

INTRODUCTION INTO AYSÉN CHILE OF PACIFIC SALMON

NO. 3

**Transportation and Rearing Trials with Chum Salmon
(*Oncorhynchus keta*), 1976—1978**

**By
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**and
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1979

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Dedicated to my wife, my sons and my friends.

Dedicado a mi esposa, mis hijos y mis amigos.

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Footnote

Division Protección Pesquera, SAG, reformed organization at 1979 and changed name, separated from SAG as Servicio Nacional de Pesca, Ministerio de Economía Fomento y Reconstrucción.

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Climatological and River data, May 1977 – April 1978

SUMMARY

This is the third report on the Project Introducing Chum salmon (*Oncorhynchus keta*) into the Aysen, Chile. The program began in 1973 and until 1978 was by the Division Protección Pesquera, Servicio Agrícola y Ganadero, Ministry of Agriculture, in association with the Japan International Cooperation Agency.

The pilot project was taken under Table 1 by the Division Pesca y Caza (now the Division de Protección Pesquera, SAG) until the end of 1978 and after that by the Servicio Nacional de Pesca. Egg were procured from Hokkaido, Japan.

The second report (1976) described the early phase of the program in 1973-1975 by Aliaky Nagasawa and Pablo Aguilera. It deals with the transportation and rearing of chum salmon on an experimental bases as preliminary to the establishment of a hatchery in 1976 to breed fry for release in the Simpson river in Aysen province. A total of 6 million eyed eggs sent from Japan during 1976-1978. However, unfortunately the last shipment of one million eggs was of poor quality, so that only 5,000,000 eyed eggs were use for fry production (Table 3 and 4).

Through 1978, these were nine shipments totalling 11,000,000 eyed eggs including 1 box lost in route in March 1975 and an other shipment resulted in total loss before reaching Chile 1978, so that the Coyhaique hatchery handled 10,950,000 eggs through 1978 (Table 4).

The egg temperatures ranged from 9.0 to 10.3°C on arrival. Minimum and maximum average of each egg tray were 5.8 and 10.5°C (Table 2).

Breeding temperatures in the incubator, for each group, were in the same range during 1976-1978 as in 1974-1976 (Table 5). The eggs were accepted in summer, they are developed to absorb yolk-sac and reach in swim-up stage at late autumn.

The total number of fry released by the program in 1977-1978 was approximately 4,069,000. The majority were released directly into the Simpson River adjacent to the hatchery at Coyhaique; a small number were released into El Salto River (Fig. 7). Total number of fry liberated was 8,226,000 during 1974-1978; about 19% were fed-fry released experimentally.

After liberation, some groups of fry were observed down-stream migration in the Simpson River. In this report described including with some summaries of the early period of released groups in 1974-1976 still sleeping data.

Groups liberated in the Autumn wintered in the river, in October, beginning of the Spring season. Some of the these fish samples were obtained in middle of September 1974, also in July 1976, 1977.

An experimental wintering feeding program was undertaken. One group of summer fry were fed in the hatchery until they reached the fingerling stage, and were thus larger when released than the rest and less prone to be preyed on by predatory trout.

In 1977, a number of fry were kept four months in the hatchery and fed during the winter season. These fish weighed up to 1.82gr. and averaged 52mm in size (Table 7 and Fig. 5).

In 1978, another group of fry were fed full scale for one month in summer. These fish weighed up to 1.24gr and averaged 54mm were released (Table 7 and Fig. 5).

INTRODUCTION

Since 1905 Chilean fishery organizations have made efforts to introduce Pacific salmon (genus *Oncorhynchus*) and Atlantic salmon (*Salmo salar*) into Chilean waters; some success was attained with the Atlantic salmon. Brown trout (*Salmo trutta fario*) and Rainbow trout (*Salmo gairdnerii irideus*) stocks have been established in Chile, and are taken exclusively as a sporting fish. Experiments with *Oncorhynchus* species have not been successful in spite of the vast potential of Chilean waters for breeding these fish.

The present program undertaken jointly by the Chilean and Japanese governments under an agreement signed in 1972 is designed to create a salmon fishing industry in the province of Aysen. It was initiated with Cherry salmon (*Oncorhynchus masou*) for the preliminary trials (Aliaky Nagasawa & Pablo Aguilera 1974) and later Chum salmon (*Oncorhynchus keta*) as a pilot program with eggs shipped from Hokkaido. The shipment schedule is shown in Table 1.

The eyed eggs were shipped to the hatchery at Coyhaique, Aysen province from Hokkaido National Salmon Hatchery Service. The total reached 10,950,000 which had been accepted between 1974 and 1978 (Table 3).

A report on part of this program, during the 2-years 1974-1975, was published in 1976 by A. Nagasawa and P. Aguilera. This report dealing with the 2-years 1976-1978 describes egg transportation and fry production of Chum salmon, their release into Simpson River continually from 1974, and the experience obtained by Coyhaique Hatchery's staff. A total 6,000,000 eggs were transported to Chile and 4,069,000 fry were released. It altogether 8,226,000 of fry were liberated in the five years 1974 to 1978 (Tables 7 and 8).

A part of KJ-76-B group of fry were fed from June to September (the winter season) as an experiment. and all of the KJ-77-A group were fed during 35 days before liberation in Summer (January and February). These experiments were regarded as preliminary to the next phase of the program now under consideration.

EGG TRANSPORTATION

The number of eggs used will largely determine the success of the experiment in establishing a run of anadromous fish in new rivers. It was assumed that at least one million eggs per year would be needed for a number of years until a run became established. The program was designed to handle 2 or 3 million eggs annually from 1974 to 1978, for a total of 11,000,000 (Table 1). However, the first shipment of one million eggs was mainly experimental because it was not clear how to incubate them and when they would emerge as free-swimming fry that could be released into the river.

In Hokkaido Chum salmon are stripped from late September to December, that is, from autumn to early winter. The eggs are incubated in the hatchery and fry emerge from the gravel in the incubator channel in March or April. When their yolk sacs are absorbed they are given food in the pond. They are liberated in the river in late spring or early summer. This is the general life cycle in the northern hemisphere.

Eyed eggs are shipped to Chile from Hokkaido in October when it is spring in the southern hemisphere. At this season water temperatures rise. Eggs hatch and fry reach the free-swimming stage in January, the beginning of summer. Thus they are sent down to the sea in time for the seasonal fullness of the organisms in which they feed.

Two shipment of eggs came from Japan each year, one in November for summer release of fry and another in March for winter release. The problem is which of these semi-annual releases will produce a dominant stock for the establishment of Chum salmon in the new world. The answer will be given by the number and timing of returning adults, of which none had appeared by the end of 1978.

The eggs were supplied by the hatcheries of the National Salmon Hatchery Service, particularly those at Chitose and Ichani. The transport route was Chitose-Tokyo-Vancouver or Los Angeles -Lima-Santiago encompassing, 42 hours and crossing the International Date Line. The flight from Chitose to Santiago was made by commercial air lines and from Santiago to Balmaceda/Coyhaique by a plane of the Fuerza Aerea de Chile (Chilean Air Force). The eggs were given a special code to establish the record for shipments and for the future return of adults and selection of breeding population, as described in the interim report by A. Nagasawa and P. Aguilera (1976). It is shown in Table 1.

One batch of eggs, KJ-77-B, died in transportation, some of them were hatched prematurely, others had broken membrane and were crushed. The A-groups (early season) were generally in better condition than the B-groups (late season).

The eggs were packed in isothermic boxes as shown Figure 1. Maximum/minimum thermometers were placed in the tray of 5 boxes at time of shipment. The temperatures as shown in Table 2 during transport indicated a range of 3.0 C to 14.0 C, the ice in the uppermost tray in each box was beginning to melt when they arrived at the hatchery. When the eggs arrived, these thermometers were recorded.

The egg temperatures when leaving Chitose hatchery which uses spring water was kept at 8.0°C. On arrival the temperature in the trays and boxes was higher by degrees from bottom tray by top, caused by air temperature when the airplane landed in route. Temperatures, specially at Santiago airport, were high, ranging from 25°C to 30°C in mid-day, from December to March, maximum temperatures occurred at Lima or Santiago, minimum temperatures at Chitose or Vancouver airports.

However, the range of egg temperatures during transport was not very harmful. Egg development under 400°C U.T. (Unit temperature) is not trouble on the transport, but over 400°C U.T. the eggs may hatch prematurely; 480°C U.T. is the temperature for successful hatch-out.

Shipment dates and condition of eggs for all shipments between 1974 and 1978 are shown in Table 3.

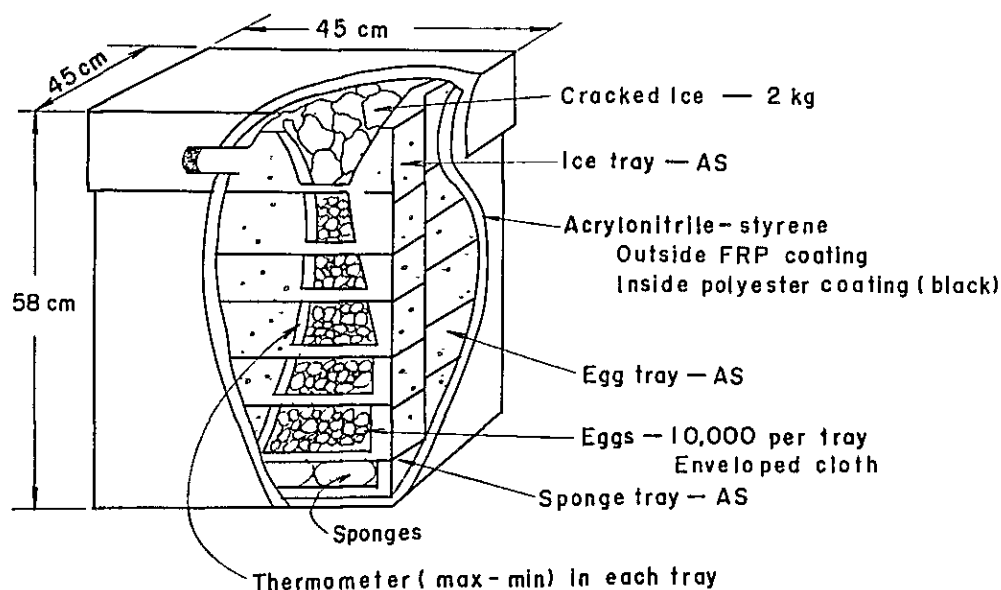


Figure 1. Transverse section of isothermic transportation box

(Preventive treatments)

The eggs were treated for 15 minutes with 1/200 Iodine (contain Poly Vinyl Pyloridon-I, 10%) by the bath method for prevention of disease when they arrived in Coyhaique hatchery. They were also treated at Chitose hatchery before packing.

These treatments were designed to prevent epidemics of virus and bacteria infections, specially IPN (Infectious Pancreatic Necrosis) and IHN (Infectious Hematopietic Necrosis). These diseases occurred in the 1950s in United States hatcheries, they invaded Japan in 1961-1975 in the transportation of trout and salmon eggs from the United State.

Table 1. Codes for the Transplanted stocks and Shipment program

No.	Code	Parent year & Egg collection	Number of eggs	Eyed egg shipment	Fry Liberation	Anticipated Return	Remarks
1.	KJ-73-B	1973 December	1,000,000	Mar. 1974	May 1974	1977-1979	Experimental
2.	KJ-74-A	1974 October	1,000,000	Nov. 1974	Jan. 1975	1978-1980	Pilot culture
3.	KJ-74-B	1974 December	1,000,000	Mar. 1975	May 1975	1978-1980	Pilot culture
4.	KJ-75-A	1975 October	1,000,000	Nov. 1975	Jan. 1976	1979-1981	Pilot culture
5.	KJ-75-B	1975 December	1,000,000	Mar. 1976	May 1976	1979-1981	Pilot culture
6.	KJ-76-A	1976 October	1,000,000	Nov. 1976	Jan. 1977	1980-1982	Pilot culture
7.	KJ-76-B	1976 December	2,000,000	Mar. 1977	May 1977	1980-1982	Pilot culture
8.	KJ-77-A	1977 October	2,000,000	Nov. 1977	Jan. 1978	1980-1983	Pilot culture
9.	KJ-77-B	1977 December	1,000,000	Mar. 1978	May 1978	1980-1983	Pilot culture
Total			11,000,000				

Code: K = *Oncorhynchus keta*
 J = Japan as original source
 Number (as 73) = Parent year as 1973
 A = Early season in egg collection such as October
 B = Late season in egg collection such as December

Table 2. Egg temperature on the trip to Coyhaique, Ayaen (CHILE) from Chitose, Hokkaido (JAPAN)

KJ-76-B (1)

Lv. Chitose Hatchery; AM 08:30, 04 Mar. 1977 -14.0°C, Winter
 Ar. Coyhaique Hatchery; PM 08:00, 05 Mar. 1977, 18.0°C, Summer
 Open package; AM 11:00, 06 Mar. 1977, 20.0°C,
 Starting temperature; 8.0 at Chitose hatchery
 Arrival temperature in each tray's egg;

Tray	Egg temperature in °C			Remarks
	Min.	Max.	Arrival	
No. 1	3.0	9.0	4.0	Upper
No. 2	6.0	9.0	8.0	
No. 3	7.0	10.0	10.0	
No. 4	7.0	11.0	11.0	
No. 5	6.0	12.0	12.0	Bottom
Average	5.8	10.0	9.0	

KJ-76-B (II)

Lv. Chitose Hatchery; AM 08:30, 11 Mar. 1977, -8.0° Winter
 Ar. Coyhaique Hatchery; PM 08:00, 12 Mar. 1977, 17.0° C Summer
 Open package; PM 08:00, 12 Mar. 1977, 17.0° C
 Starting temperature; 8.0 at Chitose hatchery
 Arrival temperature in each tray's egg;

Tray	Egg temperature in $^{\circ}$ C			Remarks
	Min.	Max.	Arrival	
No. 1	4.0	9.0	6.0	Upper
No. 2	8.0	9.0	9.0	
No. 3	7.0	10.0	10.0	
No. 4	7.0	11.0	11.0	
No. 5	6.5	11.5	11.5	Bottom
Average	6.5	10.0	9.0	

KJ-77-A (I)

Lv. Chitose Hatchery; AM 08:30, 02 Dec. 1977, -1.6° C Winter
 Ar. Coyhaique Hatchery; AM 00:30, 04 Dec. 1977, 10.5° C Summer
 Open package; AM 10:00, 04 Dec. 1977, 6.8° C
 Starting temperature; 8.0 at Chitose hatchery
 Arrival temperature in each tray's egg;

Tray	Egg temperature in $^{\circ}$ C			Remarks
	Min.	Max.	Arrival	
No. 1	3.0	9.5	6.0	Upper
No. 2	6.0	10.0	9.0	
No. 3	6.0	11.0	11.0	
No. 4	6.0	12.5	12.0	
No. 5	6.0	14.0	13.5	Bottom
Average	5.4	11.4	10.3	

KJ-77-A (II)

Lv. Chitose Hatchery; AM 09:00, 09 Dec. 1977, -5.8° C Winter
 Ar. Coyhaique Hatchery; PM 80:45, 10 Dec. 1977, 19.4° C Summer
 Open package; PM 80:45, 10 Dec. 1977, 19.4° C
 Starting temperature; 8.0° C at Chitose hatchery
 Arrival temperature in each tray's egg;

Tray	Egg temperature in $^{\circ}$ C			Remarks
	Min.	Max.	Arrival	
No. 1	4.0	9.0	6.5	Upper
No. 2	6.5	9.5	9.5	
No. 3	7.0	10.0	10.0	
No. 4	7.0	11.0	11.0	
No. 5	7.0	13.0	13.0	Bottom
Average	6.3	10.5	10.0	

Table 3. Summary of egg shipment dates and conditions

Code	Origin						Shipment from Chitose Hatchery				Arrival at Coyhaique, Atcen						
	Date of Collection	River Source	Hatchery	Date Eggs Eyed	Temp. (°C)	PH	Egg Mortality (%)	Treatment	Condition at transfer	Date	Treatment	Development (Eyed egg stage)	Date	Number of eggs Received	Temp in Incubator	Number of Dead eggs	Egg Condition
1. KJ-73-B	Jan. 7, 8, 10, 17 1974	Tokachi	Obihiro	Feb. 20-27, 1974	5.0-5.5	6.8	10.7	Malachite green 1/300,000 30 min. 3/week	Soft, more or less good	Mar. 15, 1974	1/200 Iodine 15 min. before packing	340-370°C U.T.	Mar. 16, 1974	1 million	9.8°C	-	Soft, without tension, but normal
2. KJ-74-A	Oct. 11, 12, 1974	Tokachi	Obihiro	Nov. 2-3, 1974	9.0	6.8	2.0	Malachite green 1/300,000 30 min. 2/week	Excellent	Nov. 15, 1974	At destination, 1.0% Iodine 50 cc/10 Lt.	330°C U.T.	Nov. 16, 1974	1 million	3.0°C	4,170 (0.42%)	Excellent
3. KJ-74-B	Dec. 11, 1974	Tokachi	Obihiro	Feb. 11, 1975	3.0-4.0	6.8	6.2	Malachite green 1/300,000 30 min. 2/week	Good	Mar. 14, 1975	1.0% Iodine 50 cc/10 Lt. at destination	330°C U.T.	Mar. 16, 1975	950,000 (1 box lost)	11.0°C	1,780 (0.19%)	Slightly soft but normal
4. KJ-75-A	Oct. 5, 1975	Tokachi	Obihiro	Oct. 27, 1975	11.0	6.8	2.5	Malachite green 1/300,000 30 min. 2/week	Excellent	Nov. 14, 1975	1.0% Iodine 50 cc/10 Lt.	380°C U.T.	Nov. 16, 1975	1 million	8.4°C	300 (0.03%)	Excellent
5. KJ-75-B	Dec. 5, 1975	Chewitui	Ichani	Feb. 4, 1976	4.0	7.0	6.0	Malachite green 1/200,000 30 min. 2/week	Good	Mar. 5, 1976	1.0% Iodine 50 cc/10 Lt.	360°C U.T.	Mar. 6, 1976	1 million	6.0°C	9,400 (0.94%)	Good
6. KJ-76-A	Oct. 12, 1976	Chitose	Chitose	Nov. 11, 1976	8.0	7.0	4.0	Malachite green 1/300,000 30 min. 2/week	Excellent	Nov. 26, 1976	1/200 Iodine 15 min. before packing	365°C U.T.	Nov. 27, 1976	1 million	11.0°C	200 (0.02%)	Excellent
7. KJ-76-B (I) (II)	Nov. 20, Nov. 24, 1976	Shibetsu Shibetsu	Ichani Ichani	Jan. 20, Jan. 24, 1977	4.0 3.5	7.0 7.0	11.5 12.8	Malachite green 1/200,000 30 min. 2/week	Fine Good	Mar. 4, Mar. 11, 1977	1/200 Iodine 15 min before packing	402°C U.T. 405°C U.T.	Mar. 6, Mar. 12, 1977	1 million 1 million	10.6°C 10.0°C	2,500 (0.25%) 3,000 (0.50%)	Fine Good
8. KJ-77-A (I) (II)	Oct. 19, Oct. 27, 1977	Chitose Chitose	Chitose Chitose	Nov. 18, Nov. 26, 1977	8.0 8.0	6.8 6.8	10.3 7.2	Malachite green 1/300,000 30 min. 2/week	Excellent Excellent	Dec. 2, Dec. 9, 1977	1/200 Iodine 15 min. before packing	352°C U.T. 352°C U.T.	Dec. 4, Dec. 10, 1977	1 million 1 million	9.5°C 15.6°C	600 (0.06%) 800 (0.08%)	Excellent Excellent
9. KJ-77-B	Dec. 19, 1977	Tokachi	Ichani	Jan. 27, 1978	5.0	7.0	60.0	Malachite green 1/400,000 30 min. 3/week KMnO ₄ 1/50,000 30 min. 2 time	Bad. soft-membrane	Mar. 3, 1978	1/200 Iodine 15 min. before packing	380°C U.T.	Mar. 6, 1978	1 million	12.0°C	1 million (100%)	Very Bad, like jam, partly soft-membrane, abnormal hatch-out

FRY PRODUCTION

1. Group KJ-76-A

This sixth shipment consisted of one million eyed eggs were taken from salmon in the Chitose River, a tributary of the Ishikari River, on the west coast of Hokkaido, on 12 October, 1976. They were nursed at Chitose Hatchery until shipment with water of constant 8.0°C and 7.0 pH, stable condition. They arrived in Coyhaique Hatchery at 07:30 PM on 27 November, 1976 in very good condition. Only 200 (0.02%) died in transport.

The eyed eggs were placed in Atkins type incubators with adapted troughs. Each unit is 180cm long, 35cm wide and 30cm deep, holding 4 stacks of trays set in frames. Ten trays can be set in each stack with 2,500 eggs per tray, thus each 180cm unit holds 100,000 eggs. The volume of water in each trough is 20 liters per minute, upwelling through each stack of eggs. Temperature was 11.0°C, pH 6.8, dissolved oxygen 11.5 ppm.

Malachite green (Oxalate, $C_{52}H_{54}N_4O_{12}$) was used to control fungus, at a level of 1/300,000 – 1/200,000 for 30 minutes once every three days until the beginning of hatch-out which occurred 10 days after arrival. The hatching period was December 6 to 14, most activity occurred on December 8 and 9. About 99% were sac-fry.

These sac-fry were distributed in the gravel-bottomed incubation channels outside the hatchery shaded from the sunlight by a wooden shelter completed in October 1976. It is also called the Fry-channel because it was used for sac-fry until they reached the swim-up stage, and also later used for feeding the tiny fishes on a diet of starter crumble size pellets when they became free swimmers.

The gravel incubator channels consist of six raceways each 40m long, 1m wide, 0.5m deep. Water flowing through one channel 11-20cm deep was 100-200 liters per minute during the sac-fry to swim-up fry stage. In the free-swimming stage depth of the water was increased, source of the water was the Claro River, even for the egg incubation troughs.

The sac-fry were distributed in the gravel at maximum concentration of 10,000 fry per square meter, equivalent to a layer of about one-fry deep. It was difficult to spread the fry evenly over the gravel without considerable practice. The high density was partly responsible for death by asphyxiation and fungus development which killed approximately 170,000 fry. Oxygen contents of the water was 12.5 – 7.5 ppm inlet and outlet. Daily temperatures during the breeding period are shown in Figure 2.

Many normal and healthy fry were seen swimming up as they emerged from the spawning bed in early January, with the yolk sac still attached. By 15 January nearly all had completely absorbed the yolk sac. A total of 820,000 fish survived to the liberation stage. The averaging 0.33cm length and 0.34gr in weight. Mortality of this group was as follow;

Dead eggs during transportation	200	No account
Dead eggs in incubation trough	10,100	Hand counted daily
Dead sac-fry in incubation channel	170,000	Random counted 1m ²
Total	180,000	Number in round

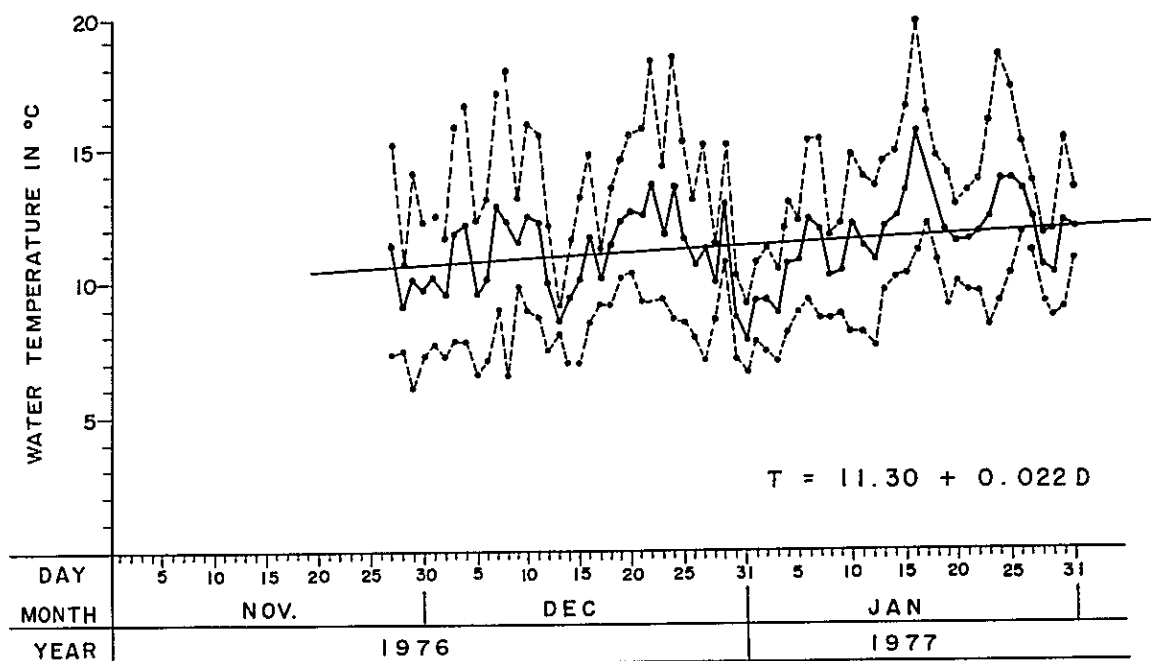


Figure 2. Daily water temperature of the breeding period for KJ-76-A.

2. Group KJ-76-B

This seventh group of two million eyed eggs arrived on 4 and 11 March 1977. They were taken from, Shibetsu River, fish on the east coast Hokkaido on 20 and 24 December, 1976, nursed at Ichani National Salmon Hatchery in water of 4.0°C until 2 days before shipment. Then they were moved to Chitose Hatchery for packaging and shipped out in 402°C – 405°C U.T. eyed egg stage. Accepting temperatures at Coyhaique Hatchery were 10.0°C and 9.5°C at both days of arrival. About 5,500 eggs were dead on arrival. Handling, nursing and treatments were almost the same as for KJ-76-A.

The egg mortality totalled 33,500 until hatch-out in late March, the producing of 1,961,000 sac-fry. Mortality of the sac-fry in the gravel incubator channel was approximately 300,000 by heavy rain and muddy water in May. As the temperature decreased fry development slowed down, so that it took about two months for the entire group to absorb their yolk sacs and reach the free-swimming stage. By then it was autumn, the raining season.

Swim-up fry totalled 1,661,000 at the end of May 1977. Daily temperatures during the breeding period is shown in Figure 3. The fish averaged 0.33gr in weight and 36mm in size. Mortality of this group was as follow;

Dead eggs in transportation	5,500	Hand counted
Dead eggs in incubation trough	33,500	Hand counted
Dead sac-fry in incubation channel	300,000	Approximately
Total	339,000	

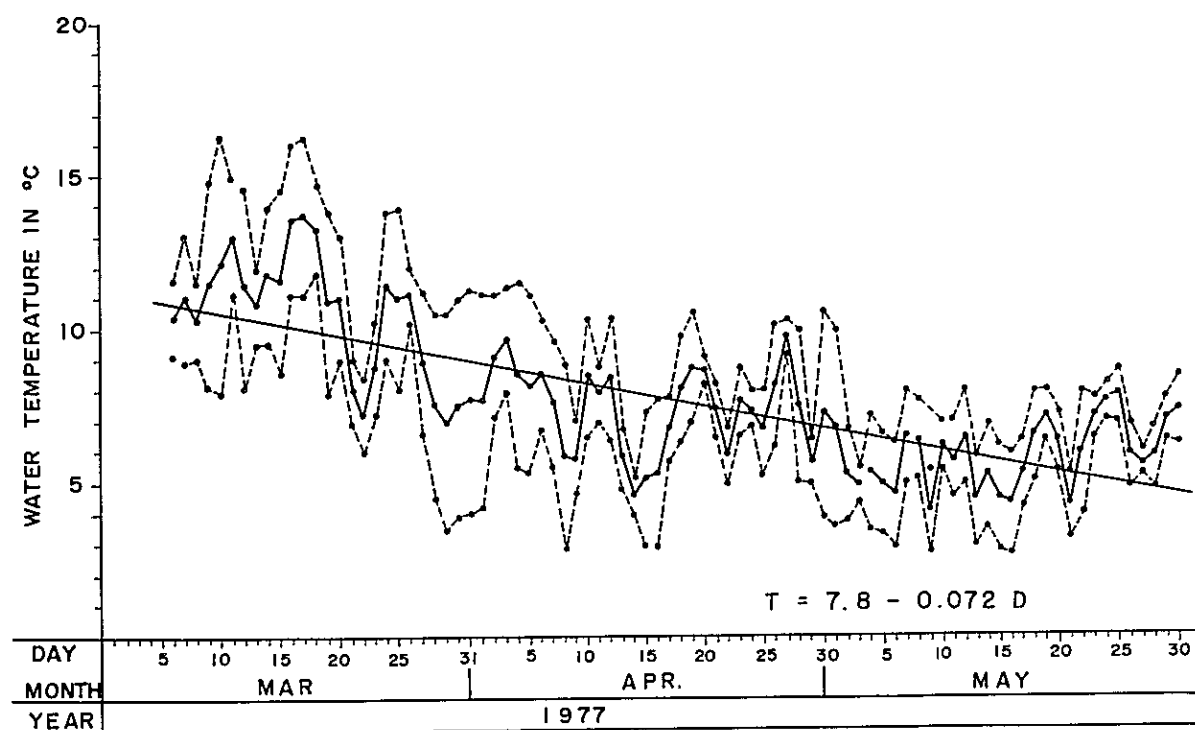


Figure 3. Daily water temperature of the breeding period for KJ-76-B.

(Feeding trial)

A portion of the 200,000 fry of this group was used in the feeding experiment during four months June to September 1977. This was the first time the feeding of Chum salmon was undertaken in the history of Chilean fish culture. However, this experiment was beset with difficulties because the fish ponds were inundated by heavy storms in the Coyhaique and Puerto Aysen area on 11-13 June 1977, by screen trouble, by rats and weasels attacking fish in the rearing ponds, etc. Only 61,000 fish survived the feeding experiment. Averaging 1.74gr in weight and 59mm fork length. Mortality of this feeding trial group was as follows;

Dead fry	800	Hand counted daily
Escaped and unknown due to inundation, etc	137,600	Counted from survival
Total	138,400	

In preparation is a report of the feeding experiment by the staff of the Coyhaique Hatchery.

Total fry produced for liberation of this group was as follows;

Unfed fry	1,461,000	weighing	482kg (0.33g per fish)
Fed fry	61,000	weighing	106kg (1.74g per fish)
Total	1,522,000		588kg

3. Group KJ-77-A

The eight shipment of 2 million eyed eggs fared better than KJ-76-B from the time they were stripped in Hokkaido to the liberation of fry in the Simpson River. They arrived at two separated times i million each a week apart, 4th and 10th December, like shipment KJ-76-B.

The eggs were collected on the 19th and 27th October, 1977 in batches of 1 million from fish taken in the Chitose River. Nursing of the eggs before shipment was the same as for KJ-76-B and temperatures were 35°C U.T. on both shipment days at the Chitose Hatchery.

Only 1,400 dead eggs were found on arrival condition of the group was excellent. Acceptable water temperatures in Coyhaique Hatchery were 6.8°C on the 4th and 15.6°C on 10th December. Treatment and facilities used were the same as before.

Produced swim-up fry totalled 1,879,000 (94%) at the end of January 1978. Water temperature ranged from a minimum of 4.5°C to maximum of 24.0°C, averaging 14.0°C. Daily temperatures during the breeding period of 48 days are shown in Figure 4. The weight of the fish averaged 0.30gr and length 35mm. Mortality of this group was as follows;

Dead eggs in transportation	1,400	Hand counted
Dead eggs in incubation trough	59,600	Hand counted
Dead sac-fry in incubation channel	60,000	Random counted per 1m ²
Total	121,000	

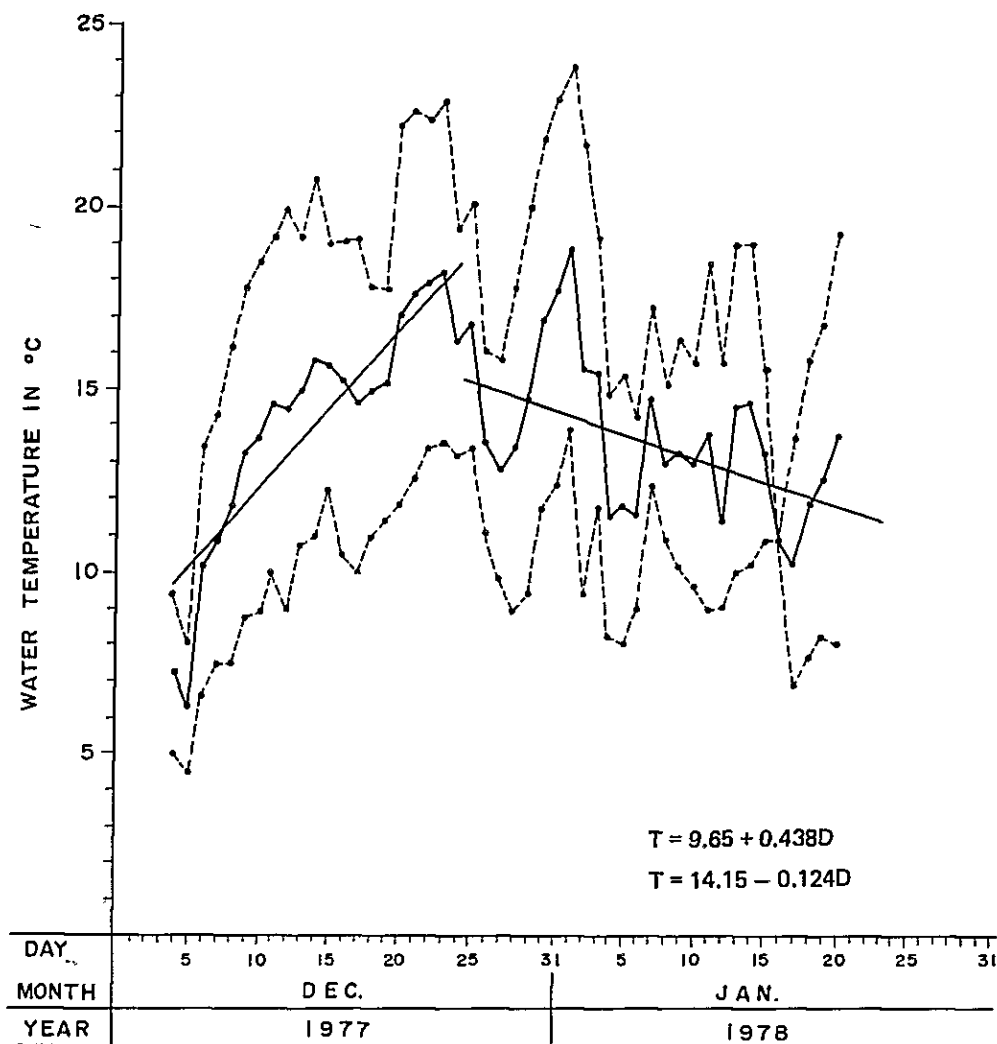


Figure 4. Daily water temperature of the breeding period for KJ-77-A.

(Feeding trial)

Of the 1,879,000 swim-up fry, 238,000 were experimentally released in El Salto River (Fig. 7) by tank transportation from Coyhaique Hatchery, a distance of about 85km, without feeding. The remaining 1,641,000 fry were fed for 35 days during their swim-up stage, 20th January until 23rd February, 1978.

This was also the first time at the Coyhaique Hatchery that summer of Chum salmon fry feeding was undertaken on such a large scale. A total of 860kg of food was given the fry in this period. The diet was mixed-dry-pellet, the same as in the KJ-76-B feeding trial. The incubator channel was used continuously on the free-swimming stage. Water temperatures were in the high levels, maximum 21.4°C and minimum 8.0°C, averaging 14.1°C. Cumulative unit temperature (Day × C) of this feeding period was 503.2°C U.T.

After 35 days, the fry averaged 1.2gr and 60mm, closely recembling KJ-76-B after four months of feeding in the winter season (Fig. 5). Mortality totalled 141,000 (8.6%) fry, due to starvation (stopped growth); these fish could not runup against the flow in the raceway (incubation channel) and stayed at the bottom near the outlet all day. They were stamped on the outlet screen everyday and counted daily. A descroption of this feeding trail will be made available in a subsequent report.

Total fry produced for release was as follow;

	Number	Weight
Unfed-fry	238,000	71kg (0.3gr per fish)
Fed-fry	1,500,000	1,800kg (1.2gr per fish)
Total	1,738,000	1,871kg

4. Group KJ-77-B

This group of one million eyed eggs was a misfortune as all were dead on arrial, a terrible sight.

The eggs were taken from Tokachi River fish in East Hokkaido on December 19th, 1977. They were transported to Ichani National Salmon Hatchery which has alow water temperatures and slow fish development in the Autumn season.

Sixty per cent of this group died from shocking treatment in Ichani Hatchery due to soft-membrance disease. They were treated with Potassium Permanganate (KMnO₄) 1/50,000 in 30 minute flushes to prevent soft-membrance from increasing, twice before shipment, once in the tender period and again in the eyed stage.

In general, most of the late season's eggs are not of excellent in Hokkaido and mortality is high with abnormal early hatch-out.

However, Japan was short of eyed eggs at this time of year and this was the last opportunity for shipment to Chile in 1977. This group was scheduled to be sent to Coyhaique Hatchery on 3 March, 1978.

Further, by some mistake, the eggs were compelled to spend one day at Santiago, They arrived at Balmaceda airport at 22:45 PM on 6 March,1978 by Chilean Air Force, were immediatly taken in two trucks to Coyhaique Hatchery, a distance of about 70km. They arrived at 00:30 AM. This trip was smooth with no special incident that could account for the egg condition.

Upon all arrival packages were opened immediatly with great care. About 50% of the eggs were crushed and membranes were broken so abnormal hatching had occurred with the yolk flowing. The other 50% were almost dead, with changed color or beginning to appear white inside. Some of eggs were still red but the embryos were dead. All eggs were soft and broken when picked up with the fingers, clearly due to soft-desease.

Five max-min thermometers were placed inside the egg tray that indicated a range of 1.5°C to 11.0°C during transport. The ice in the uppermost tray in each box was beginning to melt but about 50% remained in good condition, as in previous shipments. It was surely soft-membrance disease before shipment that killed them.

The eggs were placed in the Atkins type incubator until next morning, in the hope of saving some of those still alive, but to no avail. Mortality of this group was total (100%). Fry produced for liberation was zero.

5. Discussion

(Fry survival in incubator)

The incubator process of egg to fry is shown in Table 4. Total survival was 77.4% of 10,950,000 eyed eggs which arrived in Coyhaique Hatchery from Japan during 1974-1978 including shipment KJ-77-B which was a total failure. Except for this batch, survival was about 85% from egg to fry. This level was established as Coyhaique Hatchery and should be maintained in future programs.

Table 4. Chum Salmon Survival in the Incubator Process, Coyhaique Hatchery, Aysen, Chile, 1974-1978

Code	Breed Year	Number of Eyed eggs	Dead egg	Hatch-out Sac-fry	Dead fry	Swimm-up Fry	%	RMKS
KJ-73-B	1974	1,000,000	200,000	800,000	155,000	645,000	64.5	(a)
KJ-74-A	1975	1,000,000	20,000	980,000	80,000	900,000	90.0	
KJ-74-B	1975	950,000	10,000	940,000	140,000	800,000	84.2	(b)
KJ-75-A	1976	1,000,000	1,000	999,000	29,000	970,000	97.0	
KJ-75-B	1976	1,000,000	9,000	991,000	155,000	836,000	83.6	
KJ-76-A	1977	1,000,000	10,000	990,000	170,000	820,000	82.0	
KJ-76-B	1977	2,000,000	39,000	1,961,000	300,000	1,661,000	83.0	
KJ-77-A	1978	2,000,000	61,000	1,939,000	600,000	1,879,000	94.0	
KJ-77-B	1978	1,000,000	1,000,000	-	-	-	0.0	(c)
Total		10,950,000	1,350,000	9,600,000	1,629,000	8,511,000	77.4	

Remarks: (a) Experimental
 (b) 50,000 eyed egg lost in transport
 (c) All eggs died in transport

Note: Breed year in Chile

(Water temperature of incubator)

Water temperatures for each breeding group are summarized in Table 5. For the B-group, March to May, autumn in Chile, these was a comparatively narrow frequency, maximum-minimum, to lowest coming at the beginning of water. For the A-group, there generally was a very wide frequency of maximum to minimum in a day and average degrees are rose in a over 10°C until February. These levels were under the influence of seasonal weather conditions in each year.

In the December to February period temperatures at times exceeded 20°C; however, hatched sac-fry were able to acclimatize themselves in bottom gravels in the channel, because these high temperature did not last long being highest at 17:00-18:00 PM (Chile is on summer time, 1 hour faster than daylight) and lowest at 05:00-07:00 AM in summer.

In general, these breeding temperatures were very similar from year to year and are useful for hatchery schedules or incubation arrangements.

Table 5. Water temperature during period of Chum salmon breeding, Coyhaique Hatchery, 1974-1978

No.	Stock code	Incubating period	Season	Formula	Coefficient
1	KJ-73-B	16 Mar 1974-30 May 1974	Autumn	$T = 12.45 - 0.018 D$	-0.86
2	KJ-74-A	01 Nov 1974-31 Jan 1975	Spring	$T = 9.70 + 0.082 D$	0.70
3	KJ-74-B	16 Mar 1975-18 May 1975	Autumn	$T = 12.52 - 0.114 D$	-0.81
4	KJ-75-A	16 Nov 1975-31 Jan 1976	Spring	$T = 8.02 + 0.013 D$	0.19
5	KJ-75-B	07 Mar 1976-04 Jun 1976	Autumn	$T = 7.92 - 0.050 D$	-0.72
6	KJ-76-A	27 Nov 1976-31 Jan 1977	Spring	$T = 11.30 + 0.022 D$	0.26
7	KJ-76-B	06 Mar 1977-31 May 1977	Autumn	$T = 7.80 - 0.072 D$	-0.74
8	KJ-77-A	04 Dec 1977-20 Jan 1978	Spring	$T = 9.65 + 0.438D$	0.80
9	KJ-77-B	All eggs dead in arrival		$T = 14.15 - 0.124D$	-0.641

Where: T = Temperature (C),
D = Days

(Water flow and quality)

Water for the Coyhaique Hatchery comes from Claro River, 20 liters per minute for eggs in the incubator and 100-200 liters for sac-fry in the channel. Water quality analysis is shown in Table 6. The Claro River supports resident Brown Trout (*Salmo trutta fario*) and Rainbow trout (*Salmo gairdnerii irideus*).

Table 6. Analysis of the incubator water, Coyhaique hatchery

Date of sample	June 24 1977	
Source	Rio Claro	
Aspect	Transparent	
Color	None	
Odor	None	
pH	6.9	
Iron	0.0	
Copper	0.0	
Nitrate	0.559 ppm	
Nitrite	0.013 ppm	
Sulfate	140.0 ppm	
Phosphate	0.16 ppm	
Silica	23.0 ppm	
Phenolphthalein	0.0	
Alkaline total	30.0 ppm	CaCO ₃
Ca	10.0 ppm	
Mg	10.0 ppm	
Color	20.0 unid.	Co-Pt
Turbidity	10.0 unid.	Jackson

Analysis by Sra. Maria del Carmen Jacques V., Division Proteccion Pesquera, SAG.

(Feeding and Growth)

From the beginning of this project, it was recommended that, feeding techniques be use, in the process of breeding fry to the release stage. Hatchery facilities and fish food supply were considered to prepare for establishment of a feeding operation designed to release the fish at an optimal time for their survival with emphasis on size.

In 1977 and 1978, experimental feeding was attempted in winter and summer. This works are given many possibilities and potenciales to be development salmon culture in Chile.

The results in fry size from sample feeding are shown in Figure 5. More details will be given the next report.

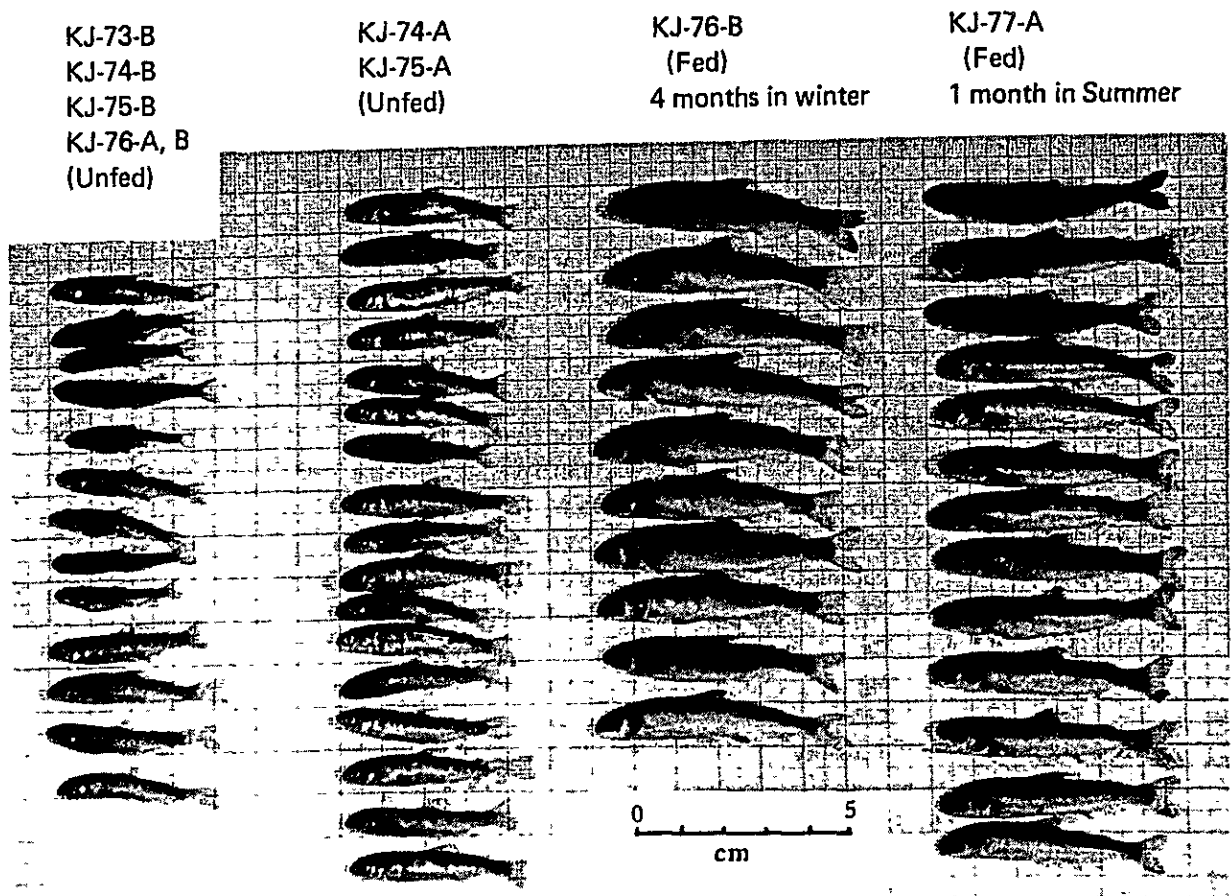


Figure 5. Produced fry size of Chum salmon for release, Coyhaique Hatchery, Chile.

FRY RELEASE

1. Group KJ-76-A

This group of eggs produced 820,000 fry in the middle of January, the beginning of summer in the province Aysen. All were released into the Simpson River; 640,700 fry liberated from the hatchery at Coyhaique; 115,700 transferred by tank truck to Pto. Piedra on the Aysen River; 30,900 at Veintiseis 45km below the Simpson from the hatchery and 32,900 at Virgen 35km below the hatchery. Location of release points is shown in Figure 6. Up to the end of January, all produced fry were liberated as follows;

(Released fry)

River	Locality	Number	Method	Date
Simpson R.	Coyhaique	640,700	Hatchery release	15-31 Jan. 1977
	La Virgen	32,900	Tank release	25 Jan. 1977
	Veintiseis	30,900	Tank release	27 Jan. 1977
Aysen R.	Pto Piedra	115,700	Tank release	18-19 Jan. 1977
Total		820,000		

(Location Diagram)

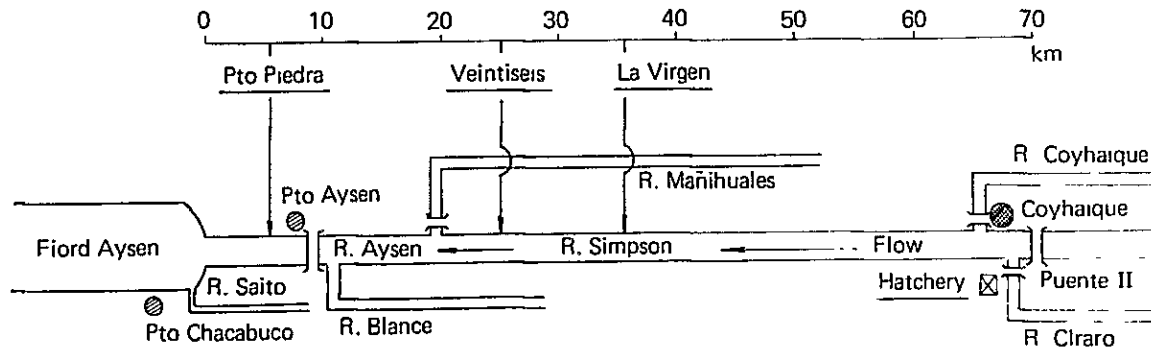


Figure 6. Location of Fry released Point on Simpson River.

2. Group KJ-76-B

This group of eggs produced 1,522,000 fry including 61,000 fish fed for 4 months. The 1,461,000 unfed-fry were liberated into the Simpson River at the hatchery during 15-30 May 1977 and 61,000 into the Aysen River by tank truck on 9th June 1977.

50,000 of the fed-fry were liberated into the Simpson River on 30th September; 11,000 were transferred to El Salto River, but 1,000 fish were lost, so that only 10,000 were release on 3rd October 1977, the onset of spring in the Aysen.

Date on releases into the Aysen River at Pto Piedra and at El Salto River on the date of liberation were as follows;

Aysen River (Pto Piedra)	Date;	09 June 1977
	Time;	AM 10:15
	Air temperature;	5.0°C
	Water temperature;	6.0°C
	pH;	8.2
	Dissolved Oxygen;	9.5 ppm
El Salto River	Date;	03 October 1977
	Time;	AM 11:30
	Water temperature;	6.8°C
	Water color;	Stainless peaty brown
	Water flow;	0.3-0.4 m ³ /sec in estimated

(Released fry)

River	Number	Method	Date
Simpson R.	1,400,000 unfed	Hatchery release	15-30 May 1977
Simpson R.	50,000 fed	Hatchery release	30 Sep 1977
Aysen R.	61,000 unfed	Tank release	30 May 1977
El Salto R.	10,000 fed	Tank release	03 Oct 1977
Total	1,521,000		

3. Group KJ-77-A

The number of fry kept to the liberation stage from this group was 1,738,000; 86.3% (1,500,000) were fed for one month and 13.7% (238,000) were release as unfed fry. The fed-fry went into the Simpson River and the unfed into El Salto.

Liberation into El Salto River occurred on 27th January, 1978 at 10:00 AM by tank track. Condition of the river was as follows;

Water temperature	12.0°C
pH;	6.6
Dissolved Oxygen;	9.3 ppm
Turbid;	40.0 ppm

The 1,500,000 fed-fry were liberated into Simpson River at 10:00 AM on 24th February, 1978. This was the largest group were liverated during the program. Condition of the river was as follows;

Weather;	Raining
Water temperature;	15.6° C
pH;	7.2
Dissolved Oxygen;	8.3 ppm
Water level;	Very low, Dry season
Water quantity;	2.6 ton/sec approximately
Turbidity;	15.0 ppm
Place;	Puente II Simpson, Coyhaique

(Released fry)

River	Number		Method	Date
El Salto R.	238,000	Unfed-fry,	Tank release	27 Jan. 1978
Simpson R.	1,500,000	Fed-fry,	Hatchery release,	24 Feb. 1978
Total	1,738,000			

4. Group KJ-77-B

No fish produced, all died in eyed egg stage during transportation.

5. Discussion

Tables 7 and 8 show that the number of fry released was placed on feeding trials, with additional track releases in new streams near the fiord, El Salto River was used as a salmon culture river experimentally.

It seems that the liberated fish are not always in good condition for survival and return as spawners will be put on fry production for survival in the sea in the hope of getting adult returns on a scale eventually to establish a commercial salmon fishery.

The problem still unsettle is to find an optimal time for migration to the sea and survival in the fjord. This is a high priority in next phase of the project.

Table 7. Chum Salmon Fry Release Quantity, Season, Fish size and River
(1974–1978)

Coyhaique Hatchery
Servicio Nacional de Pesca
Region XI Aysen, Chile

Stock code	Number of eyed eggs from Japan	Number of released fry	Fry Liberation						Remarks
			Date			Fish size		River	
			Day	Man.	Year	gr.	mm		
1.- KJ-73-B	1,000,000	645,000	15-26	May	1974	0.33	32	Simpson	Experiment
Total	1,000,000	645,000							
2.- KJ-74-A	1,000,000	900,000	07-10	Jan.	1975	0.44	35	Simpson	Pilot release
3.- KJ-74-B	950,000	800,000	20-25	May	1975	0.35	33	Simpson	Pilot release
Total	1,950,000	1,700,000							
4.- KJ-75-A	1,000,000	976,000	08-27	Jan.	1976	0.45	35	Simpson	Pilot release
5.- KJ-75-B	1,000,000	756,000	26-30	May	1976	0.37	35	Simpson	Pilot release
		80,000	28	May	1976	0.35	35	El salto	Experiment
Total	2,000,000	1,812,000							
6.- KJ-76-A	1,000,000	820,000	15-31	Jan.	1977	0.33	34	Simpson	Pilot release
7.- KJ-76-B	2,000,000	1,461,000	15-30	May	1977	0.35	37	Simpson	Pilot release
		50,000	30	Sep.	1977	1.82	59	Simpson	Feeding trial
		10,000	03	Oct.	1977	1.82	59	El salto	Experiment
Total	3,000,000	2,341,000							
8.- KJ-77-A	2,000,000	228,000	27	Jan.	1978	0.30	35	El salto	Experiment
		1,500,000	24-25	Feb.	1978	1.24	54	Simpson	Pilot release
9.- KJ-77-B	1,000,000	-0	All eggs were dead in transport which egg condition very bad						
Total	3,000,000	1,728,000							

Gr. total 10,950,000 8,226,000

* 1 Box (50,000 eggs) less in transportation

Table 8. Annual Release of Chum Salmon Fry in Aysen, Chile.
(1974-1978)

Year	Simpson River		El Salto River		Total	Remarks
	Unfed-fry	Fed-fry	Unfed-fry	Fed-fry		
1974	645,000	-	-	-	645,000	KJ-73-B
1975	1,700,000	-	-	-	1,700,000	KJ-74-A, B
1976	1,732,000	-	80,000	-	1,812,000	KJ-75-A, B
1977	2,281,000	50,000	-	10,000	2,341,000	KJ-76-A, B
1978	-	1,500,000	228,000	-	1,728,000	KJ-77-A
Total	6,258,000	1,550,000	308,000	10,000	8,226,000	Unfed 81.04% Fed 18.86%
	7,908,000		318,000			

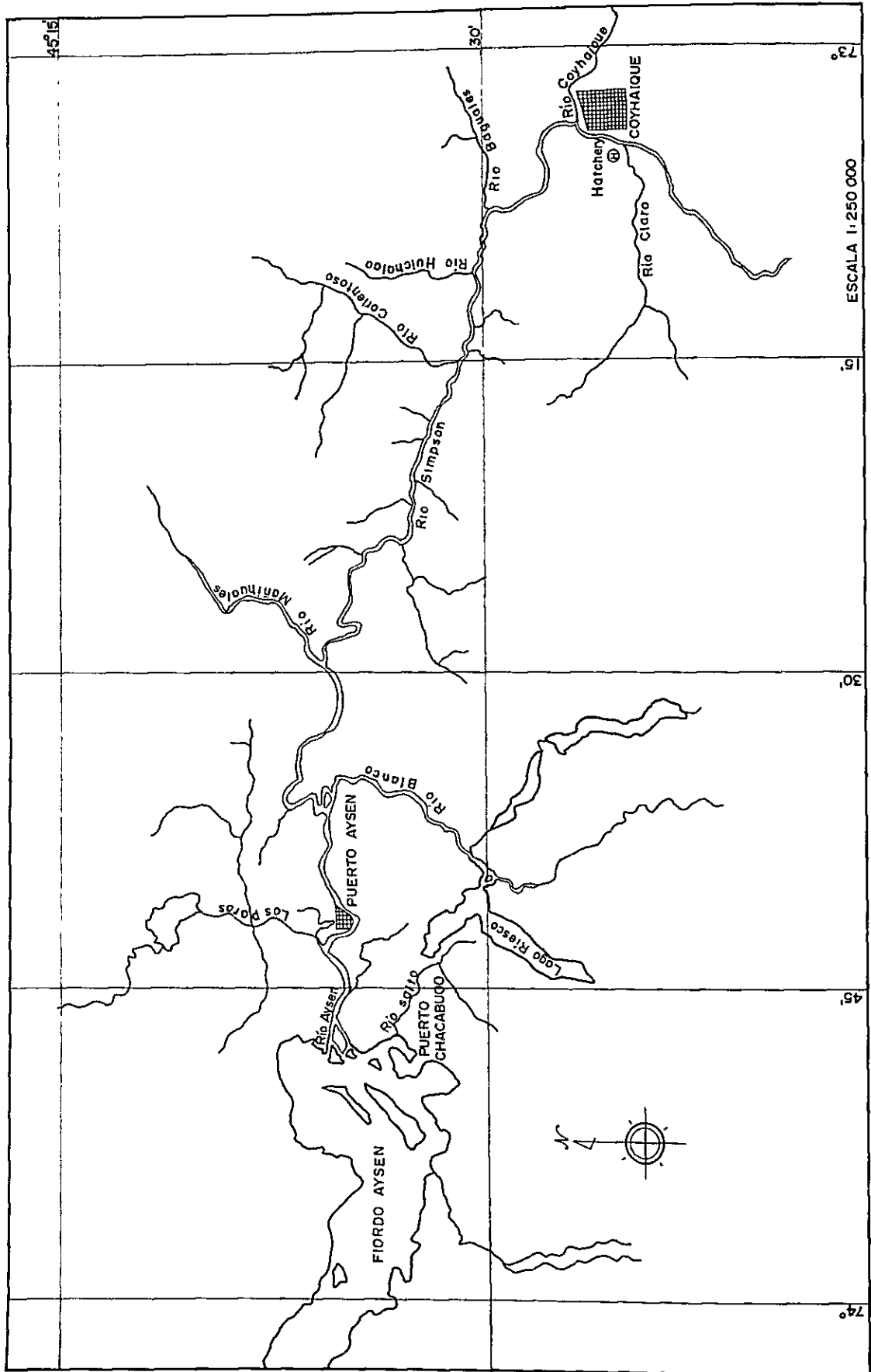


Figure 7. Simpson River System from Coyhaique Hatchery and El Salto River

FRY MIGRATION

1. Group KJ-73-B

This is first time that Chum salmon were released in Chilean waters. About 645,000 fry were liberated from the hatchery in the free-swimming stage from 15 to 26 May, 1974 at the onset of winter in the Southern Hemisphere. They averaged 0.33gr and 32mm.

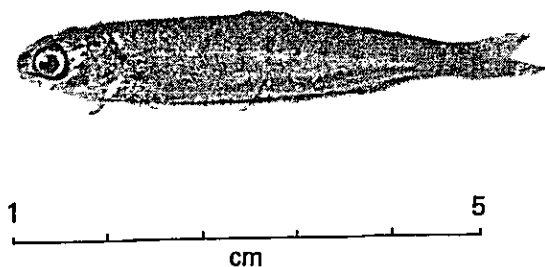
This was a period of heavy rains unfortunately, causing the river to rise. Consequently many young fry were trapped in the small pools where they were lost through predation by birds or asphyxiation as the pools dried. About 100,000 fry were estimated to have died in this way. Up to June 10th, no fry were seen in the Simpson River close to the hatchery site. Some fish seemed to have gone down the river.

After that, this group of fish were monitored down river from 27 July to 22 October, 1974. During this period, Samples were taken by fyke-netting at a station 25km below the hatchery. Migrating fry were sampled and enumerated at PM 16:00.

A small number of fry were taken in the sampling. Thirteen fish were trapped from August 6th to September 13th. This seems to have been the period of peak migration from hatchery to the mouth of the river. They grew from a range of 0.70gr to 2.25gr and 46mm to 58mm. A details of these observations will be made available in a later report.

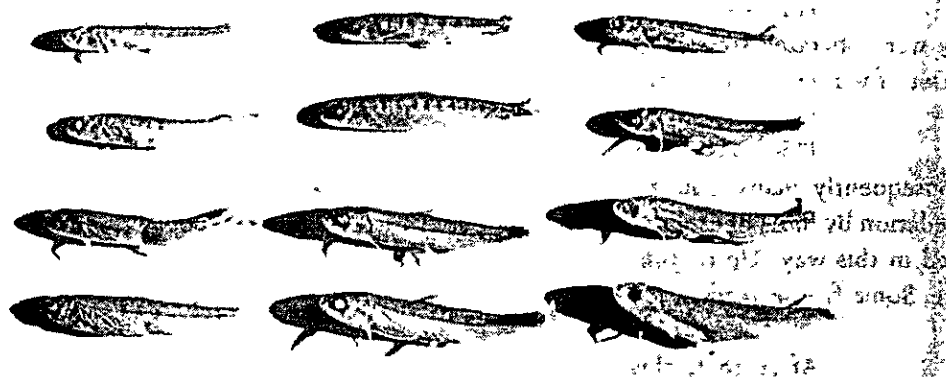
Oncorhynchus Keta
Liberated in MAY 1974.

Catch on 6 Aug. 1974
Rio Simpson AYSÉN, CHILE
Weight 1.25g

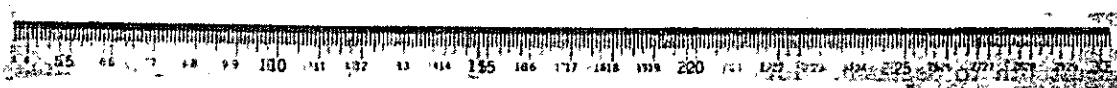


CHUM SALMON IN CHILE
GROWTH IN RIO SIMPSON

AUG.-SEP. 1974
AT HUICHALAO



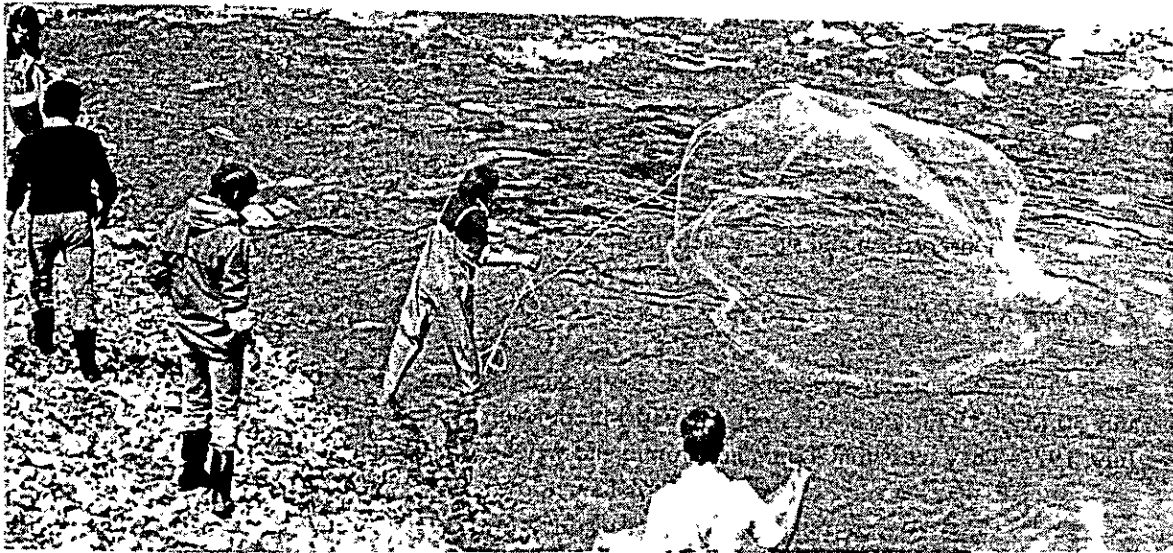
SAMPLE OF FRY TAKEN FROM THE DOWNSTREAM TRAP



2. *Group KJ-74-A*

This group of 900,000 fry was released from hatchery between January 7 and 10, 1975. Their movements were traced with casting nets 10km along the banks of the Simpson River once every ten days. In addition a Fyke-net was placed on 17 January, 1975 at the same station as the year before, 25km downstream, from the coyhaique Hatchery, for KJ-73-B fry observation.

The Fyke-net was checked once daily at 16:00 PM. Only 5 fish were taken from January 17 to February 20. 52 fish were sampled by the casting-net, 17 on 23 January, and 36 on 3rd February. Sampled fish size averaged 1.53gr and the biggest was 2.50gr taken on 3rd February, almost one month after liberation into the river. A report of this observation will be made in the next issue of this series, including KJ-73-B.



Sampling work by Casting-net for trace of KJ-74-A migration in Simpson River. (Feburary 3, 1975)

3. *Group KJ-74-B*

About 800,000 fry were released from the hatchery directly into the Simpson River between 20 and 25 May, 1975. Released fish weight averaged 0.44gr and size 35mm.

This group could not be observed and none confirmed to the previously collected sample. Probably, they were comparable to KJ-73-B in group behavior.

4. *Group KJ-75-A*

Some 976,000 fry from this group survived to the liberation stage. The fish were liberated beginning 8 January, 1976. As this was the season of low water in the river, predators appeared near the outlet of the release canal, especially Brown and Rainbow trout. For this reason 120,000 fry were transferred by tank truck and released at Pto Piedra, a tributary of the Aysen that connecting with Simpson River (Fig. 7). The remaining 856,000 fry were liberated from the hatchery in Coyhaique. All fry had migrated out from the fry-channel by 27 January, 1976.

Migration of this group could not be observed in the river. However, two fish were caught in Claro River by casing-net on 18 Feburary, 1976. They weighed 1.94gr and 1.07gr and were 66mm and 53mm long.

5. *Group KJ-75-B*

About 636,000 fry from this group were released directly into the Simpson River from the hatchery and 120,000 fry were transported to Pto Piedra by tank truck and released into the Aysen River. 80,000 fry were taken to El Salto River located near Pto Chacabuco (Fig. 7) this was an experimental release.

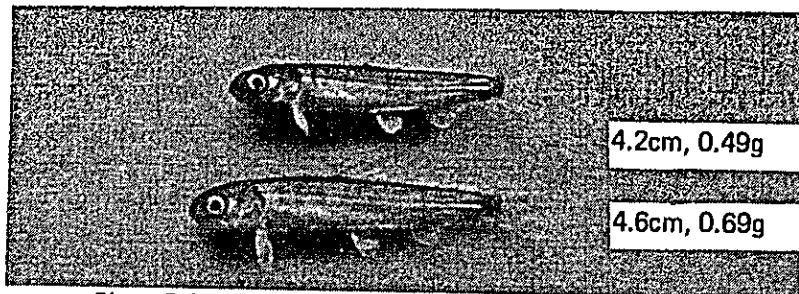
Migration of these fish could not be observed. However, one fish was caught by casting-net on 08 July, 1976, at Huichalao 25km below the hatchery. It weighed 0.45gr and was 42mm long.

6. *Group KJ-76-A*

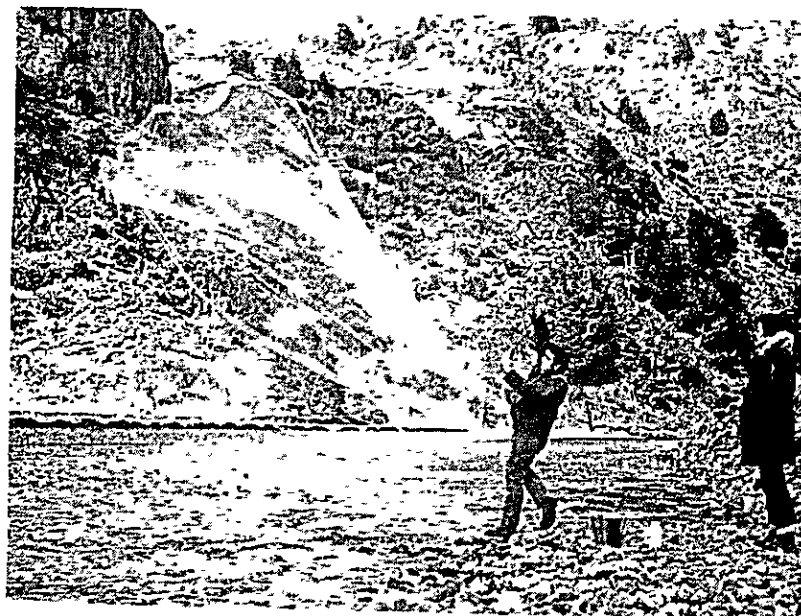
Observation and survey were not provided for this group.

7. *Group KJ-76-B*

Observation and survey were not provided but two fish, released at the hatchery 15 and 30 May, 1977, were captured by casting-net at Huichalao 25km below the hatchery on 27 July, 1977. They measured 42mm and 46mm and weighed 0.49gr and 0.69gr.



Chum Salmon Fry (KJ-76-B) in Simpson River
Aysen, Chile. 27 July 1977



Fry sampling for KJ-76-B at Huichalao, Simpson River.
(July 27, 1977)

8. *Group KJ-77-A*

An observation program was activated on this group in the Simpson River immediately after release, but no monitoring was conducted on the fish released into El Salto River. Daily memorandum of observation follows;

<u>Date</u>	<u>Observation</u>
24 Feb. 1978	Liberation of 1,500,000 fed-fry from hatchery.
25 Feb. 1978	Small shoals were observed along the banks of the river near hatchery. However, main number of fish had already migrated.
26 Feb. 1978	Many fish were observed at Huichalao 25km below the hatchery. Water temperature was 15.0°C.
27 Feb. 1978	A fyke-net was set at point 45km down stream from Coyhaique hatchery.
01-10 March 1978	Small shoals observed at fyke-net site.
13 Mar. 1978	Information come from ranchers in Rto Piedra that they saw many shoals of fry in Aysen River in early March.
17 Mar. 1978	No more fish were seen at Pto Piedra.
23 Mar. 1978	Discontinued fyke-net sampling. Observation indicated termination of fry migration.

Unfortunately no samples of migrating fry were obtained from the fyke-net despite the fact that fish were in the vicinity during early March.

9. *Group KJ-77-B*

The Simpson River is empty of Chum salmon; none released.

10. *Discussion*

This chapter summarizes three years work, 1974-1976, with results still unpublished.

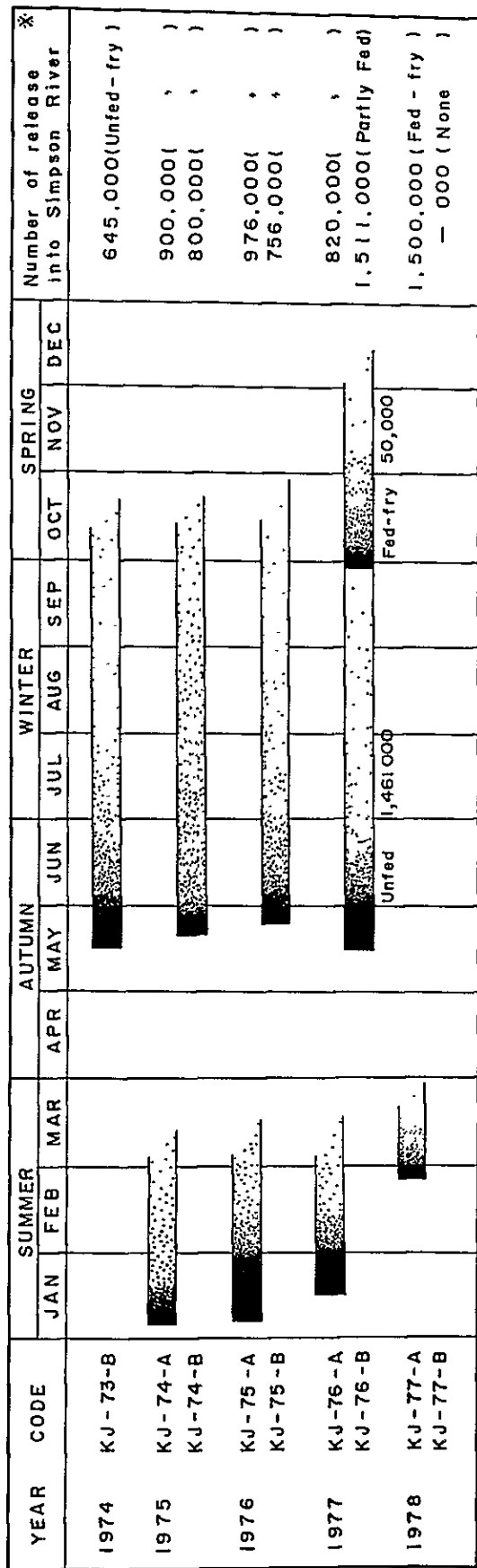
Observation of fry migration in Simpson River suggests two things; (1) Autumn releases of fry (A-group) indicates that fish stay in the river until spring when temperatures rise, and (2) Summer released B-group moved down river immediately and entered the fiord (Figure 8).

This is very interesting because in the Northern hemisphere Chum salmon never winter in the river. Both Chum and Pink salmon, migrate to salt water as soon as the yolk sac is absorbed in the Northern hemisphere. The fact that Chum in Chile came from Northern stock yet behaved differently than in their nature waters is an ecologic mystery associated perhaps with the several of the seasons on a calendar basis.

The other noteworthy observation is that the A and B groups almost reached the same size at time of entering the fjord despite the fact that they were released in different seasons. Fish in the river tend to be less active in winter when metabolism slows down and more active in summer when metabolism speeds up.

(Water quality and Predators)

Water of the Simpson River which originates in nearby Argentina, was analyzed on June 25, 1977, in Table 9. Samples were taken at Coyhaique Hatchery site almost in the middle of the stream.



Released time
 Migrate Period (Stay in River)
 Except Release into EL Salt River

Figure 8. Chum salmon fry release time and Down migration period, Simpson River, Aysen Chile, 1974-1978

② Both Brown and Rainbow trout are present in these waters, but browns are in a ratio of 20 to one, Judged by angling catches. Both brown and rainbow trout weighing one to three kilograms preyed on migrating fry of Chum salmon.

Table 9. Analysis of Simpson River water,
at Coyhaique hatchery site

Date of sample	June 25, 1977
River name	Rio Simpson
Sampled place	Puente II Simpson, Coyhaique
Aspect	Slightly turbid
Color	Slight yellow
Odor	No smell
pH	7.05
Iron	0.0
Copper	0.0
Nitrate	0.651 ppm
Nitrite	0.009 ppm
Sulfate	220.0 ppm
Phosphate	0.280 ppm
Silica	40.0 ppm
Phenolphthalein	0.0
Alkaline total	40.0 ppm CaCO ₃
Ca	20.0 ppm
Mg	10.0 ppm
Color	120.0 unid. Co-Pt
Turbidity	50.0 unid. Jackson

Analysis by Sra. Maria del Carmen Jacques V., Division Proteccion Pesquera, SAG.

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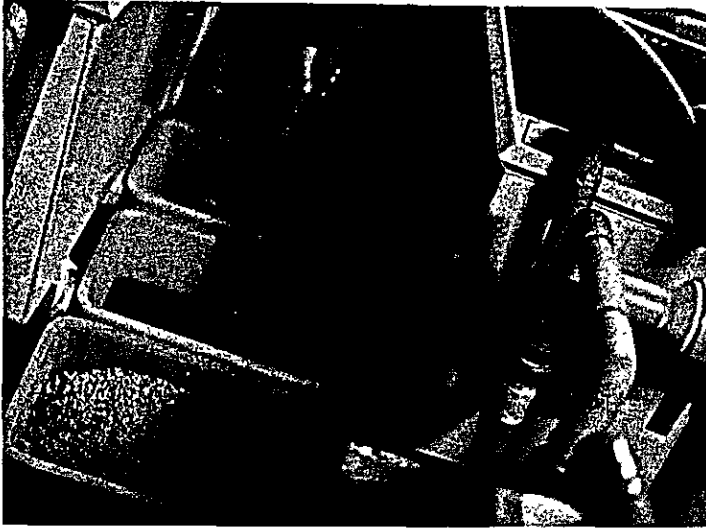


Plate 1.
Iodin treatment before shipment package eggs, at Chitose Hatchery.



Plate 2.
Egg packing for shipment to Coyhaique Hatchery, at Chitose Hatchery.

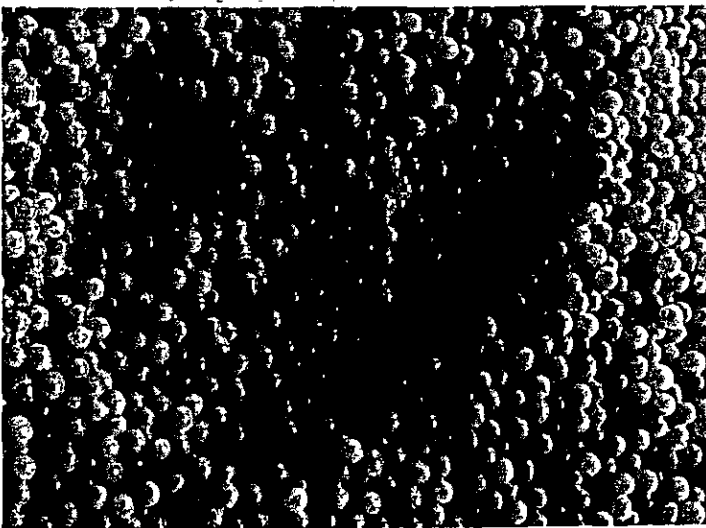


Plate 3.
Serected eggs for Chile, about 360-380°C U.T. at Chitose Hatchery.

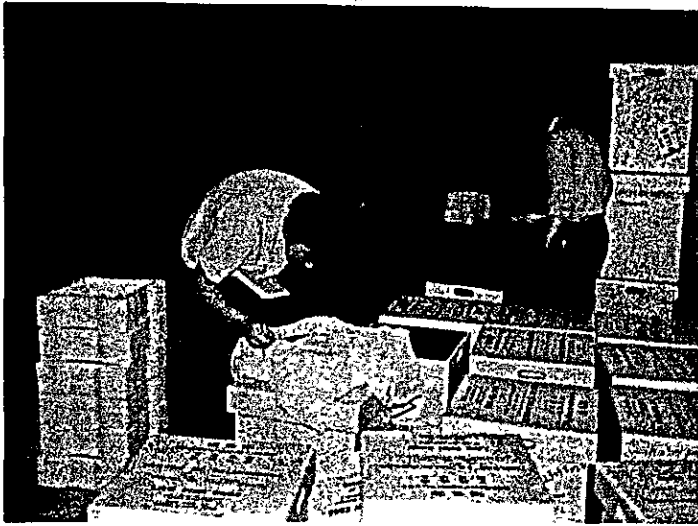


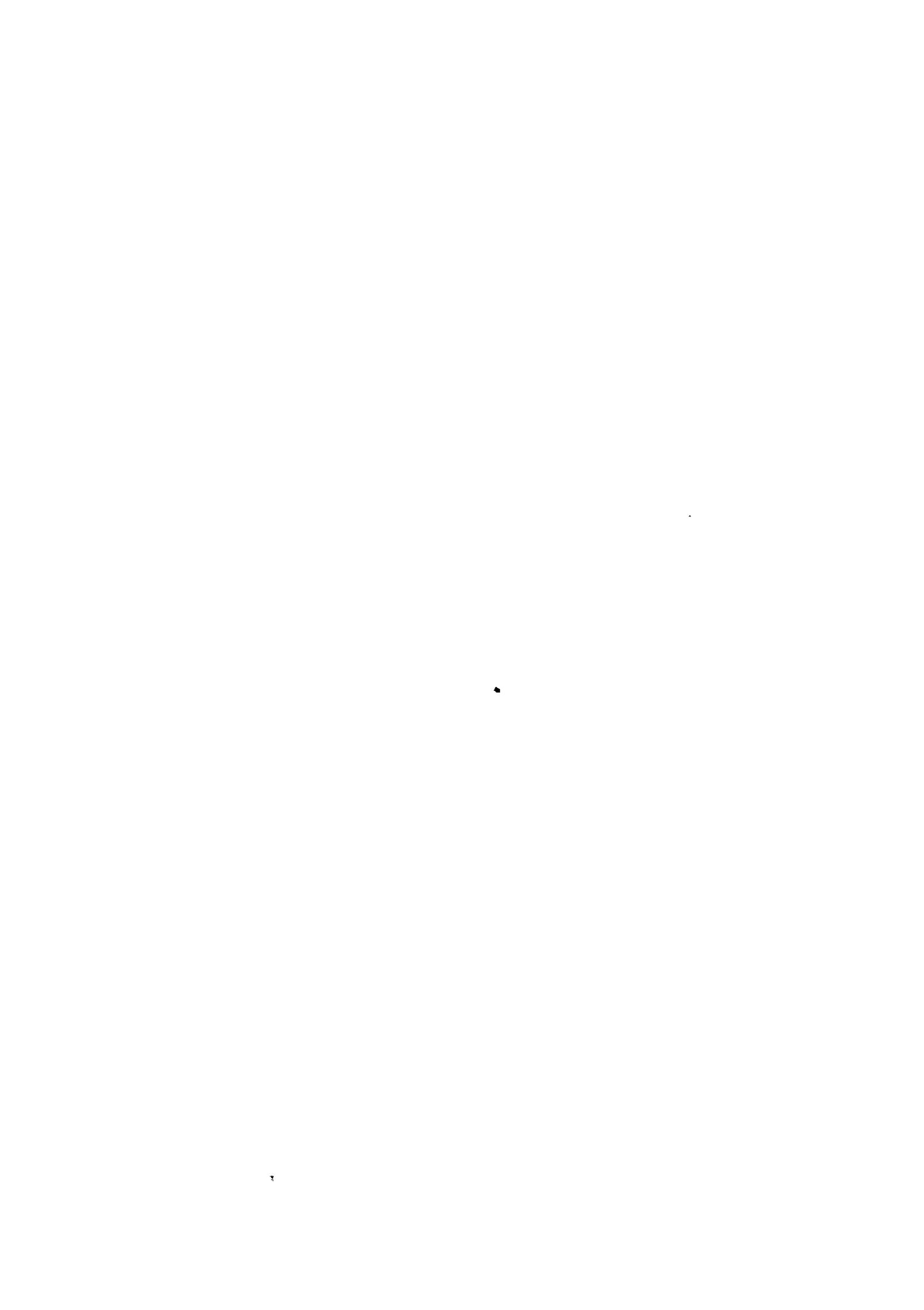
Plate 4.
Checking arrived egg condition
and temperature record with
thermometer setting inside
egg-tray, at Coyhaique
Hatchery.



Plate 5.
Egg treatment with Iodin in
the incubator trough.



Plate 6.
Egg rinse after Iodin treat-
ment.



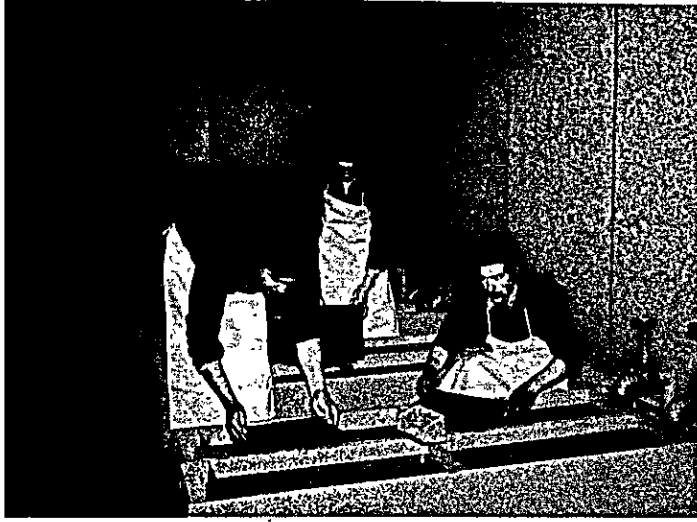


Plate 7.
Egg setting in the screen tray
of Atkins incubator.

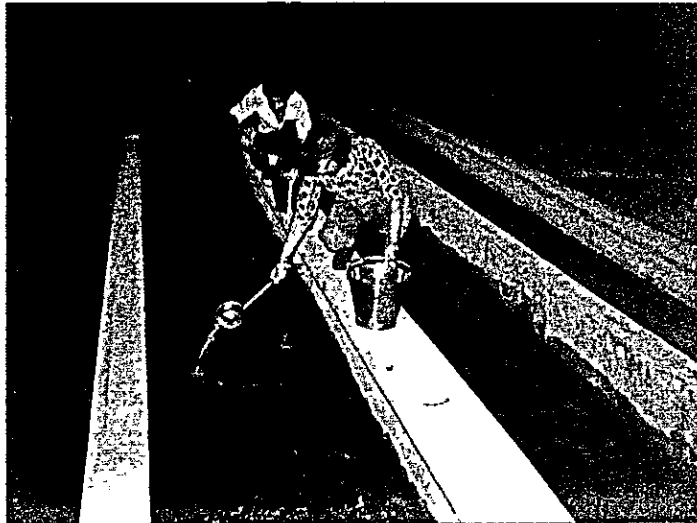


Plate 8.
Accommodate sac-fry in the
incubator channels after
hatch-out.



Plate 9.
Swim-up fry in the incubation
channels.

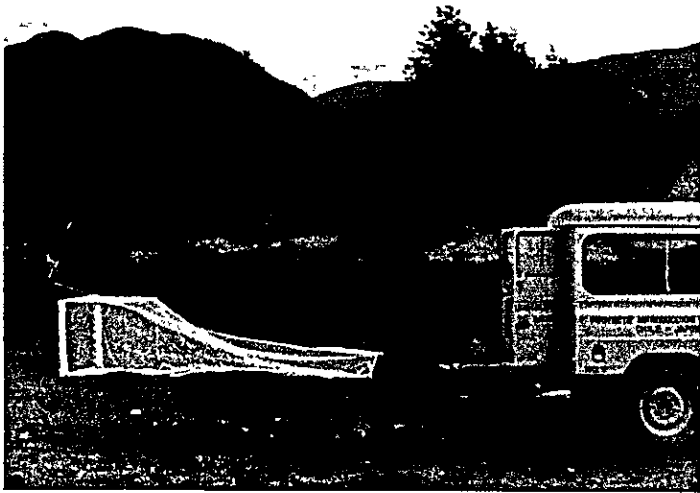


Plate 10.
In preparation for a Fykenet
setting at 45km down stream
in Simpson River.



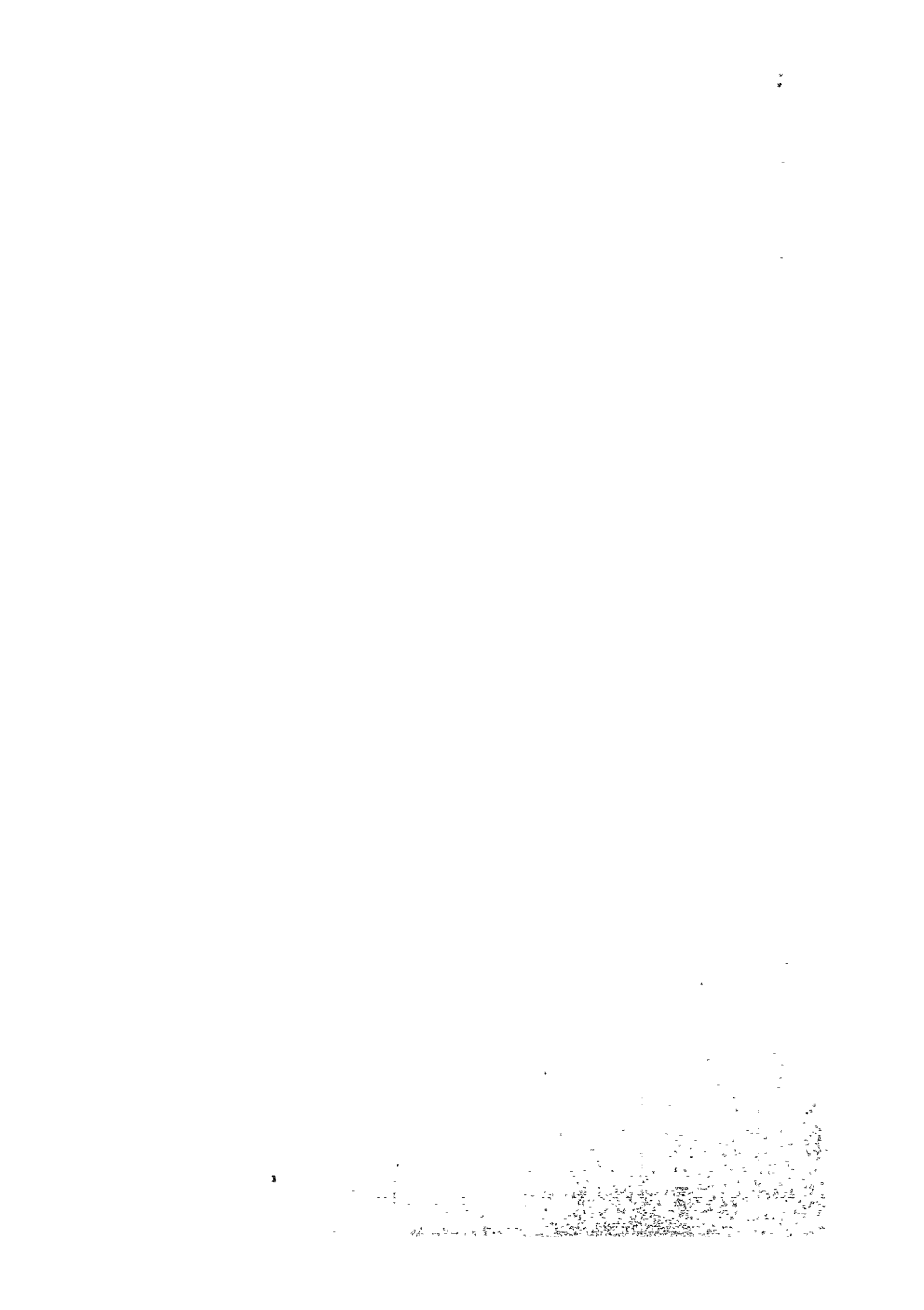
Plate 11.
El Salto River.



Plate 12.
Winter view of Simpson River
at Puente II, nearby Hatchery.

APPENDIX

**Climatological and River Observation
at Hatchery site – Simpson River
(May 1977 – April 1978)**



Climatological and River Observation at Hatchery site – Simpson River
May 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	CR	2.0	9.0	5.0	52	180	
2	CR	1.0	8.0	5.5	47	168	
3	RS	-1.5	3.0	4.6	42	175	
4	B	-2.0	2.0	4.2	52	155	
5	B	-4.0	1.0	3.2	21	148	pH = 7.4 DC = 11.4 ppm
6	B	-5.0	2.0	2.6	13	140	
7	C	2.0	5.0	4.4	13	140	
8	BC	3.0	8.0	5.5	20	135	
9	B	-5.0	-1.0	3.3	13	136	
10	C	-1.0	5.5	5.1	06	130	
Average		(-1.1)	(4.2)	(4.3)	(28)	(151)	
11	C	-1.0	4.0	5.2	12	125	
12	BC	-3.0	3.5	6.1	06	125	
13	BC	-4.0	5.0	3.5	07	123	
14	B	-5.0	3.5	3.3	06	120	
15	B	-5.5	3.0	3.0	08	120	pH = 7.4 DO = 11.3 ppm
16	C	-4.0	-1.5	2.8	03	118	
17	CR	-2.0	-1.0	3.4	01	115	
18	B	-1.0	5.0	5.3	01	115	
19	BC	1.0	5.5	6.1	06	110	
20	C	2.0	5.0	6.1	05	110	
Average		(-2.3)	(3.2)	(4.5)	(06)	(118)	
21	B	-3.0	5.0	3.3	04	108	
22	C	-1.0	5.0	4.3	06	107	
23	R	1.0	3.0	6.7	03	108	
24	CR	1.0	9.5	8.9	06	110	
25	DR	1.0	11.0	10.0	98	120	PH = 9.2 DO = 9.0 ppm
26	B	-1.0	9.0	7.5	177	170	
27	R	3.0	8.0	6.5	71	145	
28	CR	5.0	8.0	5.8	19	148	
29	R	5.0	10.0	7.5	12	135	
30	R	7.0	11.0	6.8	15	130	
31	R	8.5	10.0	8.4	125	220	
Average		(2.4)	(8.1)	(7.6)	(54)	(150)	
		-0.3	5.2	5.5	29	140	

Sky code: B = Blue Sky, cloud cover not more than 1/10 R = Rain
 BC = Blue Sky with detached clouds S = Snow
 C = Cloudy, complete overcast DR = Drizzling rain

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
June 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	R	9.0	10.0	6.8	124	230	
2	B	9.0	11.8	6.5	170	225	
3	B	-3.0	8.3	3.0	148	200	
4	C	-3.0	9.0	3.8	82	180	
5	B	-1.0	6.0	4.1	60	170	pH = 7.5 DO = 8.5ppm
6	BC	-1.0	8.0	4.2	60	160	
7	R	1.0	8.0	4.4	90	170	
8	C	-4.0	3.5	4.5	550	260	
9	B	-1.0	6.0	3.6	400	230	
10	BC	-2.0	8.0	2.9	130	200	
Average		(0.4)	(7.9)	(4.4)	(182)	(202)	
11	R	-7.0	7.0	6.2	500	310	Inundation
12	R	1.0	6.0	6.5	Muddy	460	
13	B	-1.0	1.0	4.0	"	340	
14	C	-1.0	3.0	3.7	"	240	
15	S	-1.0	2.0	3.3	"	220	pH = 7.0 DO = 8.0ppm
16	S	-1.0	2.0	2.0	78	210	
17	S	-1.0	4.0	1.5	60	180	
18	B	-4.0	1.0	1.4	30	170	
19	B	-7.0	4.0	0.8	35	155	
20	B	-12.0	-2.0	0.5	40	140	
Average		(-3.4)	(2.8)	(3.0)	(-)	(242)	
21	C	-16.0	-8.0	0.1	37	140	
22	C	-4.0	8.0	0.5	32	138	
23	B	6.0	8.0	2.8	85	130	
24	C	2.0	7.0	2.2	44	138	
25	DR	-1.0	3.0	2.5	29	135	pH = 7.0 DO = 10.6ppm
26	R	1.0	2.0	2.4	32	147	
27	B	2.0	6.0	2.4	23	145	
28	DR	1.5	4.0	3.0	07	140	
29	DR	1.5	3.0	3.3	28	153	
30	DR	-1.5	2.3	3.5	89	149	
Average		(-0.8)	(3.5)	(2.3)	(41)	(141)	
		-1.3	4.7	3.2	-	195	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
July 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	S	-0.5	2.0	3.3	30	130	
2	BC	-1.8	6.0	8.7	25	122	
3	B	0.5	5.0	4.2	08	115	
4	B	0.5	2.9	2.3	02	110	
5	C	1.9	4.0	5.2	11	110	pH = 6.4 DO = 8.3ppm
6	C	-2.5	3.5	3.3	07	110	
7	C	-3.5	5.0	2.4	06	109	
8	BC	-4.0	4.0	2.2	04	100	
9	B	-1.8	4.0	2.0	51	100	
10	DR	-2.5	3.0	2.4	16	100	
Average		(-1.8)	(3.9)	(3.6)	(16)	(111)	
11	C	0.0	1.2	1.5	05	100	
12	C	0.0	1.2	1.7	01	98	
13	BC	-2.8	4.0	0.1	02	94	
14	C	-4.0	1.2	1.3	33	87	
15	B	-8.7	-0.5	2.2	04	80	pH = 7.6 DO = 8.5ppm
16	B	-5.1	4.7	1.6	00	85	
17	B	-1.5	4.0	2.3	05	85	
18	B	-3.0	0.1	2.5	03	87	
19	C	0.0	3.5	2.8	05	87	
20	BC	-1.0	4.0	2.5	02	87	
Average		(-2.6)	(2.3)	(1.8)	(06)	(89)	
21	CDR	1.5	3.0	2.8	01	87	
22	BC	0.0	2.5	2.5	30	87	
23	BC	-3.0	5.0	2.6	75	85	
24	C	-2.0	3.5	2.4	30	83	
25	S	0.0	3.0	2.4	21	83	pH = 7.0 DO = 8.2ppm
26	C	-1.5	1.0	2.6	01	80	
27	BC	-3.0	1.0	2.3	02	78	
28	CS	-2.0	4.0	3.3	18	75	
29	BC	-1.0	2.0	2.5	02	75	
30	BC	-5.0	2.0	2.2	49	72	
31	R	-1.0	1.0	2.1	02	72	
Average		(-1.5)	(2.8)	(2.5)	(23)	(80)	
		-2.0	3.0	2.6	15	93	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
August 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	C	-3.0	6.0	1.8	02	70	
2	S	-2.0	7.0	2.2	02	72	
3	C	-4.0	4.0	1.4	02	71	
4	BC	-3.0	4.0	1.4	08	71	
5	C	-8.0	6.0	1.0	07	70	pH = 7.1 DO = 8.3 ppm
6	C	-4.0	3.0	2.0	04	70	
7	C	-3.0	4.0	2.2	07	70	
8	BC	-3.0	0.0	1.8	12	70	
9	C	-3.0	6.0	3.0	02	69	
10	C	-2.0	4.0	2.8	06	69	
Average		(-3.5)	(4.4)	(1.4)	(04)	(70)	
11	C	-2.0	4.0	3.0	05	69	
12	BC	-1.0	10.0	2.6	05	68	
13	BC	-3.0	6.0	2.2	03	70	
14	BC	-0.5	10.0	3.0	03	69	
15	C	1.0	11.0	3.2	03	72	pH = 6.9 DO = 8.1 ppm
16	BC	3.0	8.0	4.4	07	77	
17	C	4.0	14.0	5.0	35	70	
18	BC	8.0	16.0	6.0	103	115	
19	S	2.0	14.0	4.8	120	140	
20	BC	0.0	8.0	3.0	47	113	
Average		(1.6)	(10.1)	(3.7)	(33)	(86)	
21	BC	1.0	8.0	3.4	55	98	
22	BC	3.5	10.5	4.6	79	92	
23	CDR	2.5	10.0	4.2	58	105	
24	BC	5.0	11.5	5.0	66	130	
25	BC	1.5	9.0	3.6	88	135	pH = 7.1 DO = 9.5 ppm
26	B	2.0	9.0	3.2	29	125	
27	B	1.0	13.0	3.7	14	110	
28	R	4.0	13.0	4.8	20	115	
29	BC	3.0	10.0	4.0	131	188	
30	BC	1.0	8.0	3.2	75	168	
31	B	-2.5	13.0	2.2	29	145	
Average		(2.0)	(10.5)	(3.8)	(59)	(141)	
		-0.5	8.4	3.0	33	99	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site -- Simpson River
September 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	C	1.0	12.0	3.3	25	138	
2	BC	4.0	15.0	5.2	25	127	
3	C	1.0	14.0	5.0	15	125	
4	BC	-2.0	15.0	5.0	30	125	
5	CDR	1.0	14.0	5.4	20	125	pH = 7.1 DO = 9.9 ppm
6	C	3.0	11.0	6.0	73	150	
7	C	4.0	13.5	5.4	58	145	
8	CDR	4.5	12.0	5.4	34	142	
9	C	2.0	10.0	5.2	34	135	
10	C	1.0	11.0	4.4	19	125	
Average		(2.0)	(12.8)	(5.0)	(33)	(134)	
11	C	1.0	9.5	4.2	11	119	
12	BC	3.0	8.5	4.1	08	115	
13	BC	3.0	10.0	3.6	08	110	
14	BC	3.0	11.0	4.2	25	104	
15	BC	1.0	11.0	5.0	08	102	pH = 7.3 DO = 8.9 ppm
16	BC	2.5	13.0	5.2	13	100	
17	BC	2.0	13.0	5.9	13	95	
18	C	3.0	13.0	5.6	29	95	
19	RS	0.0	6.0	5.8	32	98	
20	C	1.0	11.0	4.2	36	94	
Average		(2.0)	(10.6)	(4.8)	(18)	(103)	
21	C	1.0	12.5	5.1	19	120	
22	C	5.0	15.0	5.7	26	115	
23	C	6.0	14.8	7.1	23	110	
24	R	8.3	13.0	7.5	99	190	
25	R	7.5	15.0	7.4	616	285	pH = 7.1 DO = 11.3 ppm
26	BC	2.0	12.0	7.4	630	285	
27	C	3.0	11.0	5.4	404	195	
28	BC	2.0	10.5	4.7	233	190	
29	B	3.0	13.0	5.1	141	165	
30	B	2.0	13.0	6.4	180	150	
Average		(4.0)	(13.0)	(6.2)	(237)	(180)	
		2.7	12.1	5.3	96	139	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
October 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	BC	2.0	16.0	6.6	78	143	
2	R	8.0	11.5	8.2	70	150	
3	C	3.0	14.0	6.9	469	190	
4	BC	4.5	19.0	7.2	165	160	
5	C	7.0	14.5	8.1	103	151	pH = 6.8 DO = 9.9 ppm
6	C	6.5	15.0	8.2	116	155	
7	CDR	5.5	12.5	7.4	84	148	
8	BC	1.5	12.0	5.3	64	136	
9	B	0.5	15.0	5.5	48	135	
10	B	1.0	15.0	6.4	39	128	
Average		(4.0)	(14.5)	(7.0)	(124)	(150)	
11	B	1.0	18.0	7.2	34	115	
12	C	7.0	16.0	9.2	32	110	
13	BC	4.5	15.0	8.4	21	112	
14	BC	3.0	15.0	7.6	25	110	
15	C	5.0	14.0	7.2	13	108	pH = 7.2 DO = 11.5 ppm
16	BC	6.0	17.5	7.4	18	100	
17	C	9.5	15.5	9.2	40	148	
18	BC	3.8	12.0	5.8	133	168	
19	C	5.0	16.2	6.7	61	135	
20	CDR	8.0	17.0	7.8	35	132	
Average		(5.3)	(15.6)	(7.7)	(41)	(124)	
21	C	9.0	16.0	8.0	79	150	
22	B	6.0	18.0	8.4	51	136	
23	B	1.5	21.5	8.2	46	128	
24	B	5.5	19.5	9.0	44	125	
25	BC	4.0	22.0	9.2	51	125	pH = 7.2 DO = 10.1 ppm
26	R	9.0	22.0	9.2	61	129	
27	B	2.0	22.0	7.3	49	130	
28	BC	6.5	20.0	8.8	40	117	
29	BC	4.0	24.0	9.8	38	115	
30	BC	6.0	23.0	7.2	35	110	
31	BC	5.0	23.0	9.2	33	115	
Average		(5.3)	(19.2)	(8.6)	(47)	(125)	
		4.9	16.4	7.8	70	(133)	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
November 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	C	4.0	23.0	10.0	25	105	
2	B	5.0	21.0	9.8	20	100	
3	B	3.0	24.0	10.4	23	110	
4	B	3.0	26.0	10.5	34	110	
5	RBC	8.0	16.0	11.5	73	108	pH = 7.2 DO = 9.3 ppm
6	R	5.0	14.0	7.8	51	125	
7	CDR	3.0	12.0	6.5	37	120	
8	C	4.0	13.0	7.0	22	105	
9	C	6.0	13.5	7.4	26	105	
10	C	6.0	20.0	7.8	32	100	
Average		(5.0)	(18.3)	(8.9)	(37)	(109)	
11	B	0.5	18.5	7.7	30	90	
12	BC	6.0	14.0	9.5	35	90	
13	C	6.0	15.0	9.0	38	100	
14	R	8.5	18.0	9.2	30	105	
15	BC	9.0	19.5	10.1	71	145	pH = 6.9 DO = 9.0 ppm
16	R	8.5	19.0	10.3	78	130	
17	R	8.0	20.0	9.8	212	147	
18	BC	6.0	19.0	9.5	118	134	
19	C	3.0	21.0	9.6	102	110	
20	BC	6.0	18.5	10.2	82	102	
Average		(6.1)	(18.3)	(9.5)	(80)	(115)	
21	BC	5.0	16.0	10.2	51	104	
22	BC	8.0	19.0	10.2	38	85	
23	BC	4.0	14.0	10.2	38	85	
24	C	5.5	16.0	8.9	30	80	
25	B	5.5	18.0	9.9	37	80	pH = 7.2 DO = 9.4 ppm
26	BC	4.0	10.0	9.4	25	70	
27	BCR	2.5	12.0	8.0	28	70	
28	R	6.0	14.0	8.8	26	50	
29	BC	6.0	15.0	7.5	85	110	
30	CDR	7.0	18.0	9.5	132	90	
Average		(5.4)	(15.0)	(9.3)	(49)	(82)	
		5.5	17.2	9.2	55	102	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
December 1977

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	BC	7.0	17.5	10.3	42	88	
2	B	4.5	17.0	10.6	61	85	
3	C	5.0	18.0	10.8	55	78	
4	R	7.0	11.0	10.2	47	85	
5	R	2.0	14.5	7.2	56	95	pH = 7.1 DO = 9.7 ppm
6	B	4.0	10.5	7.8	48	79	
7	B	10.0	15.5	9.6	46	78	
8	BC	7.0	19.0	10.3	53	78	
9	BC	9.0	22.0	12.0	37	89	
10	B	8.0	23.0	12.8	48	95	
Average		(6.4)	(16.8)	(10.2)	(49)	(85)	
11	BC	10.5	23.7	13.2	54	98	
12	B	7.0	27.0	13.0	64	100	
13	BC	10.5	27.5	13.8	41	93	
14	B	10.5	28.0	14.3	34	92	
15	BC	15.0	27.5	15.8	44	99	pH = 7.1 DO = 8.7 ppm
16	B	12.5	22.8	13.8	113	105	
17	BC	9.0	25.0	14.5	89	90	
18	BC	7.0	21.0	12.1	84	75	
19	B	6.0	26.0	13.2	39	70	
20	B	11.0	29.0	14.0	24	50	
Average		(9.9)	(25.8)	(13.8)	(59)	(87)	
21	B	13.0	29.5	15.5	31	50	
22	B	10.5	32.0	16.8	40	50	
23	B	10.0	30.0	17.2	35	78	
24	B	12.0	26.0	16.8	44	50	
25	BC	14.0	22.0	16.0	43	50	pH = 7.0 DO = 8.0 ppm
26	C	11.0	21.0	13.8	42	50	
27	C	8.0	16.0	12.3	33	50	
28	BC	6.5	19.0	11.5	45	48	
30	B	8.0	26.0	15.0	41	40	
31	B	8.0	30.0	16.2	35	35	
Average		(9.5)	(24.9)	(14.9)	(38)	(50)	
		8.6	22.5	13.0	48	74	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
January 1978

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	B	9.0	31.0	18.5	45	35	
2	B	11.5	27.5	18.6	46	35	
3	C	13.0	18.0	16.2	55	40	
4	C	9.0	18.0	12.0	49	35	
5	C	8.0	20.0	11.6	57	30	pH = 7.0 DO = 9.7 ppm
6	C	8.5	19.0	12.0	46	30	
7	C	10.0	24.0	14.0	33	30	
8	C	12.0	23.0	15.5	42	35	
9	BC	11.0	21.5	16.0	43	35	
10	C	12.0	19.0	14.5	39	35	
Average		(10.4)	(21.9)	(14.9)	(46)	(34)	
11	B	9.0	20.0	12.5	60	35	
12	BC	8.0	20.5	14.0	60	35	
13	BC	12.0	22.0	13.8	54	35	
14	BC	12.0	21.5	14.0	54	30	
15	BC	13.0	20.0	15.0	59	35	pH = 7.2 DO = 9.1 ppm
16	R	13.0	18.0	15.0	59	50	
17	C	7.0	17.0	10.0	65	50	
18	BC	8.0	18.0	10.8	127	50	
19	BC	9.0	20.0	11.0	57	40	
20	B	5.0	25.5	13.0	63	40	
Average		(9.6)	(20.3)	(12.9)	(66)	(40)	
21	B	7.0	26.0	15.4	51	40	
22	C	10.0	21.0	16.6	48	40	
23	B	7.0	21.0	14.0	51	35	
24	C	12.0	21.0	15.2	02	35	
25	BC	9.0	20.0	12.6	48	40	pH = 7.2 DO = 8.5 ppm
26	B	5.5	21.5	12.6	55	35	
27	BC	11.0	21.0	15.2	12	35	
28	BC	8.0	20.0	14.2	43	35	
29	R	9.0	16.5	13.2	42	35	
30	BC	8.0	17.0	12.0	39	35	
31	C	10.0	19.0	11.8	24	35	
Average		(8.8)	(20.4)	(13.9)	(42)	(36)	
		9.6	20.9	13.9	51	37	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
February 1978

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	BC	9.0	18.0	12.2	29	35	
2	BC	7.0	20.0	12.1	29	35	
3	BC	5.0	20.0	13.0	12	35	
4	B	5.0	24.5	12.6	15	30	
5	B	9.0	29.0	15.2	10	30	pH = 7.2 DO = 8.6 ppm
6	B	10.0	26.0	17.0	13	30	
7	BC	9.5	23.0	16.6	18	30	
8	B	9.0	22.0	15.5	23	25	
9	B	7.0	24.0	14.6	19	25	
10	B	6.0	21.0	14.4	23	20	
Average		(7.7)	(22.8)	(13.8)	(18)	(29)	
11	BC	8.0	22.5	14.8	29	20	
12	B	10.0	26.5	15.0	7	20	
13	B	12.0	28.5	17.2	9	20	
14	B	12.0	27.5	18.0	13	20	
15	BC	8.0	25.5	16.5	42	20	pH = 7.2 DO = 8.5 ppm
16	BC	9.0	27.0	16.0	17	20	
17	BC	12.5	21.0	17.0	23	20	
18	B	12.0	26.0	15.8	9	20	
19	BC	12.5	25.0	17.2	9	20	
20	B	12.0	25.5	16.2	21	20	
Average		(10.8)	(25.5)	(16.4)	(18)	(20)	
21	C	15.0	18.0	17.4	25	20	
22	C	13.0	22.0	14.2	23	20	
23	B	12.0	22.0	14.0	11	20	
24	DR	13.0	16.0	15.6	5	20	
25	C	12.0	19.0	14.0	37	25	pH = 7.1 DO = 9.5 ppm
26	R	14.0	21.5	15.0	58	25	
27	C	13.0	19.0	15.2	23	25	
28	C	13.0	23.0	14.4	18	30	
Average		(13.1)	(20.0)	(15.0)	(25)	(23)	
		10.3	23.0	15.1	20	24	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
March 1978

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	R	11.5	18.0	40	40	40	
2	BC	10.0	17.0	11.6	43	55	
3	BC	10.0	17.5	11.3	51	55	
4	BC	8.0	18.0	10.8	35	60	
5	BC	5.0	21.0	10.6	45	55	pH = 6.9 DO = 9.7 ppm
6	C	5.0	20.0	13.2	39	50	
7	BC	12.0	24.0	14.6	44	50	
8	B	6.0	24.0	15.0	41	50	
9	C	11.0	18.5	14.0	44	50	
10	C	6.0	19.0	11.4	43	40	
Average		(8.5)	(19.7)	(12.7)	(43)	(50)	
11	C	10.0	20.0	14.0	37	35	
12	BC	9.0	21.0	14.0	30	30	
13	B	2.0	20.5	13.8	6	25	
14	BC	6.0	17.0	13.3	12	25	
15	BC	8.5	18.5	13.0	5	20	pH = 6.6 DO = 9.3 ppm
16	BC	6.0	16.0	12.2	13	20	
17	BC	5.0	16.0	11.4	11	20	
18	C	8.0	17.0	10.6	20	20	
19	BC	10.0	20.0	12.2	15	20	
20	B	5.0	20.5	12.2	19	20	
Average		(7.0)	(18.7)	(12.7)	(18)	(23)	
21	BC	4.0	22.0	13.0	43	20	
22	BC	3.0	20.0	13.0	23	20	
23	B	5.0	18.0	12.2	15	15	
24	B	-1.0	18.0	10.8	00	15	
25	B	-1.0	18.0	10.4	6	15	pH = 7.2 DO = 10.2 ppm
26	BC	6.0	17.0	11.2	8	15	
27	CDR	8.5	15.5	11.1	15	20	
28	C	9.0	19.0	10.8	6	20	
29	BC	12.0	19.0	11.6	4	20	
30	B	12.0	18.0	11.8	10	20	
31	B	9.0	19.0	10.4	11	15	
Average		(5.8)	(18.5)	(11.5)	(13)	(18)	
		7.1	19.0	12.3	25	30	

River level at Puente II, Coyhaique, about 70km from the estuary.

Climatological and River Observation at Hatchery site – Simpson River
April 1978

Day	Sky	Air temp.		River (AM 10:00)			Remarks
		Min. C	Max. C	Temp. C	Turbid ppm	Level cm	
1	BC	5.0	17.0	11.0	8	15	
2	RBC	9.0	14.0	11.7	8	20	
3	BC	4.0	14.0	9.4	17	25	
4	C	8.0	14.0	9.5	2	25	
5	B	1.0	13.0	8.8	9	20	pH = 7.2 DO = 10.6 ppm
6	B	1.0	16.0	9.2	12	20	
7	B	0.1	20.0	8.8	6	20	
8	B	-2.0	16.0	9.4	6	20	
9	BC	2.0	17.0	9.9	4	20	
10	BC	9.0	18.0	11.8	46	25	
Average		(3.7)	(15.9)	(10.0)	(12)	21	
11	BC	10.0	14.5	11.8	12	25	
12	BC	-5.0	14.0	8.2	9	25	
13	BC	1.0	12.0	9.4	12	20	
14	BC	-3.0	12.0	7.2	8	20	
15	B	0.5	17.5	7.4	5	20	pH = 7.0 DO = 10.5 ppm
16	BC	-1.5	16.0	8.7	5	17	
17	B	3.0	16.0	8.8	9	17	
18	C	7.0	17.0	9.6	6	15	
19	R	5.0	17.0	10.1	17	15	
20	BC	-2.0	18.0	8.4	4	15	
Average		(1.5)	(15.4)	(9.0)	(9)	(19)	
21	C	-2.0	11.0	7.4	19	20	
22	C	2.0	10.5	8.0	11	20	
23	B	-0.5	14.0	7.2	13	20	
24	C	5.5	13.0	7.8	4	25	
25	C	4.0	11.5	7.4	11	30	pH = 6.9 DO = 10.6 ppm
26	B	7.0	12.0	7.8	25	30	
27	B	1.0	11.0	6.6	24	25	
28	CDR	5.0	15.0	7.8	26	30	
29	R	3.5	10.0	7.9	21	40	
30	R	6.0	16.0	8.4	21	60	
Average		(3.2)	(12.4)	(7.6)	(18)	(30)	
		2.9	14.6	8.8	13	23	

River level at Puente II, Coyhaique, about 70km from the estuary.

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