

# STOCK ASSESSMENT OF THE DOLLY VARDEN CHAR OF KOTZEBUE SOUND

By: David R. Bernard and  
A. L. DeCicco



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STATE OF ALASKA  
Steve Cowper, Governor  
ALASKA DEPARTMENT OF FISH AND GAME  
Don W. Collinsworth, Commissioner  
DIVISION OF SPORT FISH  
Norval Netsch, Director



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P.O. Box 3-2000, Juneau, Alaska 99802

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## ABSTRACT

Stock assessment of Dolly Varden char, *Salvelinus malma* (Walbaum), of the Kotzebue Sound area continued in 1986. Average lengths of char caught in the Wulik River subsistence fishery and in the commercial fishery for chum salmon in Kotzebue Sound were 408 and 622 millimeters fork length, respectively. Immature char were most abundant in the catch of the subsistence fishery, and mature females outnumbered mature males. In the commercial fishery, females dominated the catches; no immatures were observed. Also, females dominated samples from the summer spawning population on the Kugururok River; average length was 614 millimeters fork length for spawners. An estimated 7,176 char were caught in the Wulik River subsistence fishery and an estimated 2,526 in the commercial fishery for chum salmon. Analysis of information from interviews of commercial fishermen indicated that mesh regulations on gill nets might have been effective in protecting char in 1986, but not in most years. Analysis of the same information indicated no possibility of closing subdistricts to protect char without sacrificing catches of chum salmon. During aerial surveys of spawning populations, 527 and 1,232 spawning char were counted in the Kivalina and Wulik Rivers, respectively. During aerial surveys of overwintering populations, 5,030 and 5,590 char were counted in the Kivalina and Wulik Rivers, respectively. Inclement weather hampered surveys of spawning and overwintering char, especially of spawning char in the Noatak River.

KEY WORDS: *Salvelinus malma*, Dolly Varden Char, chum salmon, *Oncorhynchus keta*, subsistence fishery, sport fishery, incidental catch, commercial fishery, migratory timing, aerial surveys, gill net selectivity, sex composition, length.

## INTRODUCTION

Anadromous Dolly Varden char, *Salvelinus malma* (Walbaum) (Behnke 1980), in Kotzebue Sound support several subsistence fisheries, a sport fishery, and are incidentally caught in a commercial fishery for chum salmon, *Oncorhynchus keta* (Walbaum). Char migrate through Kotzebue Sound and into the Noatak, Kivalina, and Wulik Rivers (Figure 1) where some spawn and all overwinter (DeCicco 1985). Fall spawners move to the ocean in the spring from overwintering areas, then return to freshwater in August, spawn in September, and remain to overwinter. Summer spawners remain in freshwater through the spring to spawn in August then remain in freshwater to overwinter. Char are indiscriminant in selecting a river in which to overwinter but do home to their natal stream to spawn (Armstrong 1974); therefore, spawning populations are a single stock while overwintering populations are not. Fisheries for char around Kotzebue Sound occur as the fish migrate through the Sound or as these fish reside in freshwater.

This report is another installment in the the efforts of the Alaska Department of Fish and Game to assess char stocks in the Kotzebue Sound Area. The long-term goal of this research is to estimate the catches and population sizes of stocks of anadromous Dolly Varden char in the Kotzebue Sound Area and to estimate sustained yield. The objectives for this project in 1986 were:

- 1) To count the overwintering and fall spawning Dolly Varden char in the Wulik, Kivalina, and Noatak Rivers;
- 2) To estimate the proportion of tagged char in the summer spawning population of the Kugururok River;
- 3) To estimate the length composition and sex composition of the summer spawners in the Kugururok River;
- 4) To estimate the number of char harvested incidentally in the commercial fishery for chum salmon in Kotzebue Sound;
- 5) To estimate the size composition and sex composition of char harvested incidentally in the commercial fishery for chum salmon in Kotzebue Sound;
- 6) To estimate the number of char harvested in the fall subsistence fishery in the Wulik River; and,
- 7) To estimate the size composition and sex composition of the fall subsistence fishery in the Wulik River.

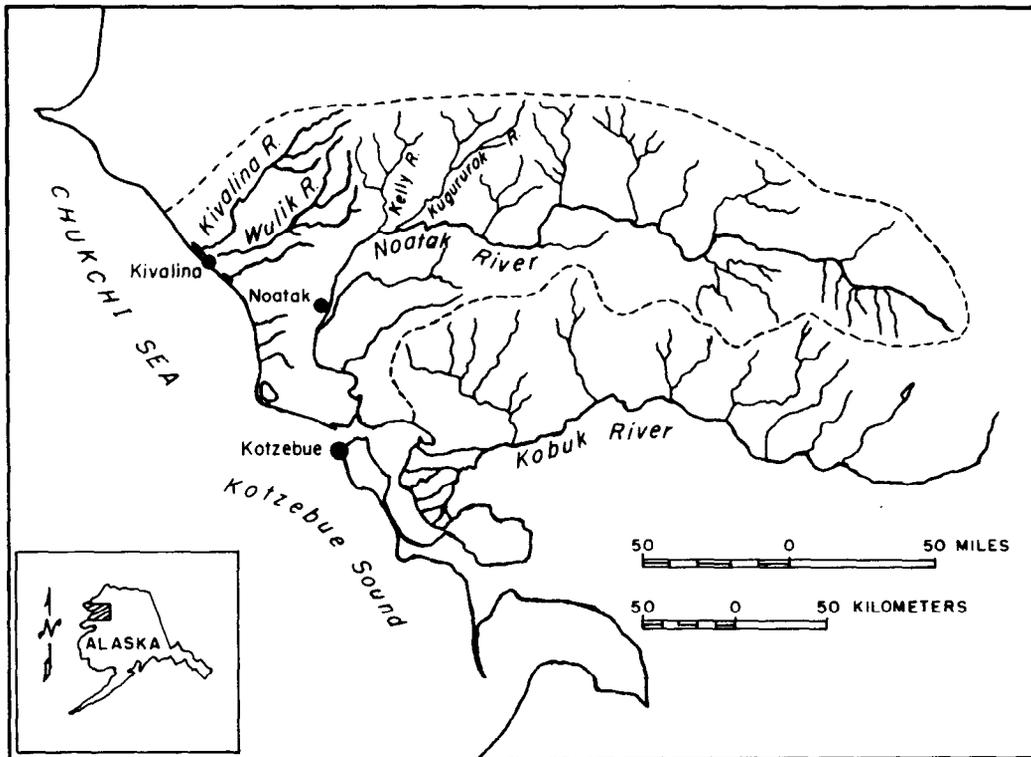


Figure 1. Watersheds of the Kivalina, Wulik, and Noatak Rivers with cities, towns, and villages.

## BACKGROUND

### Subsistence Fisheries

Although residents of Kivalina harvest char throughout the year on the Wulik River (except for midsummer), approximately 80% of the annual harvest is taken with seines during September and October (Burch 1985).

Representatives from several households comprise each seine crew. Catches are divided by shares, and most harvested char are stored frozen in caches on the riverbank. Catches are landed, placed in tubs, sacks, or baskets, carried to the cache, dumped in a pile, and then stacked in the cache. Char not stored in caches are transported to the village and stored in burlap bags. Char caught in this fishery on the Wulik River originate from this river, the Kivalina River, and all major spawning tributaries of the Noatak River (DeCicco 1985). Mostly small, immature fish are caught.

Residents of the village of Noatak catch char in the Noatak River with seines in the fall and with hook and line through the ice in the winter. Most of the catch occurs during the winter fishery from October through April.

### Commercial Fishery

Char are incidentally caught in the chum salmon fishery in District 331, the Kotzebue District (Figure 2). Gill nets up to 275 m (150 fathoms) of 130- to 195-mm (5 to 7-5/8 inch) stretch mesh are fished. Open skiffs powered by outboard motors are used to operate fishing gear and to transport the catch of chum salmon and char directly to buyers in Kotzebue. All chum salmon and some char are sold, with all sales recorded on fish tickets; however, most char are not sold but are retained for subsistence. In 1979, the Alaska Board of Fisheries adopted regulations opening this fishery for 15 periods beginning on 10 July with openings announced by emergency order in July and ending in August with two 36-hour periods per week for the entire month. Most of the catch of chum salmon has been taken in midseason during the fourth through the tenth fishing periods, while most of the char catch has been made during the last two to three weeks of the season.

### Sport Fishery

Annual sport catches have averaged an estimated 1,560 char since 1977 with the highest harvest of 4,842 reported for 1984 (Mills 1986). Hook and line is the legal gear. Char are caught in freshwater during periods of open water.

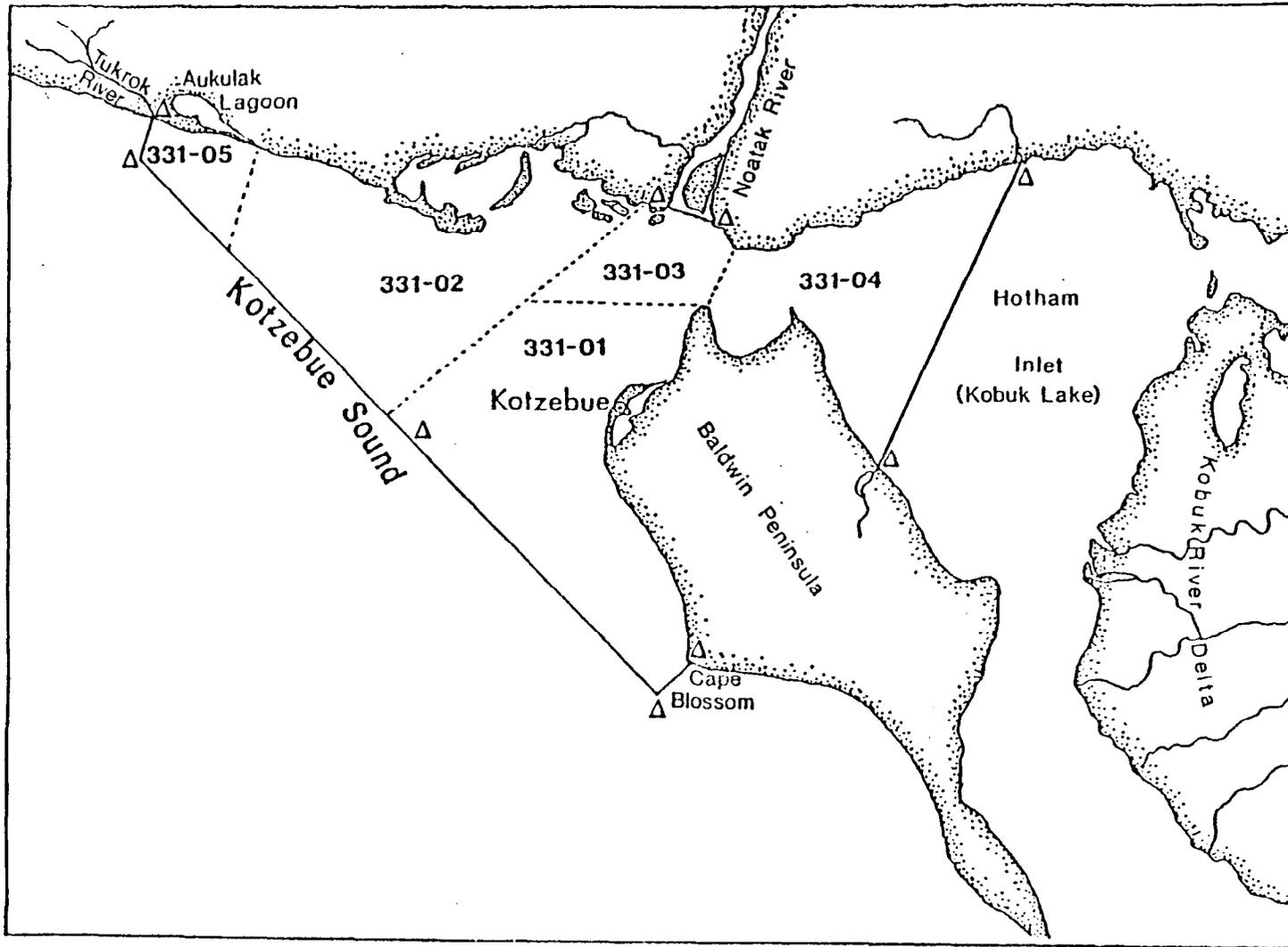


Figure 2. Commercial Fishing District 331 and its subdistricts in Kotzebue Sound.

## METHODS

### Subsistence Fishery

Most of the harvest in the fall seine fishery on the Wulik River was actually counted; the rest of the harvest was estimated from counts of tubs, sacks, or baskets of fish. In the past, catches have been estimated by counting containers of char as they were transported from the shore to the cache, estimating the average number of fish per container, and multiplying the two estimates. However, the number of fish per container and type of tub has varied from year to year and probably from crew to crew (Winslow 1969, Braund and Burnham 1982, DeCicco 1985). Therefore, average numbers of char contained in tubs, sacks, and baskets were estimated anew for 1986.

Char were sampled as they lay in piles near each cache. When possible, all fish in a pile were sampled. All sampled fish were measured to the nearest millimeter fork length (FL). Sex was determined from external morphological characteristics; head shape and length were the primary criteria. When time precluded sampling the entire pile, three fish were sampled then three ignored until the entire pile was worked through.

### Commercial Fishery

Data for estimating the number of incidentally harvested char in the commercial fishery were collected by interviewing fishermen and counting their catch as fish were delivered at the five buying stations in Kotzebue. One interviewer/sampler simultaneously worked the three stations near the airport south of town. Another interviewer/sampler worked the two stations at the north end of town, alternating stations between periods. Interviewing was performed in cooperation with personnel from the Fisheries Resource, Enhancement, and Development Division of the Alaska Department of Fish and Game who were examining commercial catches for fin-clipped chum salmon from hatchery-reared stocks.

The catch of char in a delivery was sampled after fishermen had been interviewed and their catch counted (as long as the fish were still available). The time, delivery number, number of salmon, number of char, net mesh size used, and location fished were recorded for each interview. Fish were measured to the nearest millimeter FL, weighed to the nearest 25 g with a 6-kg Chatillon spring scale, and examined externally to determine sex.

The catch (sold and kept) of Dolly Varden char was estimated by expanding the observed catch of char by two methods, each based on information from fish tickets (Alaska Dept. of Fish and Game 1986). First, the average, observed catch of char was expanded by fishing effort:

$$1) \quad \hat{C} = \bar{c} D$$

where;

$\hat{C}$  = estimated catch of Dolly Varden char;

$\bar{c}$  = average number of char per delivery estimated through interviews of fishermen; and

D = number of deliveries from fish tickets.

The variance for  $\hat{C}$  was calculated with a finite population correction factor:

$$2) \quad V[\hat{C}] = (1-d/D)D^2V[\bar{c}]$$

where;

d = the number of deliveries observed by the interviewers.

The second method of estimating the catch of char was based on the ratio of char to chum salmon in the observed catches. This procedure takes advantage of any significant correlations between the catch of chum salmon and the catch of char among deliveries. The average ratios were calculated according jackknife procedures in Efron (1982) because these procedures minimize the inherent bias of ratio estimators (Cochran 1977). The ratio was then expanded by the number of chum salmon in the catch:

$$3) \quad \hat{C} = r X$$

where;

r = average ratio of char to chum salmon in the catch as estimated from the observed catches through jackknife procedures; and

X = the number of chum salmon reported on fish tickets.

The variance for these expansions also has a finite population correction factor:

$$4) \quad V[\hat{C}] = (1-d/D)X^2V[r]$$

Although the catches of char were calculated with both procedures, only the more precise estimates were reported. The estimates based upon ratios are more precise than expansions by fishing effort only when the correlation between catches of char and chum salmon by delivery are large relative to the coefficients of variation for these variables (Cochran 1977).

### Aerial Counts of Char

Char in streams were counted from a Piper PA-18 aircraft flying slowly over the streams at an elevation of 100 to 200 m. Polarized sunglasses were worn to minimize glare on the water surface. Char were counted singly when few and in groups of 10 or 100 when many. During the last week in August, spawning char were counted in the Kelly (a tributary of the Noatak River), Wulik, and Kivalina Rivers. Overwintering char on the Wulik and Kivalina Rivers were counted during early October. Because of bad weather, each river was flown but once.

### Spawning Populations

Samples of spawning char were collected on the Kugururok River using rod and reel with barbless lures from 12-20 July. Char were examined for tags and measured to the nearest millimeter FL on a padded measuring board. Fish were suspended in a basket net, weighed to the nearest 25 g on a 6-kg Chatillon spring scale, and then released. Sex was determined by external examination of the fish.

## RESULTS

### Wulik River Subsistence Fishery

The people of Kivalina harvested an estimated 7,176 char from the Wulik River during the 1986 fall seine fishery. Five fishing groups participated in the fishery, however only two crews established camps on the river for more than two days. One crew's entire catch of 3,068 char was counted. This crew used tubs to divide part of their catch; their 32 tubs contained an average 59 char per tub (SE = 4.75). The other major fishing crew caught 2,899 char and divided their catch with a plastic laundry basket. Of their harvest, 2,447 char were counted, representing 19 baskets. Unfortunately, the fish in each basket were not counted. Their remaining harvest, 3.5 baskets, was estimated to be 452 char ( $3.5 \times 2447/19$ ).

The remaining 1,209 char were distributed among three groups that fished from one to two days each. Their catches of 295, 756, and 158 char were recorded as 5 tubs, 12 sacks, and 2.5 sacks, respectively. Catches transported in sacks were estimated by dividing the weight of sacks by the average weight of char in the catch. Each sack was estimated to weigh 57 kg (Burch 1985); no sacks were weighed in 1986. The average weight of char in the catch in 1986 was 0.89 kg<sup>1</sup>. Therefore, each 57-kg sack was estimated to contain 63 char.

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<sup>1</sup> Mean weight was estimated using the length-weight regression in Appendix Figure 1 to translate individual length measurements made in 1986 into estimates of weight for each fish in the sample. Data for the regression were collected in 1981 and 1982 with hook and line gear fishing on overwintering char in the Kivalina River. Parameters for this regression

A few additional char were caught by people who gillnetted for whitefish, but this harvest was small and was not sampled. Also, 293 grayling were counted in the catch.

When this subsistence catch was sampled from 27-30 September, 2,398 char were sampled. Over half of the catch consisted of immature char with females significantly outnumbering males in the remainder (Table 1). Sampled char ranged from 220 to 796 mm FL with three peaks in abundance at 280, 380, and 450 mm (Figure 3). Males were significantly larger than females with immature char significantly smaller than either sex (Table 1).

#### Incidental Commercial Fishery

An estimated 2,526 Dolly Varden char were caught incidentally during the last four fishing periods in the commercial fishery for chum salmon in Kotzebue Sound from 14-26 August 1986 (Table 2). Each fishing period began at 1800 hours and ran for 24 hours. By the last period (25-26 August), there was only one buying station still operating. Catches were not estimated by subdistrict as planned because information on fish tickets about location of catch often was not the same as the location given during the interview for the same delivery. The number of deliveries dropped as the fishing season came to an end during the last two weeks of August. During this time, the number of chum salmon per delivery dropped slightly while the number of char per delivery increased dramatically (Figure 4).

The ratios of Dolly Varden char to chum salmon in catches were the same for Subdistricts 1 and 2 throughout the season and sometimes were the same for Subdistricts 1, 2, and 3 (Table 3). Most of the catch of chum salmon occurred in the first three subdistricts. Only during the second period (18-19 August) was there a significantly different ratio among the first three subdistricts; the ratio in Subdistrict 3 was lower. Little fishing activity in Subdistricts 4 and 5 produced small catches and few or no interviews.

The ratios of Dolly Varden char to chum salmon in commercial catches were different in nets of different sizes of mesh (Figure 5; Appendix Table 1). Only interviews of fishermen who used nets with a single mesh size were used in this analysis. Mesh sizes ranged from 140 to 160 mm (5-1/2 to 6-1/4 inches) stretch measure with most of the interviewed fishermen using nets with 146 to 152 mm (5-3/4 to 6 inch) mesh. The proportions of char were significantly different for catches made in different sizes of mesh ( $\chi^2 = 96.98$ ,  $P < 0.005$ ,  $df = 4$ )<sup>2</sup>. The highest proportions occurred for

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were estimated through a least-squares, iterative algorithm which selects the "best" solution after starting from a series of initial parameter values.

<sup>2</sup> Data for the 140-mm (5-1/2 inch) mesh nets were excluded from the test and data for the 143-mm (5-5/8 inch) and 146-mm (5-3/4 inch) mesh nets were combined to make all expectations of catch more than five fish as per the requirements of this test.

Table 1. Mean length and sex composition of populations of Dolly Varden char in 1986.

	WULIK RIVER SUBSISTENCE FISHERY <sup>1</sup>					KUGURUROK RIVER <sup>2</sup>					COMMERCIAL FISHERY <sup>3</sup>				
	Mean <sup>4</sup> Length	SE <sup>5</sup>	Number Sampled	Fraction	SE	Mean Length	SE	Number Sampled	Fraction	SE	Mean Length	SE	Number Sampled	Fraction	SE
All Sexes	408	2	2,398			614	2	755			622	3	808		
Females	478	3	662	0.276	0.009	595	3	580	0.768	0.015	606	4	499	0.618	0.017
Males	526	5	401	0.167	0.008	675	6	175	0.232	0.015	648	4	309	0.382	0.017
Immatures	338	1	1,335	0.557	0.010										

<sup>1</sup> Char were caught with seines in the Wulik River and these catches were sampled 27-30 September.

<sup>2</sup> Char were caught with hook and line from 12-20 July in the Kugururok River.

<sup>3</sup> Char were incidentally caught in gillnets in the commercial fishery from 14-26 August.

<sup>4</sup> mm FL

<sup>5</sup> Standard Error.

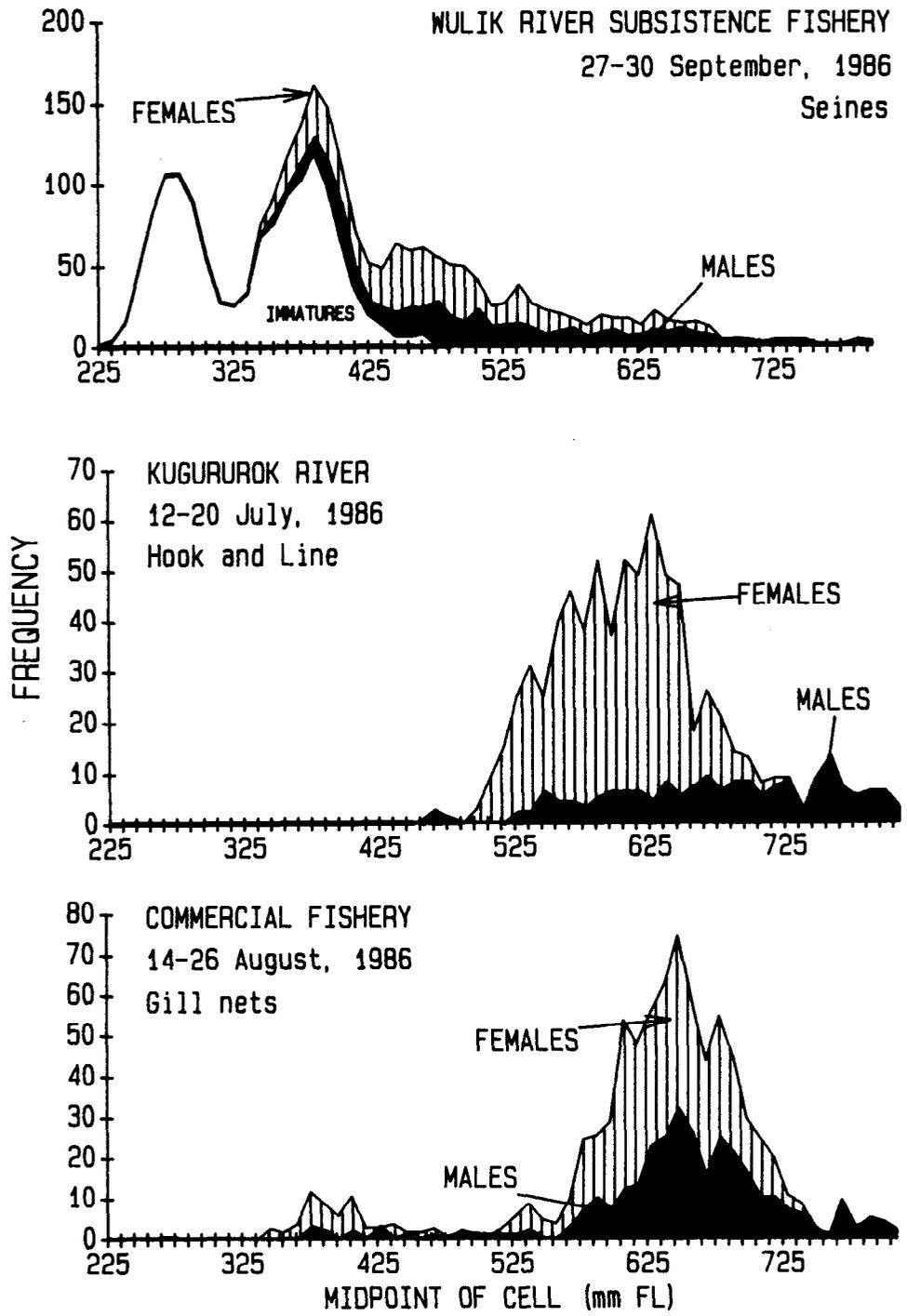


Figure 3. Length frequencies of mature and immature Dolly Varden char sampled from the fall subsistence fishery on the Wulik River, from the commercial fishery for chum salmon in Kotzebue Sound, and from a spawning population in the Kugururok River.

Table 2. Estimated catch of Dolly Varden char in the commercial fishery for chum salmon in Kotzebue Sound during 1986.

Fishing Period	Interviews			Fish Tickets		Jackknife Ratio Estimates		Expansion Estimates		Estimated Catch of Char		
	Deliveries (d)	Chum <sup>1</sup>		Deliveries (D)	Chum Salmon (X)	Ratio (r)	SE <sup>2</sup>	Mean	SE	Catch	SE	CV[C] <sup>3</sup>
		Char <sup>1</sup>	Salmon									
14-15 August	156	73	6,681	333	14,324	0.011	0.0026			156	27	3.3%
18-19 August	139	701	5,144	183	6,975	0.136	0.0204			951	70	0.9%
21-22 August	83	792	2,990	104	3,851	0.265	0.0304			1,020	53	0.7%
25-26 August	55	328	1,341	67	1,674			5.964	0.7191	400	20	1.1%
TOTALS	433	1,894	16,156	687	26,824					2,526	94	0.4%

<sup>1</sup> Summed over all deliveries.

<sup>2</sup> Standard Error.

<sup>3</sup> Coefficient of Variation.

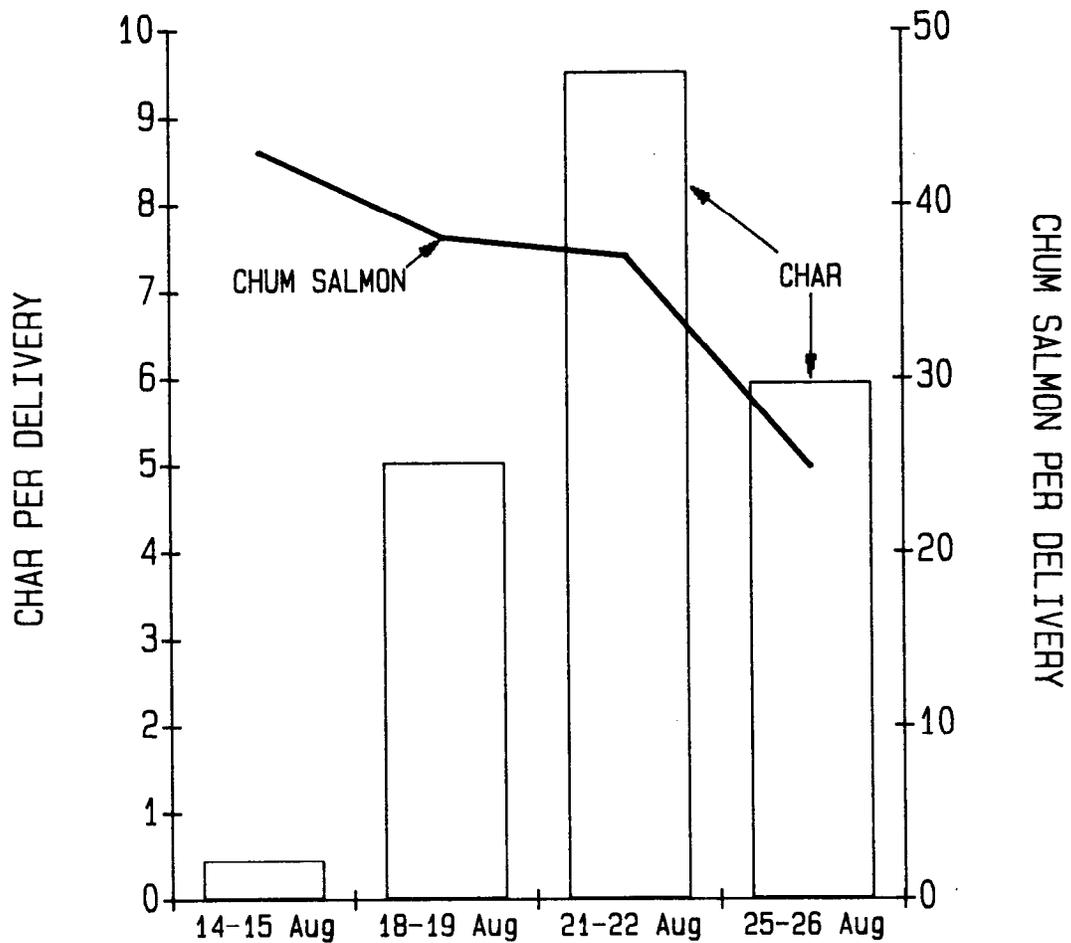


Figure 4. Average numbers of Dolly Varden char and chum salmon per delivery to buying stations in Kotzebue in 1986 during the last four fishing periods in the commercial fishery.

Table 3. Estimated ratio of Dolly Varden char to chum salmon in the commercial fishery for chum salmon in Kotzebue Sound during 1986.

Fishing Period	Sub- <sup>2</sup> district	Interviews			Jackknife Ratio Estimates <sup>1</sup>		
		Deliveries (d)	Char	Chum Salmon	Ratio (r)	SE <sup>3</sup>	CV[r] <sup>4</sup>
14-15 August:	1 <sup>5</sup>	55	13	1,948	0.007	0.0021	30.0%
	2	81	30	3,849	0.008	0.0017	21.3%
	3	15	8	478	0.017	0.0053	31.2%
	4	0					
	5	4	22	406	0.051	0.0306	60.0%
18-19 August:	1	65	319	1,725	0.185	0.0439	23.7%
	2	22	152	726	0.210	0.0568	27.0%
	3	45	168	2,264	0.074	0.0158	21.4%
	4	4	8	189	0.043	0.0163	37.9%
	5	2	49	223	0.142	0.2014	141.8%
21-22 August:	1	41	351	1,180	0.297	0.0439	14.8%
	2	9	87	370	0.237	0.0665	28.1%
	3	31	342	1,384	0.247	0.0547	22.1%
	4	2	12	56	0.214	0.1010	47.2%
	5	0					
25-26 August:	1	35	196	843	0.233	0.0372	16.0%
	2	5	39	116	0.346	0.1471	42.5%
	3	13	88	273	0.322	0.0734	22.8%
	4	2	5	109	0.073	0.0853	116.8%
	5	0					

<sup>1</sup> Jackknife estimates were calculated according to procedures in Efron (1982).

<sup>2</sup> Locations of subdistricts are given in Figure 2.

<sup>3</sup> Standard Error.

<sup>4</sup> Coefficient of Variation.

<sup>5</sup> Numbers for subdistricts are vertically aligned into groups whose members have similar char to chum salmon ratios ( $\chi^2$  test at  $\alpha = 0.01$ ).

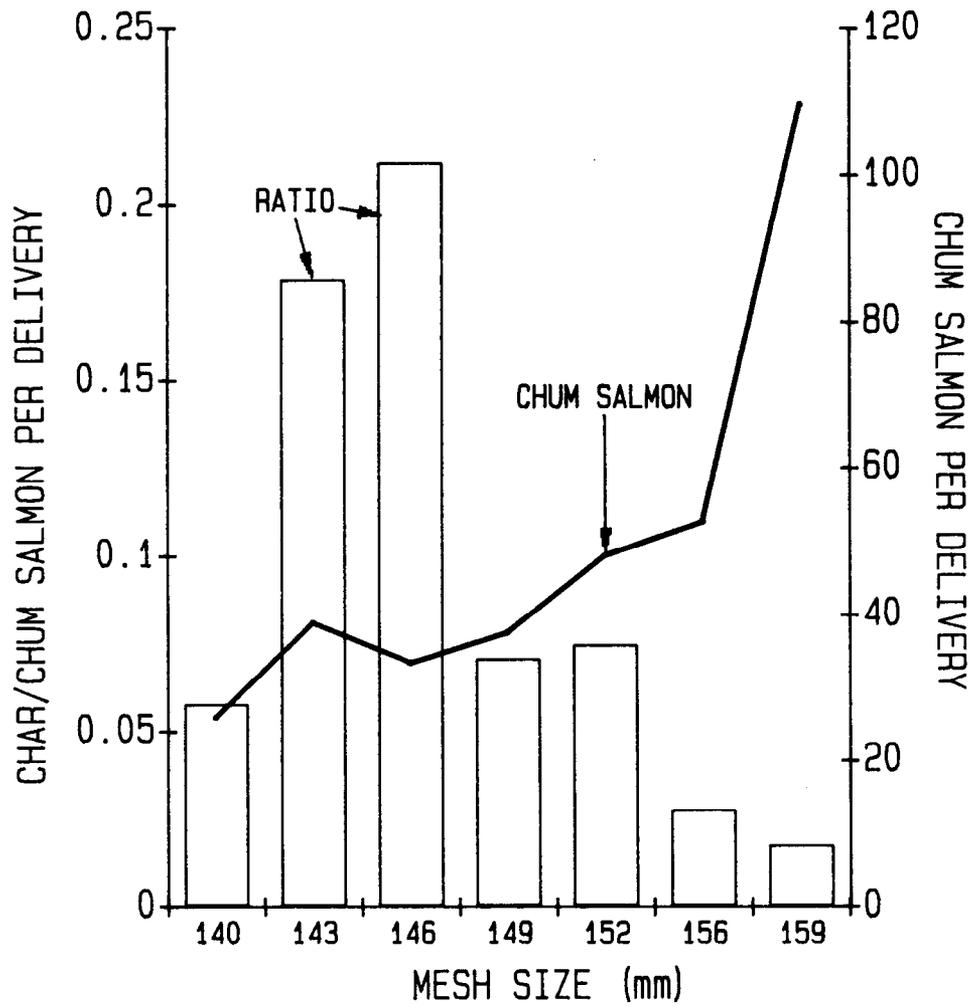


Figure 5. Average ratios of Dolly Varden char to chum salmon per delivery and number of chum salmon per delivery in catches made with gill nets of various sizes of mesh from interviews of commercial fishermen.

catches made in nets with 143- and 146-mm (5-5/8 and 5-3/4 inch) mesh and the lowest for catches in nets with meshes 156 mm (6-1/8 inches) and larger. Nets with intermediate mesh sizes had intermediate proportions of char. Of the 192 interviews in the analysis, only ten interviews concerned nets with 146-mm (5-3/4 inch) mesh and nine with 156-mm (6-1/8 inch) and larger mesh. Only three interviews concerned nets with mesh smaller than 146-mm (5-3/4 inches). Also, as mesh size increased, so did the number of chum salmon made per delivery.

During the fishery, 808 char were measured and inspected to determine their sex, and 284 were weighed (Tables 1 and 4). Female char were most of the catch in all four periods; the percentage of males and females was not significantly different among the periods ( $\chi^2 = 4.68$ ,  $0.10 < P < 0.25$ ,  $df = 3$ ). Therefore, the overall percentage of females and males (about 62% and 38%, respectively) was considered indicative of the catch. Also, this divergence from a sex ratio of 50:50 was significant ( $H_0: p = 0.5$ ,  $t = 6.94$ ,  $P < 0.001$ ,  $df = 807$ ). The average length and weights of male and female char were similar in the catches from all four periods with the average length of females during the second period being the one exception. Overall, male char in the catch were on average longer than females because of the higher ratio of females to males in the smaller sizes (Figure 3).

#### Spawning Populations

Seven hundred fifty-five summer spawning Dolly Varden char were sampled on the spawning grounds in the Kugururok River from 12-20 July 1986 (Table 1). Almost 77% of the sample were females. Measurements on char ranged from just over 400 mm to just over 800 mm FL (Figure 3). Only one tag was recovered from the 833 char that were examined. The recaptured individual had been tagged on the Kugururok River in July 1982; 501 char had been tagged and released during this period. A complete history of the recoveries on this tagged group of char is provided by DeCicco (1985).

#### Aerial Counts of Char

Inclement weather hindered the counting of summer spawning Dolly Varden char, especially in the Noatak River and its tributaries. Nine hundred thirty-six and 1,089 char were counted in Wrench Creek and the mainstem of the Kelly River, respectively, during a single flight on 24 August. Other waters in the Noatak River watershed could not be surveyed. Five hundred twenty-seven char were counted in the Kivalina River watershed, and 1,232 char were counted in the Wulik River watershed during a single flight on 25 August. Water conditions were fair during all flights, only slightly impairing ability to count fish. Counts of spawning char by tributary are provided in Appendix Table 2.

Table 4. Mean lengths, mean weights, and sex composition by fishing period of Dolly Varden char caught incidentally in the commercial fishery for chum salmon in Kotzebue Sound during 1986.

	Females		Males		All Sexes		Sex Composition	
	mm FL	kg	mm FL	kg	mm FL	kg	Female	Male
<u>14-15 August:</u>								
Sample Size	42	11	25	13	67	24		
Mean	588	2.75	660	3.44	615	3.12	62.7%	37.3%
Standard Error	15	0.31	11	0.22	11	0.20	6.0%	6.0%
<u>18-19 August:</u>								
Sample Size	128		92		220			
Mean	634		649		640		58.2%	41.8%
Standard Error	6		6		4		3.3%	3.3%
<u>21-22 August:</u>								
Sample Size	204	58	104	39	308	97		
Mean	600	2.84	641	3.62	614	3.15	66.2%	33.8%
Standard Error	6	0.15	6	0.23	5	0.13	2.7%	2.7%
<u>25-26 August:</u>								
Sample Size	125	90	88	73	213	163		
Mean	594	2.72	650	3.42	617	3.03	58.7%	41.3%
Standard Error	9	0.11	11	0.16	7	0.10	3.4%	3.4%
<u>All Periods:<sup>1</sup></u>								
Sample Size	499	159	309	125	808	284		
Mean	606	2.76	648	3.48	622	3.08	61.8%	38.2%
Standard Error	4	0.08	4	0.12	3	0.07	1.7%	1.7%

<sup>1</sup> Statistics for all fishing periods and for both sexes were calculated by combining length and weight measurements across fishing periods and across sexes, respectively.

During a single flight of the Wulik and Kivalina Rivers on 2 October, 5,590 and 5,030 overwintering char, respectively, were counted. Turbid water hampered the effectiveness of the survey.

## DISCUSSION

The inclement weather that plagued efforts to count Dolly Varden char in 1986 from an airplane is not uncommon. Since 1962, aerial surveys of chum salmon and char populations in the Noatak River have been impaired in 1963, 1965, 1966, 1968, 1969, 1972, and 1977 (Alaska Dept. of Fish and Game 1986). Aerial surveys of char populations only have fared little better with inclement weather impairing surveys in 1983 and in 1986 (Appendix Table 2). The watersheds of the Wulik, Kivalina, and Noatak Rivers are largely open with little tree cover. Moderate to strong winds can obscure fish in these waters. In 1986, heavy rains and winds in August and September kept aircraft on the ground, thereby making counts of spawning char in this report conservative.

Anecdotal evidence from residents of the area implies that many char moved into overwintering areas under the ice in November. Similar evidence exists for other years (see DeCicco 1985). Since no survey is possible once ice forms on the overwintering rivers, estimates of overwintering char in this report are most likely conservative.

DeCicco (1985) attributes the low rate of recovery of tagged char to either: (1) high mortality rates, (2) non-consecutive spawning, or (3) to a large abundance of char beyond what has been counted in surveys. Since 1982, 4,620 char have been tagged and released in spawning and overwintering areas around Kotzebue Sound; about 2.9% of these tags have been recovered, mostly from subsistence fisheries. The single tag recovery made in the Kugururok River in the summer of 1986 adds little support to arguments concerning the three possible explanations for low rates of recapture of tagged fish.

The selectivity of gill nets with different mesh sizes was analyzed to see if there is a mesh size (and potentially a mesh-size regulation) that would minimize the incidental catch of Dolly Varden char while maintaining high catches of the target species, chum salmon. Results of the analysis on data from 1986 indicate that a mesh regulation could possibly have achieved the desired results in 1986. However, age 0.4 chum salmon comprised an estimated 77.8% of the catch of that species in 1986; the average percentage of this group in the previous 24 years has been 19.1% with a range from 1.7% to 40.3% (Alaska Dept. of Fish and Game 1986). In 1986, chum salmon age 0.4 were larger than the usually dominant age 0.3 chum salmon (613 mm vs. 587 mm measured from mideye to fork of tail, respectively; Helen Hamner, personal communication, 16 September, 1987). This difference in size is typical of most years (Hamner 1987). In contrast, the average length of char in the catch is about the same in 1986 as in previous years (Appendix Table 3). Obviously, 1986 was an atypical

year for the size of chum salmon, but not for char. In a typical year, the opportunity to protect char with little impact on catches of chum salmon through regulation of mesh size would most likely disappear. Historical data concerning number of char and chum salmon reportedly caught by period in the Kotzebue Sound commercial fishery are summarized in Appendix Table 4.

Closing certain subdistricts in the Kotzebue Sound commercial fishery would not have significantly reduced the catch of Dolly Varden char in 1986. The three subdistricts that had the largest catches of chum salmon (Subdistricts 1-3) generally had the largest catches of char. Any differences in the char to chum salmon ratios among these three subdistricts were not consistent over the four fishing periods. Very few char or chum salmon were caught in Subdistricts 4 and 5.

Closing of the commercial fishery early would have had an effect on the catch of Dolly Varden char. In 1986, 95% of the chum salmon had been caught in the commercial fishery by 18 August. According to average trends in catch of chum salmon per unit of effort, this is a typical pattern for the fishery (Alaska Dept. of Fish and Game 1986). Most of the catch of char occurred after this date in 1986 as is the case in most years (Appendix Table 5). Unfortunately, if the fishery were to be regulated according to this difference in run timing between char and chum salmon, there would be a direct relationship between the number of char "saved" from the fishery and the number of chum salmon "lost" to it.

Information on stock assessment in this report does not cover all fisheries. Catches in the sport fishery are estimated through a mail-in survey of fishermen and are reported annually (i.e., Mills 1986). There are no estimates of catch from fall and winter subsistence fisheries in the Noatak River for 1986.

There are no estimates of stock separation for the catches in each fishery. Char caught during the summer in freshwater by sport fishermen are summer spawners and, as such, are separate stocks in separate rivers. Unfortunately, catches are not reported by river for the sport fishery. Char caught in subsistence and in the commercial fisheries are both fall spawners and overwintering char and, as such, represent many stocks. The winter subsistence fisheries also exploit several stocks in each fishing location because char indiscriminantly select a river for winter residence.

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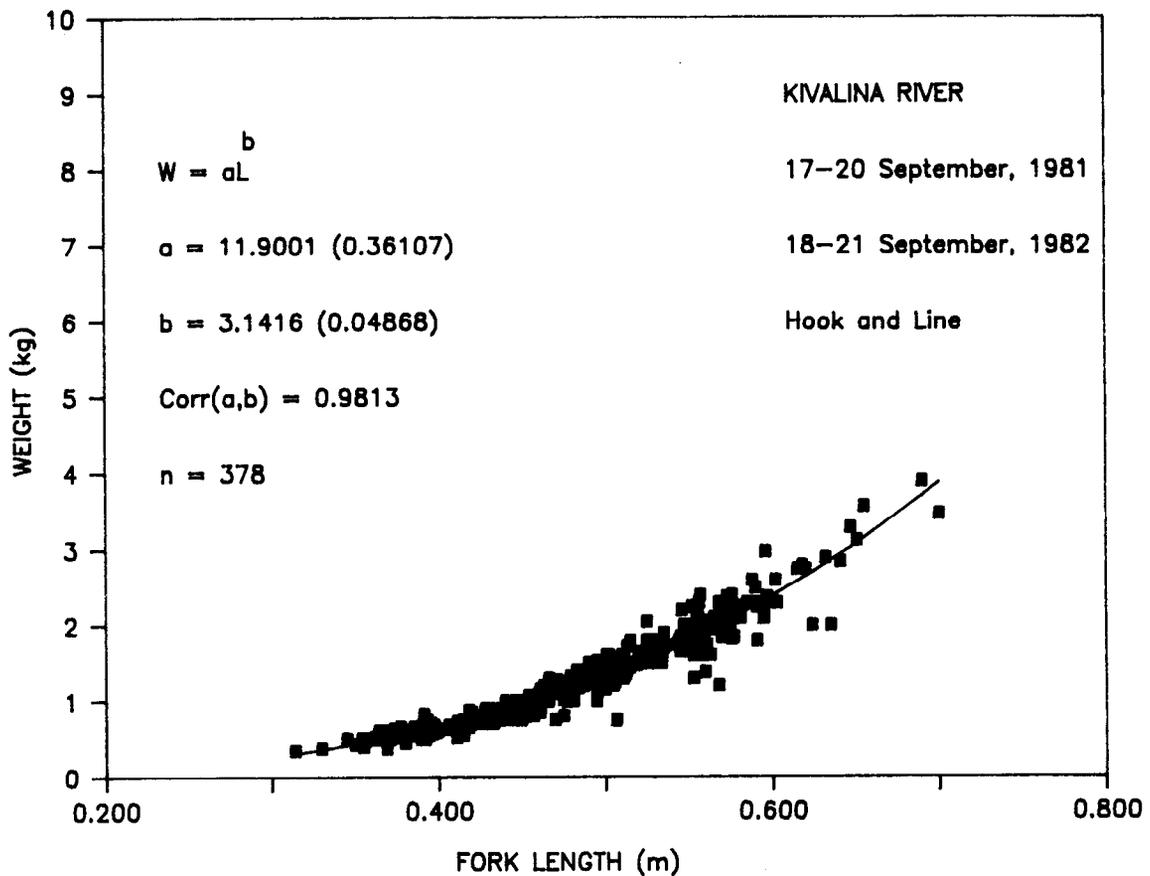
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APPENDIX



Appendix Figure 1. Estimated parameters and their standard errors (in parentheses) for the length-weight relationship of Dolly Varden char overwintering in the Kivalina River in 1981 and 1982. Sampling dates and sampling gear are listed in the figure.

Appendix Table 1. Statistics from interviews of commercial fishermen as they delivered chum salmon at Kotzebue during 1986.<sup>1</sup>

Mesh Size (mm)	Number of			Ratio of Char to Chum Salmon	% Char
	Deliveries	Chum Salmon	Char		
140 <sup>2</sup>	2	52	3	0.058	5.5%
143	1	39	7	0.179	15.2%
146	10	335	71	0.212	17.5%
149	86	3,246	229	0.071	6.6%
152	84	4,045	303	0.075	7.0%
156	6	317	9	0.028	2.8%
159	3	329	6	0.018	1.8%

<sup>1</sup> Only fishermen that fished with gill nets with single mesh sizes are included. Rows are grouped according to mesh sizes with similar proportions of char in the catch ( $\chi^2$  tests at  $\alpha = 0.01$ ).

<sup>2</sup> The proportion of char in these two deliveries was not included in the  $\chi^2$  tests because of the few chum salmon and char found in this interview.

Appendix Table 2. Counts of spawning Dolly Varden char in the mainstems and tributaries of the Noatak, Kivalina, and Wulik Rivers from 1981 through 1986.<sup>1</sup>

Waterbody	1981	1982	1983	1984	1985	1986
Noatak River:	8,088	9,599		10,340	11,937	2,025
Kelly River:	2,589	2,326	2,924	2,618	3,875	2,025
Mainstem	882	1,079	943	951	1,685	1,089
Wrench Creek	1,005	748	1,066	1,182	1,452	936
No Name Creek	356	158	661	317	124	w <sup>2</sup>
Avan Creek	346	341	254	168	614	w
Kugururok River:	3,284	3,986	1,386	4,751	5,067	w
Mainstem	1,756	2,499	884	2,818	3,518	w
Tributary below						
Trail Creek	x <sup>3</sup>	10	39	30	x	w
Trail Creek	419	485	w	617	304	w
Kagvik Creek	792	620	463	726	919	w
Nunaviksak Creek	317	257	w	430	232	w
Okatak Creek	x	115	w	130	94	w
Poktovik Creek	x	x	x	20	x	w
Tributary below						
Kelly River	193	331	w	232	236	w
Kaluktavik River	x	549	w	584	455	w
Nimiuktuk River:	2,022	2,170	w	1,921	2,131	w
Mainstem	202	857	w	587	1,460	w
Tumit Creek	853	783	w	899	513	w
Kukukpilak Creek	361	56	w	97	14	w
Seagull Creek	606	474	w	338	144	w
Eli River	x	237	301	214	x	w
Anisak River	x	x	x	x	173	x
Kivalina River:	561	452	695	652	1,786	527
Mainstem	73	w	90	119	604	75
Braided Fork	382	299	412	286	580	317
Grayling Creek	106	146	183	247	596	135
Little River	x	7	10	x	6	x
Wulik River:	272	418	1,180	1,705	1,853	1,232
Mainstem	129	184	394	420	712	453
West Fork	x	133	196	410	252	246
East Fork	x	73	223	213	356	194
Sheep Creek	54	28	123	209	159	179
Ikalukrok Creek	89	x	201	240	136	160
Tutak Creek	x	x	43	213	238	x

<sup>1</sup> Char were counted from a fixed-wing airplane. Early counts are reported first in DeCicco (1982, 1984, 1985, 1986).

<sup>2</sup> A "w" connotes a missing count due to inclement weather over all of the tributary.

<sup>3</sup> An "x" denotes a missing count for reasons other than weather.

Appendix Table 3. Average size of incidentally caught Dolly Varden char estimated from samples drawn from the commercial gill net fishery for chum salmon in Kotzebue Sound from 1969, 1980-1, and 1983-6.

Category	Length (mm FL)			Weight (kg)		
	Sample Number	Mean	Standard Deviation	Sample Number	Mean	Standard Deviation
<u>1969:</u>						
Males	24	622	53	24	3.098	0.775
Females	14	625	43	14	3.113	0.678
All Sexes	38	623	50	38	3.103	0.741
<u>1980:</u>						
Males	14	662	42	14	3.307	0.661
Females	16	626	61	16	3.082	1.037
All Sexes	30	643	56	30	3.187	0.889
<u>1981:</u>						
Males	22	629	50	22	2.902	0.674
Females	4	657	53	4	2.988	0.537
All Sexes	26	633	52	26	2.915	0.655
<u>1983:</u>						
Males	49	624	60	42	2.735	0.740
Females	27	554	63	18	1.954	0.687
All Sexes	76	599	69	60	2.500	0.808
<u>1984:</u>						
Males	72	632	61	43	2.801	0.771
Females	67	598	60	37	2.419	0.615
All Sexes	139	616	63	80	2.622	0.728
<u>1985:</u>						
Males	107	637	61	43	3.065	0.776
Females	128	605	70	42	2.688	0.732
All Sexes	235	616	69	85	2.879	0.778
<u>1986:</u>						
Males	314	648	75	125	3.482	1.354
Females	499	606	89	186	2.764	1.062
All Sexes	813	622	86	411	3.080	1.252

Appendix Table 4. Ratios of catches Dolly Varden char to chum salmon by period in the commercial fishery as reported on fish tickets from Kotzebue Sound, 1980 to 1986.<sup>1</sup>

Year	Days in August	Number of			Ratio of Char to Chum Salmon
		Boats Fishing	Chum Salmon Caught	Char Caught	
1980	7-9	147	60,330	37	0.0006
	11-13	156	64,914	22	0.0003
	14-16	153	30,784	345	0.0112
	18-20	138	20,499	1,032	0.0503
	21-23	86	13,215	1,162	0.0879
	25-27	86	12,359	342	0.0277
	28-30	50	4,566	89	0.0195
1981	No recorded sales of char				
1982	16-18	164	28,613	142	0.0050
	19-21	156	16,383	544	0.0332
	22-24	94	8,183	2,672	0.3265
	26-28	48	3,583	89	0.0248
1983	11-12	133	11,713	56	0.0048
	18-19	97	6,013	779	0.1296
1984	16-18	135	14,287	270	0.0189
	20-22	85	4,247	820	0.1931
1985	22-24	104	10,900	707	0.0649
	26-28	81	7,200	1,823	0.2532
	29-31	45	2,800	1,097	0.3918
1986	14-15	149	14,324	5	0.0003
	18-19	112	6,975	0	0.0000
	21-22	66	3,851	0	0.0000
	24-25	40	1,674	0	0.0000

<sup>1</sup> Data were obtained from Alaska Dept. of Fish and Game (1981-1986).

Appendix Table 5. Estimated catches of Dolly Varden char from the subsistence fisheries on the Wulik River.

Year	Season	Kilograms	Number	Source
1959	Fall	39,000		Sarrio and Kessel (1966)
1960	Fall	57,000		Sarrio and Kessel (1966)
1964/5	Year <sup>1</sup>	42,725		Burch (1985)
1965/6	Year	12,790		Burch (1985)
1968	Fall		49,152	Winslow (1969)
1969	Spring		8,402	Roguski and Winslow (1970)
1971	Fall		29,281	Yoshihara (1973)
1972	Fall		35,733	Yoshihara (1973)
1979	Fall		14,600	DeCicco (1982)
1981	Fall		15,000-18,000	DeCicco (1982)
1982	Fall		18,438	
	Winter	2,000		Braund and Burnham (1982)
1982/3	Year <sup>1</sup>	31,390		Burch (1985)
1983	Spring	5,500		Burch (1985)
	Fall		16,270	DeCicco (1984)
1983/4	Year <sup>1</sup>	31,121		Burch (1985)
1984	Fall		12,000	DeCicco (1985)
1985	Fall		10,500	DeCicco (1986)
1986	Fall		7,176	This Report

<sup>1</sup> The subsistence year is 1 July to 30 June.