INTRODUCTION INTO AYSEN CHILE OF PACIFIC SALMON

No. 12

Recapture of Juvenile Chum Salmon *(Oncorhynchus keta)* Released into Aysén Fiord, Southern Chile, with Notes on Their Conditions Factor, Feeding Index and Migration Rate

By

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and

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"INTRODUCTION INTO AYSEN CHILE OF PACIFIC SALMON"

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Akira Zama and Eduardo Cárdenas G.

ABSTRACT

Attempts to recapture juvenile chum salmon (*Oncorhynchus keta*) released into Aysén Fiord were made by gill net and purse seine between September and November during the years from 1979 to 1983. Surface water temperature and salinity of Aysén Fiord from September to November are shown. A total of 89 juvenile chum salmon were recaptured by both gill net and purse seine. In addition, 19 species of fishes belonging to 15 families were also collected during this study, and the stomach contents of most fishes collected were examined. The length, body weight, stomach contents, and migration rate of the chum salmon were studied.

INTRODUCTION

The introduction of Pacific salmon into the Aysén (XI) Region, southern Chile, is being conducted as a cooperative project between Chile and Japan. Juveniles of chum salmon have been released into the Simpson River (at Coyhaique) every year since 1974 and into Ensenada Baja since 1979. We suppose that the juvenile chum salmon released must migrate from Aysén Fiord to Moraleda Channel and thereafter through narrow channels to the Pacific Ocean (Fig. 1). However, no information is available on the feeding habits and behaviors of migrating chum salmon.

We attempted to recapture the chum salmon by gill net and purse seine in Aysén Fiord between September and November from 1979 to 1983. This paper presents the oceanographic condictions of Aysén Fiord, species identification and stomach contents of the fishes collected in the present study, and the length, body weight, detailed stomach contents and migration rate of the recaptured chum salmon.

MATERIAL AND METHODS

Data on the released chum salmon pertaining to the present recapture study are shown in Table 1. The chum salmon, which were reared at the Dr. Shiraishi Hatchery of Coyhaique, were released into the Simpson River (Fig. 1), of which the lower reaches are known as the Aysén River. At the Ensenada Baja Hatchery, juvenile chum were kept in both ponds and floating pens and all released into Ensenada Baja, a small inlet, which is located at the innermost part of Aysén Fiord (Fig. 2).

Aysén Fiord is about 60 km long and 2.5 to 6.5 km wide, and connected with Moraleda Channel on the west (Fig. 1). In this study the fiord area was divided into four sections (I to IV) for convenience from the innermost part toward mouth. Surface water temperature and salinity, which are shown in Table 3, were based on data obtained from six stations in Aysén Fiord (Fig. 2) between 08:00 and 17:00 hours during September to November from 1980 to

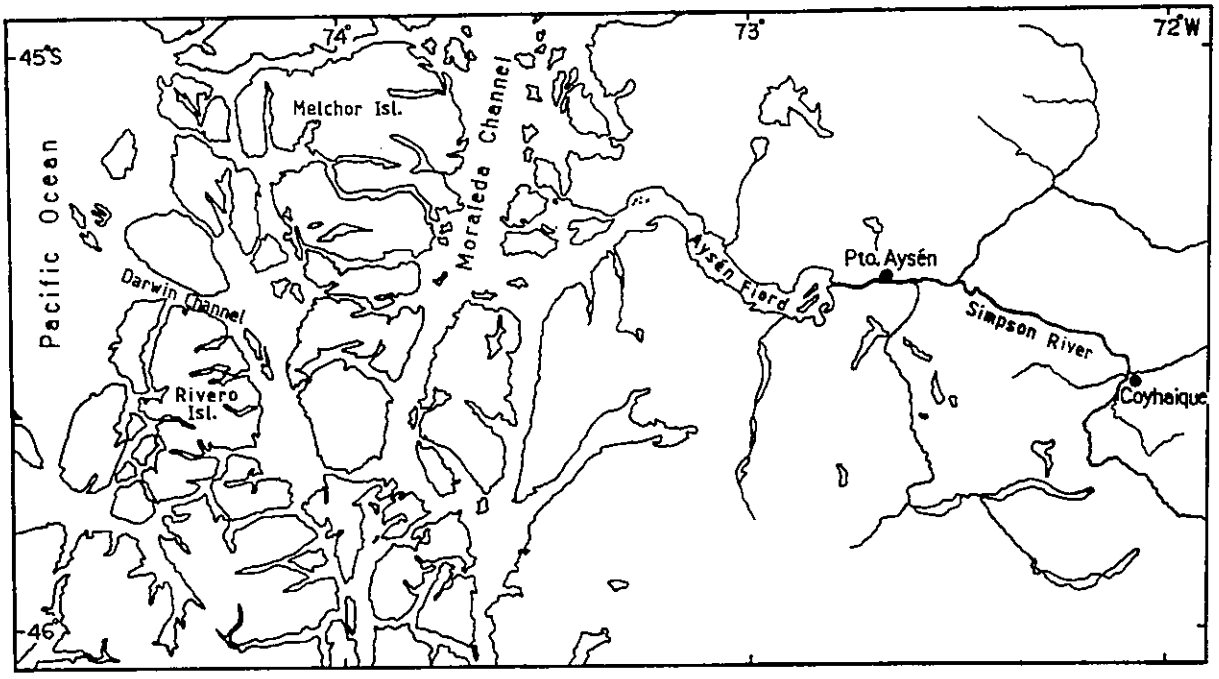

Fig. 1. Map showing the Simpson River and waters from Aysén Fiord to the Pacific Ocean.

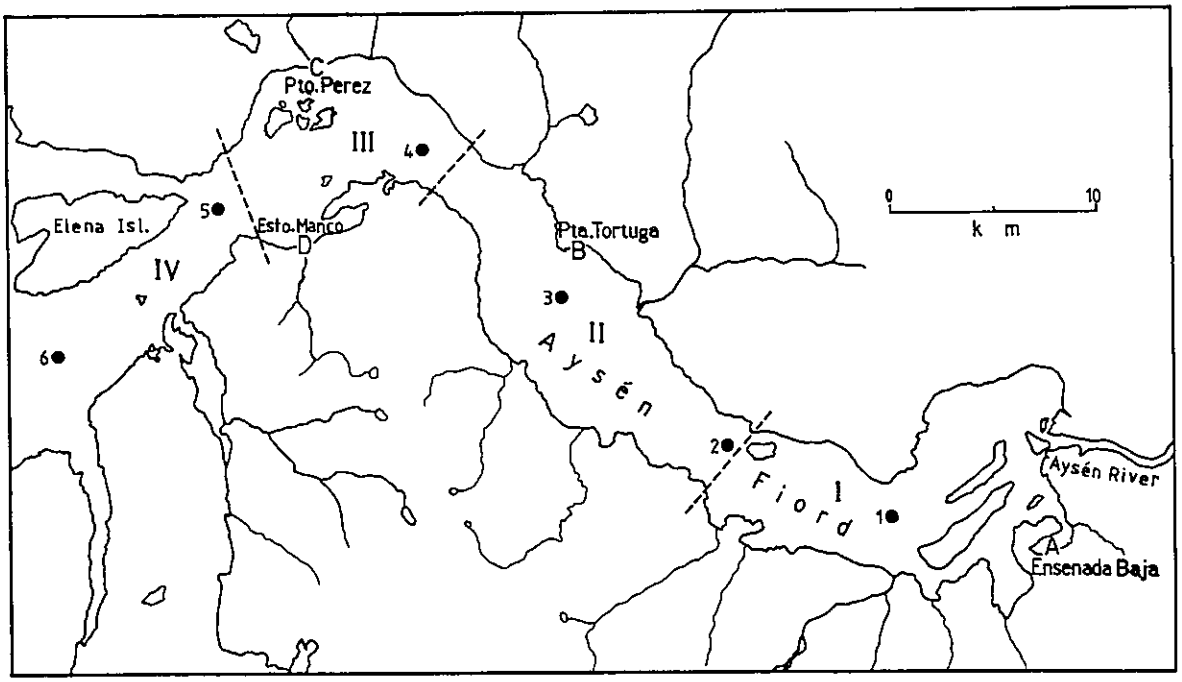

Fig. 2. Map of Aysén Fiord, showing sections (I to IV), stations (1 to 6) for oceanographic observations and sampling stations (A to D) for the gill-net operation from 1979 to 1982.

Table 1. Date, number, mean size (in cm and g) and rearing facility for juvenile chum salmon released at Ensenada Baja and Coyhaique between 1979 and 1983. SD, standard deviation.

Date of release	Place of release	Number released	Mean size at release		Rearing facility
			Length (SD)	Weight (SD)	
Nov. 24, 1979	Ensenada Baja	25,000	8.6 TL	5.1	Pond to floating pen
Oct. 22, 1980	Coyhaique	449,000	8.9 FL	5.5	Pond
Oct. 26, 1980	Ensenada Baja	83,000	10.9 TL	8.4	Pond
Oct. 27, 1980	Ensenada Baja	363,000	12.6 TL	14.1	Pond to floating pen
Sep. 7, 1981	Coyhaique	428,000	7.7 FL	4.9	Pond
Sep. 12, 1981	Ensenada Baja	553,000	11.4 FL (± 1.1)	11.5 (± 4.5)	Pond to floating pen
Oct. 15, 1982	Coyhaique	810,000	8.2 FL	4.4	Pond
Oct. 22, 1982	Ensenada Baja	457,000	12.1 FL (± 1.0)	15.4 (± 3.8)	Pond to floating pen
Oct. 22, 1982	Ensenada Baja	181,000	9.3 FL (± 0.8)	6.5 (± 1.5)	Pond
Sep. 20, 1983	Coyhaique	895,000	8.2 FL	4.8	Pond
Oct. 1, 1983	Ensenada Baja	497,000	8.4 FL (± 0.7)	5.0 (± 1.1)	Pond
Oct. 1, 1983	Ensenada Baja	390,000	9.0 FL (± 0.7)	6.0 (± 1.2)	Pond to floating pen
Oct. 1, 1983	Ensenada Baja	901,000	11.7 FL (± 1.1)	13.7 (± 4.0)	Pond to floating pen

Table 2. Size and number of gill nets used for the recapture of chum salmon released between 1979 and 1982. Asterisks indicating bottom gill nets; surface gill net without asterisk. H, height; L, length; M, stretched mesh size.

Period	Station		Small gill net					Large gill net			
		H (m):	2	2	2	2	2	6.5	6.5	8.0	3.5
		L (m):	15	15	15	15	15	50	50	53	30
		M (mm):	20	30	40	50	20 - 40 (mixed)	60	105	114	120
Nov. 25 - 30, 1979	A						4				
Nov. 8, 1980	C		2*	2*	2*	2*			4		
Nov. 8, 1980	D		2*	2*	2*	2*					
Sep. 15 - 16, 1981	C		4	5				1			2
Sep. 17, 1981	B		4	5				1			2
Oct. 13, 1981	C		4	5							2
Oct. 14, 1981	B		4	5							2
Oct. 24 - 28, 1982	C		11	12			5			2	
Oct. 29 - 31, 1982	C		3	15						2	

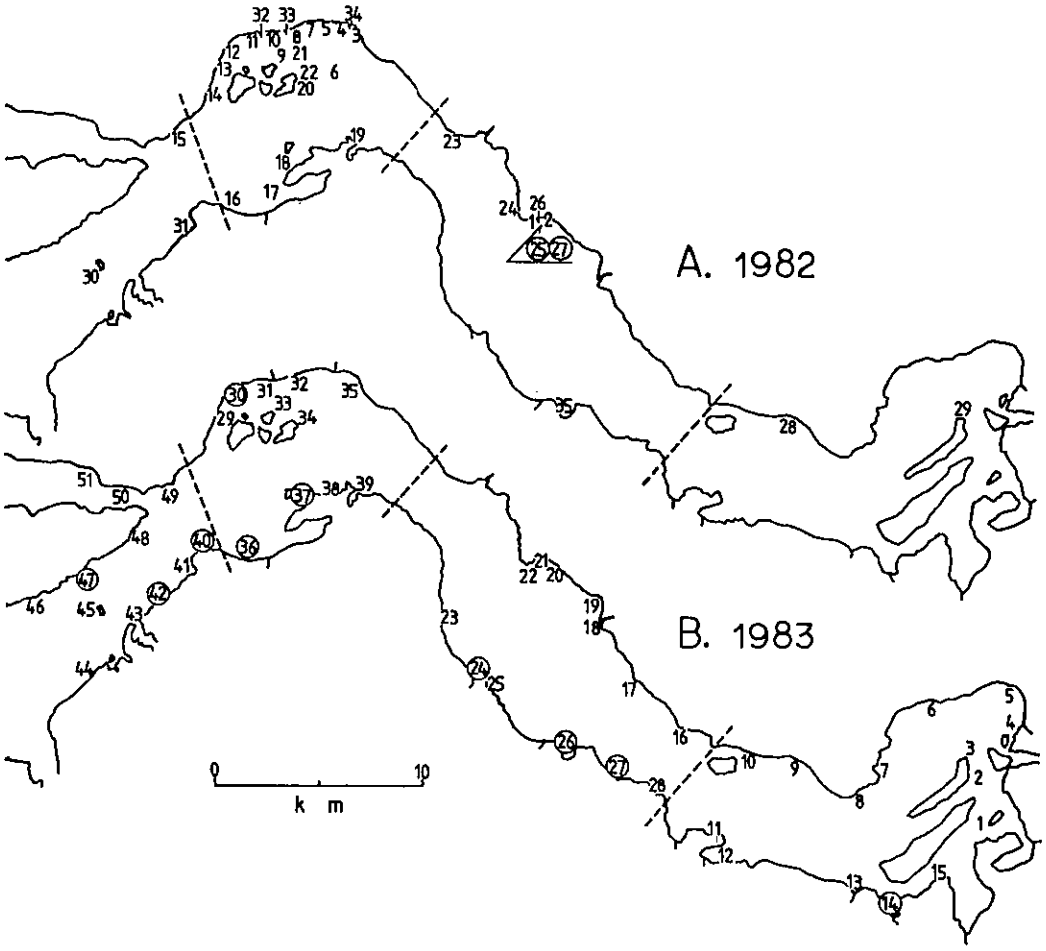

Fig. 3. Sampling stations for the purse-seine operation in Aysén Fiord in 1982 and 1983. Circles indicate where juvenile chum salmon were recaptured.

1982, in a separate study. As shown in Fig. 2, Station 1 is located in the section I, Sts. 2 and 3 in II, St. 4 in III and Sts. 5 and 6 in IV. Specific gravity was measured at each station and converted into salinity. There is a probable error of ± 1 °/oo for calculated values, particulary ± 2 °/oo for the data taken in November 1980, due to the low precision of the specific gravimeters used.

The recapture of juvenile chum salmon in Aysén Fiord was carried out using two kinds of fishing gear, the gill net and purse seine. Operation by gill net took place between September and November from 1979 to 1982, and that by purse seine in October and November 1982 and in October 1983. For the gill-net operation, surface gill nets were used in years other than 1980 (Table 2). The gill nets used were grouped into two categories, small and large gill nets, according to mesh size. The small gill nets had 20 to 50 mm stretched mesh and were utilized for direct capture of juvenile chum salmon, while the large ones, which had 60 to 120 mm mesh, were used for the purpose of obtaining the chum salmon from stomachs of other carnivorous fishes netted.

The gill nets were set at four stations, A (Ensenada Baja), B (Punta Tortuga), C (Puerto Perez) and D (Estero Manco) (Fig. 2). Measurements and the number of gill nets used in each operation are shown in Table 2. At St. A both ends of the nets were fixed in the bay at depths of 5 to 8 m, but at other stations, the nets were extended off from the shore and one end was anchored at depths of 10 to 30 m to the bottom. When fishes were taken out of the nets once or twice a day, meteorolophic and ocenaographic conditions were also observed (Appendix Table 1).

The purse seine had a height of 10 m, length of 126 m and 13 to 28 mm stretched mesh, and was operated by a 5-ton boat, 12 m long. The purse-seine operation was performed at 35 stations (Fig. 3, A) between October 23 and November 4 (1982) and at 51 stations (Fig. 3, B) between October 5 and 21 (1983). Meteorolophic and oceanographic observations at each station are shown in Appendix Tables 2 and 3.

Standard length (SL) or total length (TL) and body weight of most fishes collected during this study were measured immediately after capture and stomach contents were examined by naked eye in the field. Microscopic examination of stomach contents was performed only for some samples of *Sprattus fuegensis* and *Odontesthes smitti,* which were collected by purse seine in 1983. For all the chum salmon captured, except for eight collected at St. 42 (1983) and released again, fork length (FL) and body weight were measured in the laboratory more than a week after preservation in formalin. The stomach contents of each chum salmon were identified under a binocular microscope and weighed to the nearest 0.01 g after the removal of surface water with filter paper. The condition factor (CF) of chum salmon was calculated using the following formula:

$$CF = \frac{\text{Body weight (g)}}{\text{Fork length}^3 \text{ (cm)}} \times 10^3$$

The feeding index (FI) was calculated as follows:

$$FI = \frac{\text{Weight of stomach contents (g)}}{\text{Body weight (g)}} \times 100$$

Table 3. Surface water temperature (°C) and salinity (°/oo) by section of Aysén Fiord between September and November 1980 to 1982. Mean values are indicated in parentheses.

SURFACE WATER TEMPERATURE

Year	Month/date	Section				
		I	II	III	IV	I - IV
1980	SEP	–	–	–	–	–
	OCT	–	–	–	–	–
	NOV / 7 - 8	7.9	9.9	9.4	9.1 - 11.1	7.9 - 11.1
1981	SEP /14 - 17	7.5 - 7.6	7.5 - 9.4	8.1	8.8	7.5 - 9.4
	OCT / 9 - 13	11.1	11.3 - 12.4	10.1 - 12.7	9.9 - 11.9	9.8 - 12.7
	NOV	–	–	–	–	–
1982	SEP /15 - 16	6.9 - 7.9	6.8 - 8.0	7.8 - 8.7	8.4 - 8.9	6.8 - 8.9
	OCT /12 - 14	9.2 - 10.1	9.5 - 10.1	10.1 - 10.2	9.9 - 10.6	9.2 - 10.6
	NOV / 4	10.3	10.1 - 10.5	11.2	11.2 - 11.6	10.1 - 11.6
1980-	SEP	6.9 - 7.9(7.5)	6.8 - 9.4(7.9)	7.8 - 8.7(8.2)	8.4 - 8.9(8.7)	6.8 - 9.4(8.0)
1982	OCT	9.2 - 11.1(10.1)	9.5 - 12.4(10.5)	10.1 - 12.7(10.8)	9.9 - 11.9(10.7)	9.2 - 12.7(10.6)
	NOV	7.9 - 10.3(9.1)	9.9 - 10.5(10.1)	9.4 - 11.2(10.3)	9.1 - 11.6(10.8)	7.9 - 11.6(10.2)
OVERALL RANGE		6.9 - 11.1(8.7)	6.8 - 12.4(9.3)	9.8 - 12.7(9.8)	8.4 - 11.9(10.1)	6.8 - 12.7(9.5)

SURFACE SALINITY

Year	Month/date	Section				
		I	II	III	IV	I - IV
1980	SEP	–	–	–	–	–
	OCT	–	–	–	–	–
	NOV/ 7 - 8	3.0	3.0	3.0	10.0 - 13.0	3.0 - 13.0
1981	SEP /14 - 17	10.7 - 20.3	20.5 - 23.5	24.5	22.5	10.7 - 24.5
	OCT / 9 - 13	2.3	2.3 - 4.5	3.5 - 28.1	12.2 - 26.2	2.3 - 28.1
	NOV	–	–	–	–	–
1982	SEP /15 - 16	2.8 - 10.3	3.5 - 18.7	18.3 - 21.1	19.2 - 23.3	2.8 - 23.3
	OCT /12 - 14	3.5 - 6.4	13.5 - 21.7	14.2 - 26.6	22.6 - 29.4	3.5 - 29.4
	NOV/ 4	3.0	3.7 - 4.3	15.9	15.0 - 20.1	3.0 - 20.1
1980-	SEP	2.8 - 20.3(11.0)	3.5 - 23.5 (17.0)	18.3 - 24.5 (21.3)	19.2 - 23.3(21.9)	2.8 - 24.5(17.4)
1982	OCT	2.3 - 6.4(4.1)	2.3 - 21.7 (11.6)	3.5 - 28.1 (18.1)	12.2 - 29.4(23.0)	2.3 - 29.4(15.4)
	NOV	3.0 (3.0)	3.0 - 4.4 (3.5)	3.0 - 15.9 (9.5)	10.0 - 20.1(14.5)	3.0 - 20.1(8.2)
OVERALL RANGE		2.3 - 20.3(6.9)	2.3 - 23.5 (12.2)	3.0 - 28.1 (17.2)	10.0 - 29.4(20.2)	2.3 - 29.4(14.4)

Table 4. Number by locality of fishes collected by small gill net, large gill net (in parentheses) and purse seine (with and asterisk) in Aysén Fiord between 1979 and 1983.

Family and species	1979	1980		1981		1982		1983	TOTAL
	St. A	St. C	St. D	St. C	St. B	St. C	Aysén Fiord	Aysén Fiord	
Scyliorhinidae									
Halaelurus bivius		5							5 5
Clupeidae									
Sprattus fuegensis			5	4(1)	329	253	2*	42*	591 (1)44* = 636
Engraulidae									
Engraulis ringens						1			1 1
Salmonidae									
Oncorhynchus keta	12			1			11*	65*	13 76* = 89
Salmo trutta	5	(4)			(1)		1*	3*	5 (5) 4 = 14
Moridae									
Salilota australis		4			6				10 10
Merlucciidae									
Macruronus magellanicus			1						1 1
Merluccius australis	1		1		(1)	4			6 (1) = 7
M. gayi					(1)				(1) 1
Atherinidae									
Odontesthes smitti	3	1	1	19	17	133		1*	174 1* = 175
Scorpaenidae									
Sebastes oculatus			1						1 1
Normanichthyidae									
Normanichthys crockeri						(1)			(1) 1
Agonidae									
Agonopsis chiloensis		4	22						26 26
Branchiostegidae									
Prolatilus jugularis			2						2 2
Carangidae									
Trachurus murphyi		(2)				(1)	1*		(3) 1* = 4
Nototheniidae									
Eleginops maclovinus	1	32	10		1	76(17)			120(17) = 137
Notothenia longipes		13	37			21			71 71
N. tessellata			6	1		4			11 11
Clinidae									
Calliclinus geniguttatus						1			1 1
Bothidae									
Hippoglossina macrops		3							3 3
TOTAL	22	62 (6)	86	25 (1)	353 (3)	493 (19)		1041*	1041 (29)
							15*	111*	126* 1196

Table 5. Number, length (standard, total or fork length), and body weight of fishes collected by different fishing gear in Aysén Fiord between 1979 and 1983. SGN, small gill net; LGN, large gill net; PS, purse seine.

Species	Fishing gear	No. of fishes	Length (cm)	Weight (g)
Halaelurus bivius	SGN	5	17.4 - 22.7 TL	?
Sprattus fuegensis	SGN	591	9.0 - 15.3 SL	8 - 39
	LGN	1	11.6 SL	10
	PS	44	7.0 - 14.0 SL	4 - 28
Engraulis ringens	SGN	1	10.0 SL	10
Oncorhynchus keta	SGN	13	8.1 - 11.3 FL	4.2 - 9.2
	PS	76	7.3 - 13.0 FL	3.3 - 20.8
Salmo trutta	SGN	5	?	?
	LGN	5	42.0 - 59.0 SL	900 - 3200
	PS	4	15.1 - 16.9 SL	59 - 66
Salilota australis	SGN	10	11.8 - 14.7 SL	? - 38
Macruronus magellanicus	SGN	1	17.3 SL	?
Merluccius australis	SGN	6	21.1 - 76.5 SL	77 - 2100
	LGN	1	65.3 SL	1700
M. gayi	LGN	1	35.8 SL	375
Odontesthes smitti	SGN	174	11.4 - 28.7 SL	14 - 255
	PS	1	15.7 SL	41
Sebastes oculatus	SGN	1	21.8 SL	?
Normanichthys crockeri	LGN	1	7.5 SL	4
Agonopsis chiloensis	SGN	26	6.7 - 13.4 SL	?
Prolatilus jugularis	SGN	2	16.3 - 22.1 SL	?
Trachurus murphyi	LGN	3	43.0 - 46.5 SL	900 - 1200
	PS	1	40.7 SL	810
Eleginops maclovinus	SGN	120	11.9 - 43.5 SL	23 - 1225
	LGN	17	36.7 - 50.4 SL	945 - 1635
Notothenia longipes	SGN	71	7.7 - 17.8 SL	?
N. tessellata	SGN	11	7.8 - 14.5 SL	? - 45
Calliclinus geniguttatus	SGN	1	11.4 SL	31
Hippoglossina macrops	SGN	3	7.4 - 8.7 SL	?

RESULTS

I. Oceanographic conditions of Aysén Fiord

Surface water temperature of Aysén Fiord varied from 6.8° to 12.7°C between September and November, from 1980 to 1982 and gradually increased going from section I towards IV (Table 3). In September, the water temperature ranged from 6.8° to 9.4°C, and became 1.6° to 2.6°C higher (on the average in each section) in October and November.

There was a great fluctuation in surface salinity within each section between September and November, varying from 2.3 to 29.4 °/oo (Table 3). However, mean values in the sections showed that in this period the surface salinity was usually lower than 10°/oo at the innermost part of Aysén Fiord and increased to about 20°/oo at its mouth. In each section, the salinity tended to decrease from September to November.

Many rivers run into Aysén Fiord as shown in Fig. 2. From the above data on both the water temperature and salinity, there is little doubt that the surface water of the fiord is strongly influenced by freshwater flows from the rivers, particularly from the largest, the Aysén (Simpson) River.

II. Fishes collected.

A total of 1196 fishes belonging to 20 species contained in 15 families were collected in Aysén Fiord during this study. Of the fishes collected, 1041 belonging to 17 species were caught by small gill net, 29 belonging to 7 species by large gill net, and 126 belonging to 5 species by purse seine (Table 4). Table 5 summarizes the number, length, and body weight of each species according to type of fishing gear used. The fishes captured by small gill net contained the most number of species. Of these, *Sprattus fuegensis, Odontesthes smitti* and *Eleginops maclovinus* formed the largest part of the catch. *E. maclovinus, Salmo trutta* and *Trachurus murphyi* were dominat in number of those fishes caught by large gill net. The catch by purse seine was composed largely of the chum salmon *O. keta* and *S. fuegensis*. With respect to the chum salmon, 13 fish were captured by small gill net and 76 by purse seine. Most of the two species, *S. fuegensis* and *O. smitti* had well-developed or mature gonads, and spawning of these species seemed to take place in September or October.

III. Stomach contents of fishes collected.

Of the 20 species collected, 16 underwent a stomach content analysis. A large number of the fishes examined were obtained between the middle and mouth of Aysén Fiord. No chum salmon were found in the stomachs of any other fishes. *Engraulis ringens, Macruronus magellanicus, Merluccius gayi* and *Normanichthys crockeri,* of which only one fish was collected respectively, had empty stomachs. The stomach contents of the remaining 12 species were classified into 25 prey items in nine higher taxonomic categories (Table 6). Except for the species of which few samples were examined, *O. smitti* and *S. fuegensis* showed high percentages (69.2 and 53.9°/o respectively) of empty stomachs. *O. keta* and *E. maclovinus* had a smaller number of empty stomachs, less than 10°/o of the total, and a great variety of prey organisms in their stomachs, although a more detailed examination of stomach contents was made in *O. keta*. Omnivorousness was found in the three notothenid species, *E. maclovinus, Notothenia longipes* and *N. tessellata* (Table 6). In *E. maclovinus,* particularly, algae had the highest frequency of occurrence (Table 6 and Fig. 4).

As shown in Fig. 4, crustaceans were a very important food source for most species. Planktonic crustaceans such as cladocerans, calanoids, balanid larvae and decapod larvae were eaten mainly by surface swimmers, i.e. *S. fuegensis, O. keta* and *O. smitti.* In addition, terrestrial

Table 6. Stomach contents of fishes obtained by gill net and purse seine from Aysén Fiord between 1979 and 1983, showing frequency of occurrence and percentage of the total in parentheses.

Species	*S. fuegensis*	*O. keta*	*S. trutta*	*S. australis*	*M. australis*	*O. smitti*	*A. chiloensis*	*P. Jugularis*	*T. murphyi*	*E. maclovinus*	*N. longipes*	*N. tessellata*
No. of fish examined	245	81	9	10	6	133	25	2	4	132	70	10
No. of stomachs with preys	113	76	6	6	1	41	22	1	2	121	58	10
No. of empty stomachs	132	5	3	4	5	92	3	1	2	11	12	0
(% of total number)	(53.9)	(6.2)	(33.3)	(40.0	(83.3)	(69.2)	(12.0)	(50.0)	(50.0)	(8.3)	(17.1)	(0)
ALGAE										100(52.6)	1(1.3)	6(27.3)
GASTROPODA larvae	3(3.1)											
BIVALVIA										3(1.6)	1(1.3)	
POLYCHAETA TOTAL		1(0.4)						1(100)		1(0.5)	1(1.3)	
Amphinomorpha								1(100)				
Nereimorpha		1(0.4)								1(0.5)	1(1.3)	
CRUSTACEA TOTAL	91(94.8)	167(64.5)	3(37.5)	11(100)		72(94.7)	32(100)		2(100)	78(41.1)	71(93.4)	15(68.2)
Cladocera	4(4.2)	30(11.6)				1(1.3)						
Calanoida	6(6.3)	36(13.9)				1(1.3)				1(0.5)		
Harpacticoida		14(5.4)										
Balanidae cypris	4(4.2)	16(6.2)				1(1.3)						
Cirripedia		2(0.8)								17(8.9)	1(1.3)	2(9.1)
Isopoda				3(27.3)			7(21.9)			2(1.1)	6(7.9)	
Amphipoda	6(6.3)	10(3.9)	2(25.0)	4(36.4)			20(62.5)			41(21.6)	24(31.6)	9(40.9)
Euphausiacea	6(6.3)	14(5.4)					5(15.6)				11(14.5)	1(4.5)
Macrura				2(18.2)								
Brachyura				1(9.1)						3(1.6)	21(27.6)	1(4.5)
Decapoda larvae	43(44.8)	45(17.4)	1(12.5)	1(9.1)		64(84.2)			2(100)	13(6.8)	6(7.9)	2(9.1)
Crustacea digested	22(22.9)					5(6.6)				1(0.5)	2(2.6)	
INSECTA TOTAL		37(14.3)	1(12.5)							1(0.5)		
Aquatic insects		8(3.1)	1(12.5)							1(0.5)		
Terrestrial insects		29(11.2)										
SAGITTOIDEA		6(2.3)										
APPENDICULARIA		4(1.5)										
PISCES TOTAL	2(2.1)	44(17.0)	4(50.0)		1(100)	4(5.3)				7(3.7)	2(2.6)	1(4.5)
Fishes			4(50.0)		1(100)					7(1.1)	2(2.6)	1(4.5)
Fish eggs	1(1.0)	1(0.4)				4(5.3)				4(2.1)		
Fish larvae	1(1.0)	43(16.6)								1(0.5)		
Number of prey items	10	15	4	5	1	6	3	1	1	14	11	7
Total occurrence of preys	96	259	8	11	1	76	32	1	2	190	76	22

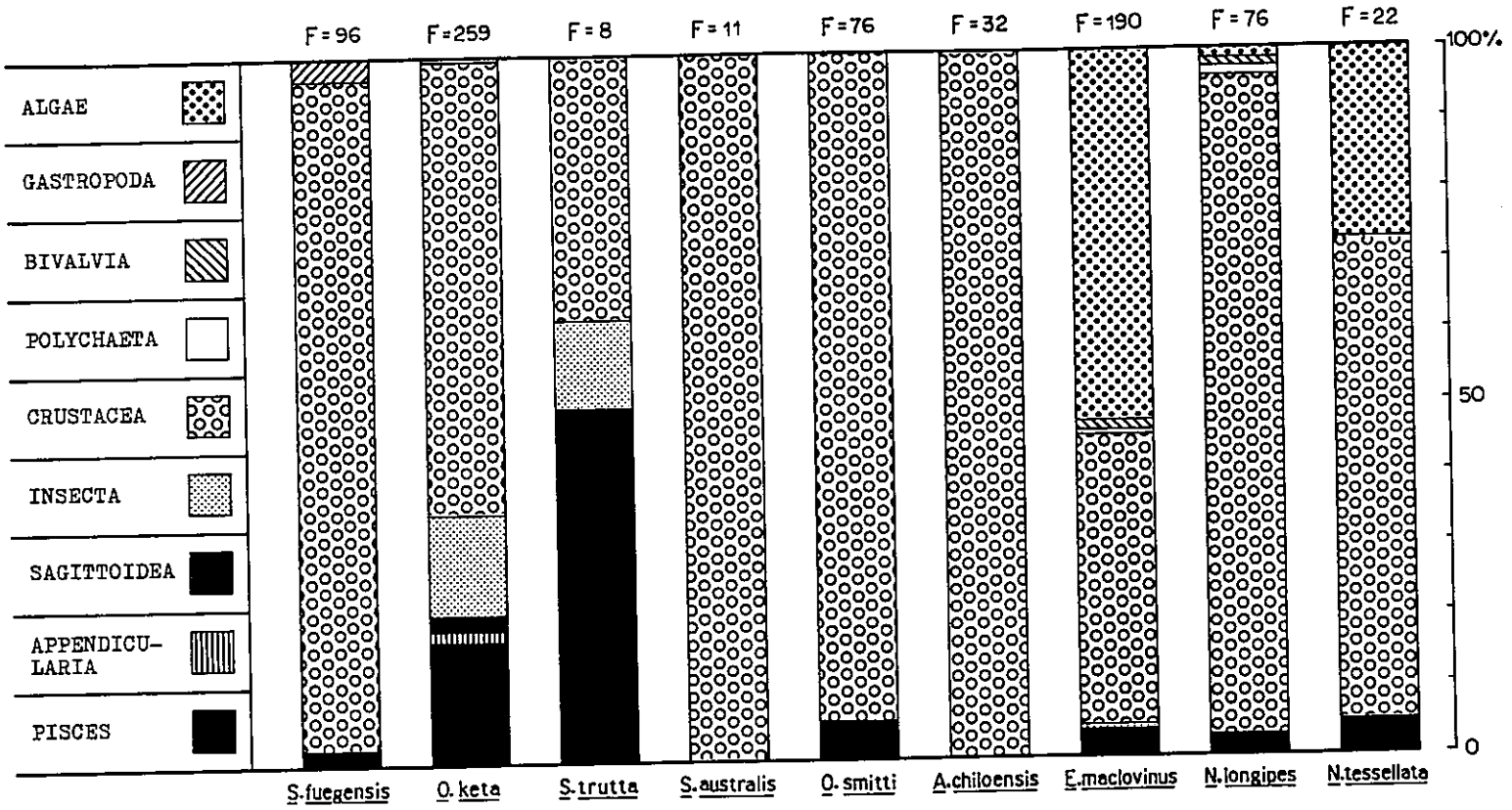

Fig. 4. Composition of stomach contents of selected species obtained from Aysén Fiord between 1979 and 1983, depicted by frequency of ocrrurence percentage. F, total frequency of occurrence.

Table 7. Summary of juvenile chum salmon captured at each station in Aysén Fiord between 1979 and 1983. Under feeding index, 0.0 for fish with stomach contents less than 0.01 g. SGN, small gill net; PS, purse seine.

Date	Station (section)	Fishing gear	No. of fish	Fork length (cm)	Body weight (g)	Condition factor	Feeding index	No. of gill rakers
1979								
Nov. 25	A(I)	SGN	9	8.2 - 9.3	4.2 - 6.9	7.1 - 8.6	0.0 - 1.52	8 - 9 + 13 - 14 = 21 - 23
26	A(I)	SGN	2	8.1 - 8.6	4.3 - 5.4	8.1 - 8.5	0.0 - 1.40	8 + 12 - 14 = 20 - 22
27	A(I)	SGN	1	8.5	4.2	6.8	0.0	8 + 13 = 21
1981								
Sep. 15	C(II)	SGN	1	11.3	9.2	6.4	0.43	8 + 13 = 21
1982								
Oct. 31	25(II)	PS	6	10.0 - 12.6	8.4 - 18.0	8.4 - 9.0	0.0 - 2.22	8 - 9 + 13 - 14 = 21 - 23
31	27(II)	PS	5	7.8 - 9.5	4.1 - 7.4	8.3 - 8.7	0.14 - 1.56	8 - 9 + 12 - 14 = 20 - 23
1983								
Oct. 5	14(I)	PS	6	11.0 - 12.2	13.8 - 18.4	9.4 - 10.4	0.49 - 0.94	8 - 9 + 13 - 15 = 22 - 24
11	24(II)	PS	14	11.0 - 13.0	11.2 - 20.8	8.3 - 10.1	0.05 - 3.87	8 - 10 + 12 - 15 = 20 - 25
11	26(II)	PS	2	9.3 - 11.0	7.5 - 12.0	9.0 - 9.3	0.25 - 2.40	9 + 14 = 23
11	27(II)	PS	4	7.3 - 8.5	3.4 - 5.5	8.7 - 11.8	0.0 - 6.74	8 - 9 + 13 - 14 = 21 - 23
18	30(III)	PS	1	8.5	5.5	9.0	0.36	9 + 14 = 23
18	36(III)	PS	6	10.2 - 12.7	11.1 - 19.5	9.4 - 10.5	0.26 - 2.89	8 - 9 + 13 - 15 = 22 - 24
18	37(III)	PS	4	8.6 - 9.9	5.6 - 9.4	8.8 - 9.7	0.53 - 0.89	8 - 9 + 13 - 14 = 21 - 23
21	40(IV)	PS	8	8.5 - 12.5	5.2 - 16.7	7.7 - 9.1	0.0 - 4.28	8 - 9 + 13 - 15 = 21 - 24
21	42(IV)	PS	16	7.5 - 11.5	3.6 - 12.9	7.2 - 9.2	0.0 - 2.25	8 - 9 + 12 - 14 = 20 - 23
21	47(IV)	PS	4	7.5 - 9.4	3.3 - 6.3	6.9 - 7.8	0.61 - 3.49	8 - 10 + 12 - 15 = 20 - 24
TOTAL OR RANGE			89	7.3 - 13.0	3.3 - 20.8	6.4 - 11.8	0.0 - 6.74	8 - 10 + 12 - 15 = 20 - 25

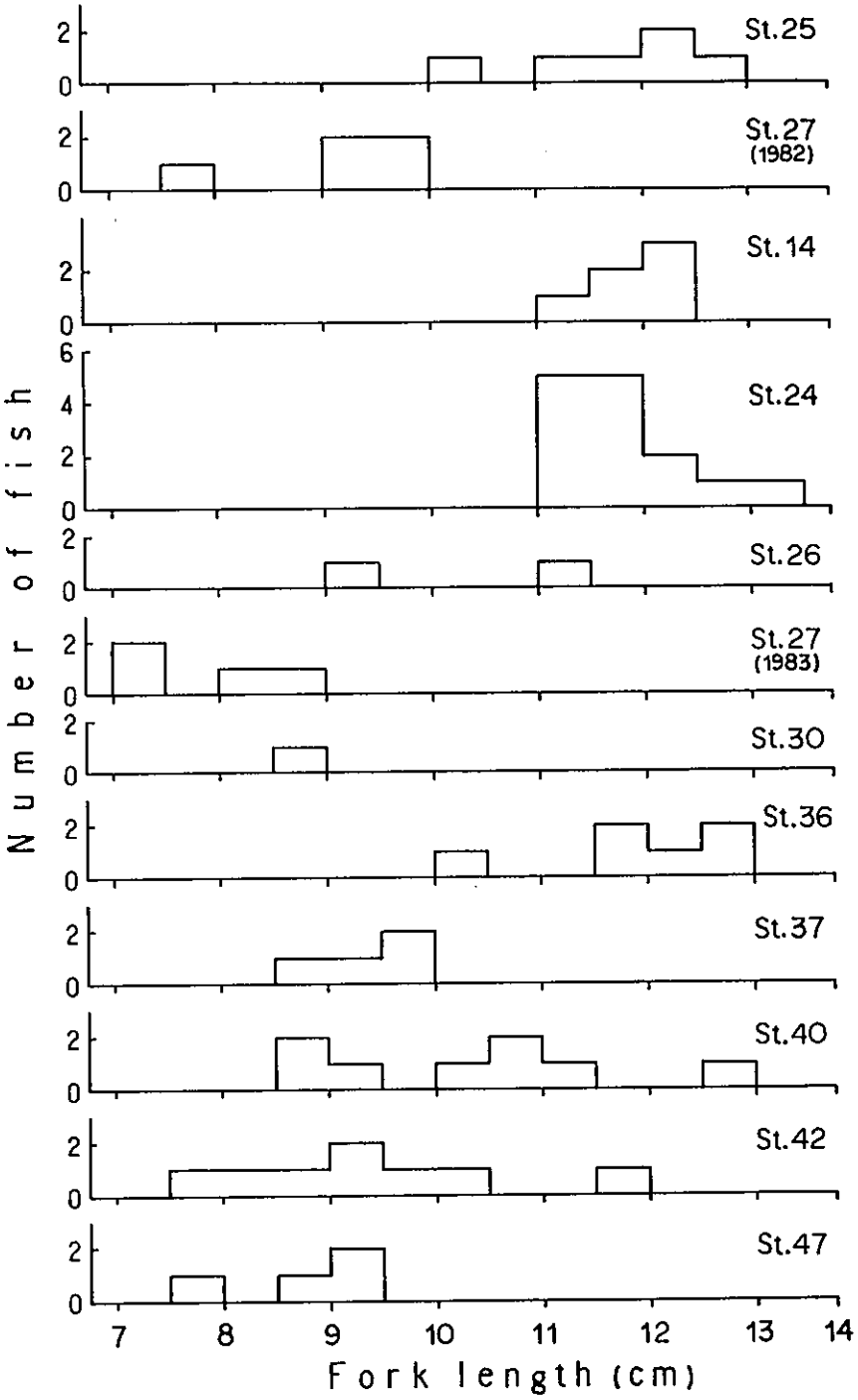

Fig. 5. Fork length composition of juvenile chum salmon captured by purse seine at each station in Aysén Fiord in 1982 and 1983.

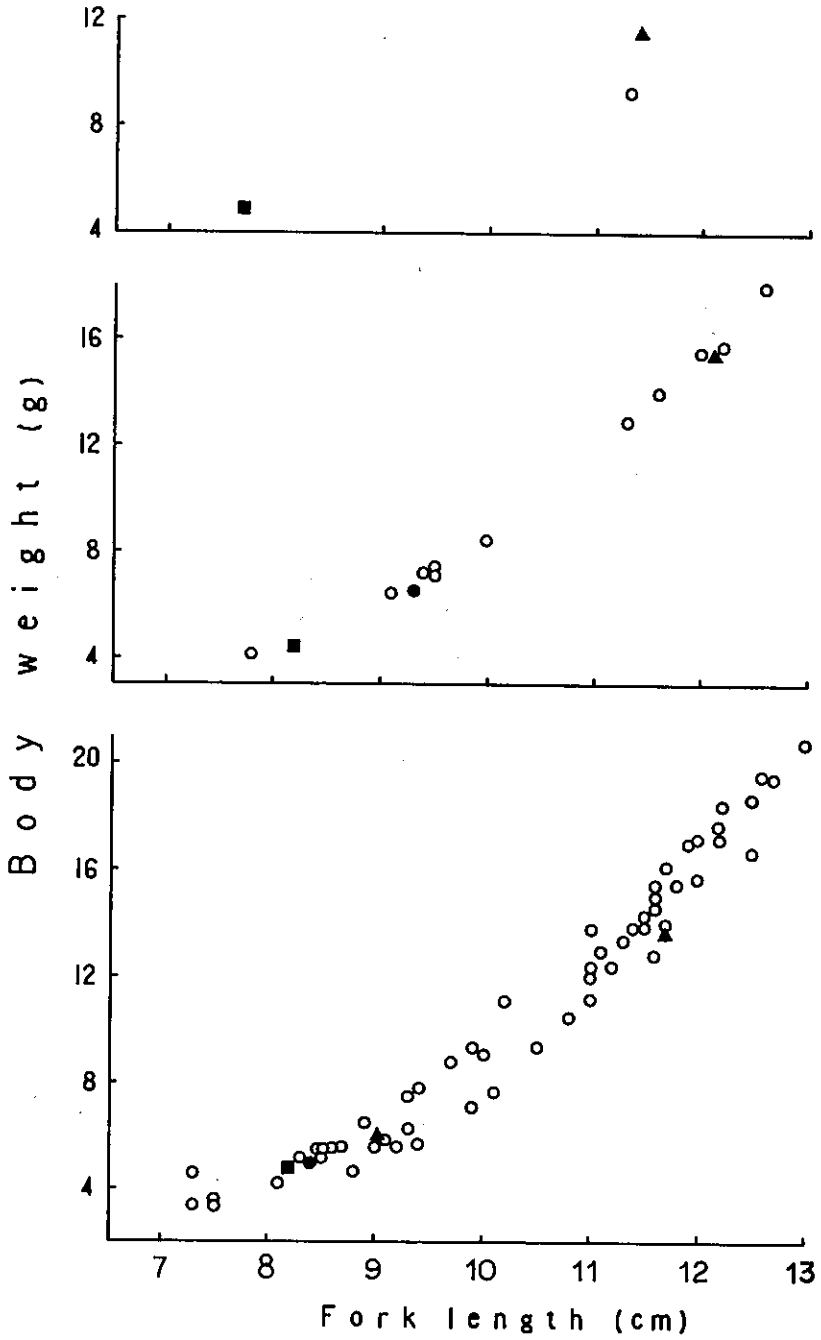

Fig. 6. Relationship between fork length and condition factor of juvenile chum salmon captured in Aysén Fiord from 1981 to 1983. Black circles, triangles, and squqres show average measurements of fish at release from ponds at Ensenada Baja, from floating pens at Ensenada Baja, and from ponds at Coyhaique, respectively (see Table 1).

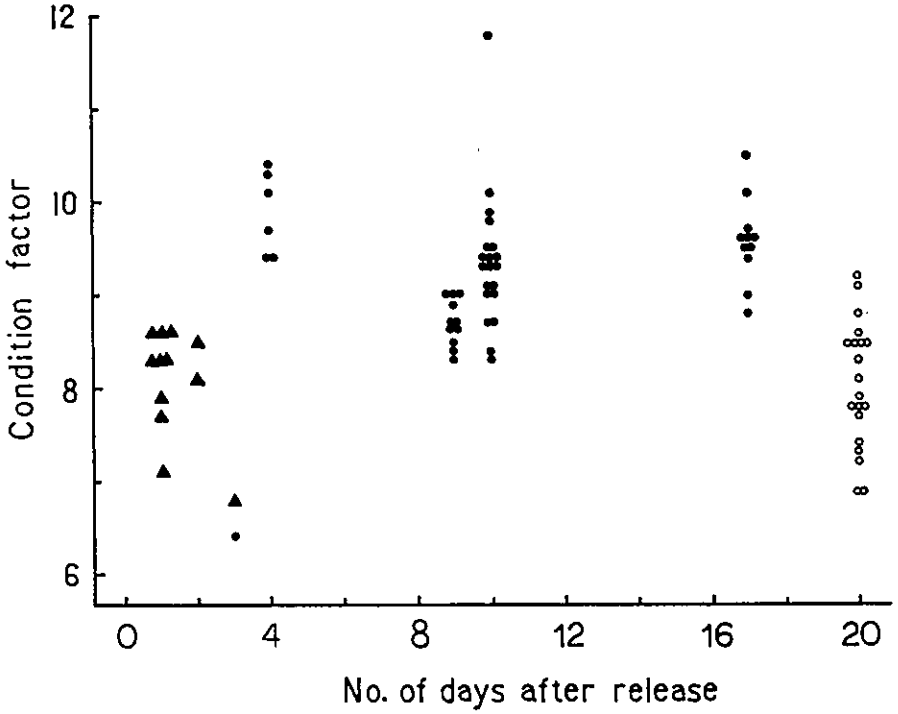

Fig. 7. Relationship between fork length and condition factor of juvenile chum salmon obtained from Aysén Fiord between 1979 and 1983. Black triangles and white circles depict fish collected on November 25 to 27 (1979) and on October 21 (1983), respectively; black circles for all others.

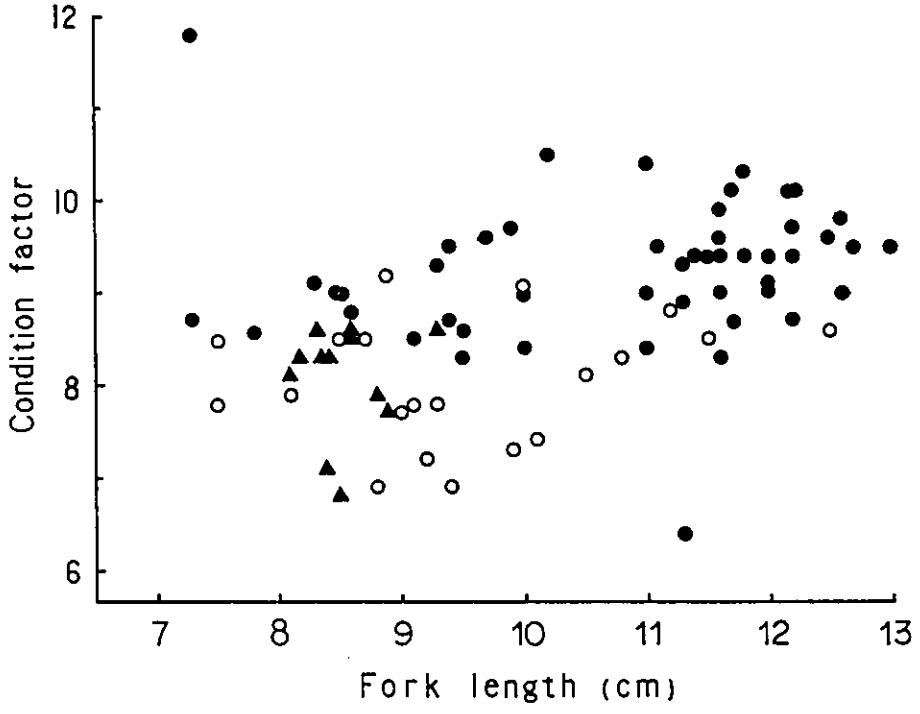

Fig. 8. Change in condition factor after release of juvenile chum salmon obtained from Aysén Fiord between 1979 and 1983. Symbols as in Fig. 7.

insects and fish larvae were frequently utilized as food by O. *keta*. On the hand, benthic cirripedians, isopods, amphipods, and brachyurans formed important foods for *Salilota australis*, *Agonopsis chiloensis* and the three nototheniids, which all inhabit the bottom layers. These differences in prey organisms between the surface swimmers and bottom dewellers may reflect not only food preference, but availability. Among the species presently examined, *S fuegensis* and *O. smitti* are likely competitors for food with juvenile chum salmon in Aysén Fiord.

IV. Number, length, and body weight of recaptured chum salmon.

Within a few days after release, 12 chum salmon were collected by small gill net at St. A in 1979. No chum salmon were caught in 1980, although the recapture of fish released was attempted at Sts. C and D (Table 2). In 1981, only one fish was netted at St. C. Thereafter,11 fish were obtained by purse seine from two stations in 1982 (Fig. 3, A), and in 1983, 65 fish from 10 stations were collected in all the sections of Aysén Fiord (Fig. 3, B). Thus, a total of 89 released juvenile chum salmon were recaptured in the fiord between 1979 and 1983.

The number, fork length, and body weight of the chum salmon collected at each station are summarized in Table 7. The fork length of the fish ranged from 7.3 to 13.0 cm, and the body weight (BW) from 3.3 to 20.8 g. As shown in Fig. 5, the fork length composition of the fish obtained by purse seine tended to be grouped at each station although the ranges overlapped. This suggest that the chum salmon released may form schools acoording to size.

It was apparent that the 12 chum salmon collected at St. A (Ensenada Baja) in 1979 were those released into the bay. The FL-BW relationship of the fish collected from 1981 to 1983 is shown in Fig. 6, which also presents average measurements of fish released at Ensenada Baja and Coyhaique for each year. There is little doubt that the one fish which was captured in 1981 originated from Ensenada Baja. As for the fish obtained in 1982 and 1983, it is likely that they were a mixture of fish from both Ensenada Baja and Coyhaique, but most fish, larger than 9 cm FL, are regarded to be of Ensenada Baja origin according to the FL - BW relationship (Fig. 6).

In 1981 and 1982 all the fish were captured on the north shore of Aysén Fiord, while in 1983 all but 5 (at St. 30) were collected on the south shore (Figs. 2 and 3). Although Ensenada Baja is located on the south side of Aysén Fiord (Fig. 2), it is certain that the fish of Ensenada Baja origin move outward along both sides of the fiord.

V. Condition factor of recaptured chum salmon.

The condition factor of chum salmon examined in this study ranged from 6.4 to 11.8 (Table 7). The condition factor tended to increase with the size of the fish although there were a few exceptions (Fig. 7). Fig. 8 depicts the change in condition factor after release. The fish collected on November 25-27, 1979 and on Octover 21, 1983 showed relatively low values, less than about 9.0.

The low values of the 1979-group may result from the small size of fish (Fig. 7). However, the condition factor of the latter group was low, even in larger fish (Fig. 7). This group is presumed to have consisted of less-grown fish. In general, there seems to be no great change in condition factor in fish migrating through Aysén Fiord.

VI. Stomach contents of recaptured chum salmon.

Among the chum salmon examined, only five from St. A had empty stomachs. Ensenada Baja is a small inlet 2.3 km long and 0.9 km wide. It is likely, therefore, that food availability was reduced because of the large number of chum salmon released. The feeding index of chum salmon collected in this study varied from 0.0 to 6.74, usually 0.1 to 3.0, showing no correlation

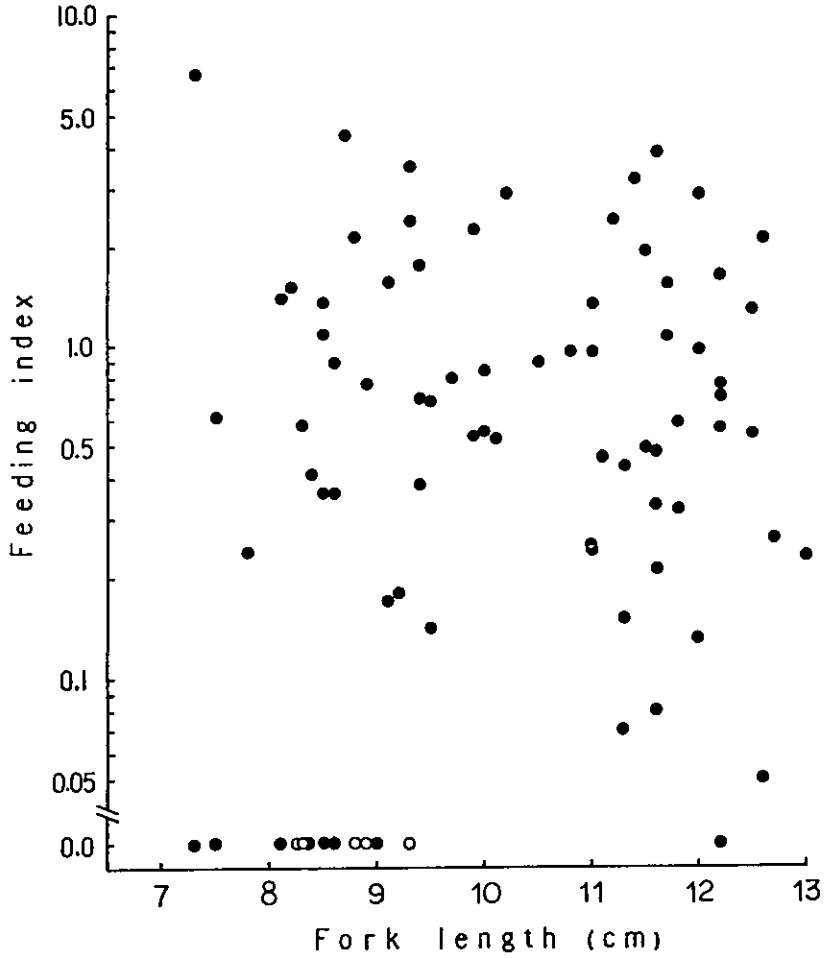

Fig. 9. Relationship between fork length and feeding index of juvenile chum salmon from Aysén Fiord between 1979 and 1983. White circles for fish which had no stomach contents.

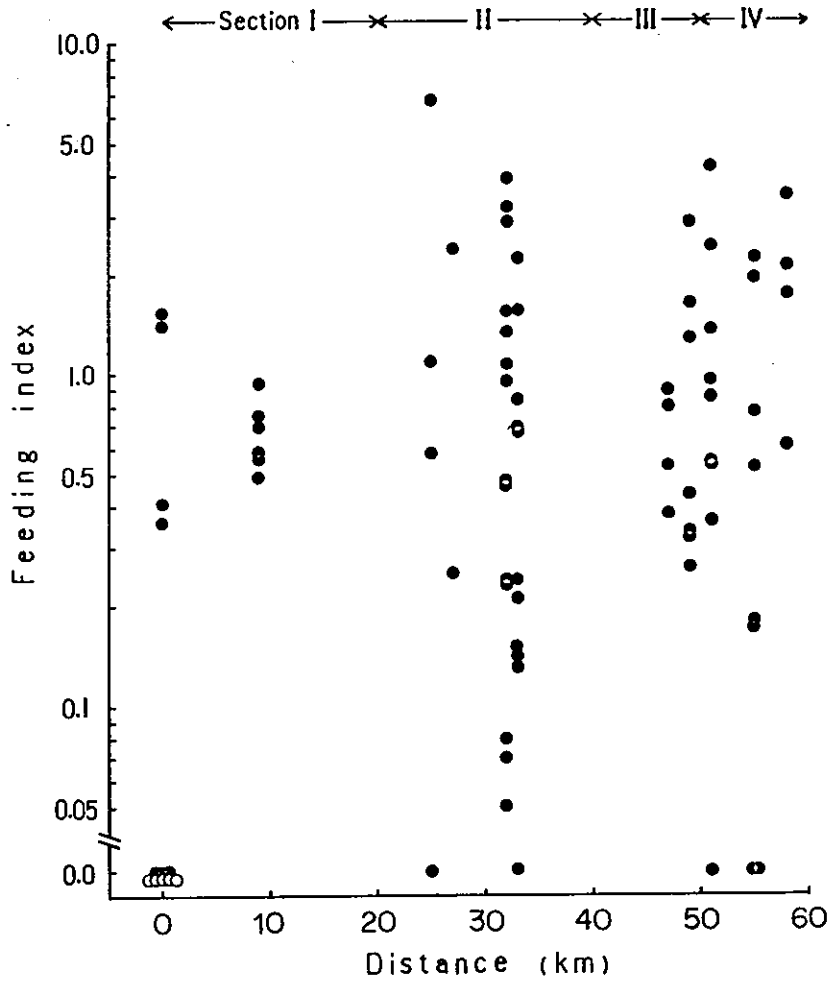

Fig. 10. Relationship between migrating distance from Ensenada Baja and feeding index of juvenile chum salmon from Aysén Fiord between 1979 and 1983. White circles as in Fig. 9.

Table 8. Stomach contents of juvenile chum salmon obtained from each section of Aysén Fiord between 1979 and 1983, showing average number of prey organisms per stomach and frequency of occurrence in parentheses. Plus signs indicate less than 0.1.

Section	I	II	III	IV	I - IV
No. of fish examined	18	31	12	20	81
Total no. of preys	13461	871	1238	873	16443
Average no. of preys per stomach	748	28	103	44	203
POLYCHAETA					
Syllidae juvenile			+ (1)		+(1)
CLADOCERA					
Podon leuc karti	719.9(6)	16.6(14)	60.4(9)	0.1(1)	175.3(30)
CALANOIDA					
Acartia tonsa			0.4(4)	+(1)	+(5)
Aetideus armatus				+(1)	+(1)
Calanoides patagoniensis			14.6(9)	1.9(7)	2.6(16)
Calanus chilensis		0.1(3)	0.5(4)	7.0(10)	1.8(17)
Calanus sp.		+(1)		+(1)	+(2)
Candacia cheirura			+(1)	0.2(3)	+(4)
Drepanopus sp.			2.6(5)	0.6(5)	0.5(10)
Euchaeta sp.				7.7(3)	1.9(3)
Metridia lucens			2.3(4)	3.1(7)	1.1(11)
Paracalanus parvus		+(1)			+(1)
Rhincalanus nasutus		+(2)	0.2(2)	8.0(6)	2.0(10)
Calanoida spp.	0.2(1)	0.2(4)	7.7(7)	0.7(4)	1.4(16)
HARPACTICOIDA					
Harpacticoida sp.	0.7(5)	0.9(7)	0.2(2)		0.5(14)
CIRRIPEDIA					
Balanidae cypris	22.4(6)	1.4(6)	1.6(4)		5.7(16)
Cirripedia (cirri)		+(1)	+(1)		+(2)
AMPHIPODA					
Gammaridea spp.		0.3(7)			+(7)
Hyperiidae spp.				0.2(3)	+(3)
EUPHAUSIACEA					
Euphausiidae larvae			+(1)	2.0(13)	0.5(14)
MACRURA					
Sergestes larvae	0.3(2)	3.3(11)	3.8(7)	1.0(9)	2.1(29)
Macrura mysis			+(1)	0.1(1)	+(2)
ANOMURA					
Munida zoea		+(1)	0.2(2)	1.6(9)	0.4(12)
Callianassidae zoea				+(1)	+(1)
Porcellanidae zoea	0.5(1)	+(1)	0.3(4)		0.2(6)
BRACHYURA					
Atelecyclidae zoea	1.8(4)	0.5(3)	1.1(4)		0.7(11)
Brachyura zoea	0.7(2)	0.3(4)	0.7(2)	0.2(3)	0.4(11)
Brachyura megalopa			+(1)	1.4(5)	0.4(6)
INSECTA					
Chironomidae larvae	0.1(2)	+(1)			+(3)
Aquatic insects		0.2(4)	0.2(2)		+(6)
Terrestrial insects	1.3(6)	2.5(8)	0.4(3)	0.4(4)	1.4(21)
SAGITTOIDEA					
Sagitta sp.			0.3(2)	1.0(4)	0.3(6)
APPENDICULARIA					
Oikopleura sp.			+(1)	0.6(3)	0.2(4)
PISCES					
Fish eggs				0.2(1)	+(1)
Sprattus fuegensis larvae		1.0(7)	3.3(8)	5.3(11)	2.2(26)
Galaxias maculatus larvae		+(2)		+(1)	+(3)
Eleginops maclovinus larvae		0.1(3)	0.5(2)	0.2(3)	0.2(8)
Fish larvae		0.5(11)	1.5(6)	0.3(3)	0.5(20)
Number of prey items	10	22	28	28	38
Total occurrence of preys	35	102	99	123	359

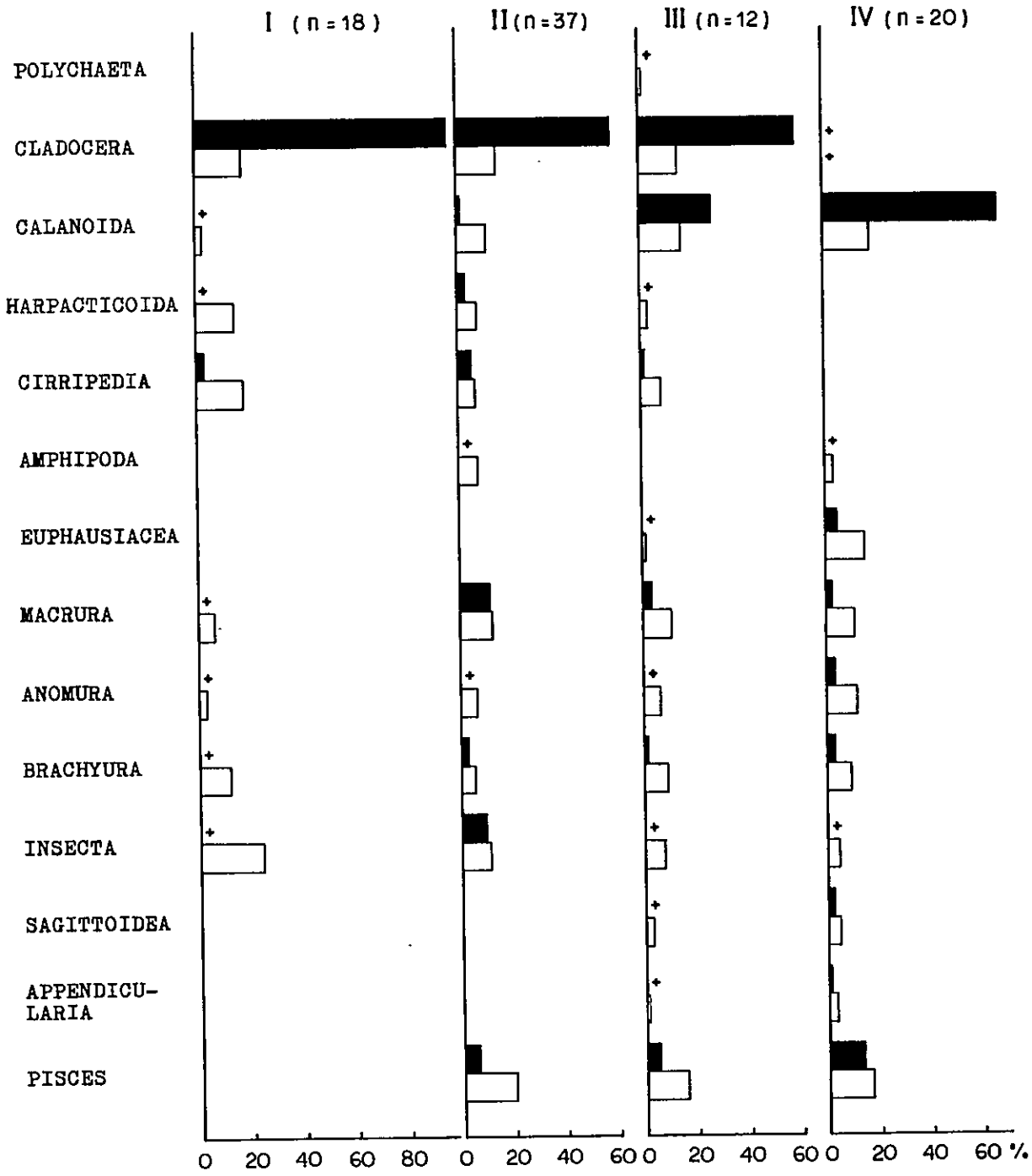

Fig. 11. Composition of stomach contents of juvenile chum salmon by animal group from each section of Aysén Fiord between 1979 and 1983. Black and white bars show numerical and frequency of occurrence percentages, respectively. +, less than 1%; n, number of fish examined.

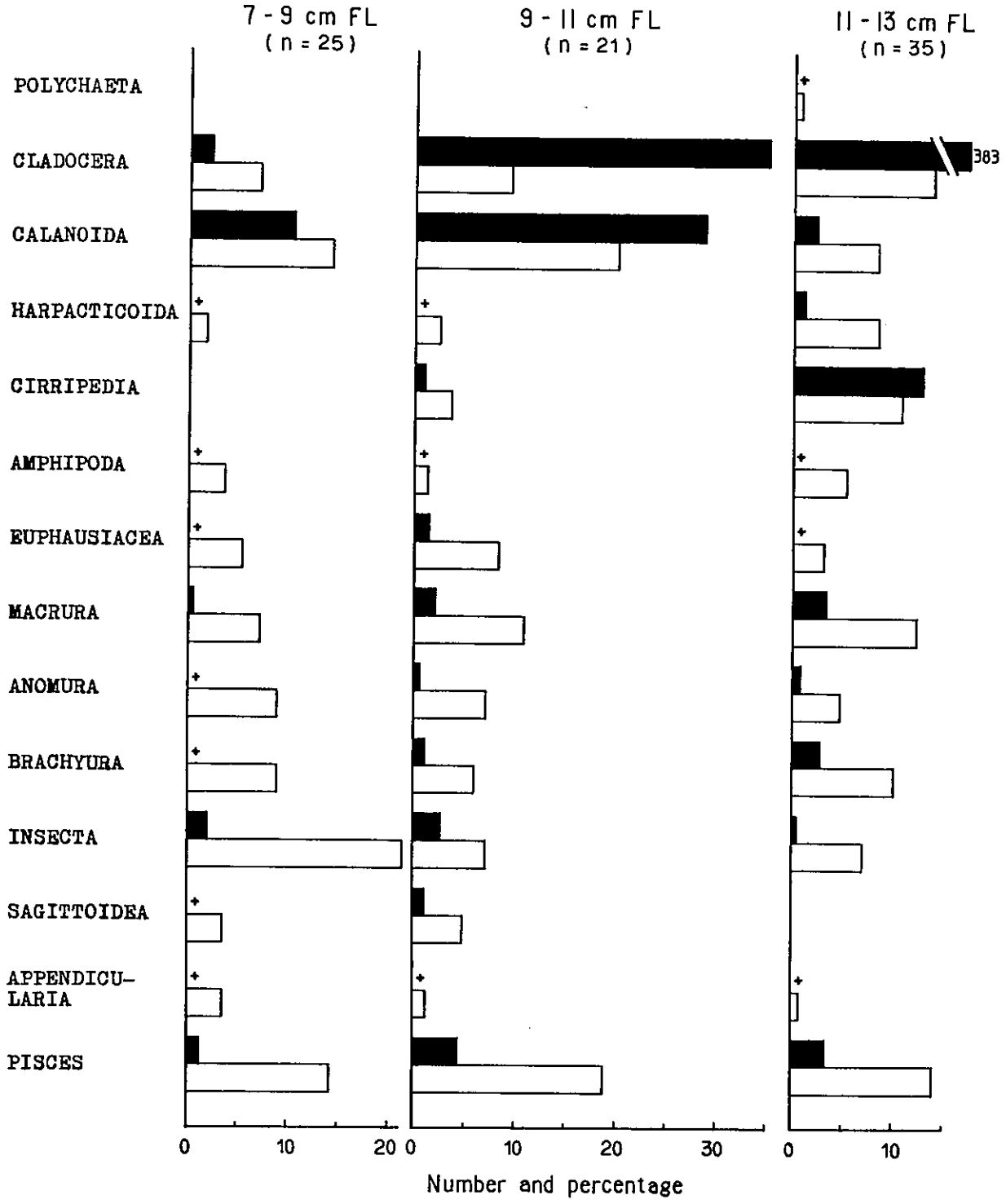

Fig. 12. Average number (black bar) of prey organisms per stomach and frequency of occurrence percentage (white bar) in juvenile chum salmon of different size groups from Aysén Fiord between 1979 and 1983. +, less than 1 or 1 %; n, number of fish examined.

with the size of the fish (Table 7 and Fig. 9). A great variation in feeding index was found in fish from each section, but in the section I, there was no fish which had a feeding index higher than 2.0 (Fig. 10).

The stomach contents of the chum salmon were identified to the lowest possible taxonomical level and classified into 38 items (Table 8). The average number of prey organisms eaten per fish and frequency of occurrence are shown in Table 8. The number of prey items was smallest at 10 in section I, 22 in II and 28 in both III and IV. Cladocerans, calanoids, decapod (Macrura, Anomura and Brachyura) larvae and terrestrial insects were found in the stomachs of the chum from all the sections. An exceeding number of cladocerans (*Podon leuckarti*), which are minute plankton, were eaten in section I. Dominant calanoid species included *Calanoides patagoniensis, Calanus chilensis, Rhincalanus nasutus, Euchaeta sp., Metridia lucens* and *Drepanopus* sp. Macrurans were mostly made up of *Sergestes* larvae which occurred in all the sections. *S. fuegensis* was the most dominant species of the fish larvae preyed upon.

Cladocerans, harpacticoids, balanid larvae (Cirripedia), decapod larvae and insects are regarded as the main food in the innermost parts of Aysén Fiord (Fig. 11). Cladocerans were most numerous in sections I to III, and replaced by calanoids in IV. The calanoids increased in both number and frequency of occurrence going from section I towards IV. Between sections II and IV, cladocerans, copepods, decapod larvae and fish larvae were important food sources for chum salmon. Harpacticoids, balanid larvae and aquatic insects occurred in the three inner sections (I to III), while euphausiids, arrow worms (*Sagitta* sp.) and appendicularians (*Oikopleura* sp.) were confined to the outer two (III and IV) (Table 8). These changes in prey utilized by the chum salmon seem to result from the difference in food organism fauna corresponding with the salinity of Aysén Fiord (Table 2).

In order to analyze the utilization of food organisms by chum salmon of different sizes, the fish examined were grouped into three at the FL-interval of 2 cm (Fig. 12). Calanoids, insects and arrow worms were more important for the smaller two groups. Cladocerans, harpacticoids, balanid larvae and decapod larvae became increasingly important for larger fish. Larger chum salmon did not contain larger prey such as euphausiids, arrow worms and fish larvae. As mentioned above, the fauna of food organisms in Aysén Fiord is presumed to change from the innermost part to the mouth. Therefore, the different sampling stations of the chum may have affected this analysis.

VII. Migration rate of released chum salmon.

The chum salmon recaptured in this study included largely those released at Ensenada Baja in each year (Fig. 6). Supposing that each collection included fish of Ensenada Baja origin, the approximate migration rates from Ensenada Baja to various stations are shown in Table 9. In October 1981 one fish reached St. C at the exceptionally fast rate of 16.3 km per day. The migration rates for the other fish are estimated to be 2.3 to 3.7 km per day, an average of 2.9 km. Juvenile chum salmon may migrate through Aysén Fiord at a rate of about 3 km per day.

DISCUSSION

The present study shows that crustaceans are a very important food source for most species of fishes obtained largely between the middle and mouth of Aysén Fiord, and the prey items utilized by chum salmon increased from the innermost part of the fiord toward the mouth. According to Hirakawa (1984), the zooplankton biomass of Aysén Fiord is much lower in the

Table 9. Approximate migration rate through Aysén Fiord of chum salmon released into Ensenada Baja in 1981 to 1983.

Date of release	Date of collection	No. of days after release	Station	Distance from Ensenada Baja (km)	Migration rate per day (km)
1981					
Oct. 12	Oct. 15	3	C	49	16.3
1982					
Oct. 22	Oct. 31	9	25 & 27	33	3.7
1983					
Oct. 1	Oct. 5	4	14	9	2.3
Oct. 1	Oct. 11	10	24	32	3.2
Oct. 1	Oct. 11	10	26	27	2.7
Oct. 1	Oct. 11	10	27	25	2.5
Oct. 1	Oct. 18	17	30	51	3.0
Oct. 1	Oct. 18	17	36	49	2.9
Oct. 1	Oct. 18	17	37	47	2.8
Oct. 1	Oct. 21	20	40	51	2.6
Oct. 1	Oct. 21	20	42	55	2.8
Oct. 1	Oct. 21	20	47	58	2.9

surface layer than in the lower layer between 10 and 15 m deep, and there is little biomass in each layer of the innermost part of Aysén Fiord. On the basis of the stomach contents of fishes collected in Ensenada Baja, we (1982) previously mentioned that the rare occurrence of crustaceans (such as mysids, isopods and decapods) and algae as prey probably results from very low intertidal and benthic communities in the bay because of the strong influence of the freshwater flows from rivers.

We (1982) also showed that in Ensenada Baja, the degree of piscivorousness is higher in *Merluccius gayi, M. australis, Trachurus murphyi* and *Salmo trutta.* We observed that the latter three and *Eleginops maclovinus* preyed on juvenile chum and pink (*Oncorhynchus gorbuscha*) salmon released into Ensenada Baja (Agencia de Cooperación Internacional del Japón, 1981 and unpublished data). In addition to the above five species, *Salmo gairdneri, Macruronus magallanicus* and *Sebastes oculatus,* which occur in Aysén Fiord and show a fairly strong piscivorousness (unpublished data), may also be predators of the juvenile salmon.

Crustaceans (such as copepods, mysids, amphipods and euphausiids), insects and fish larvae are generally regarded as important food for juvenile chum salmon staying in inshore waters (Bakkala, 1970; Okada and Taniguchi, 1971; Kobayashi, 1977; Healey, 1980; Seki el al., 1981). In this study no mysids were found in the stomachs of any chum salmon examined, and amphipods and euphausiids were not dominant prey. The composition of prey organisms eaten by the Aysén Fiord chum was similar to that of juvenile chum from Georgia Strait, British Columbia (Canada), which was reported by Healey (1980), except that in Georgia Strait, amphipods were frequently the most important prey (in volume). Hirakawa (1984) noted that *Calanus chilensis, Calanoides patagoniensis, Rhincalanus nasutus, Paracalanus parvus, Clausocalanus* spp. and *Metridia lucens* are dominant copepods in Aysén Fiord and they make up high zooplankton biomass from spring to early summer. The occurrence and abundance of copepods in the stomachs of the chum examined are considered to reflect the natural conditions of the copepod fauna in the fiord. *Sprattus fuegensis* and *Odontesthes smitti* in the present collection preyed on planktonic animals similar to the chum salmon preys. In an earlier report, we (1982) suggested that a stromateid *Stromateus stellatus* is also a probable competitor for food with the juvenile chum.

Okada and Taniguchi (1971) pointed out that the largest preys eaten by juvenile of chum and pink salmon change rapidly from a small-sized group to a larger one when the fishes attain about 5.5 cm FL. According to observations by Okada and Taniguchi (1971), Irie et al. (1981) and Sakamoto et al. (1982), smaller prey such as harpacticoids, copepods and insects were important foods for chum salmon up to 5 to 7 cm FL, but in larger fish the important foods were replaced by larger animals, e.g. amphipods, euphausiids and fish larvae. On the other hand, Kobayashi (1977), Suzuki et al. (1979) and Awamori (1980) reported that there was no size or type selectivity of prey animals according to size of fish. In the surface of Aysén Fiord and Moraleda Channel, the high abundance of brachyuran larvae occurs during spring and summer (Hirakawa, 1984; Zama and Cárdenas, in press). The present study suggests that brachyuran larvae may not an important food source for juvenile chum salmon in intances where there are other preferable prey, as Bakkala (1970) noted.

The total number of gill rakers in adult chum salmon ranges between 18 and 27 (Clemens and Wilby, 1961; Hikita, 1962; Lindberg and Legeza, 1965; Mcphail and Lindsey, 1970; Matsubara and Ochiai, 1977). The juvenile chum (7.3 to 13.0 cm FL) examined in this study, which had 20 to 25 rakers, reached the adult level in gill-raker count. Okada and Nishiyama (1970) and Irie et al. (1981) showed that the gill rakers of the juvenile chum increase to approximately full number when the fish attain 6 to 8 cm FL. In the Japanese chum population, it is known that the juveniles generally begin to move offshore at this size, when the water temperature increases to

above 10°C, and feeding habits switch to larger animals (Kobayashi, 1977; Irie et al., 1981; Seki et al., 1981; Mayama et al., 1982). The average lengths of juvenile chum in this study were 7.7 cm FL to 12.6 cm TL at release. The size of these juveniles all corresponded with that of the fish which migrate offshore in the Japanese waters.

The feeding index of juvenile chum salmon staying inshore is usually 1.0 to 5.0 (Kobayashi, 1977; Healey, 1980; Seki et al., 1981). The chum salmon in the present collection showed comparatively low index values (0.1 to 3.0 for most fish). However, the fauna of food organisms in Aysén Fiord is not considered to be so poor, at least from spring to early summer, judging from the absence of empty stomachs (except for five fish from Ensenada Baja) and the zooplankton biomass in the fiord (Hirakawa, 1984, Zama and Cárdenas, in press).

Kobayashi et al. (1965) and Mayama et al. (1982) observed that most chum fry migrate downstream at a rate of about 10 km per day. Juvenile chum released into the Simpson River run down at 6 to 22 km per day (Agencia de Cooperación Internacional del Japón, 1980 and 1982). No data are available to us on the migration rate of chum salmon through fiords. In this study the outward migration rate of the chum through Aysén Fiord is estimated to be about 3 km per day, which is much slower than in rivers. Kjelson et al. (1982) reported that chinook smolt (*Oncorhynchus tschawytscha*) pass through the estuary from Sacramento to San Francisco (U.S.A.) at 10 to 18 km per day. According to McDonald (1969) and Bakkala (1970), the schooling of chum fry becomes more pronunced when they reach the sea.

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Appendix Table 1. Daily meteorologic and oceanographic observations at each station for gill-net operation and number of fishes collected between 1979 and 1982. Weather codes: b, blue sky; bc, blue sky with detached clouds; c, cloudy or overcast; r, rain. SGN, small gill net; LGN, large gill net.

Station	Date	Time	Weather	Air temp. (°C)	Surface w. temp. (°C)	Surface salin. (°/oo)	No. fo fishes SGN	LGN
	1979							
A	Nov. 25	17:00	r	–	15.1	–	9	
A	26	17:00	bc	17.7	15.7	–	2	
A	27	17:00	c	12.0	15.4	–	1	
A	28	11:00	bc	12.0	15.4	–	2	
A	29	10:00	bc	11.0	14.9	–	3	
A	30	10:00	c	9.9	14.4	–	5	
	1980							
C	Nov. 8	11:50	b	12.0	11.6	–	62	6
D	Nov. 8	10:20	b	14.0	11.6	–	86	
	1981							
C	Sep. 15	08:15	bc	–	8.4	23.1	2	0
C	16	07:30	r	–	9.0	23.5	23	0
B	17	08:00	r	–	9.3	23.7	101	0
C	Oct. 13	07:40	r	–	10.6	–	0	1
B	Oct. 14	06:30	r	–	9.9	–	252	3
	1982							
C	Oct. 24	07:00	r	9.0	9.5	13.8	73	2
C	24	18:00	c	9.0	10.2	6.9	9	0
C	25	07:00	c	6.5	10.0	20.0	37	0
C	25	18:15	c	10.0	10.7	6.9	2	2
C	26	06:30	c	7.0	10.1	23.4	68	1
C	26	18:30	c	8.0	10.2	17.4	5	0
C	27	06:30	c	8.5	9.9	16.3	86	1
C	27	18:00	c	11.0	10.5	13.5	5	0
C	28	08:00	r	7.0	9.2	17.8	46	2
C	28	16:00	c	10.0	10.0	26.1	0	0
C	29	07:00	c	6.5	10.0	24.3	2	2
C	29	18:00	c	10.0	10.5	19.1	5	2
C	30	06:30	r	6.5	9.8	17.9	110	2
C	30	18:00	r	9.5	10.0	18.6	0	2
C	31	07:00	r	6.5	10.0	17.1	46	3
C	31	18:00	bc	14.0	10.2	1.9	0	0

Appendix Table 2. Meteorologic and oceanographic observations at each station for purse-seine operation and number of fishes collected in 1982. Weather codes as in Appendix Table 1.

Station	Date	Time	Weather	Wind	Air temp. (°C)	Surface w. temp. (°C)	Surface salin. (°/oo)	No. of fishes
	1982							
1	Oct. 23	12:05	c	Calm	10.5	8.8	3.7	0
2	23	12:30	c	Calm	10.5	8.8	3.7	0
3	25	15:00	c	NW	9.0	10.5	–	0
4	25	15:45	c	NW	10.0	10.8	–	0
5	25	16:00	c	NW	10.0	10.8	–	1
6	25	16:30	r	NW	9.5	10.7	–	1
7	25	16:55	c	NW	10.5	10.7	–	0
8	25	17:10	r	NW	9.0	10.6	–	0
9	25	17:25	c	NW	10.0	10.7	–	0
10	25	17:40	c	NW	10.0	10.7	6.9	0
11	27	10:30	r	NW	9.0	10.4	–	0
12	27	11:00	r	NW	8.5	10.4	–	0
13	27	11:20	r	NE	8.5	10.4	–	0
14	27	11:40	c	NE	9.5	10.5	–	0
15	27	12:00	c	NE	10.0	10.5	–	0
16	27	12:20	r	NE	10.0	10.0	–	1
17	27	12:35	r	NE	10.0	10.4	–	0
18	27	12:50	r	NE	9.5	10.4	–	0
19	27	13:15	r	NE	9.5	10.4	–	0
20	27	13:40	r	NE	10.0	10.4	–	0
21	27	14:00	r	NE	9.5	10.4	24.1	0
22	31	12:45	r	NW	10.0	10.1	–	0
23	31	13:30	bc	NW	10.0	10.2	13.6	0
24	31	14:00	c	NW	13.0	10.2	–	1
25	31	14:25	c	NW	13.5	10.3	13.7	6
26	31	14:40	c	NW	13.0	10.1	–	0
27	31	14:55	c	NW	11.5	10.2	–	5
28	31	16:15	bc	NW	14.0	10.3	4.1	0
29	31	17:00	bc	NW	14.0	10.2	1.9	0
30	Nov. 4	13:05	c	Calm	12.5	11.2	–	0
31	4	13:35	c	Calm	10.0	11.9	–	0
32	4	14:15	c	SW	12.0	11.2	–	0
33	4	14:50	c	SW	13.5	11.6	–	0
34	4	15:10	c	SW	13.5	11.5	–	0
35	4	17:00	c	NW	12.0	11.7	–	0

Appendix Table 3. Meteorologic observations and surface water temperature at each station for purse-seine operation and number of fishes collected in 1983. Weather codes as in Appendix Table 1.

Station	Date	Time	Weather	Air temp. (°C)	Surface w. temp. (°C)	No. of fishes
	1983					
1	Oct. 5	11:00	c	8.0	8.1	0
2	5	11:30	c	8.5	7.7	2
3	5	12:10	c	10.0	7.8	0
4	5	12:35	c	10.0	8.2	1
5	5	13:00	c	10.0	9.3	5
6	5	13:35	c	10.0	12.1	0
7	5	13:55	c	11.0	8.5	2
8	5	14:20	c	11.5	8.5	9
9	5	15:00	c	12.0	10.1	0
10	5	15:40	c	11.0	8.5	1
11	5	16:05	c	11.0	8.9	0
12	5	16:30	c	11.0	8.5	0
13	5	17:00	c	11.0	8.4	0
14	5	17:30	c	11.0	8.8	31
15	5	17:45	c	11.0	8.8	0
16	11	10:05	c	8.0	9.8	0
17	11	10:25	c	8.5	9.9	0
18	11	10:55	c	9.0	9.9	0
19	11	11:15	c	9.5	8.8	0
20	11	11:40	c	10.0	9.2	0
21	11	12:00	c	10.5	9.2	0
22	11	12:15	c	10.5	9.2	0
23	11	12:40	c	11.0	9.6	0
24	11	13:00	c	11.5	9.8	15
25	11	14:20	c	12.5	10.5	0
26	11	14:50	c	13.5	9.6	2
27	11	15:20	c	12.5	9.7	4
28	11	16:00	c	12.0	9.8	0
29	18	11:50	c	9.0	9.6	0
30	18	12:10	c	9.5	9.4	1
31	18	12:30	c	10.0	10.0	0
32	18	12:45	c	10.0	9.6	0
33	18	13:10	c	11.0	10.2	0
34	18	13:25	c	11.5	9.9	0
35	18	13:50	c	12.0	9.9	0
36	18	16:50	c	10.0	9.3	6
37	18	17:15	c	10.0	10.2	4
38	18	17:40	c	10.0	9.9	0
39	18	18:00	c	10.0	9.7	0
40	21	11:25	c	9.0	9.4	8
41	21	11:45	c	9.0	9.6	0
42	21	12:10	c	9.0	10.2	16
43	21	12:25	c	9.5	9.8	0
44	21	12:50	c	10.0	10.2	0
45	21	13:10	c	10.0	10.1	0
46	21	13:35	c	10.5	10.3	0
47	21	15:30	c	11.0	10.2	4
48	21	15:45	c	10.0	10.6	0
49	21	16:25	c	9.0	11.5	0
50	21	17:00	c	9.0	11.2	0
51	21	17:20	c	9.0	10.0	0

Appendix Table 4. Number, standard length (total or fork length), and body weight of fishes collected by gill net at each station between 1979 and 1982. Figures in parentheses indicate the number of fishes whose stomach contents were examined. SGN, small gill net; LGN, large gill net.

Period	Station (gear)	Species	No. of fish	Standard length (cm)	Body weight (g)
1979					
Nov. 25 - 30	A (SGN)	*O. keta*	12 (12)	7.4 - 8.5	4.2 - 7.9
		S. trutta	5 (0)	–	–
		M. australis	1 (0)	–	–
		O. smitti	3 (0)	–	–
		E. maclovinus	1 (0)	–	–
1980					
Nov. 8	C (SGN)	*H. bivius*	5 (0)	17.4 - 22.7 (TL)	–
		S. australis	4 (4)	11.8 - 12.3	–
		O. smitti	1 (1)	21.0	–
		A. chiloensis	4 (4)	10.9 - 13.4	–
		E. maclovinus	32 (32)	17.8 - 39.1	–
		N. longipes	13 (13)	7.7 - 17.8	–
		H. macrops	3 (0)	7.4 - 8.7	–
Nov. 8	C (LGN)	*S. trutta*	4 (4)	42.0 - 59.0	900 - 3200
		T. murphyi	2 (2)	43.0 - 46.5	900 - 1200
Nov. 8	E (SGN)	*S. fuegensis*	5 (5)	11.2 - 12.5	–
		M. magellanicus	1 (1)	17.3	–
		M. australis	1 (1)	76.5	2100
		O. smitti	1 (0)	16.7	–
		S. oculatus	1 (0)	21.8	–
		A. chiloensis	22 (21)	6.7 - 13.1	–
		P. jugularis	2 (2)	16.3 - 22.1	–
		E. maclovinus	10 (10)	14.4 - 30.5	–
		N. longipes	37 (36)	8.0 - 17.2	–
		N. tessellata	6 (6)	7.9 - 14.0	–
1981					
Sep. 15 - 16	C (SGN)	*S. fuegensis*	4 (0)	11.1 - 13.8	17 - 28
		O. keta	1 (1)	11.3 (FL)	9.2
		O. smitti	19 (0)	22.8 - 27.2	130 - 220
		N. tessellata	1 (0)	10.1	16
Sep. 15 - 16	C (LGN)	(All fishes netted were eaten out by sea birds)			
Sep. 17	B (SGN)	*S. fuegensis*	101 (0)	9.8 - 14.8	10 - 34
Sep. 17	B (LGN)	(No fish collected)			

(continued)

Appendix Table 4.

Period	Station (gear)	Species	No. of fish	Standard length (cm)	Body weight (g)
Oct. 13	C (SGN)	(All fishes netted were eaten out by sea birds)			
Oct. 13	C (LGN)	*S. fuegensis*	1 (1)	11.6	10
Oct. 14	B (SGN)	*S. fuegensis*	228 (30)	11.8 - 15.3	19 - 39
		S. australis	6 (6)	12.3 - 14.7	22 - 38
		O. smitti	17 (15)	11.4 - 25.6	14 - 225
		E. maclovinus	1 (1)	26.3	325
Oct. 14	B (LGN)	*S. trutta*	1 (1)	57.5	2580
		M. australis	1 (1)	65.3	1700
		M. gayi	1 (1)	35.8	375
1982 Oct. 24 - 31	C (SGN)	*S. fuegensis*	253 (203)	9.0 - 15.1	8 - 37
		E. ringens	1 (1)	10.0	10
		M. australis	4 (1)	21.1 - 60.0	77 - 1240
		O. smitti	133 (116)	12.8 - 28.7	16 - 255
		E. maclovinus	76 (72)	11.9 - 43.5	23 - 1225
		N. longipes	21 (21)	11.2 - 17.7	21 - 76
		N. tessellata	4 (4)	12.3 - 14.5	30 - 45
		C. geniguttatus	1 (0)	11.4	31
Oct. 24 - 31	C (LGN)	*N. crockeri*	1 (1)	7.5	4
		T. murphyi	1 (1)	43.6	1170
		E. maclovinus	17 (17)	36.7 - 50.4	945 - 1635

Appendix Table 5. Number, standard length (or fork length), and body weight of fishes collected by purse seine at each station in 1982 and 1983. Figures in parentheses indicate the number of fishes whose stomach contents were examined.

Period	Station	Species	No. of fish	Standard length (cm)	Body weight (g)
1982					
Oct. 25	5	*S. fuegensis*	1 (1)	7.0	4
25	6	*T. murphyi*	1 (1)	40.7	810
27	16	*S. fuegensis*	1 (1)	13.8	26
31	24	*S. trutta*	1 (1)	16.9	59
31	25	*O. keta*	6 (6)	10.0 - 12.6(FL)	8.4 - 18.0
31	27	*O. keta*	5 (5)	7.8 - 9.5(FL)	4.1 - 7.4
1983					
Oct. 5	2 - 14	*S. fuegensis*	42 (4)	12.0 - 14.0	20 - 28
5	5	*S. trutta*	3 (3)	15.1 - 15.7	59 - 66
5	14	*O. keta*	6 (6)	11.0 - 12.2(FL)	13.8 - 18.4
11	24	*O. keta*	14 (14)	11.0 - 13.0(FL)	12.2 - 20.8
11	24	*O. smitti*	1 (1)	15.7	41
11	26	*O. keta*	2 (2)	9.3 - 11.0 (FL)	7.5 - 12.0
11	27	*O. keta*	4 (4)	7.3 - 8.5 (FL)	3.4 - 5.5
18	30	*O. keta*	1 (1)	8.5 (FL)	5.5
18	36	*O. keta*	6 (6)	10.2 - 12.7 (FL)	11.1 - 19.5
18	37	*O. keta*	4 (4)	8.6 - 9.9 (FL)	5.6 - 9.4
21	40	*O. keta*	8 (8)	8.5 - 12.5 (FL)	5.2 - 16.7
21	42	*O. keta*	16 (8)	7.5 - 11.5 (FL)	3.6 - 12.9
21	47	*O. keta*	4 (4)	7.5 - 9.4 (FL)	3.3 - 6.3