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OF KOTZEBUE SOUND IN SUMMER
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Number 37

Alaska Department of Fish & Game
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ABSTRACT

Nearshore fishes of Kotzebue Sound were collected with beach seines, gill nets, a tow net, and a trawl during the summer months of a 4-yr period. Saffron cod (Eleginus gracilis), whitefishes (Coregonus spp.), and herring (Clupea harengus) had the largest biomasses of the species caught. Shrimp (Crangon septemspinosa), juvenile chum salmon (Oncorhynchus keta), smelts (Osmeridae), and saffron cod were caught in the greatest numbers. Whitefishes, ciscos (Coregonus spp.), starry flounders (Platichthys stellatus), and smelts were found with the greatest frequency. Length distributions for 10 of the most common species are given. Beach seines were not as efficient as gill nets in collecting herring, sculpin (Cottidae) and sheefish (Stenodus leucichthys).

KEY WORDS: Kotzebue Sound, nearshore fishes, Pacific herring, Clupea harengus, chum salmon, Oncorhynchus keta, pink salmon, Oncorhynchus gorbuscha, arctic char, Salvelinus alpinus, humpback whitefish, Coregonus pidschian, broad whitefish, Coregonus nasus, round whitefish, Prosopium cylindraceum, least cisco, Coregonus sardinella, arctic cisco, Coregonus autumnalis, Bering cisco, Coregonus laurettae, sheefish, Stenodus leucichthys, rainbow smelt, Osmerus mordax, pond smelt, Hypomesus olidus, capelin, Mallotus villosus, saffron cod, Eleginus gracilis, nine-spine stickleback, Pungitius pungitius, sculpin, Myoxocephalus spp., sturgeon poacher, Agonus acipenserinus, snake prickleback, Lumpenus sagitta, Pacific sand lance, Ammodytes hexapterus, starry flounder, Platichthys stellatus, arctic flounder, Liopsetta glacialis, yellowfin sole, Limanda aspera, shrimp, Crangon septemspinosa.

INTRODUCTION

Studies of the nearshore fishes of Kotzebue Sound have been primarily limited to chum salmon (Oncorhynchus keta) (Yanagawa 1970; Bird 1980; Merritt and Raymond 1983) and herring (Clupea harengus) (Barton 1978; Whitmore and Bergstrom 1983). A few of these reports contain information on incidentally caught species. Merritt and Raymond reported incidental tow net and trawl catches, as well as stomach contents of several species. Whitmore and Bergstrom reported summaries of their gill net and beach seine catches. Bird reported data on several species of fish found in Kotzebue Sound, but most of his catches were made in the Lower Noatak River.

Most of the incidental catches by Merritt and Raymond (1983) were caught with beach seines and have not yet been reported. Catches with other gear types were only qualitatively reported. We report here a compilation of all the catches made in that study and additional beach seine catches made in the year following the study.

Other studies of offshore fishes have been made in Kotzebue Sound (Wolotira et al. 1977) and in the Chukchi Sea (Andriashev 1937; Alverson and Wilimovsky 1966; Quast 1972; Barton 1978; Frost and Lowry 1983). Some of these data will be compared to the nearshore catches that we report here.

MATERIALS AND METHODS

The study area consisted of the nearshore waters of the northern and eastern shores of Kotzebue Sound (Fig. 1). The locations of the sampling stations are shown in Figures 1, 2, and 3. Descriptions of the stations including water temperature, salinity, gear type, and fishing effort are given in Appendix Table 1.

The fishing gear consisted of three beach seines, two gill nets, a tow net, and a trawl (Table 1). The study was conducted during the summer months of 1979 through 1982.

The beach seine sampling stations were lumped into one of four sampling areas (Table 2). Catch per unit effort of beach seining is given as catch per hectares seined. The surface area fished by the seines was estimated as a rectangle having length L and width L/2, where L is length of the seine.

The catch was expressed in numbers and in kilograms. A rough estimate of the biomass density was obtained from the length distributions using the formula

$$W = .0083 * L^3$$

where W is the weight in grams and L is the length in centimeters. The coefficient .0083 is the condition factor for chum salmon, and thus, is only a crude approximation for other species. The weight for each length range was weighted by the number of fish in that range to arrive at an average weight. The average weight was then multiplied by the number density to get the biomass density. Length distributions were not made for chum and pink salmon (O. gorbuscha) fry or for the shrimp (Crangon septemspinosa). The average lengths of the salmon fry and shrimp were estimated at 4.0 and 1.9 cm, respectively.

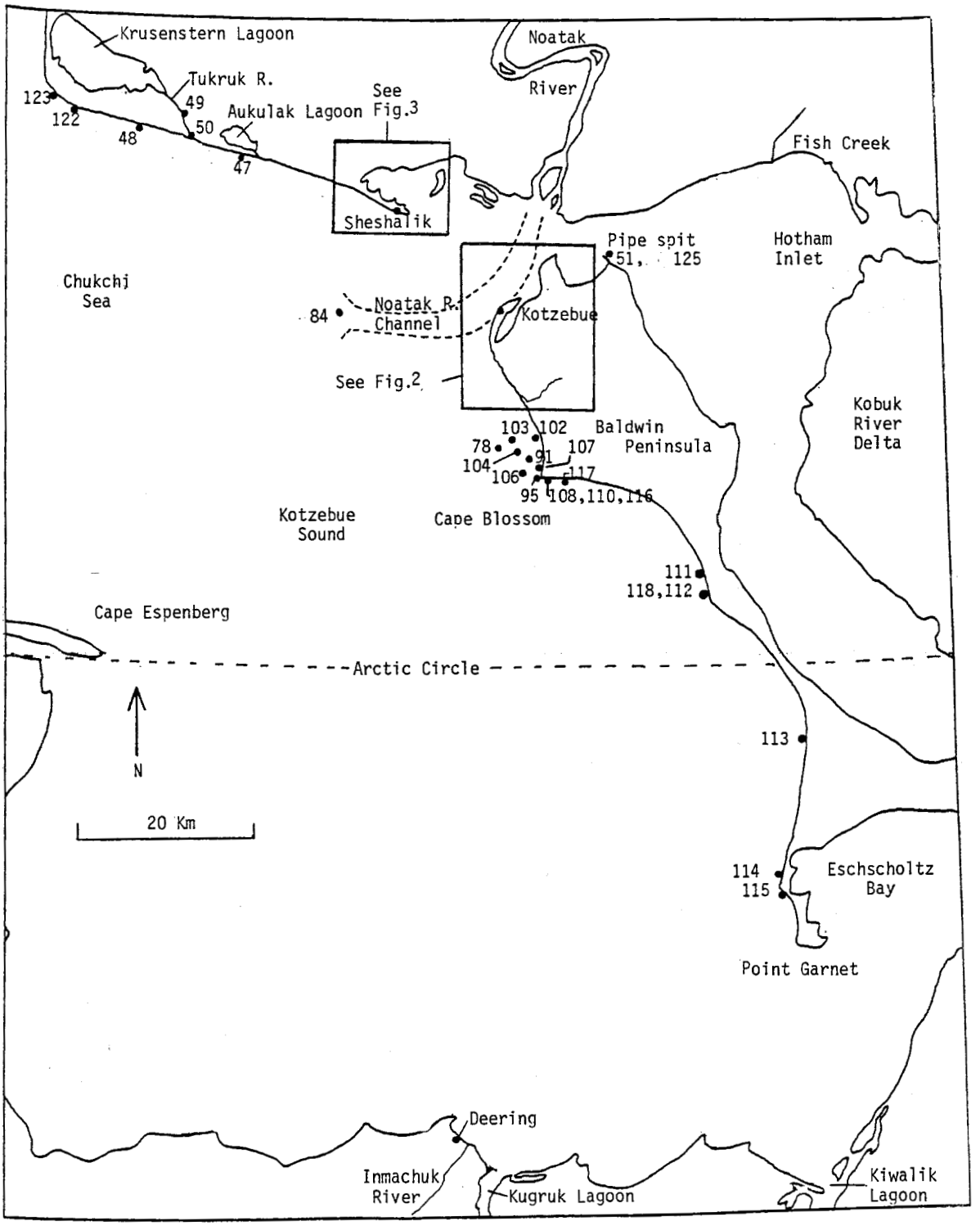

Figure 1. Map of the Kotzebue Sound area showing locations of fish sampling stations. Descriptions of the sampling stations are given in Appendix Table 1. Details of the Kotzebue and Sheshalik areas are shown in Figs. 2 and 3.

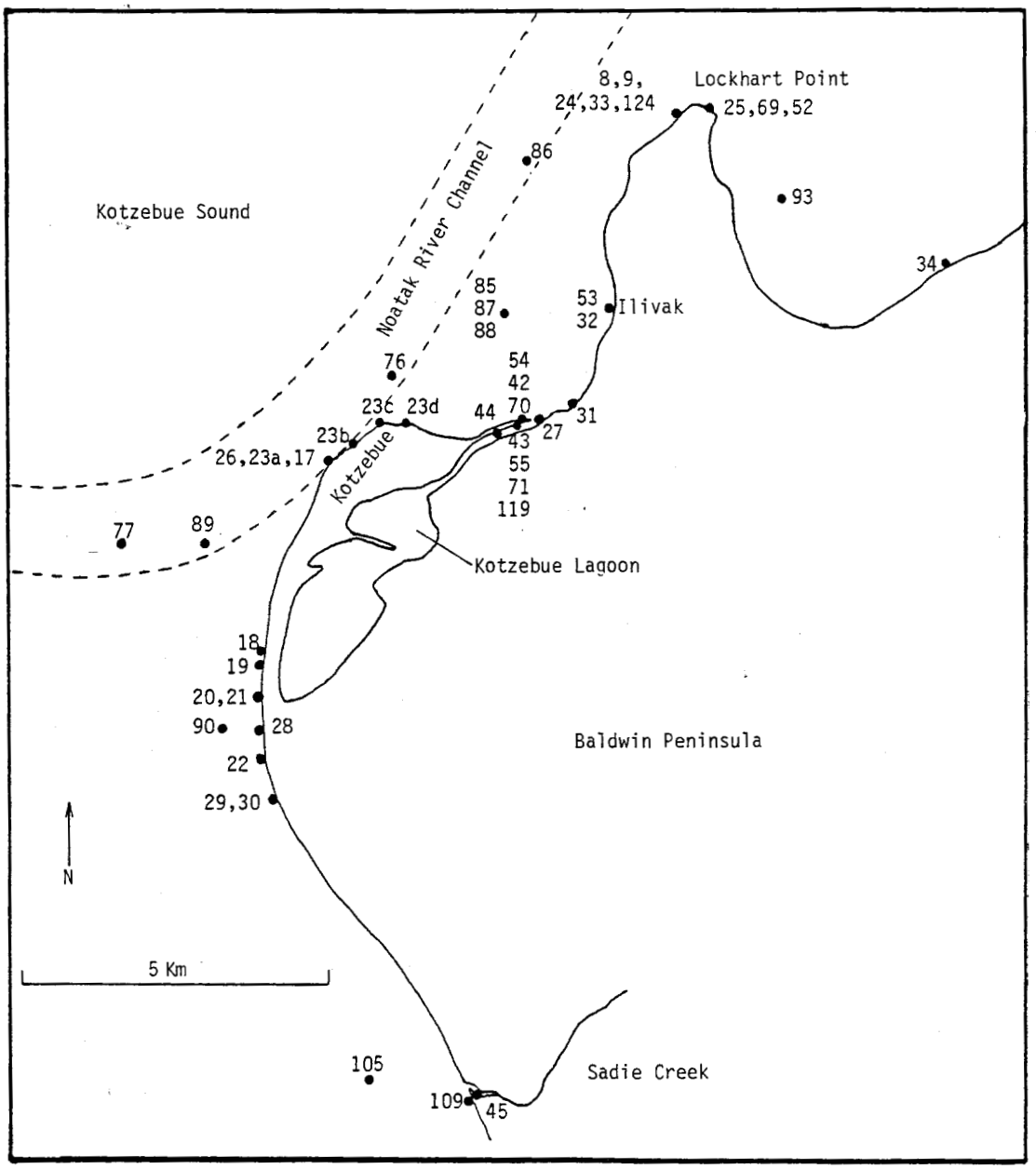

Figure 2. Map of the nearshore waters near Kotzebue showing fish sampling stations. Descriptions of the sampling stations are given in Appendix Table 1.

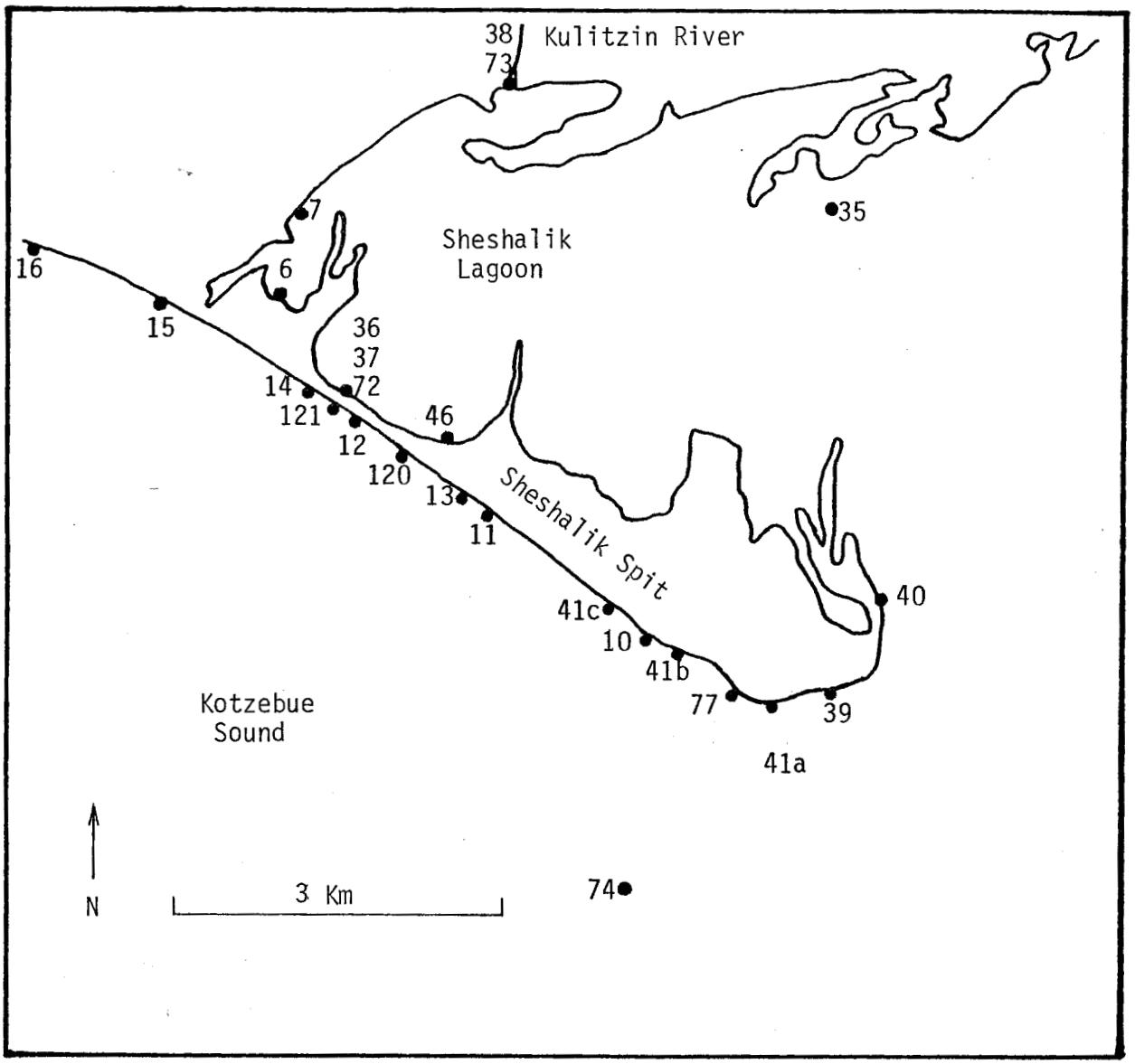

Figure 3. Map of the nearshore waters near Sheshalik showing fish sampling stations. Descriptions of the sampling stations are given in Appendix Table 1.

Table 1. Sampling gear types used to collect nearshore fishes in Kotzebue Sound. Gear type numbers are used in Appendix Tables 1, 3 and 5.

No.	Gear	Length (m)	Width (m)	Height (m)	Mesh (stretch) (mm)
1	beach seine	7.6	1.8		6
2	beach seine	41	1.8		12
3	beach seine	61	1.8		12
4	gill net	30	2.4		2.5-15
5	gill net	38	2.4		2.5-15
6	tow net	8.2	2.7	2.7	3 (cod end)
7	trawl	4.9	5.8	0.8	3

Table 2. Description of the seining areas in Kotzebue Sound. Area numbers are used only in Appendix Tables 1 and 3.

No.	Location	Description
1	N. coast	North coast of Kotzebue Sound from Sheshalik Spit to Cape Krusenstern.
2	N. Lagoons	North coast lagoons and rivers (specifically, Sheshalik Lagoon, Kulitzin River, Tukrok River and Krusenstern Lagoon).
3	Kotz. area	Mouth of the Noatak River and north western Baldwin Peninsula from Pipe Spit to Sadie Creek.
4	Baldwin P.	Baldwin Peninsula south of Sadie Creek.

Length distributions of the fishes caught in the beach seines were based primarily on catches made in 1979 and 1980. Some of the fish used in the length distributions were caught by Craig Whitmore and Daniel Bergstrom (unpublished data). When collected, the range in length of fish was recorded in inches rather than centimeters because of an error in experimental protocol. For tabulation purposes, the length distributions were later separated into 1-in groups. For example, if a catch were originally recorded as 300 smelt 3-5 in, the catch would have been separated into 100 fish in the 2.5- to 3.5-in group, 100 fish in the 3.5- to 4.5-in group, and 100 fish in the 4.5- to 5.5-in group.

Water temperatures were measured with a mercury thermometer (0 to 20^{o}C in 0.1^{o}C divisions). Salinities were determined from temperature and conductivity in 1979 and 1980 according to the method of Bennett (1976). In 1981 and 1982 salinity was calculated from the density and temperature with a programmable calulator. The program was based on Knudsen's equations (U. S. Navy 1953). Density was measured with a hydrometer with .0005 g/cc divisions (model 89H, Brooklyn Thermometer Co., Farmingdale, NY 11735).

RESULTS

Several species of fish and invertebrates were collected on the northern and eastern shores of Kotzebue Sound (Table 3). The most commonly caught species are described below. Catches of other, less common species are described in Appendix Table 5.

Beach Seine Catches

A total of 6.07 hectares were seined at 70 stations in the Kotzebue Sound area (Appendix Table 1). Whitefishes (Coregonus spp., ciscos (Coregonus spp.), starry flounder (Platichthys stellatus) and juvenile smelts (Osmeridae) were caught with the greatest frequency, while saffron cod (Eleginus gracilis), whitefishes, and herring had the highest biomass densities (Table 4). Catches of the most common species are described in Appendix Table 2.

The number caught per unit effort of beach seining (CPUE) is shown as functions of both date and area in Tables 5 and 6. The length distribution of each species is given in Table 7.

Juvenile chum salmon were abundant in June and early July between Lockhart Point and Sadie Creek but were difficult to find after mid July, presumably because of a movement to deeper water. Few chum salmon were found outside this area. Juvenile chum salmon in Kotzebue Sound are more fully described by Merritt and Raymond (1983).

The whitefish species were usually not identified. Whitmore and Bergstrom (1983) identified most of the whitefishes that they caught with gill nets. Of 460 whitefishes caught in 1980, 96% were humpback whitefish (C. pidschian), 3.6% were broad whitefish (C. nasus) and 0.4% were round whitefish (C. cylindraceum). Thus, it is probable that most of the whitefishes that we caught

Table 3. Fish and invertebrate species collected in nearshore waters of Kotzebue Sound in summer.

Family and species	Common name
Phylum Arthropoda, Class Crustacea	
Crangonidae	
Crangon septemspinosa	shrimp
Phylum Chordata, Superclass Pisces	
Clupeidae	
Clupea harengus pallasi	Pacific herring
Salmonidae	
Oncorhynchus keta	chum salmon
Oncorhynchus gorbuscha	pink salmon
Salvelinus alpinus	arctic char
Coregonus pidschian	humpback whitefish
Coregonus nasus	broad whitefish
Prosopium cylindraceum	round whitefish
Coregonus sardinella	least cisco
Coregonus autumnalis	arctic cisco
* *Coregonus laurettae*	Bering cisco
Stenodus leucichthys	sheefish
Osmeridae	
Osmerus mordax dentex	rainbow smelt
Hypomesus olidus	pond smelt
Mallotus villosus	capelin
Gadidae	
Eleginus gracilis	saffron cod
Gasterosteidae	
Pungitius pungitius	nine-spine stickleback
Cottidae	sculpin spp.
Agonidae	
Agonus acipenserinus	sturgeon poacher
Stichaeidae	
* *Lumpenus sagitta*	snake prickleback
Ammodytidae	
Ammodytes hexapterus	Pacific sand lance
Pleuronectidae	flatfish spp.
Platichthys stellatus	starry flounder
Liopsetta glacialis	arctic flounder
Limanda aspera	yellowfin sole

* Tentative identification

Table 4. Frequency of occurrence and catch per unit effort of fish and invertebrate species collected with beach seines in the Kotzebue Sound area. Species are ranked by the frequency of their occurrence. Rank is given in parentheses.

Species	Frequency (%) 1/		Catch/hectare seined 2/ number		kg 3/	
Whitefish spp.	63.4	(1)	129	(6)	13.2	(2)
Cisco spp.	50.7	(2)	111	(7)	3.35	(4)
Starry flounder	46.5	(3)	80.8	(8)	1.87	(5)
Smelt spp. <10 cm	39.4	(4)	1460	(2)	0.82	(6)
Stickleback	32.4	(5)	55.4	(9)	0.03	(13)
Chum salmon juv.	29.6	(6)	233	(3)	0.53	(12)
Sculpin spp.	28.2	(7)	17.6	(12)	0.33	(10)
Smelt spp. >10 cm	19.7	(8)	27.9	(10)	0.51	(8)
Flatfish spp.	19.6	(9)	18.1	(11)	0.35	(9)
Pacific herring	14.1	(10)	151	(5)	6.02	(3)
Shrimp	12.7	(11)	5050	(1)	0.30	(11)
Saffron cod	9.9	(12)	205	(4)	29.7	(1)
Pink salmon juv.	8.5	(13)	3.1	(13)	0.00	(14)
Sheefish	7.0	(14)	1.5	(14)	0.82	(7)

1/ Percent of the 70 stations at which a species was found

2/ 6.07 hectares seined

3/ Rough estimate. See METHODS for derivation.

Table 5. Beach seine catches and (in parentheses) catch per unit effort in Kotzebue Sound for half-month periods from 1 June to 15 August. Total effort (in hectares seined) is given in brackets for each time period.

Species	Jun 1-15 [0.36]	Jun 16-30 [1.88]	Jul 1-15 [1.73]	Jul 16-31 [0.42]	Aug 1-15 [1.68]	Total [6.07]
chum salmon	50 (140)	1260 (669)	66 (38.3)	0 (0)	38 (22.6)	1410 (232)
whitefish spp.	21 (59.0)	338 (179)	114 (66.1)	70 (167)	239 (142)	782 (129)
cisco spp.	101 (284)	93 (49.4)	144 (83.5)	11 (26.1)	323 (192)	672 (111)
smelt spp. (>10 cm)	29 (81.4)	16 (8.5)	83 (48.1)	0 (0)	41 (24.4)	169 (27.9)
smelt spp. (<10 cm)	17 (47.7)	663 (352)	1080 (626)	81 (193)	7010 (4170)	8850 (1460)
saffron cod	23 (64.6)	1200 (637)	18 (10.4)	0 (0)	3 (1.8)	1240 (204)
Pac. herring	50 (140)	654 (348)	3 (1.7)	0 (0)	208 (124)	915 (151)
starry fl.	281 (789)	40 (21.2)	61 (35.4)	25 (59.5)	83 (49.4)	490 (80.8)
flatfish spp.	0 (0)	4 (2.1)	84 (48.7)	19 (45.2)	3 (1.8)	110 (18.1)
sculpin spp.	46 (129)	6 (3.2)	21 (12.2)	34 (80.9)	0 (0)	107 (17.6)
stickleback	42 (118)	44 (23.4)	15 (8.7)	9 (21.4)	226 (134)	336 (55.4)
sheefish	0 (0)	3 (1.6)	6 (3.5)	0 (0)	0 (0)	9 (1.5)
shrimp	204 (573)	5 (2.7)	420 (243)	1 (2.4)	30000 (17800)	30600 (5040)
pink salmon	14 (39.3)	2 (1.1)	3 (1.7)	0 (0)	0 (0)	19 (3.1)

Table 6. Beach seine catches and (in parentheses) catch per unit effort in four regions in Kotzebue Sound during the period 1 June to 15 August. Total effort (in hectares seined) is given in brackets for each region.

Species	N. coast [1.64]	N. lagoons [1.18]	Kotz. area [2.16]	Baldwin Penin. [1.09]	Total [6.07]
chum salmon	2	6	1369	37	1410
	(1.2)	(5.1)	(634)	(33.9)	(232)
whitefish spp.	248	110	296	128	782
	(152)	(93.3)	(137)	(117)	(129)
cisco spp.	55	122	493	2	672
	(33.6)	(103)	(228)	(1.8)	(111)
smelt spp. (>10 cm)	131	4	31	3	169
	(80.1)	(3.4)	(14.4)	(2.7)	(27.9)
smelt spp. (<10 cm)	7480	512	850	10	8850
	(4570)	(434)	(394)	(9.2)	(1460)
saffron cod	15	6	23	1200	1240
	(9.2)	(5.1)	(10.7)	(1100)	(204)
Pac. herring	500	6	259	150	915
	(306)	(5.1)	(120)	(137)	(151)
starry fl.	20	63	326	81	490
	(12.2)	(53.4)	(151)	(74.1)	(80.8)
flatfish spp.	86	20	4	0	110
	(52.6)	(17.0)	(1.9)	(0)	(18.1)
sculpin spp.	6	39	62	0	107
	(3.7)	(33.1)	(28.7)	(0)	(17.6)
stickleback	241	16	79	0	336
	(147)	(13.6)	(36.6)	(0)	(55.4)
sheefish	3	2	2	2	9
	(1.8)	(1.7)	(0.9)	(1.8)	(1.9)
shrimp	30100	305	205	2	30600
	(18400)	(259)	(95.0)	(1.8)	(5040)
pink salmon	1	4	14	0	19
	(0.6)	(3.4)	(6.5)	(0)	(3.1)

Table 7. Length distributions of fish caught with beach seines in the nearshore waters of Kotzebue Sound. Lengths have been sorted into 1-in groups (see Materials and Methods). For example, the 5-in group represents all fish lengths between 4.5 and 5.5 in. The length range is also expressed in centimeters. Abbreviations: WF = whitefish spp., Cisc = Cisco spp., Smelt = Smelt spp., Cod = Saffron cod, Herr = Pacific herring, StFl = Starry flounder, Flat = Flatfish spp., Scul = Sculpin spp., Stik = Nine-spine stickleback, Shee = Sheefish.

Length Group		Species									
(in)	(cm)	WF	Cisc	Smlt	Cod	Herr	StFl	Flat	Scul	Stik	Shee
1	1.3- 3.8	33	10	16,837	1	28		4	37	562	
2	3.8- 6.6	28	10	11,144	1	30	1	19	3	547	
3	6.6- 8.9	5	55	96		31	20	47	8	3	
4	8.9-11.4	16	279	112	2		129	49	11		
5	11.4-14.0	26	156	148	2		131	26	12		
6	14.0-16.5	46	315	10	8	10	110	24	10		
7	16.5-19.0	76	54		5	10	18	9	11		
8	19.0-21.6	89	58	2	9	11	8	26	3		1
9	21.6-24.1	72	15		6	10					
10	24.1-26.7	80	15		3	11	7		2		2
11	26.7-29.2	64	14		5		3				2
12	29.2-31.8	69	12		19				1		4
13	31.8-34.3	6									4
14	34.3-36.8	7			6		1				6
15	36.8-39.4	4				1					2
16	39.4-41.9									1	
20	41.9-52.1				1						
21	52.1-54.6									1	
25	54.7-64.8									1	
30	74.9-77.5									1	
Totals		621	993	28349	67	143	428	204	98	1112	25
Ave length (cm)		20.6	13.7	3.63	23.9	11.2	13.0	11.4	9.4	3.8	36.2

were humpback whitefish. The whitefishes were primarily found in two length ranges: juveniles in the 2- to 5-cm range and adults in the 15- to 30-cm range. No significant difference in their abundance was observed during the June-August period. Whitefishes were found in relatively high numbers in all parts of the study area. Whitefishes were the most frequently caught species and had the second highest biomass density.

The cisco species were usually not identified. Of 539 ciscos caught with gill nets in 1980 by Whitmore and Bergstrom (1983), 95% were least ciscos (C. sardinella) and and 5% were arctic ciscos (C. autumnalis). No Bering ciscos (C. laurettae) were caught with gill nets, but one was caught with a beach seine in Hotham Inlet. The lengths of the ciscos that we caught ranged from 2 to 30 cm with most falling in the 6- to 20-cm range. The ciscos did not appear to change in abundance over the summer. They were more commonly caught near the mouth of the Noatak River than in other parts of the study area. Ciscos were the second most frequently caught species and were fourth in biomass density.

The smelt species were usually not identified. Of 347 smelts caught with gill nets in 1980 by Whitmore and Bergstrom (1983), 342 were rainbow smelt (Osmerus mordax), four were capelin (Mallotus villosus), and one was a pond smelt (Hypomesus olidus). Both juvenile and larger smelts were found in each part of the study area. Most of the smelts were juveniles in the 1.5- to 6-cm range. The largest catch of juveniles, 7000, was made on the south side of Sheshalik Spit. The larger smelts ranged from 8 to 20 cm in length.

Saffron cod were found in all parts of the study area but the frequency with which they appeared in the catches was low. However, one catch of about 1200 adults in a school southeast of Cape Blossom put the saffron cod in first place in biomass density. Saffron cod appeared to be more abundant in early

summer than in late summer. The lengths of the saffron cod ranged from 2 to 35 cm, but most were in the 14- to 30-cm range.

Pacific herring were caught throughout the study area and did not appear to change in abundance during the summer. Like saffron cod, herring were caught infrequently but ranked high in biomass density. The herring were found in two sizes: 1- to 9-cm juveniles and 14- to 26-cm adults.

The starry flounder (Platichthys stellatus) was the third most frequently caught fish. It was found throughout the study area and did not appear to change in abundance during the summer. The starry flounder ranged in length from 4 to 35 cm with most falling in the 9- to 15-cm range.

The flatfishes, other than the starry flounder, were usually not identified beyond the Family level. Those that were identified were either arctic flounder (Liopsetta glacialis) or yellowfin sole (Limanda aspera). The flatfishes ranged in length from 1 to 20 cm with most in the 6- to 11-cm range. Non-starry flounder flatfishes were low in abundance compared to the starry flounder. They appeared to be more abundant in July and more abundant in the northern parts of the study area.

The sculpins were rarely identified beyond the Family level. Most appeared to be of the genus Myoxocephalus. The sculpins ranged in length between 1 and 30 cm. Aside from the juveniles, most were in the 6- to 20-cm range. Although few sculpins were found along the lower part of the Baldwin Peninsula, they were common throughout the rest of the study area. The sculpins did not appear to change in abundance during the summer.

Nine-spine stickleback (Pungitius pungitius) were most common on the north coast of Kotzebue Sound. Almost all of the sticklebacks were 2 to 5 cm long. Their abundance in nearshore waters did not change during the summer period.

Sheefish (Stenodus leucichthys) were found in small numbers in each of the regions in the study area. They ranged in length from 20 to 75 cm, which made them the largest fish that we caught. Larger numbers of sheefish were found in Hotham Inlet by Whitmore and Bergstrom (1983).

Shrimp were collected in many sizes ranging from 1 to 5 cm in length. Three samples were preserved and all were identified as Crangon septemspinosa (Kathy Frost, Alaska Dept. Fish & Game, personal communication). The largest catch was made on Sheshalik Spit. This catch consisted of small shrimp in close asssociation with drifting eel grass. Shrimp ranked first in number density but were caught infrequently and had a relatively small biomass density.

Juvenile pink salmon were found in very small numbers. Like the juvenile chum salmon, they were found in nearshore waters only in June and early July.

Gill Net, Tow Net and Trawl Catches

Gill net, tow net, and trawl stations are given in Appendix Table 3. The catches of major species using these gear types are shown in Appendix Table 4. Catches of less common species are shown in Appendix Table 5. The tow net and trawl catches were reported previously (Merritt and Raymond 1983, Appendix Table 6), but only qualitatively.

Saffron cod and flatfishes dominated the gill net catches. The tow net caught mostly juvenile fish and jelly fish. The low catches may be a result of the low speed at which the tow net was pulled (55 cm/s). The major catches with the trawl were flatfishes, juvenile smelt, shrimp, and saffron cod.

DISCUSSION

Besides the catches reported here, other fisheries studies using gill nets and beach seines (Whitmore and Bergstrom 1983) and bottom trawls and gill nets (Wolotira et al. 1977) have been made in Kotzebue Sound. Additional notes on most of the species that are reported here are given by Percy (1975), who collected fish in a roughly similar environment: the Mackenzie River Delta.

Caution must be applied when using the catch per unit effort data to arrive at abundances of fishes in Kotzebue Sound. First, the sampling areas were not random but were chosen to maximize the catch of chum salmon fry. Second, different gear types may have different selectivities for a species. The gill nets used by Whitmore and Bergstrom (1983), for example, were far more effective at catching herring, sheefish, and sculpins and less effective at catching saffron cod, ciscos, and whitefish than our beach seines (Table 8).

Herring catches on the southern shore of Kotzebue Sound and in Hotham Inlet (Whitmore and Bergstrom 1983) showed a similar dependency on gear type. Herring were absent from their beach seine catches, but many were caught in these areas with gill nets.

Fishes in offshore waters of Kotzebue Sound (Wolotira et al. 1977) resembled those of the nearshore waters (this report; Whitmore and Bergstrom 1983) in that herring, saffron cod flatfishes, and smelt had relatively high CPUEs in both regions. However, the abundances of these species appeared to be far lower offshore. Wolotira et al. (1977, Table VIII-16) reported bottom trawl catches of 0.53 kg herring, 0.31 kg saffron cod, 0.24 kg rainbow smelt, .09 kg flatfish spp. (excluding starry flounder),

Table 8. Comparison of gill net and beach seine catches of several species of fish caught on the northern and eastern shores of Kotzebue sound. Beach seine data is derived from Table 5 and gill net data is from Whitmore and Bergstrom (1983, Tables 3 and 4 [Kotzebue and Sheshalik areas only]).

Species	Percent composition of the catch		Ratio
	seine	gill net	gill net/seine
saffron cod	27.7	5.2	0.19
Pac. herring	20.4	69.6	3.4
whitefish spp.	17.4	4.3	0.25
cisco spp.	15.0	2.9	0.19
flatfish spp.	13.4	7.8	0.58
smelt spp. (>10 cm)	3.8	2.5	0.65
sculpin spp.	2.4	6.8	2.8
sheefish	0.2	0.9	4.7

.04 kg starry flounder, and .03 kg sculpin spp. per hectare.1/ These values are all small compared to the estimated biomass densities in nearshore waters (Table 4). During the summer period, Percy (1975) also found higher abundances of fishes in coastal waters than in offshore waters near the Mackenzie River Delta.

The winter distribution and abundance of fishes in the nearshore waters of Kotzebue Sound may differ from what they are in summer, but few winter data are available to confirm this. In October, a gill net set on the south side of Seshalik Spit in October caught many saffron cod and arctic cod (Boreogadus saida), and some arctic lamprey (Lampetra japonica), sturgeon poachers (Agonus acipenserinus), Pacific sand lance (Ammodytes hexapterus), and capelin (Bob Uhl, private communication). In Kotzebue in November 1982, a storm surge caused water to pour out of cracks in the offshore ice. Hundreds, perhaps thousands, of herring were washed up on the ice (Joe Dinnocenzo, Alaska Dept. of Fish & Game, private communication). In March and April, sheefish are caught mostly in Hotham Inlet, but occasionally they are caught offshore Kotzebue. In winter, the sheefish's presence in waters offshore Kotzebue appears to be tied to periods when the salinity is below 15 ppt (J.A. Raymond, unpublished data). A local fisherman said that the stomachs of winter-caught sheefish contain saffron cod, smelt, and herring. While fishing for the sheefish, local fishermen often catch sculpins, probably of the genus Myoxocephalus, and occasionally large (~100 cm-long) burbot (Lota lota).

1/ Wolotira et al. (1977) reported their catches in kg/km. The above values were obtained by converting the area swept by their 41.3-m-wide trawl into hectares.

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REFERENCES

Alverson, D. L. and N. J. Wilimovsky. 1966. Fishery investigations of the southeastern Chukchi Sea. In: Environment of the Cape Thompson Region, Alaska. N. Wilimovsky, Ed. U. S. Atomic Energy Commission, Washington, D. C. pp. 843-860.

Andriashev, A. P. 1937. A contribution to the knowledge of the fishes from the Bering and Chukchi Seas. Explorat. des mers de L'URSS. fasc. 25, Inst. Hydro., Leningrad, pp. 292-235. English translation: U. S. Dept. Interior, Fish and Wildlife Service Spec. Sci. Rep.-Fisheries No. 145. 81 pp.

Barton, L. H. 1978. Finfish resource surveys in Norton Sound and Kotzebue Sound. Alaska Dept. Fish & Game, Juneau. 202 pp.

Bennett, A. S. 1976. Conversion of in situ measurements of conductivity to salinity. Deep Sea Research 23, 157-165.

Bird, F. 1980. Chum salmon and other fisheries investigations in Kotzebue Sound in 1979. AYK Region NS/K Resource Rep. No. 6. Alaska Dept. Fish & Game, Juneau. 76 pp.

Frost, K. J. and L. F. Lowry. 1983. Demersal fishes and invertebrates trawled in the northeastern Chukchi and Western Beaufort Seas, 1976-77. National Oceanic and Atmospheric Administration Tech. Rep. NMFS SSRF-764. 22 pp.

Merritt, M. and J. A. Raymond. 1983. Early life history or chum salmon in Kotzebue Sound and in the Noatak River. F.R.E.D. Report No. 1. Alaska Dept. Fish & Game, Juneau, AK.

Percy, R. 1975. Fishes of the Mackenzie Delta. Beaufort Sea Project Tech. Rep. No. 8. Available from Dept. of the Environment, 512 Federal Bldg., 1230 Government St., Victoria, B.C., Canada, 114pp.

Quast, J. C. 1972. Preliminary report on the fish collected on WEBSEC-70. In: WEBSEC-70, an ecological survey in the eastern Chukchi Sea, September-October 1970, p. 203-206. U. S. Coast Guard Oceanogr. Rep. No. 50.

Quast, J. C. and E. L. Hall. 1972. List of fishes of Alaska and adjacent waters with a guide to some of their literature. National Oceanic and Atmospheric Administration Tech. Rep. NMFS SSRF-658. 47 pp.

U.S. Navy Hydrographic Office. 1953. Tables for sea water density. H.O. Publ. No. 615, Washington, D.C.

Whitmore, D. C. and D. J. Bergstrom. 1983. Assessment of herring stocks in southeastern Chukchi Sea, 1980-1981. Informational Leaflet No. 210, Alaska Dept. Fish & Game, Juneau.

Wolotira, R. J., T. M. Sample and M. M. Morin, Jr. 1977. Demersal fish and shellfish resources of Norton Sound, the southeastern Chukchi Sea, and adjacent waters in the baseline year 1976. National Oceanic and Atmospheric Administration Processed Report. Available from Northwest and Alaska Fisheries Center, 2725 Montlake Blvd. E., Seattle, WA 98112. 292 pp.

Yanagawa, C. M. 1970. Kotzebue chum salmon tagging project, 1966-1968. AYK Region Fish. Bull. No. 7, Alaska Dept. Fish & Game, Juneau.

APPENDIX A

LIST OF APPENDIX TABLES

Appendix Table 1. Beach seine stations in Kotzebue Sound. Gear type is described in Table 1. Stations are listed chronologically.

No.	Area	Date	Temp. (°C)	Sal. (‰)	Gear	No. Hauls	Collectors 1/
8	3	06 Aug 79			2	2	1
9	3	07 Aug 79			2	1	1
10	1	11 Aug 79			2	1	1
11	1	11 Aug 79			2	1	1
12	1	11 Aug 79			2	1	1
13	1	15 Aug 79			2	1	1
14	1	15 Aug 79			2	1	1
15	1	15 Aug 79			2	1	1
16	1	15 Aug 79			2	1	1
17	3	06 Jun 80	4.9	1	1	11	1
18	3	06 Jun 80	7.8	1	2	2	1
19	3	06 Jun 80	7.9	1	2	1	1
20	3	07 Jun 80	5.7	1	1	4	1
21	3	11 Jun 80	6.6	1	1	7	1
22	3	11 Jun 80	6.0	22	1	1	1
23	3	11 Jun 80	8.8	1	1	5	1
24	3	15 Jun 80	11.5	3	1	5	1
25	3	15 Jun 80	12.0	3	1	3	1
26	3	16 Jun 80	10.0	2	1	3	1
27	3	17 Jun 80	12.0	3	2	1	1
28	3	18 Jun 80	14.0		1	1	1
29	3	18 Jun 80	14.0		2	2	1
30	3	18 Jun 80	14.0		1	1	1
31	3	23 Jun 80	14.0	4	2	1	1
32	3	23 Jun 80	12.9	4	2	1	1
33	3	23 Jun 80	12.8		1	1	1
34	3	23 Jun 80	13.0		1	1	1
35	2	26 Jun 80	20.0	0	1	2	1
36	2	26 Jun 80	16.0	1	2	2	1
37	2	26 Jun 80	16.0	1	2	1	1
38	2	26 Jun 80	16.0	0	1	2	1
39	1	27 Jun 80	17.0	0	2	1	1
40	1	27 Jun 80	17.0		1	1	1
41	1	27 Jun 80	16.0	0	2	3	1
42	3	02 Jul 80	15.5	3	2	1	1
43	3	02 Jul 80	15.0	3	2	1	1
44	3	02 Jul 80	15.5	3	1	2	1
45	3	03 Jul 80	13.0	11	1	4	1
46	2	07 Jul 80	16.0	6	3	2	1,2
47	1	08 Jul 80	13.0		3	1	1,2
48	1	08 Jul 80	10.5	22	3	1	1,2
49	2	08 Jul 80	13.5	3	1	1	1,2
50	2	08 Jul 80	15	2	3	2	1,2

(continued)

Appendix Table 1 (continued)

No.	Area	Date	Temp. (°C)	Sal. (‰)	Gear	No. Hauls	Collectors 1/
51	3	11 Jul 80	15.5	2	2	1	1
52	3	11 Jul 80	16.0	2	2	1	1
53	3	11 Jul 80	15.0	2	2	1	1
54	3	11 Jul 80	15.5		2	1	1
55	3	11 Jul 80	15.5	2	2	1	1
69	3	22 Jul 80	18.0	1	2	1	1
70	3	22 Jul 80	16.0	1	2	1	1
71	3	22 Jul 80	17.0	1	2	1	1
72	2	23 Jul 80	17.0	0	2	1	1,2
73	2	23 Jul 80	16.0	0	2	1	1
108	4	04 Aug 81	14.5	20.9	2	4	3
109	4	05 Aug 81	11.4	21.1	2	1	3
110	4	05 Aug 81	11.5	21.8	2	1	3
111	4	05 Aug 81	11.9	21.9	2	1	3
112	4	05 Aug 81	13.0	22.1	2	1	3
113	4	05 Aug 81	12.3	22.6	2	1	3
114	4	05 Aug 81	13.3	20.9	2	1	3
116	4	24 Jun 82	8.0	13.5	2	1	3
117	4	24 Jun 82	6.8	15.3	2	1	3
118	4	24 Jun 82	10.5	13.2	2	1	3
119	3	25 Jun 82	14.5	1.0	2	1	3
120	1	25 Jun 82	14.0	6.7	2	1	3
121	1	25 Jun 82			2	1	3
122	1	25 Jun 82			2		3
123	1	25 Jun 82	7.0	18.5	2	1	3
124	3	26 Jun 82	18.3	1.8	2	1	3
125	3	26 Jun 82			2	1	3

1/ 1 = Merritt and Raymond (this report)
2 = Whitmore and Bergstrom (1983)
3 = Raymond and Skaugstad (this report)

Appendix Table 2. Beach seine catches in the nearshore waters of Kotzebue Sound. Areas are defined in Table 2. Column headings: No. = station number; chum = juvenile chums salmon; WF = whitefish spp. excluding ciscos; Cisco = cisco spp.; smelt = smelt spp. >10 cm; Jsmelt = juvenile smelt spp. <10 cm; Cod = saffron cod; Herr = Pacific herring; Stfl = starry flounder; Flat = flatfish spp. excluding starry flounder; Sculp = sculpin spp.; Stickl = nine-spine stickleback; Shee = sheefish; Shrimp = Crangon septemspinosa; Pink = juvenile pink salmon. j = juvenile; a = adult.

No.	Date	Chum	WF	Cisco	Smelt	Jsmelt	Cod	Herr	Stfl	Flat	Sculp	Stickl	Shee	Shrimp	Pink
					N. coast area; total area seined = 1.64 hectares										
10	11 Aug 79		5		3		3			2		200		6	
11	11 Aug 79		200		3									30000	
12	11 Aug 79	1	4	1					1			8			
13	15 Aug 79		10	25j	25	7000						6			
14	15 Aug 79			15j					1						
15	15 Aug 79			8	3							6			
16	15 Aug 79		12	4	4					1					
39	27 Jun 80			2											
40	27 Jun 80								1			1			
41	27 Jun 80		2		16	28			7		3	20			
47	08 Jul 80		4			200	1		7	28	1		3		
48	08 Jul 80				77	250	11			51	2			120	
120	25 Jun 82		1			2				2					
121	25 Jun 82							500							
122	25 Jun 82	1	10						3						1
123	25 Jun 82									2					
					N. Lagoons area; total area seined = 1.18 hectares										
35	26 Jun 80					1									
36	26 Jun 80		12	6				2	14					5	1
37	26 Jun 80		7	5				1	4						
38	26 Jun 80	3													
46	07 Jul 80	3	59	104		450	6	1	27		6				3
49	08 Jul 80											6			
50	08 Jul 80		1	1	4	60		2	6	2	2	8	2	300	
72	23 Jul 80		7	5		1			3	16	3				
73	23 Jul 80		1,23j	1					9	2j	2,26j	2			
					Kotz. area; total area seined = 2.16 hectares										
8	06 Aug 79			185				140j				3			
9	07 Aug 79			83				68j				3			
17	06 Jun 80	9	2		9				2		39	1			
18	06 Jun 80	8	4	32		5			203			11			
19	06 Jun 80	1	5	20	12		15	50	60		2	10			
20	07 Jun 80	1	4	12	8		8					16			1
21	11 Jun 80			8		9					4	3			
22	11 Jun 80					2			1					200	
23	11 Jun 80	1		17					14		1				
24	15 Jun 80		4	2					1			1		4	3
25	15 Jun 80	30	2	10		1									10
26	16 Jun 80	8	1	1		400					1	6	1		
27	17 Jun 80	170		15				1	2		1				
28	18 Jun 80			1											
29	18 Jun 80		80			40			4			14			
30	18 Jun 80					40			1						
31	23 Jun 80	30	2	25					3		1				
32	23 Jun 80	35	3	25		150			1						
33	23 Jun 80	2	6	2		2									
34	23 Jun 80		3	1								3			
42	02 Jul 80	60	6	12					3						
43	02 Jul 80	2	2	20		6							1		
44	02 Jul 80										1	1			
45	03 Jul 80	1	2								4				
51	11 Jul 80		2	1		50			1						
52	11 Jul 80		2		1				3						
53	11 Jul 80		1,20j		1	20									
54	11 Jul 80		2	3		20			14	2	1				
55	11 Jul 80		9,4j	3		25				1	4				
69	22 Jul 80		22			10					1				
70	22 Jul 80		1,9j			10			11		2	2			
71	22 Jul 80		2,5j	5		60			2	1		5		1	
119	25 Jun 82	1000													
124	26 Jun 82	11	50												
125	26 Jun 82		40	10											
					Baldwin P. area; total area seined = 1.09 hectares										
108	04 Aug 81	37	3			7									
109	05 Aug 81		3			3									
110	05 Aug 81		2	2					25					2	
111	05 Aug 81				3				30						
112	05 Aug 81								25						
113	05 Aug 81								1						
114	05 Aug 81														
116	24 Jun 82		100										2		
117	24 Jun 82		20												
118	24 Jun 82						1200	150							

Appendix Table 3. Gill net, tow net and trawl stations in Kotzebue Sound. Gear type is described in Table 1. Effort is given as distance for the tow net and trawl stations and as hours for the gill net stations.

No.	Area	Date	Temp. (°C)	Sal. (‰)	Gear	Effort	Collectors 1/
74	1	24 Jul 80	6	28	6	350 m	1
76	3	29 Jul 80	15	0	6	2100 m	1
77	3	29 Jul 80	16	3	6	1705 m	1
78	4	29 Jul 80	13	22	6	1750 m	1
84	3	18 Aug 80	13.5	12	6	3170 m	1
85	3	20 Aug 80	12.5	4	7	600 m	1
86	3	20 Aug 80	12.5	3	7	1160 m	1
87	3	20 Aug 80	12.5		7	1380 m	1
88	3	20 Aug 80	12.5		7	1060 m	1
89	3	21 Aug 80	12.5	7	7	290 m	1
90	3	21 Aug 80	13	20	7	310 m	1
91	4	22 Aug 80	13	25	7	1060 m	1
93	3	27 Aug 80	9	7	7	800 m	1
95	4	19 Sep 80	7.5	21	7	130 m	1
102	4	31 Jul 81	13.0	16.3	4	3 h	3
103	4	02 Aug 81	4.7	29.0	6	1000 m	3
104	4	02 Aug 81	4.7	29.0	6	530 m	3
105	3	03 Aug 81	8.8	20.7	6	2290 m	3
106	4	03 Aug 81	10.8	21.0	6	2170 m	3
107	4	03 Aug 81	11.45	21.2	6	1910 m	3
115	4	06 Aug 81			9	14 h	3

1/ 1 = Merrittt and Raymond (1983)
3 = Raymond and Skaugstad, unpublished data

Appendix Table 4. Gill net, tow net and trawl catches of major species of fishes in Kotzebue Sound in summer. No. is station number. Gear type and effort are given in Appendix Table 1. Column headings for species are explained in the footnotes of Appendix Table 2.

No.	Date	Chum	WF	Cisco	Smelt	Jsmelt	Cod	Herr	StFl	Flat	Sculp	Stickl	Shee	Shrimp	Pink
						GILL NET									
102	31 Jul 81						4		10				1		
115	06 Aug 81				2		8		10	10					
Totals		0	0	0	2	0	12	0	20	10	0	0	1	0	0
						TOW NET									
74	24 Jul 80				1									1	
76	29 Jul 80		4j	4j		300				3				250	
77	29 Jul 80					200		1						2	
78	29 Jul 80						10								
84	18 Aug 80					250	29	2				7			
103	02 Aug 81														
104	02 Aug 81														
105	03 Aug 81											1			
106	03 Aug 81														
107	03 Aug 81														
Totals		0	4j	4j	1	750	39	3	0	3	0	8	0	253	0
						TRAWL									
85	20 Aug 80			3	1	75	5		1	1	2			15	
86	20 Aug 80									1					
87	20 Aug 80						1								
88	20 Aug 80														
89	21 Aug 80		5	5	1		5		2	2	1				
90	21 Aug 80					10	2		12	83	2			35	
91	22 Aug 80				2	30	26		4	29	4			115	
93	27 Aug 80								19	7	6				
95	19 Sep 80								1	3				1	
Totals		0	5	8	4	115	39	0	39	126	15	0	0	166	0

Appendix Table 5. Less common or unidentified fish and invertebrates caught in the nearshore waters of Kotzebue Sound. Gear type is described in Table 1.

No.	Date	Gear	Catch
35	26 Jun 80	1	35 juv. fish, 20 clams
38	26 Jun 80	1	3 juv. fish
48	08 Jul 80	3	4 pricklebacks, 2 sturgeon poachers
59	13 Jul 80	3	12 sandlance, 11 sturgeon poachers, 1 prickleback
60	13 Jul 80	3	1 sturgeon poacher, 1 capelin
66	16 Jul 80	3	15 sturgeon poachers
68	16 Jul 80	3	1 arctic char smolt (?)
78	29 Jul 80	6	16 jellyfish
81	07 Aug 80	3	100 juv. fish
84	18 Aug 80	6	100 jellyfish
90	21 Aug 80	7	1 greenling
91	22 Aug 80	7	2 sturgeon poachers, 2 jellyfish
95	19 Sep 80	7	1 jellyfish
96	19 Sep 80	3	1 sturgeon poacher
98	15 Jun 81	3	1 salmon adult, 1 char
101	22 Jun 81	3	1 char
102	31 Jul 81	4	1 sticheid
103	02 Aug 81	6	jellyfish, larval fish
105	03 Aug 81	6	3 juv. fish, 100 larval fish
106	03 Aug 81	6	4 larval fish
107	03 Aug 81	6	12 juv. fish
108	04 Aug 81	2	100 larval fish
111	05 Aug 81	2	60 larval fish, 2 sturgeon poachers
112	05 Aug 81	2	1 sticheid
114	05 Aug 81	2	2 sandlance
121	25 Jun 82	2	1 arctic char
124	26 Jun 82	2	4 juv. fish