0.0	0	0.0	0	0.0	0	0.0	4
500> mm	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Total	25	50.0	10	20.0	4	8.0	4	8.0	7	14.0	50
Live Immigration											
<200 mm	10	1.2	1	0.1	0	0.0	0	0.0	0	0.0	11
200-249 mm	101	11.7	10	1.2	0	0.0	0	0.0	0	0.0	111
250-299 mm	141	16.3	7	0.8	0	0.0	0	0.0	3	0.3	151
300-349 mm	187	21.6	14	1.6	0	0.0	0	0.0	1	0.1	202
350-399 mm	74	8.5	0	0.0	0	0.0	0	0.0	1	0.1	75
400-449 mm	100	11.5	2	0.2	0	0.0	0	0.0	0	0.0	102
450-499 mm	122	14.1	0	0.0	0	0.0	0	0.0	2	0.2	124
500> mm	88	10.2	1	0.1	0	0.0	0	0.0	1	0.1	90
Total	823	95.0	35	4.0	0	0.0	0	0.0	8	0.9	866

Table 9.-Estimated sexual maturity of Dolly Varden sampled at the Anchor River weir from July through 15 August, 1987-1995.

			Nonspawners				Potential Spawners				Spawners			
Year	Period	Weir Cnt	n	%	$\hat{N}$	SE	n	%	$\hat{N}$	SE	n	%	$\hat{N}$	SE
1987[a]	July 4-17	596	17	3.8	23	5	57	12.9	77	8	369	83.3	496	9
	July 18-31	14,688	215	17.3	2,534	46	237	19.0	2,794	48	794	63.7	9,360	58
	Aug 1-15	2,490	431	39.4	982	24	264	24.2	601	21	398	36.4	907	24
	Total	17,774	663	23.8	3,539	57	558	20.1	3,472	53	1,561	56.1	10,763	66
1988[a]	July 4-17	5,323	105	7.8	417	20	431	32.2	1,712	34	804	60.0	3,194	36
	July 18-31	7,713	337	29.3	2,258	40	403	35.0	2,701	42	411	35.7	2,754	42
	Aug 1-15	1,480	8	14.8	219	14	8	14.8	219	14	38	70.4	1,041	18
	Total	14,516	450	17.7	2,895	46	842	33.1	4,632	57	1,253	49.2	6,989	60
1989[b]	July 5-18	1,229	3	4.5	56	7	21	31.8	391	16	42	63.6	782	17
	July 19-31	6,429	50	32.9	2,115	38	22	14.5	931	28	80	52.6	3,384	40
	Aug 1-15	3,034	43	34.4	1,044	26	30	24.0	728	24	52	41.6	1,262	27
	Total	10,692	96	28.0	3,215	46	73	21.3	2,050	42	174	50.7	5,428	52
1990[b]	July 2-15	1,201	12	15.8	190	13	15	19.7	237	14	49	64.5	774	17
	July 16-31	7,418	16	23.9	1,771	37	12	17.9	1,329	33	39	58.2	4,318	42
	Aug 1-15	1,808	55	63.2	1,143	21	20	23.0	416	18	12	13.8	249	15
	Total	10,427	83	36.1	3,104	49	47	20.4	1,982	41	100	43.5	5,341	51
1991[b]	July 2-18	141	3	37.5	53	6	1	12.5	18	4	4	50.0	71	6
	July 19-31	13,531	24	40.0	5,412	57	12	20.0	2,706	47	24	40.0	5,412	57
	Aug 1-15	4,330	25	32.5	1,406	31	12	15.6	675	24	40	51.9	2,249	33
	Total	18,002	52	35.9	6,871	64	25	17.2	3,399	51	68	46.9	7,732	67

-continued-

Table 9.-Page 2 of 2.

Year	Period	Weir Cnt	Nonspawners				Potential Spawners				Spawners			
			n	%	$\hat{N}$	SE	n	%	$\hat{N}$	SE	n	%	$\hat{N}$	SE
1992[b]	July 4-18	3,547	5	6.9	246	15	22	30.6	1,084	27	45	62.5	2,217	29
	July 19-31	4,423	14	21.2	938	27	15	22.7	1,005	28	37	56.1	2,480	33
	Aug 1-15	953	38	65.5	624	15	10	17.2	164	12	10	17.2	164	12
	Total	8,923	57	29.1	1,808	43	47	24.0	2,253	40	92	46.9	4,861	47
1993[b]	July 3-18	5,217	7	7.9	410	19	28	31.5	1,641	34	54	60.7	3,166	35
	July 19-31	2,390	17	20.0	478	20	15	17.6	422	19	53	62.4	1,490	24
	Aug 1-15	651	35	39.8	259	12	18	20.5	133	10	35	39.8	259	12
	Total	8,258	59	22.5	1,147	38	61	23.3	2,196	38	142	54.2	4,915	45
1994[c]	July 3-18	5,648	28	19.7	1,114	326	62	43.7	2,466	284	52	36.6	2,068	387
	July 19-31	10,066	71	51.8	5,217	743	6	4.4	441	222	60	43.8	4,408	728
	Aug 1-15	1,545	102	77.9	1.203	134	11	8.4	130	47	18	13.7	212	69
	Total	17,259	201	43.6	7,533	823	79	17.6	3,037	364	130	38.8	6,689	827
1995[c]	July 4-18	3,831	10	7.2	278	330	24	17.4	666	303	104	75.4	2,887	163
	July 19-31	6,462	83	59.7	3,859	350	7	5.0	325	577	49	35.2	2,278	445
	Aug 1-12	701	95	67.4	471	34	15	10.6	75	58	31	22.0	155	53
	Total	10,994	188	45.0	4,608	482	46	11.0	1,066	654	184	44.0	5,319	477

[a] Sexual maturity based on female length frequency and maturity index data collected during 1989 (nonspawners: <300 mm; potential spawners: 300-349 mm; spawners: >349 mm).

[b] Sexual maturity based on female gonad development; male sexual maturity was assumed to be equal in proportion to female maturity findings. Nonspawners were females with egg diameter less than 0.90 mm; potential spawners were females with egg diameter greater than 0.90 mm and less than 1.75 mm; and spawners were females with egg diameter greater than 1.75 mm.

[c] Sexual maturity of females based on criteria described in footnote "b," above. Sexual maturity of males based on gonad development: nonspawners displayed gonads with little or no development; spawners displayed gonads showing signs of development (milky-white coloration).

Table 10.-Anchor River Dolly Varden estimates by age of percent composition, weir counts, annual survival and annual mortality from 1 July through 15 August, 1988-1995.

		Age									
Year	n	2	3	4	5	6	7	8	9	10+	Total
Weir Count											
1988	622	58	842	3,353	7,040	2,366	682	73	102	0	14,516
1989	557	71	750	2,492	2,681	3,520	933	231	14	0	10,692
1990	366	38	1,961	2,580	3,409	1,595	769	25	25	21	10,427
1991	240	164	1,663	6,262	6,229	2,185	1,040	423	36	0	18,002
1992	380	8	1,387	2,474	2,751	1,882	552	182	57	0	9,293
1993	400	5	858	1,585	3,097	2,065	439	194	19	0	8,262
1994	410	23	2,911	5,727	5,189	2,430	865	114	0	0	17,259
1995	418	0	1,420	4,472	3,077	1,341	526	132	26	0	10,994
Percent											
1988	622	0.4	5.8	23.1	48.5	16.3	4.7	0.5	0.7	0.0	100.0
1989	557	0.7	7.0	23.3	25.1	32.9	8.7	2.2	0.1	0.0	100.0
1990	366	0.4	18.8	24.7	32.7	15.3	7.4	0.2	0.2	0.2	100.0
1991	240	0.9	9.2	34.8	34.6	12.1	5.8	2.3	0.2	0.0	100.0
1992	380	0.1	14.9	26.6	29.6	20.3	5.9	2.0	0.6	0.0	100.0
1993	400	0.1	10.4	19.2	37.5	25.0	5.3	2.3	0.2	0.0	100.0
1994	410	0.1	16.9	33.2	30.1	14.1	5.0	0.7	0.0	0.0	100.1
1995	418	0.0	12.9	40.7	28.0	12.2	4.8	1.2	0.2	0.0	100.0

	Age				
	5-6	6-7	7-8	8-9	9-10
Annual Survival					
1988-1989	0.500	0.394	0.339	0.192	0.000
1989-1990	0.595	0.218	0.027	0.108	1.500
1990-1991	0.641	0.652	0.550	1.440	0.000
1991-1992	0.302	0.253	0.175	0.135	0.000
1992-1993	0.751	0.233	0.351	0.104	0.000
1993-1994	0.785	0.419	0.260	0.000	0.000
1994-1995	0.258	0.216	0.153	0.228	0.000
Annual Mortality					
1988-1989	0.500	0.606	0.661	0.808	1.000
1989-1990	0.405	0.782	0.973	0.892	-0.500
1990-1991	0.359	0.348	0.450	-0.440	1.000
1991-1992	0.698	0.747	0.825	0.865	1.000
1992-1993	0.249	0.767	0.649	0.896	1.000
1993-1994	0.215	0.581	0.740	1.000	1.000
1994-1995	0.742	0.784	0.847	0.772	1.000

Note: Age composition based on fish mortalities collected on the weir face (1988) and random sampling schedules (1989-1995).

Table 11.-Anchor River sport harvest estimates of percent composition, harvest and annual fishing mortality by age downstream of the fish weir, 1988-1995.

		Age									
Year	n	2	3	4	5	6	7	8	9	10+	Total
Percent by Age											
1988	224	0	2.7	26.3	47.7	17.8	3.6	1.4	0.5		100.0
1989	60	0	6.7	30.0	25.0	31.6	5.0	1.7		100.0	
1990	87	0	9.2	27.6	41.3	9.2	9.2	2.3	1.2		100.0
1991	188	0	3.7	23.4	36.2	24.5	9.6	1.6	0.5	0.5	100.0
1992	143	0	4.9	34.3	35.0	21.0	1.4	1.4	2.1		100.1
1993	47	0	4.3	21.3	40.4	23.4	10.6				100.0
1994	109	0	10.1	42.2	36.7	8.3	1.8	0.9			100.0
1995	175	0	8.6	45.7	34.3	9.1	2.3				100.0
Estimated Harvest by Age											
1988	224	0	58	567	1,028	384	78	30	11	0	2,156
1989	60	0	71	316	263	333	53	18	0	0	1,053
1990	87	0	195	586	877	195	195	49	25	0	2,124
1991	188	0	56	356	550	372	146	24	8	0	1,520
1992	143	0	124	868	885	532	35	35	53	0	2,532
1993	47	0	44	220	417	241	109	0	0	0	1,031
1994	109	0	159	664	578	131	28	14	0	0	1,574
1995	175	0	132	702	527	140	35	0	0	0	1,537
Annual Fishing Mortality (E) or Exploitation											
1988			0.065	0.145	0.127	0.140	0.102	0.293	0.096	-	
1989			0.086	0.113	0.089	0.086	0.053	0.072	0.000	-	
1990			0.091	0.185	0.205	0.109	0.203	0.661	0.505	0.000	
1991			0.033	0.054	0.081	0.146	0.123	0.054	0.174	1.000	
1992			0.082	0.260	0.244	0.220	0.060	0.163	0.483	-	
1993			0.049	0.122	0.119	0.105	0.199	0.000	0.000	-	
1994			0.052	0.104	0.100	0.051	0.032	0.111	-	-	
1995			0.085	0.136	0.146	0.094	0.063	0.000	0.000	-	

the spawning population observed from 1987 through 1990 (Figure 8) was believed to reflect an angler depressed stock (Larson 1990) and a regulatory reduction in the daily bag limit from five to two fish was imposed. Since 1990, the estimated spawner component each year has been relatively stable (Figure 8). The reduction in bag limit is believed to have reduced the harvest and altered the angler characteristics. Recent observations of the sport fishery indicate anglers are self-imposing more hook-and-release practices than before. It seems that a growing number of Dolly Varden anglers are fishing more for recreation than for food. This may be the product of public awareness of conservation concerns relating to recent Dolly Varden stocks or the two-fish bag limit restriction

may be deterring harvest oriented anglers from participating in the fishery. If an angler creel survey is conducted in the future, soliciting why anglers fish for Dolly Varden would help characterize anglers and aid managers in further developing effective management strategies.

Mortality associated with hook-and-release practices on Dolly Varden stocks remains a concern. Overall, hook injuries have been the most prevalent type of injury evident from mortalities deposited by the river current on the upstream side of the weir face and in the emigration through the downstream trap. Hook injuries which tear the protective skin layer can disrupt the osmoregulatory system of fish and become sites for bacterial and fungal infections, any of which can be lethal. Empirical evidence from this study indicates that as water temperature increases the

Table 12.-Anchor River Dolly Varden instantaneous estimates of total fishing and natural mortality, 1988-1995.

	Age				
Year	5-6	6-7	7-8	8-9	9-10
Instantaneous Total Mortality (Z)					
1988-1989	0.693	0.931	1.083	1.651	
1989-1990	0.519	1.521	3.620	2.224	-0.405
1990-1991	0.445	0.428	0.598	-0.365	
1991-1992	1.197	1.376	1.743	2.004	
1992-1993	0.287	1.456	1.046	2.260	
1993-1994	0.243	0.870	1.348		
1994-1995	1.353	1.530	1.880	1.478	
Instantaneous Fishing Mortality (F)					
1988-1989	0.066	0.034	0.043	0.000	
1989-1990	0.093	0.108	0.195	0.275	0.000
1990-1991	0.135	0.112	0.042	0.252	
1991-1992	0.146	0.030	0.072	0.291	
1992-1993	0.101	0.110	0.000	0.000	
1993-1994	0.048	0.021	0.059		
1994-1995	0.049	0.028	0.000	0.000	
Instantaneous Natural Mortality (M)					
1988-1989	0.628	0.896	1.040	1.651	
1989-1990	0.426	1.413	3.425	1.948	-0.405
1990-1991	0.309	0.315	0.556	-0.617	
1991-1992	1.050	1.346	1.671	1.713	
1992-1993	0.186	1.345	1.046	2.260	
1993-1994	0.195	0.850	1.290		
1994-1995	1.304	1.502	1.880	1.478	

mortality associated with hook injuries also increases. Because there is some level of mortality associated with hook-and-release practices, excessive catch rates can have severe impacts to a fish population. Catch rates as high as 80% of the total Dolly Varden immigration were estimated on the Anchor River during 1988 (Larson and Balland 1989). Encouraging too many people to participate in this Dolly Varden fishery, even if the harvest is low, may result in excessive hook and release mortality. Fishery managers and the public must have realistic expectations of how much fishing opportunity our wild Dolly Varden stocks can provide and regulate accordingly.

The importance that water temperature plays in fish behavior, incidence of diseases, and survival of Dolly Varden has become more evident throughout this and other studies. Anadromous Dolly Varden on the Kenai Peninsula enter fresh water during the warmest time of the year and spawn immediately before the coldest period. Excessively warm or cold water have been shown to have lethal effects on Dolly Varden. McCauley (1991) determined 23.5^{o}C to be the ultimate upper lethal temperature for Arctic char *Salvelinus alpinus*. Likewise, Bjornn (1991) found that temperatures below 4^{o}C during the early stages of egg incubation can be fatal to trout and char. Water temperatures in the Anchor River have approached the upper threshold of what char can tolerate and are often below 4^{o}C during spawning. Temperatures of 21.2^{o}C were recorded during 1993 at the weir site (Larson 1994) and fell below 3^{o}C as early as 11 September during 1992 (Larson 1993).

The protection of the watershed habitat from logging and development may be critical to the survival of Dolly Varden and salmonids, especially along clearwater streams like the Anchor River. Armstrong (1991) states that it is especially important to protect the small tributary streams where juvenile char rear before they leave streams as smolt. Overhanging vegetation minimizes the solar warming effect on stream water and plant transpiration buffers the severity of run-off from rain falls. The forest along the Chakok River, an important nursery tributary within the Anchor River watershed, is currently being logged, as are sections of every Kenai Peninsula watershed south of the Kasilof River. The short-term economic gain of logging these areas will likely have long-term impacts on our fisheries resources. The boreal forest habitat of our local watersheds are complex ecosystems that are not completely understood, but their value to our fisheries resources is becoming clearer. Without the forest habitat, especially in the riparian zone, water temperature and run-off is expected to fluctuate more dramatically and this will likely have an adverse effect on our fisheries.

Our attempt to establish a standard for determining the sexual maturity of male Dolly Varden was not conclusive. The laboratory resources were not available to conduct detailed chemical analysis of the male gonad samples. With a lack of quantitative analysis, our criteria for determining male sexual maturity remains subjective. I believe our criteria, though subjective, more accurately portrayed the true sexual maturity of the male component than past practices of assuming the male component to be equal in proportion to the female component. Intuitively, this was likely a false assumption. Males have been known to mature earlier than females and are less likely to survive multiple spawning events than females (Armstrong 1974).

Of interest in our comparison of individual male Dolly Varden gonad weights to body weights (Appendix A7), was a steady increase in the mean ratio during each biweekly period.

The mean ratio approximately doubled from the first to the third biweekly period. This indicates that male gonads are developing throughout the immigration. Because fish need to be sacrificed in order to weigh their gonads, resampling of the same fish at a later date to further assess maturation development is not possible. Establishing a standard, based on these ratios, may require the ratios to be temporally weighted.

Stock Structure and Abundance

The maximum potential for Dolly Varden production (MSY), and therefore fishing opportunity, from Anchor River stocks remains unknown. Dolly Varden recruitment to the spawning population has been shown to be dependent on multiple cohorts in any one year (Table 4), and depending on the success or failure of each cohort, a certain degree of fluctuation in the spawning population should be expected. With a particular spawning population comprising multiple age classes, the causes for the rise or fall of the spawning population is complex and comprise both natural and human influences.

An examination of dynamic rates pertaining to Dolly Varden (Tables 10-12) indicates these fish are fairly productive and the number of deaths due to fishing appears to be much lower than from "natural" causes. However, there is evidence that the sport fishery, when allowed fishing opportunities during spawning, may have a substantial influence on the annual rates of survival for fish of spawning age. Of interest is the high rates of annual survival evident from 1990-1991 (Table 10) which followed an emergency closure to all Dolly Varden fishing after 8 August 1990 (Larson 1991). Age classes 6-7 and 7-8 had their highest rates of survival (0.652 and 0.550, respectively) the year after this emergency closure was enacted. Preventing anglers from fishing on spawners may be an effective management tool to provide both larger fish to the fishery during immigration and to provide more older fish for spawning.

The spawner component, although important for potential fish production, is only one component providing for annual angler fishing opportunity. The nonspawner component of this fishery, believed to represent mixed stocks (Armstrong 1984, Larson 1993), can contribute significantly to fishing opportunity. The nonspawner component of the 1991 and 1994 Anchor River Dolly Varden return (Figure 8) was substantial; it was similar to or exceeded the estimated spawner components. An exceptionally large nonspawner component may give the illusion to anglers that a given stream's Dolly Varden stock is healthier than it really is. It is possible that a large nonspawner component may have been responsible for the exceptionally large harvests observed from 1978-1983 (Table 1). Therefore, we can not assume the large harvests from 1978-1983 necessarily represented large spawner returns as well.

There is no apparent evidence which links relatively high Dolly Varden escapements with high recruitment. From 1987-1989, the estimated number of spawners decreased each year (Figure 8), yet recruitment to the first predominant spawner age class, age 5, for each of those years is highly variable, i.e., 3,097, 5,189, and 3,077, respectively (Table 10). Because Dolly Varden in the Anchor River require several years to mature to the smolt stage, natural freshwater variables influencing spawning success, rearing and overwintering must also be taken into account. Dolly Varden abundance in the Anchor River is more likely a reflection of fresh- and saltwater environmental conditions in combination with recent spawner escapements. Important questions that remain to be answered are the spawning, rearing and

overwintering limitations of the Anchor River Dolly Varden stock.

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APPENDIX A. SUPPORTING STATISTICS

Appendix A1.-Daily river water depth and temperature readings recorded at the Anchor River weir upstream trap, 1995.

Date	Water Depth (cm)	Water Temp (2200 hours)	Thermograph Readings Highs (Celsius)	Lows (Celsius)	Difference (Celsius)
04-Jul	30.0				
05-Jul	27.5	16.0			
06-Jul	25.0	16.5	17.8	12.3	5.5
07-Jul	38.8	14.5	15.7	12.6	3.1
08-Jul	36.3	15.0	16.5	10.8	5.7
09-Jul	30.0	15.5	16.9	11.4	5.5
10-Jul	30.0	14.0	15.0	12.9	2.1
11-Jul	31.9	12.5	13.2	11.7	1.5
12-Jul	35.0	12.3	12.6	11.2	1.4
13-Jul	37.5	11.8	12.3	11.2	1.1
14-Jul	42.5	12.5	13.2	10.6	2.6
15-Jul	36.3	12.0	12.5	10.8	1.7
16-Jul	35.0	11.5	12.0	10.6	1.4
17-Jul	33.8	13.0	14.0	10.0	4.0
18-Jul	31.3	12.5	13.7	9.8	3.9
19-Jul	28.8	15.5	16.9	11.4	5.5
20-Jul	27.5	15.5	16.7	13.1	3.6
21-Jul	27.5	13.0	15.3	12.3	3.0
22-Jul	27.5	15.0	16.4	10.4	6.0
23-Jul	28.1	12.0	14.3	11.7	2.6
24-Jul	50.0	11.0	12.3	10.6	1.7
25-Jul	51.3	12.5	12.8	10.1	2.7
26-Jul	41.3	12.5	14.0	10.4	3.6
27-Jul	33.8	14.5	15.4	9.7	5.7
28-Jul	28.8	13.0	13.9	11.5	2.4
29-Jul	42.5	11.0	12.3	10.8	1.5
30-Jul	46.3	12.5	13.9	10.3	3.6
31-Jul	38.8	11.5	12.5	9.8	2.7
01-Aug	35.0	11.0	11.5	10.0	1.5
02-Aug	41.3	11.0	11.7	10.0	1.7
03-Aug	50.0	12.5	13.4	10.3	3.1
04-Aug	37.5	14.0	14.8	10.1	4.7
05-Aug	33.8	13.0	15.4	10.9	4.5

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Date	Water Depth (cm)	Water Temp (2200 hours)	Thermograph Readings		
			Highs (Celsius)	Lows (Celsius)	Difference (Celsius)
06-Aug	28.8	14.0	15.7	10.8	4.9
07-Aug	29.4	11.0	13.2	10.6	2.6
08-Aug	27.5	14.0	15.3	9.7	5.6
09-Aug	31.3	10.0	13.2	10.1	3.1
10-Aug	65.0	11.0	12.0	9.5	2.5
11-Aug	42.5	10.0	10.8	8.6	2.2
12-Aug	55.6	9.5	9.8	8.9	0.9
13-Aug	101.3		10.1	9.0	1.1
14-Aug	70.0	11.5	12.1	9.0	3.1
15-Aug	48.8	12.0	12.6	9.2	3.4

Note: Water temperature (Celsius) was recorded both continually by thermograph and instantaneously by thermometer at 2200 hours, while river depth was instantaneously recorded at 2200 hours daily. River water depth was relative to a selected location on the upstream trap.

Appendix A2.-The daily and cumulative number of fish, by species, passed downstream through the Anchor River weir during 1995.

Date	Dolly Varden		Chinook S.		Pink Salmon		Coho Salmon		Steelhead		Sockeye S.		Chum Salmon	
	Daily Count	Cum.[a] Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count
04-Jul		0		0		0		0		0		0		0
05-Jul	5	5	6	6	5	5		0		0	1	1		0
06-Jul	9	14	7	13	8	13		0		0		1		0
07-Jul	50	64	4	17	27	40		0		0	1	2		0
08-Jul	49	113	2	19	12	52		0		0		2		0
09-Jul	95	208	3	22	29	81		0		0	2	4		0
10-Jul	185	393	4	26	41	122		0		0		4		0
11-Jul	254	647	1	27	43	165		0		0	1	5		0
12-Jul	292	939	1	28	17	182		0		0		5		0
13-Jul	474	1,413	3	31	18	200		0		0	3	8	1	1
14-Jul	684	2,097	15	46	29	229		0		0	2	10	1	2
15-Jul	454	2,551	3	49	24	253		0		0	2	12		2
16-Jul	293	2,844	3	52	13	266		0	1	1		12	1	3
17-Jul	359	3,203	5	57	17	283		0		1	3	15		3
18-Jul	628	3,831	2	59	22	305		0		1	2	17	1	4
19-Jul	877	4,708	5	64	19	324		0		1		17		4
20-Jul	862	5,570	2	66	36	360		0		1	1	18		4
21-Jul	573	6,143	8	74	28	388		0		1	1	19		4
22-Jul	378	6,521	1	75	11	399		0		1		19		4
23-Jul	638	7,159	1	76	16	415		0		1	1	20		4
24-Jul	1,016	8,175	8	84	107	522	6	6		1	2	22		4
25-Jul	415	8,590	17	101	99	621	8	14		1	3	25		4

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Date	Dolly Varden		Chinook S.		Pink Salmon		Coho Salmon		Steelhead		Sockeye S.		Chum Salmon	
	Daily Count	Cum.[a] Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count	Daily Count	Cum. Count
26-Jul	240	8,830		101	47	668	5	19		1	3	28		4
27-Jul	537	9,367		101	20	688	2	21		1		28		4
28-Jul	338	9,705		101	37	725		21		1	1	29		4
29-Jul	221	9,926		101	53	778	18	39		1	4	33		4
30-Jul	250	10,176	3	104	56	834	16	55		1	3	36		4
31-Jul	117	10,293	1	105	27	861	3	58		1	1	37		4
01-Aug	130	10,423	1	106	16	877	4	62		1	1	38		4
02-Aug	80	10,503	1	107	20	897	36	98		1	3	41		4
03-Aug	35	10,538	1	108	24	921	57	155		1	14	55		4
04-Aug	43	10,581		108	8	929	17	172		1	5	60		4
05-Aug	44	10,625	1	109	8	937	21	193		1	2	62		4
06-Aug	101	10,726		109	13	950	23	216		1		62		4
07-Aug	38	10,764		109	16	966	9	225		1	3	65		4
08-Aug	76	10,840		109	10	976	96	321		1	1	66		4
09-Aug	79	10,919	1	110	36	1,012	133	454	2	3	4	70		4
10-Aug	51	10,970	1	111	74	1,086	167	621	7	10	3	73		4
11-Aug	10	10,980	1	112	6	1,092	15	636		10		73		4
12-Aug	14	10,994		112	2	1,094	89	725		10		73		4
13-Aug				112		1,094		725		10		73		4
14-Aug				112		1,094		725		10		73		4
15-Aug				112		1,094		725		10		73		4

[a] Cumulative count.

Appendix A3.-Dolly Varden samples collected at random from the Anchor River sport fishery showing daily summaries of male and female gonad maturity, sex ratios, and length samples, 1995.

	Nonspawners Code 1[a]			Spawners Code 2[a]			Potential Spawners Code 5[a]		Lengths
Date	F	M	Total	F	M	Total	F	Total	Sampled
7/11/95	1	0	1	1	0	1	0	0	2
7/12/95	0	0	0	1	0	1	0	0	1
7/14/95	0	0	0	2	1	3	1	1	4
7/15/95	1	2	3	1	2	3	6	6	12
7/16/95	1	3	4	3	3	6	6	6	16
7/17/95	1	2	3	6	6	12	4	4	19
7/18/95	1	2	3	0	0	0	0	0	3
7/19/95	1	0	1	1	2	3	0	0	5
7/20/95	0	0	0	1	0	1	0	0	4
7/21/95	0	0	0	0	1	1	1	1	2
7/23/95	4	1	5	2	3	5	1	1	18
7/24/95	2	1	3	0	2	2	1	1	6
7/25/95	4	3	7	0	3	3	2	2	12
7/26/95	1	2	3	0	1	1	0	0	4
7/27/95	2	0	2	1	0	1	1	1	7
7/28/95	3	1	4	1	1	2	0	0	6
7/29/95	1	0	1	0	1	1	0	0	5
7/30/95	2	1	3	1	1	2	1	1	8
7/31/95	8	9	17	2	1	3	0	0	20
8/01/95	2	3	5	0	0	0	1	1	6
8/03/95	3	1	4	0	1	1	1	1	6
8/04/95	3	0	3	0	0	0	0	0	10
8/05/95	1	1	2	0	0	0	0	0	2
8/06/95	0	0	0	0	1	1	1	1	2
8/07/95	1	1	2	0	1	1	0	0	3
Grand Total	43	33	76	23	31	54	27	27	183

[a] Female maturity index: code 1 = immature female with egg diameter less than 0.90 mm; code 2 = mature female with egg diameter greater than 1.75 mm; code 3 = completely mature female (eggs easily stripped); code 4 = completely spawned female; and code 5 = immature female but shows development, egg diameter greater than 0.90 mm and less than 1.75 mm.

Male maturity index: code 1 = no gonad development; code 2 = gonads showing signs of development (milky-white coloration).

Appendix A4.-Dolly Varden samples collected at random from the upstream trap of the Anchor River fish weir showing daily summaries of male and female gonad maturity, sex ratios, and length samples, 1995.

	Nonspawners Code 1[a]			Spawners Code 2[a]			Potential Spawners Code 5[a]		Lengths
Date	F	M	Total	F	M	Total	F	Total	Sampled
7/06/95	0	0	0	0	0	0	0	0	1
7/07/95	0	0	0	0	0	0	0	0	50
7/08/95	0	0	0	0	0	0	0	0	48
7/09/95	0	0	0	0	0	0	0	0	71
7/12/95	0	0	0	14	4	18	9	9	27
7/13/95	5	5	10	59	27	86	15	15	113
7/19/95	0	0	0	0	0	0	0	0	21
7/20/95	0	0	0	0	0	0	0	0	124
7/26/95	17	6	23	10	10	20	2	2	45
7/27/95	37	23	60	11	18	29	5	5	94
8/01/95	0	0	0	0	0	0	0	0	26
8/02/95	0	0	0	0	0	0	0	0	80
8/03/95	0	0	0	0	0	0	0	0	25
8/07/95	9	9	18	3	1	4	0	0	22
8/08/95	34	23	57	5	6	11	6	6	74
8/09/95	13	7	20	9	7	16	9	9	45
Grand Total	115	73	188	111	73	184	46	46	866

a Female maturity index: code 1 = immature female with egg diameter less than 0.90 mm; code 2 = mature female with egg diameter greater than 1.75 mm; code 3 = completely mature female (eggs easily stripped); code 4 = completely spawned female; and code 5 = immature female but shows development, egg diameter greater than 0.90 mm and less than 1.75 mm.

Male maturity index: code 1 = no gonad development; code 2 = gonads showing signs of development (milky-white coloration).

Appendix A5.-Daily summary of Dolly Varden age composition from fish sampled at random from the upstream trap of the Anchor River weir, 1995.

Date	Age Group							Daily Total
	3	4	5	6	7	8	9	
12-July	1	1	13	5	4	2	0	26
13-July	1	13	48	32	15	3	1	113
26-July	1	29	10	4	0	0	0	44
27-July	21	53	14	5	1	0	0	94
7-Aug	4	12	5	1	0	0	0	22
8-Aug	22	40	10	2	0	0	0	74
9-Aug	4	22	17	2	0	0	0	45
Total	54	170	117	51	20	5	1	418

Appendix A6.-Daily summary of Dolly Varden age compositions from fish sampled at random from the Anchor River sport fishery, 1995.

	Age Group					
Date	3	4	5	6	7	Daily Total
12-July	0	0	0	0	1	1
14-July	0	0	3	0	1	4
15-July	0	3	3	5	1	12
16-July	0	3	8	5	0	16
17-July	0	9	5	2	1	17
18-July	0	2	2	0	0	4
19-July	0	1	2	1	0	4
20-July	0	2	2	0	0	4
21-July	0	1	1	0	0	2
23-July	1	10	7	1	0	19
24-July	0	1	5	0	0	6
25-July	0	9	1	1	0	11
26-July	0	3	1	0	0	4
27-July	1	3	3	0	0	7
28-July	0	6	0	0	0	6
29-July	0	3	2	0	0	5
30-July	1	5	2	0	0	8
31-July	5	9	5	1	0	20
1-Aug	2	2	1	0	0	5
3-Aug	1	1	4	0	0	6
4-Aug	4	5	0	0	0	9
5-Aug	0	1	1	0	0	2
6-Aug	0	1	0	0	0	1
7-Aug	0	1	2	0	0	3
Total	15	81	60	16	4	176

Appendix A7.-Comparison of individual male Dolly Varden gonad samples collected at random from fish passing through the upstream trap of the Anchor River fish weir which showed signs of gonad development, 1995.

Sample Date	Body Length (millimeters)	Body Weight (grams)	Gonad Weight (grams)	Gonad / Body weight ratio	Age (yrs)
12-Jul	277	280	6.6	0.024	3
12-Jul	315	365	6.3	0.017	4
12-Jul	319	410	6.9	0.017	5
12-Jul	455	1,165	10.1	0.009	6
13-Jul	305	330	14.0	0.042	4
13-Jul	310	375	6.0	0.016	5
13-Jul	318	360	2.0	0.006	4
13-Jul	330	450	6.0	0.013	6
13-Jul	348	435	7.0	0.016	5
13-Jul	355	515	12.0	0.023	5
13-Jul	387	670	15.7	0.023	6
13-Jul	388	700	15.6	0.022	6
13-Jul	391	700	11.1	0.016	7
13-Jul	392	740	12.0	0.016	5
13-Jul	395	745	13.6	0.018	5
13-Jul	400	780	6.0	0.008	5
13-Jul	400	820	6.9	0.008	6
13-Jul	400	770	16.6	0.022	5
13-Jul	405	795	5.9	0.007	6
13-Jul	411	855	16.0	0.019	5
13-Jul	413	835	14.0	0.017	5
13-Jul	415	805	14.8	0.018	5
13-Jul	418	850	4.0	0.005	5
13-Jul	420	925	14.0	0.015	5
13-Jul	431	975	13.9	0.014	6
13-Jul	435	965	12.0	0.012	7
13-Jul	447	1,185	14.8	0.012	6
13-Jul	460	1,265	36.0	0.028	5
13-Jul	493	1,405	12.0	0.009	5
13-Jul	501	1,595	14.2	0.009	7
13-Jul	506	1,610	20.5	0.013	7
13-Jul	561	2,100	75.0	0.036	5
26-Jul	276	235	2.6	0.011	4
26-Jul	283	265	4.2	0.016	4
26-Jul	290	320	3.6	0.011	4
26-Jul	298	340	7.7	0.023	4
26-Jul	312	375	5.1	0.014	4
26-Jul	330	460	15.5	0.034	4
26-Jul	336	490	15.9	0.032	4
26-Jul	363	660	6.5	0.010	6
26-Jul	371	680	18.1	0.027	
26-Jul	495	1,480	59.6	0.040	6
27-Jul	243	130	2.2	0.017	3
27-Jul	250	190	6.5	0.034	3

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Sample Date	Body Length (millimeters)	Body Weight (grams)	Gonad Weight (grams)	Gonad / Body weight ratio	Age (yrs)
27-Jul	270	220	7.8	0.035	4
27-Jul	284	280	4.7	0.017	4
27-Jul	301	310	9.7	0.031	4
27-Jul	306	325	3.8	0.012	4
27-Jul	307	375	12.0	0.032	4
27-Jul	310	400	14.7	0.037	4
27-Jul	315	365	11.5	0.032	4
27-Jul	327	410	8.3	0.020	5
27-Jul	329	445	8.9	0.020	4
27-Jul	334	435	11.7	0.027	5
27-Jul	338	415	4.7	0.011	6
27-Jul	340	515	14.0	0.027	5
27-Jul	350	310	5.9	0.019	4
27-Jul	361	600	18.7	0.031	4
27-Jul	398	1,400	38.0	0.027	4
27-Jul	457	1,175	20.4	0.017	6
7-Aug	265	200	8.5	0.043	4
8-Aug	240	165	9.2	0.056	3
8-Aug	288	245	1.0	0.004	4
8-Aug	289	285	10.2	0.036	4
8-Aug	304	315	11.8	0.037	4
8-Aug	306	345	13.7	0.040	4
8-Aug	322	395	13.8	0.035	5
8-Aug	327	380	24.4	0.064	5
9-Aug	268	245	8.3	0.034	3
9-Aug	294	315	4.5	0.014	4
9-Aug	308	385	16.8	0.044	5
9-Aug	308	325	19.0	0.058	5
9-Aug	310	410	11.4	0.028	4
9-Aug	324	395	5.0	0.013	4
9-Aug	360	545	17.7	0.032	6