Northwest and
Alaska
Fisheries Center

National Marine
Fisheries Service

U.S. DEPARTMENT OF COMMERCE

NWAFC PROCESSED REPORT 79-7

Some Observations on Salmon Culture and Research in the USSR and Japan: A Report of Travel

December 1979

ERRATA NOTICE

SOME OBSERVATIONS ON SALMON CULTURE AND RESEARCH

IN THE USSR AND JAPAN.

A Report of Travel:

September and October 1978

by

John H. Helle

Northwest and Alaska Fisheries Center Auke Bay Laboratory
National Marine Fisheries Service, NOAA
P.O. Box 155, Auke Bay, Alaska 99821
USA

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BACKGROUND

The main purpose of my trip to the Far East was to present a paper and participate in the four-nation Conference on the Biology of Pacific Salmon at Yuzhno-Sakhalinsk, USSR. This conference was sponsored by the Soviets and attended by scientists from Canada, Japan, and the United States. Tours of various fisheries facilities in the Soviet Far East were also a part of the conference (Fig. 1).

Before returning to the United States, I visited Japan and toured the Tokyo Fish Market, several universities, government and private research facilities, and salmon culture stations on the islands of Honshu and Hokkaido (Fig. 1).

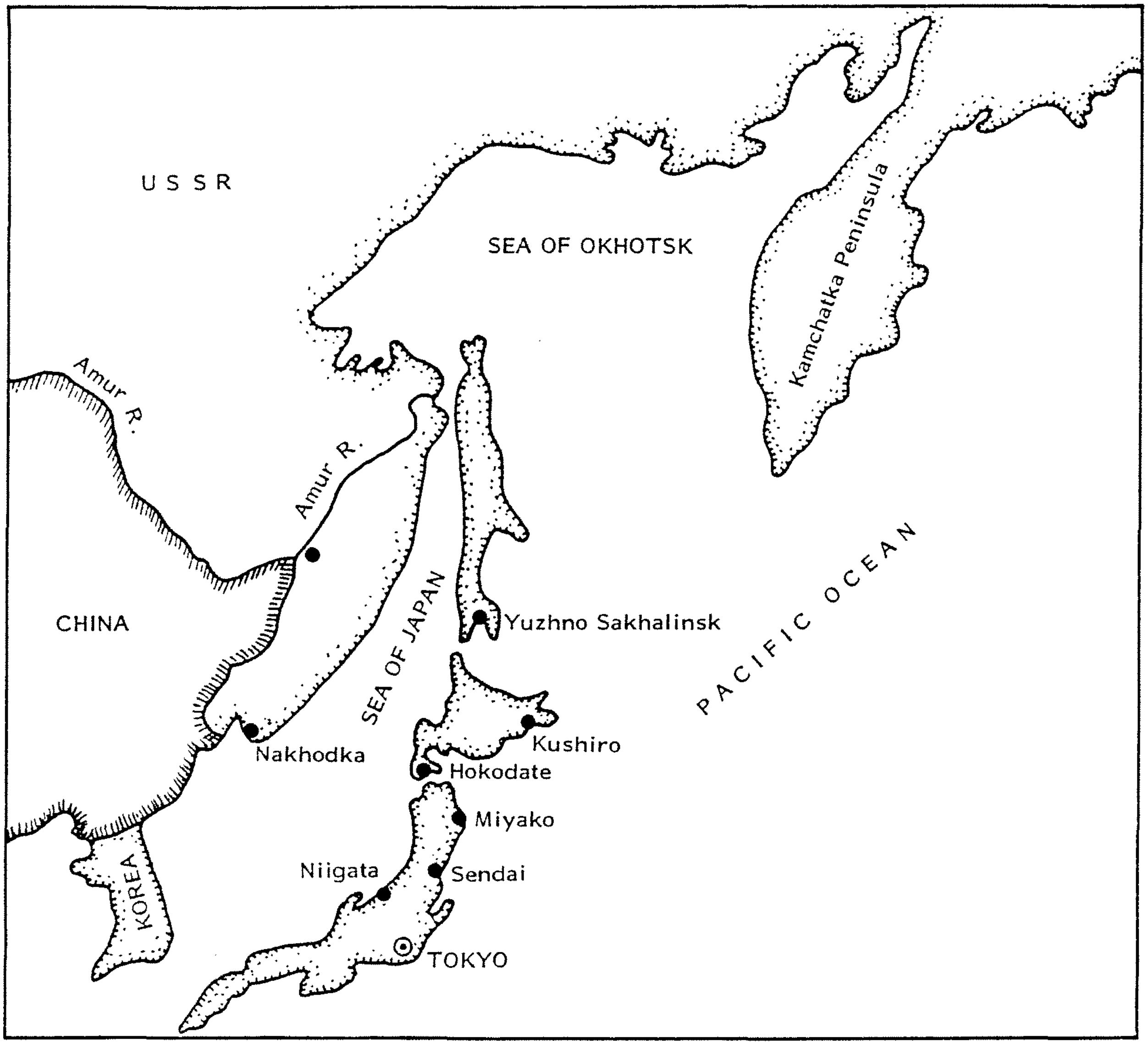

Figure 1.--Location of major cities in USSR and Japan that were visited on this trip.

ITINERARY

September 25--Juneau to Seattle (Alaska Airlines)
26--Seattle to Tokyo (Northwest Airlines)
27--Lost a day--crossed international date line
28--Tokyo to Niigata (Japan Domestic Airline)
29--Niigata to Khabarovsk (Aeroflot Airlines)
30--Khabarovsk
October 1--Khabarovsk to Yuzhno-Sakhalinsk (Aeroflot Airlines)
2-12--Yuzhno-Sakhalinsk
13--Yuzhno-Sakhalinsk to Khabarovsk (Aeroflot Airlines)
14--Khabarovsk to Nakhodka (Russian Railway)
15-16--Nakhodka to Yokohama and Tokyo (Russian steamer "Baikal")
17-18--Tokyo
19--Tokyo to Sendai (Japan Railways)
20--Sendai
21--Sendai to Miyako (Japan Railways)
22--Miyako to Hakodate (Japan Railways and Ferry)
23-24--Hakodate
25--Hakodate to Kushiro (Japan Railways)
26--Kushiro to Tokyo (Japan Domestic Airlines)
27--Tokyo to Seattle (Northwest Airlines)
28--Seattle to Juneau (Alaska Airlines)

THE CONFERENCE

Dr. Peter Moiseev, Deputy Director of All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Moscow, was chairman of the Conference on the Biology of Pacific Salmon. In his opening address, he emphasized the similarity in objectives of salmon management of the countries represented at the conference (Fig. 2). All of the four nations want to double their present levels of salmon production. International cooperation in management and research is required to accomplish this goal because the ocean-feeding areas of salmon originating in each of the countries overlap.

More than 50 papers were presented at the conference. Each paper was translated a sentence at a time into English, Russian, or

Figure 2.--Dr. Peter Moiseev delivering opening address at the Conference on Biology of Pacific Salmons.

Japanese by a staff of more than 10 translators (Fig. 3). English translations during the oral presentations were given in precise, formal English. A few of the Soviet scientists (Appendix Table 1) were very fluent in English, particularly Dr. Altukhov and Dr. Konovalov. Most of the Soviet scientists could read English and understand some spoken English if it was devoid of jargon and enunciated clearly and slowly.

Dr. F. V. Krogius, A. R. Fredin, S. Pennoyer, K. Parker, Dr. D. Stokner, M. Iwata, and R. Pressey were not at the conference, and their papers were read by others. All of the papers given at the conference will be published by VNIRO in a summary of the conference.

During the evenings, all of the participants (Appendix Table 1) were active in impromptu seminars (Fig. 4), conferences, and slide shows. Dr. I. I. Kurenkov's slides and narration describing recent volcanic activity in the Kamchatka area were especially interesting.

During the weekends, we toured museums and parks (Fig. 5), and the mayor of Yuzhno-Sakhalinsk and his staff briefed us on the activities of the city and its future plans (Fig. 6).

TINRO ACTIVITIES

Dr. S. M. Konovalov is director of the Pacific Research Institute of Marine Fisheries and Oceanography (TINRO). TINRO headquarters is located in Vladivostok; its four main branches in the Far East are located in:

1. Petropavlovsk, Kamchatka (KoTINRO)
2. Magadan (MoTINRO)
3. Yuzhno-Sakhalinsk (SakhTINRO)
4. Khabarovsk-Amur River (AoTINRO).

Figure 3.--Paul Krasnowski (Alaska Department of Fish and Game) and Soviet translator presenting paper at the Conference on Biology of Pacific Salmons.

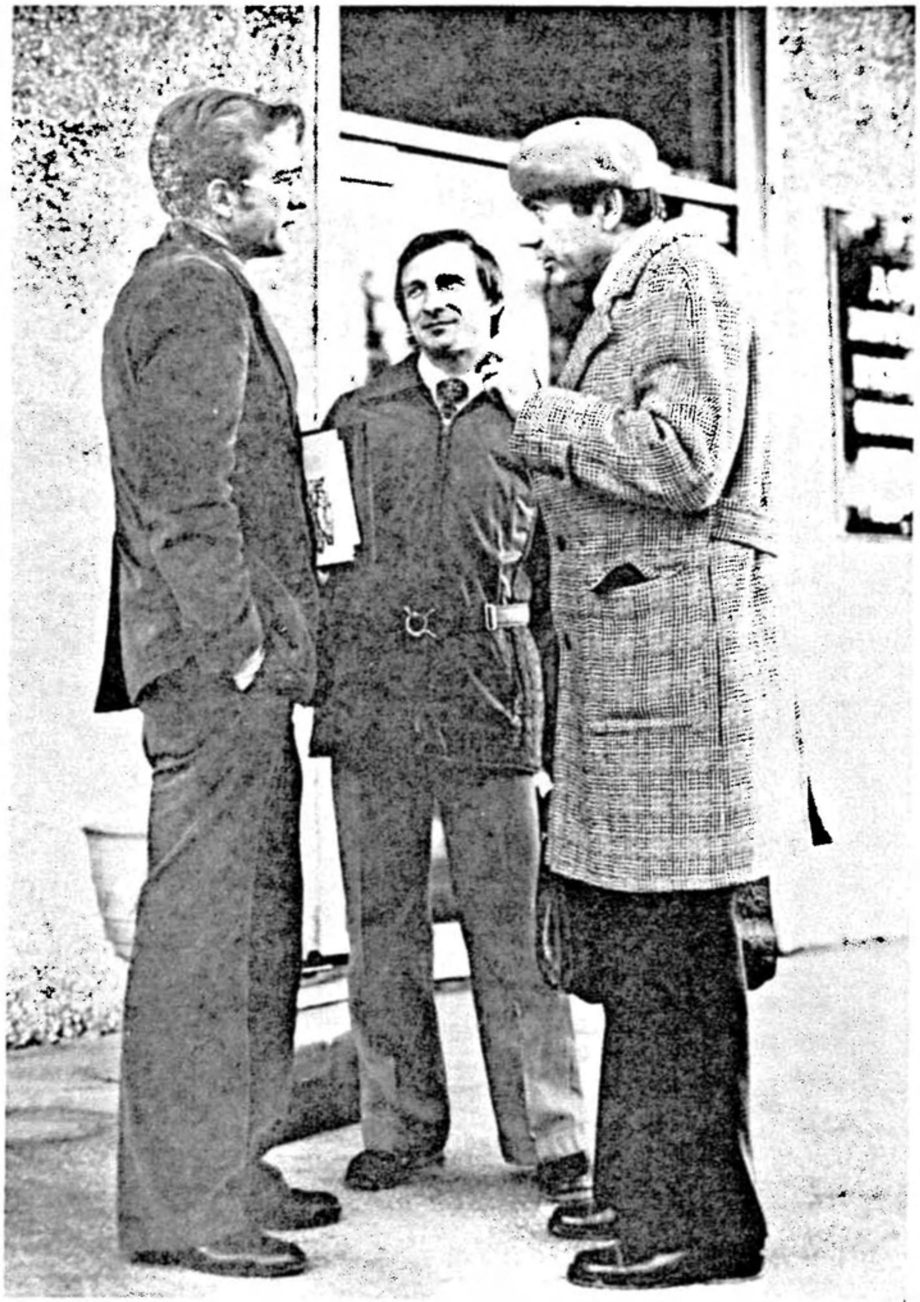

Figure 4.--Dr. McNeil, Dr. Kartavtsev, and Dr. Altukhov in a discussion during a break between meetings.

Figure 5.--Dr. Lagunov and Dr. Birman at city square in Yuzhno-Sakhalinsk.

Figure 6.--Mayor of Yuzhno-Sakhalinsk and his staff proposing a toast at a reception for the foreign-conference participants at city hall.

All of these branches receive technical advice in specific scientific disciplines from scientists at the USSR Academy of Science's major laboratory in the Far East at Vladivostok. One scientist at the USSR Academy of Sciences, Moscow, the well-known population geneticist, Professor Yu. P. Altukhov, has been active in salmon research in the Far East and has been appointed Deputy Director of the Institute of General Genetics at the USSR Academy of Sciences. Although Professor Altukhov is now more active in human genetics, many of his former students are researching the genetics of salmon in the Far East, e.g., Drs. Yu. Kartavtsev and A. A. Maximovich at Vladivostok, and E. A. Salmenkova at Moscow.

We visited the SakhTINRO at Yuzhno-Sakhalinsk, which has five laboratories:

1. Natural Reproduction of Salmon (Dr. V. N. Efanov, Director)
2. Hatchery Reproduction of Salmon (Dr. F. N. Rukhlov, Director)
3. Commercial Sea Fisheries
4. Commercial Invertebrates
5. Fur Seals.

SakhTINRO has an annual budget of 500,000 rubles (about $1.3 million) and 118 employees, including 52 scientists. Objectives of the various research activities of SakhTINRO are listed in Figure 7.

Salmon Fishery of Coastal USSR

All six species of Pacific salmon are present and caught commercially in the Soviet Far East; however, in recent years over 90% of the catch (average catch, 75,000 metric tons) has been pink salmon

THE SAKHALIN BRANCH OF THE PACIFIC SCIENTIFIC INSTITUTE OF FISHERIES AND OCEANOGRAPHY

A DIRECTION OF THE BASIC ACTIVITY IS TO STUDY RAW BIOLOGICAL RESOURCES OF THE SAKHALIN-KURILE BASIN.

THE STRUCTURAL SCHEME INCLUDES FIVE SPECIALIZED LABORATORIES:

1. NATURAL REPRODUCTION OF PACIFIC SALMON
2. ARTIFICIAL PROPAGATION OF PACIFIC SALMON
3. SEA FISH AND OCEANOGRAPHY
4. SEA INVERTEBRATA
5. FUR SEALS

THE PROGRAMMES OF RESEARCHES THE SAKHALIN BRANCH IS WORKING OUT IN X FIVE-YEAR PLAN ARE THE FOLLOWING:

1. NATURAL REPRODUCTION OF PACIFIC SALMON – THE DINAMICS OF NUMBER, CONDITIONS OF REPRODUCTION, LOCALITY OF POPULATIONS, ECOLOGY OF FRY IN THE SHORE, VALUATION OF STOCK STATE.

2. ARTIFICIAL PROPAGATION OF PACIFIC SALMON – VALUATION OF HATCHERIES' EFFECTIVENESS AND SPECIFIC GRAVITY OF ARTIFICIAL PROPAGATION, BIOTECHNICAL IMPROVMENT OF PACIFIC SALMON.

3. SEA FISH, INVERTEBRATA AND ALGAE – THE DINAMICS OF NUMBER, STUDY OF BIOLOGY, STRUCTURE OF STOCK, OBJECTIVE LAWS OF DISTRIBUTION AND BEHAVIOUR IN CONNECTION WITH THE CONDITIONS OF EXTERNAL ENVIRONMENT AND FODDER SUPPLY.

4. AQUACULTURE – THE EXPERIMENTS ON AQUACULTURE OF SALMON, SCALLOP AND SEA KALE.

5. FUR SEALS – THE DYNAMICS OF NUMBER, STUDY OF SHORE PERIOD OF FUR SEALS' LIFE, STOCK STRUCTURE, STATE OF STOCK.

6. FORECASTING – ELEBORATION OF SHORT-TERM AND LONG-TERM FORECASTS OF POSSIBLE CATCH OF AQUACULTURAL SPECIES, RECOMMENDATIONS ON RATIONAL CONDUCT OF FISHING.

7. INTERNATIONAL SCIENTIFIC-TECHNICAL COOPERATION – ENSURING REALIZATION OF ACTIVE AGREEMENTS AND CONVENTIONS ON FISHING.

AS FAR AS THE FULFILMENT OF THESE SCIENTIFIC PROGRAMMES TAKES PLACE THE SAKHALIN BRANCH

GIVES OUT SHORT-TERM AND LONG-TERM FORECASTS OF POSSIBLE CATHES OF AQUACULTURAL SPECIES, THAT ARE THE BASE OF A RATIONAL CONDUCT OF FISHING;

LAYS SCIENTIFIC BASES TO AQUACULTURAL DEVELOPMENT;

TAKES PART IN FISH SCIENCE DEVELOPING OF THE COUNTRY.

PROSPECTS OF THE SAKHALIN BRANCH'S DEVELOPMENT ARE THE FOLLOWING:

TO EXTEND RESEARCHES IN SALMON FISHERY;

TO CONTINUE TRADITIONAL RESEARCHES ON FISH AND NONFISH SPECIES, CARRYING OUT ON SHELF;

TO STRENGTHEN THE MATERIAL AND TECHNICAL BASIS OF RESEARCHES,

TO MAKE THE COMPLEX SALMON INSTITUTE ON SAKHALIN.

Figure 7.--Goals of the TINRO group at Yuzhno-Sakhalinsk.

and chum salmon. Ninety percent of the total salmon production in the Far East comes from natural reproduction.

The Soviets mainly use trap nets and recently have tried Danish seines. The trap nets look like small versions of the pre-statehood Alaskan salmon trap and are 20 m deep, have leads to shore, and must be 200 m from stream mouths. Soviets also fish in some rivers.

Soviet salmon stocks have declined greatly since the 1950's: sockeye salmon stocks by a factor of four; chum salmon stocks by a factor of five; and pink salmon, coho salmon, and king salmon stocks by a factor of three. Cherry salmon, O. masou, stocks have declined only slightly compared to declines in stocks of other species.

Laboratory of Natural Reproduction of Salmon

The Laboratory of Natural Reproduction of Salmon forecasts pink salmon and chum salmon returns; identifies races of these species; and studies the effects of logging, freshwater pollution, and marine pollution on salmon.

Soviets forecast salmon returns from counts of juvenile out-migrants, long-term weather cycles, and the climate conditions of the return year. Recently, they have increased their accuracy to 90% by adding four environmental parameters to a multiple regression analysis:

1. Precipitation in July-September of the spawning year,
2. Thickness of snow during egg incubation,
3. Flow of water (February-April) during downstream migration, and
4. Icing in the Bering Sea when fry and smolts are leaving streams.

In larger river systems, spawning adults are counted from aircraft. In smaller, more accessible river systems, spawners are counted as they pass through weirs.

Scale characteristics are used extensively in racial studies of pink salmon and chum salmon. Scale characteristics of pink salmon returning to the Sea of Japan side of Sakhalin Island are different from scale characteristics of pink salmon returning to the Pacific Ocean side. Many chum salmon stocks on the island are also identifiable by scale characters. Recently, the Soviets have verified from chum salmon returns to a Sakhalin hatchery that certain scale characteristics of this species are heritable. Characteristics of scales from returns to the same river of transplanted and indigenous chum salmon were different.

Laboratory of Hatchery Reproduction of Salmon

Nearly all of the production hatcheries in the Soviet Union are located on Sakhalin Island (Fig 8). Most of the hatcheries were built by the Japanese prior to World War II. After World War II, the Soviets utilized the existing hatchery facilities, expanded them, and built some new ones.

The Soviets release 800 million fry annually (Fig. 8, Table 1) from 18 salmon hatcheries on Sakhalin Island. Seventy percent of the fry are pink salmon; the remainder are chum salmon. From 1980 to 1985, (Five-Year Plan), the Soviets plan to release 1.5 billion fry annually, and from 1990 to 1995, they plan to release 3 billion fry annually.

Soviet hatcheries are built on rivers that have at least a small indigenous run of the species targeted for hatchery production. Fry

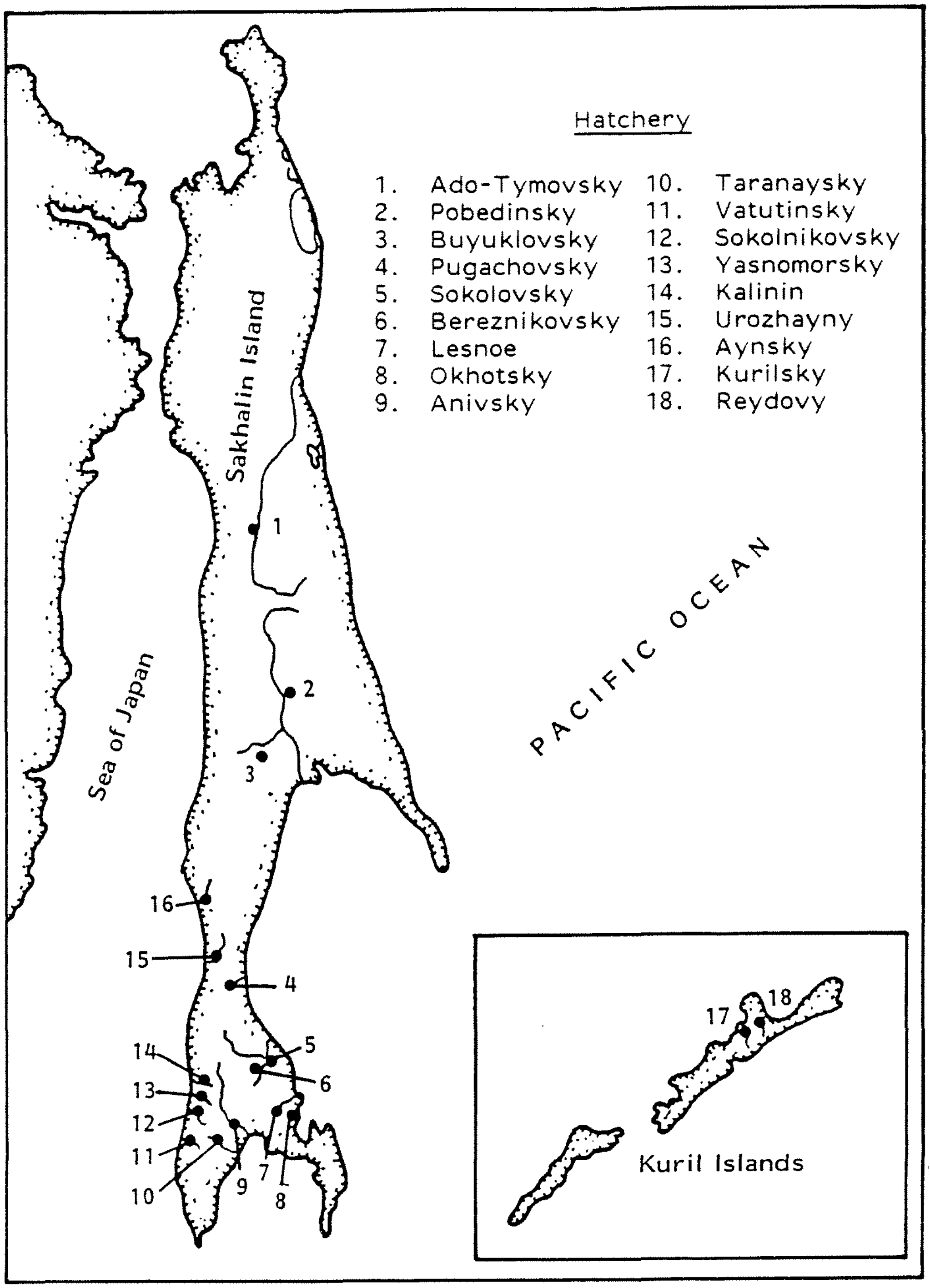

Figure 8.--Location of salmon hatcheries on Sakhalin Island. See table 1 for name, species, and egg capacity of the hatcheries.

Table 1. Name, species, and egg capacity of Soviet salmon hatcheries on Sakhalin Island. Numbers in parentheses refer to locations on Figure 8.

Hatchery	Hatchery capacity (Millions of eggs)	Species
Ado-Tymovsky (1)	55.0	chum
Pobedinsky (2)	18.0	pink, chum
Buyuklovsky (3)	38.5	pink, chum
Pugachovsky (4)	59.0	pink
Sokolovsky (5)	102.0	pink, chum
Bereznikovsky (6)	66.0	pink
Lesnoe (7)	35.0	pink
Okhotsky (8)	35.0	chum
Anivsky (9)	19.0	pink
Taranaysky (10)	40.5	pink
Vatutinsky (11)	11.5	pink
Sokolnikovsky (12)	23.0	chum
Yasnomorsky (13)	16.0	chum
Kalinin (14)	84.0	chum
Urozhayny (15)	9.5	pink
Aynsky (16)	30.5	pink
Kurilsky (17)	126.5	pink
Reydovy (18)	75.0	chum

are produced both artificially and naturally at these sites. Generally, natural reproduction is managed to minimize superimposition of eggs. The streams have fences built across them, and the upper stream "fills up" with spawners first. After there is approximately one chum salmon female per square meter or two pink salmon females per square meter in the upper stream, the Soviets close it to salmon and the process is then repeated in lower sections of the stream. Usually, the stream is divided into three large sections.

We visited two hatcheries on the southern tip of Sakhalin Island: Lesnoe Hatchery, a pink salmon hatchery on the eastern coast, and Kalinin Hatchery, a large chum salmon hatchery on the western coast near Kholmsk (hatcheries 7 and 14 on Fig. 8).

Kalinin River Hatchery (Chum Salmon)

Soviet activity at the Kalinin River Hatchery (Figs. 9 and 10) began in 1950. The wild chum salmon returns to this small river range from 5,000 to 10,000 fish. The hatchery had record returns in 1976 (240,000) and in 1978 (400,000). When we were there (1978), the run was about over, and the hatchery had about 105 million eggs incubating (Figs. 11 and 12). Usually only about 80 million eggs are incubated in the hatchery. Up to 70,000 chum salmon are allowed to spawn naturally in the river.

The water for this hatchery flows from a large spring into a settling pond, through a gravel filter bed, and then into the hatchery (Fig. 13). The temperature of the spring ranges between 0° and 7°C (mean 2.5°C), and water flow in the hatchery is 1.5 l/s for each million eggs.

Figure 9.--Entrance to Kalinin Hatchery.

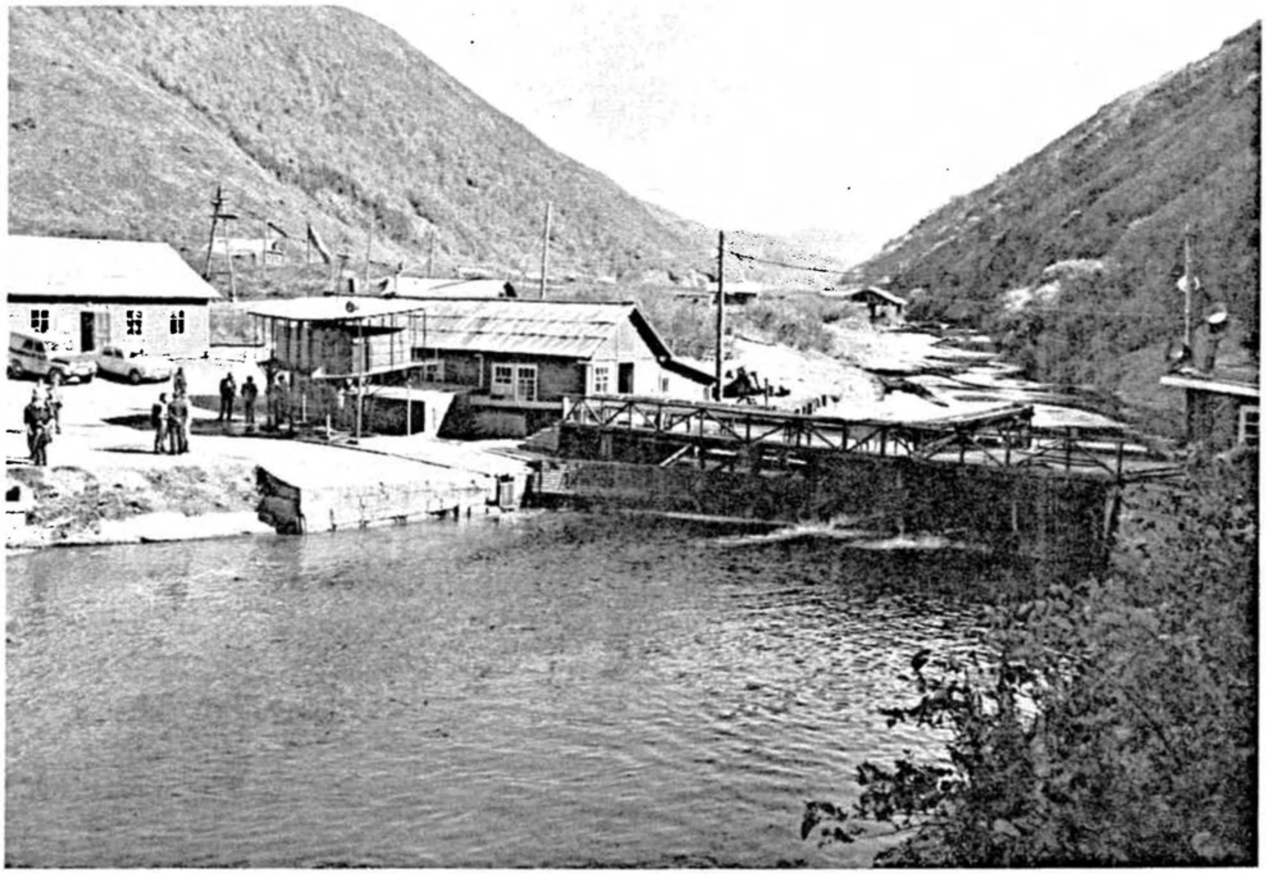

Figure 10.--Trap-weir and gamete-collection facility on the Kalinin River.

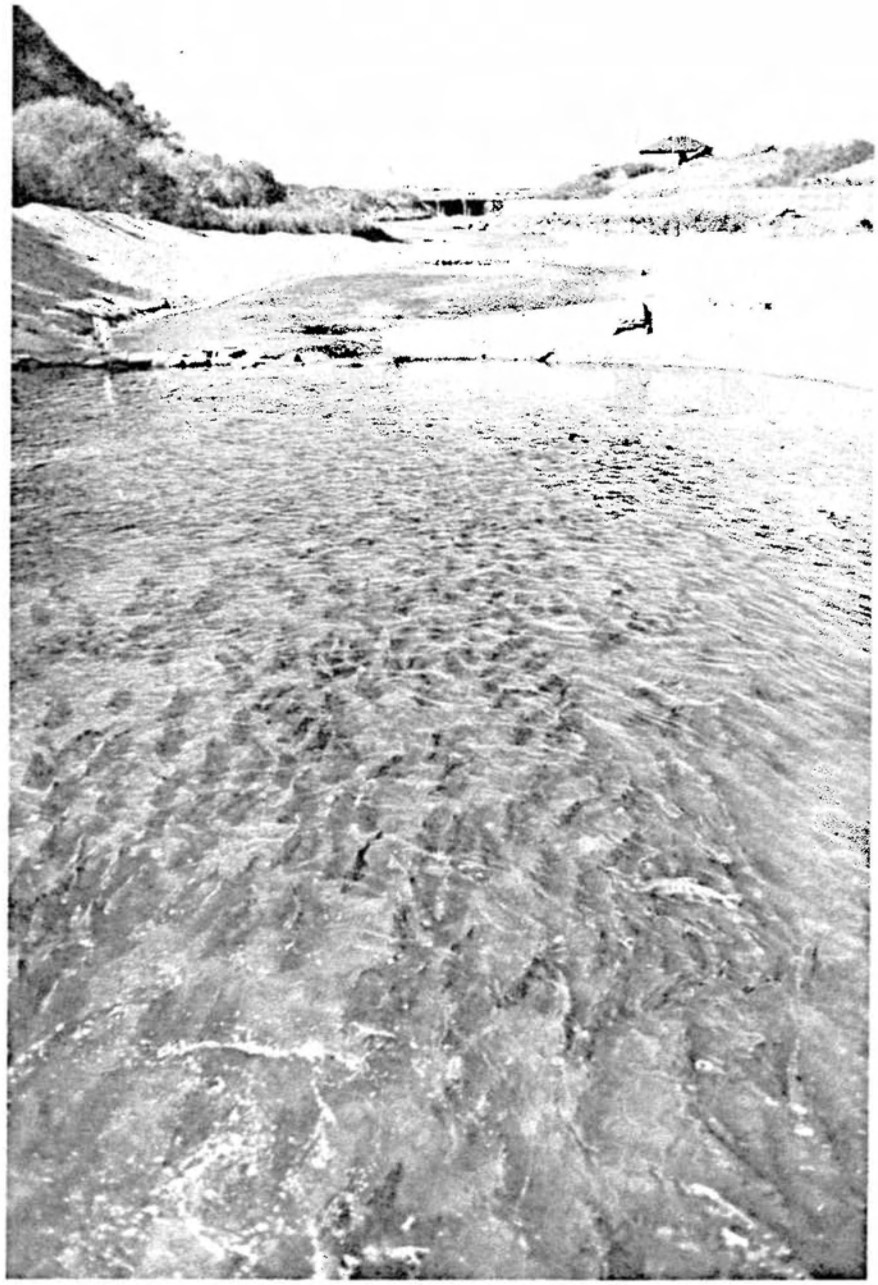

Figure 11.--Chum salmon congregating at the trap-weir on the Kalinin River.

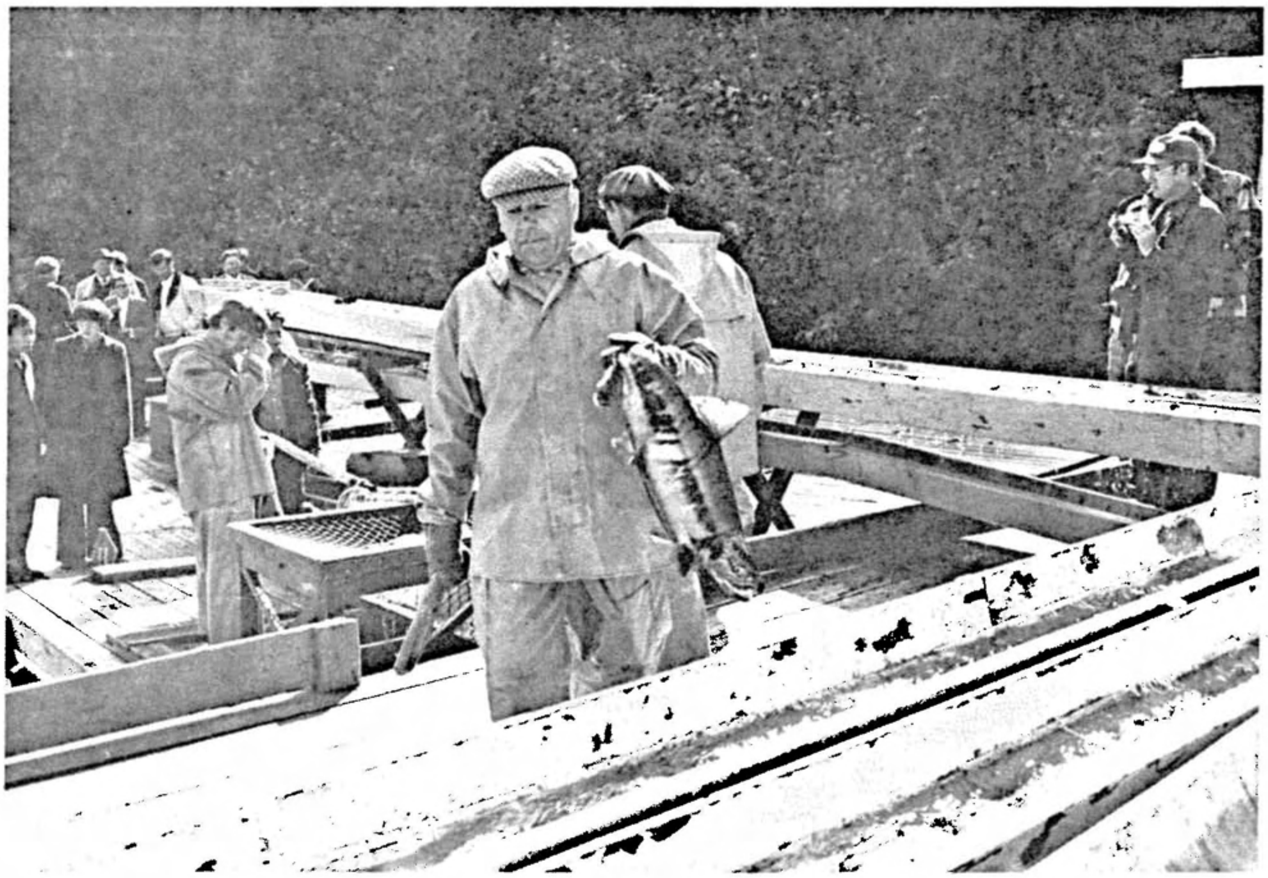

Figure 12.--Killing and sorting chum salmon at Kalinin River trap-weir.

Figure 13.--Source of springwater for Kalinin Hatchery. Gravel filter beds are visible in the lower portion of the photograph.

Soviets do not bleed female spawners. The spawners are placed on a table in a horizontal position and incised. The eggs flow (not drop) down a wooden incline into a pan placed next to and slightly below the fish. Ten females are stripped into a container, and then sperm is added (Figs. 14 and 15). The eggs are rinsed and kept for 4 h before transfer to incubators (Fig. 16).

Each incubator, a stack of 10-12 racks, is placed on a 1.35 m x 6.0 m x 0.25 m nursery section of a gravel-lined raceway (Figs. 17 and 18). Each rack, 31 cm x 31 cm x 1.5 cm high, holds about 2,500 chum salmon eggs (or about 3,000 pink salmon eggs) on a plastic "screen" with rectangular holes (Fig. 16). Water in the raceways is 15-25 cm deep and flows horizontally with no upwelling flow. A single 2.5 cm layer of gravel is in the bottom of each raceway. Three parallel raceways, 1.8 m wide, are covered by a long building (Fig. 19) that is 7 m wide.

The fry migrate out of the covered raceways (Figs. 18-20) in February and are "held" in open, gravel-lined raceways (Fig. 21) and fed for three months (Figs. 22 and 23). About 400 kg of cod roe, pollock roe, and minced chum salmon carcasses are fed to the fry each day.

Interestingly, the hatcheries had no diseases, like tuberculosis, as our Columbia River hatcheries had after feeding minced salmon carcasses.

Saprolegnia and soft shell disease (chum salmon only) are the only diseases the Soviets have seen, and these are completely controlled. The Soviets clean the gravel with chlorine after the fry leave the

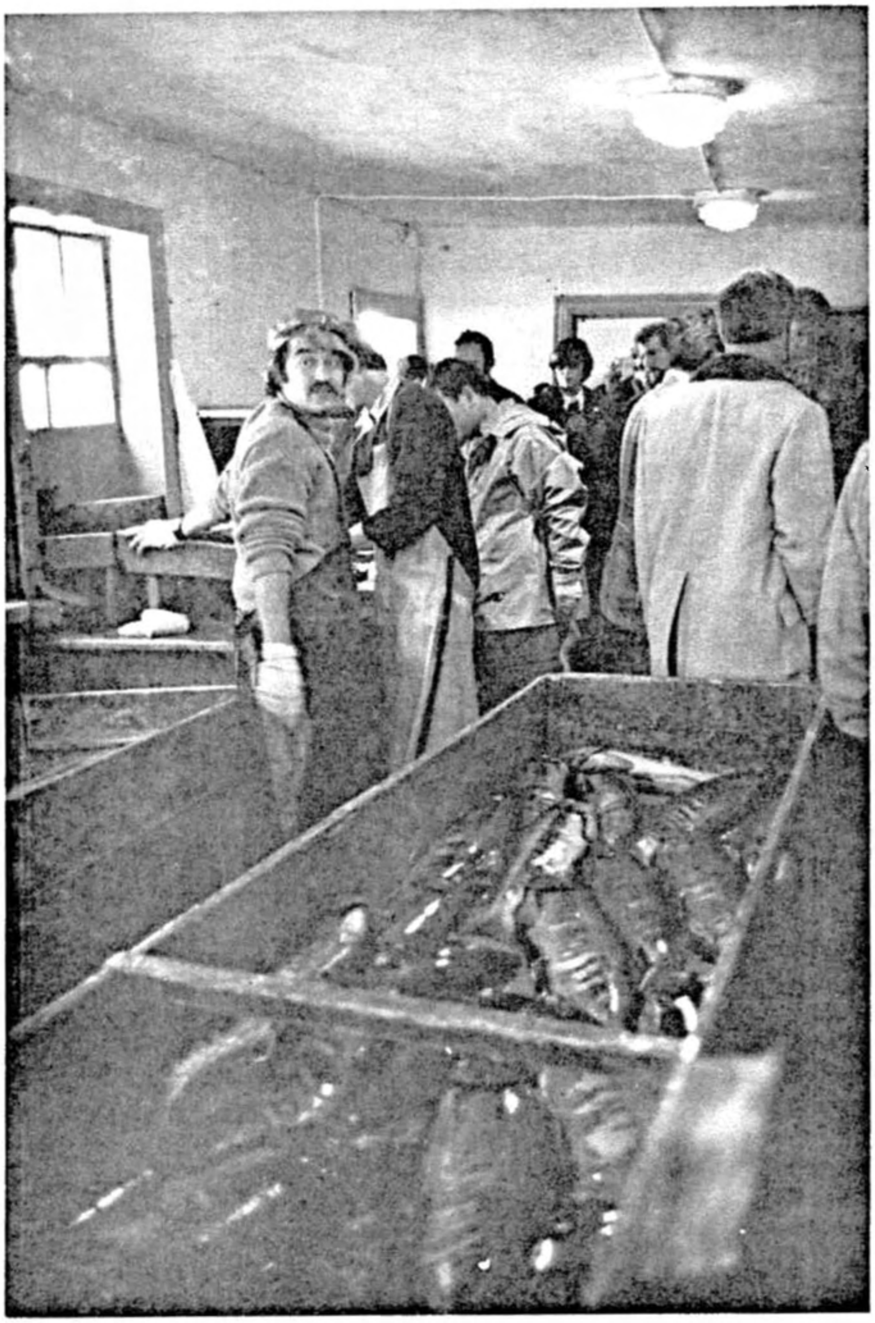

Figure 14.--Gamete-collection facility at Kalinin Hatchery.

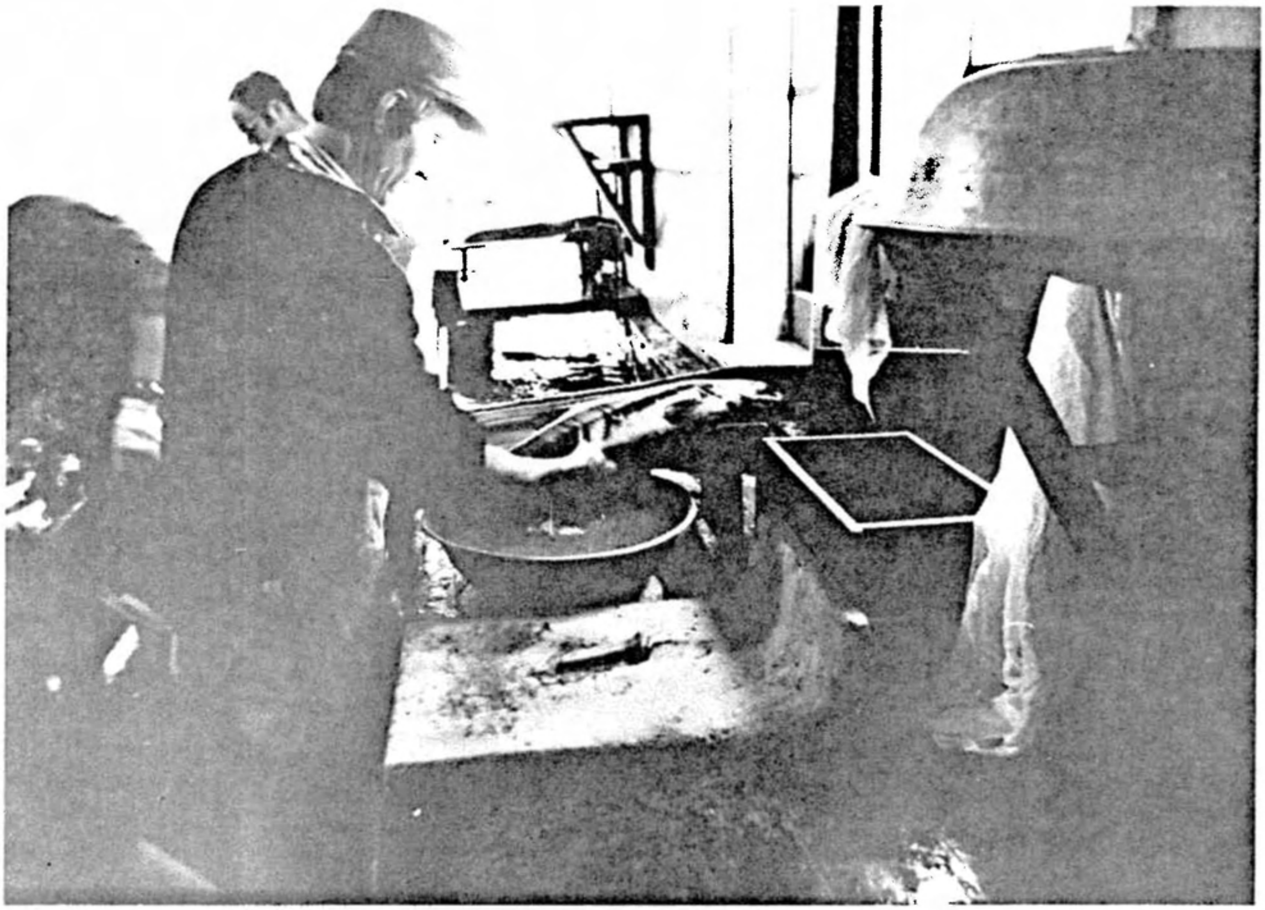

Figure 15.--Fertilizing eggs at the gamete-collection facility at Kalinin Hatchery.

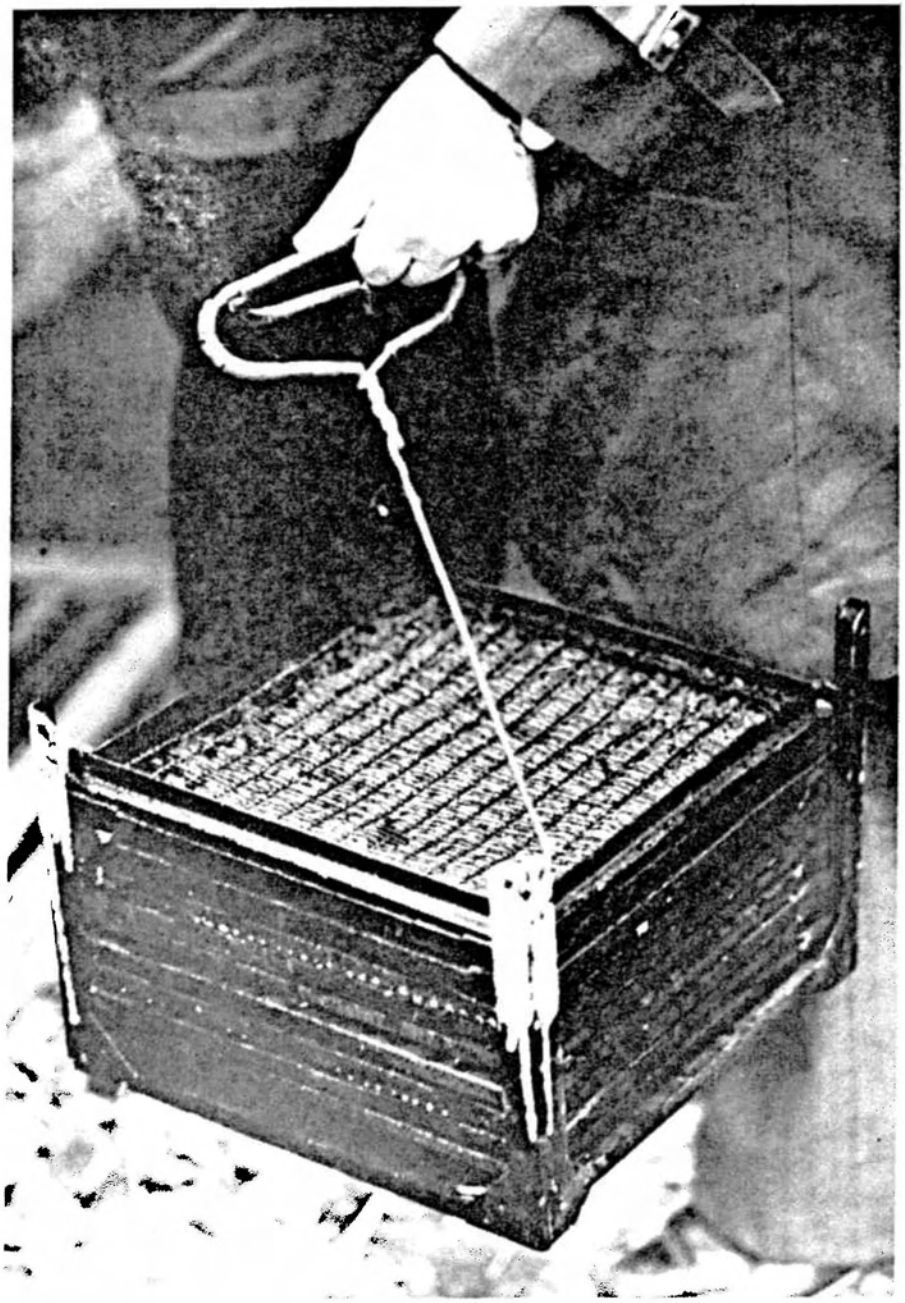

Figure 16.--Soviet egg-incubation device. A stack of 10 racks of pink salmon eggs at Lesnoe Hatchery.

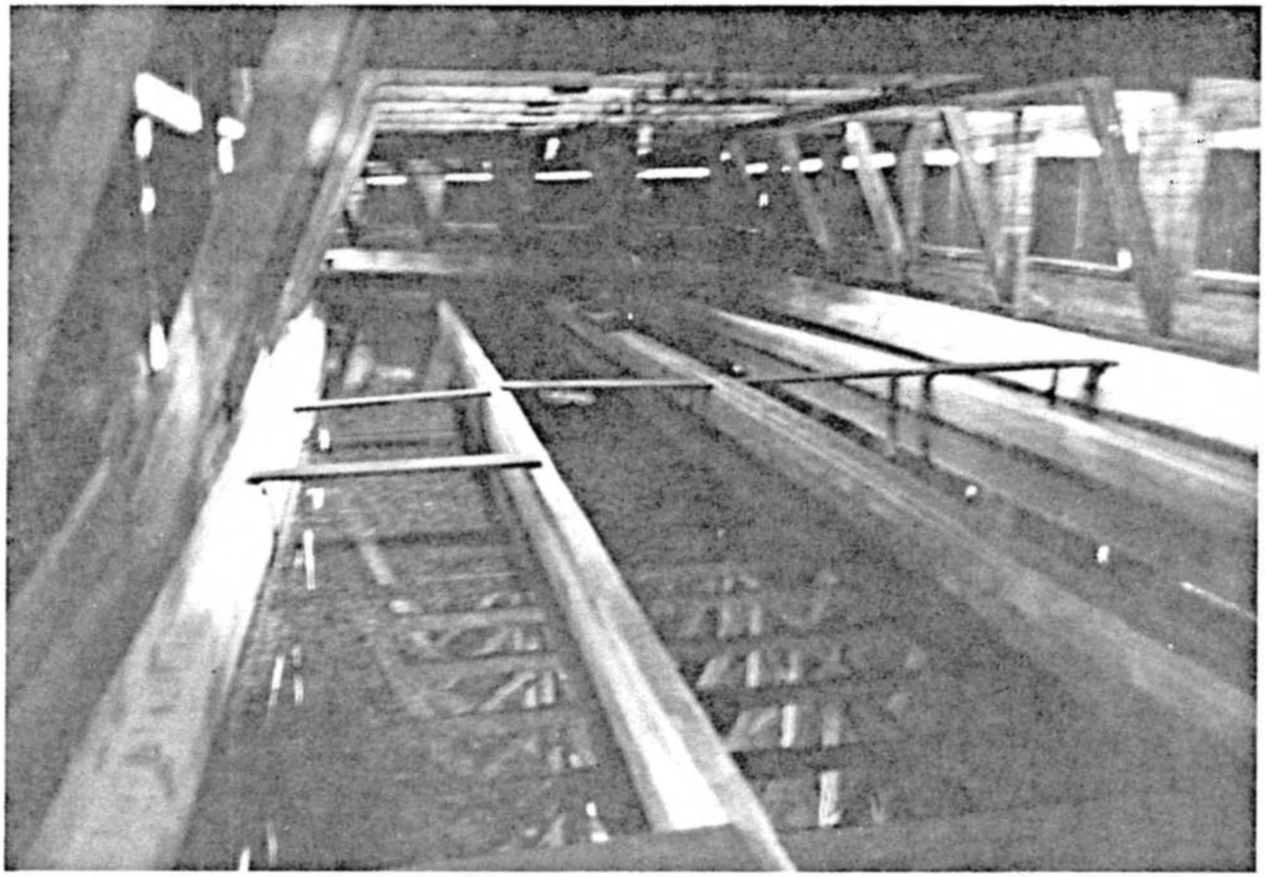

Figure 17.--Interior of covered gravel-lined nursery raceways for raising alevins at Kalinin Hatchery.

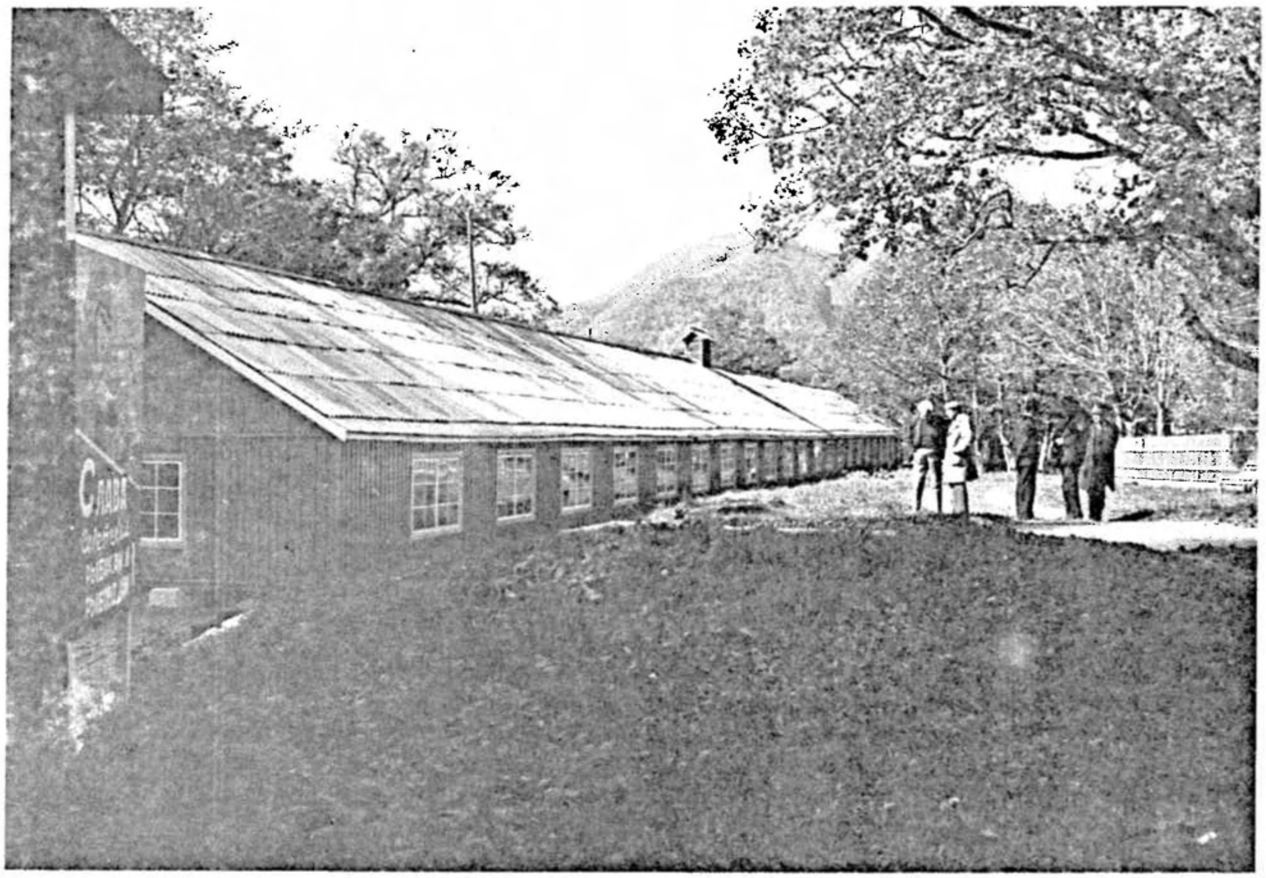

Figure 18.--A covered alevin-nursery raceway at Kalinin Hatchery. Drs. Moiseev and Altukhov in the background on the left.

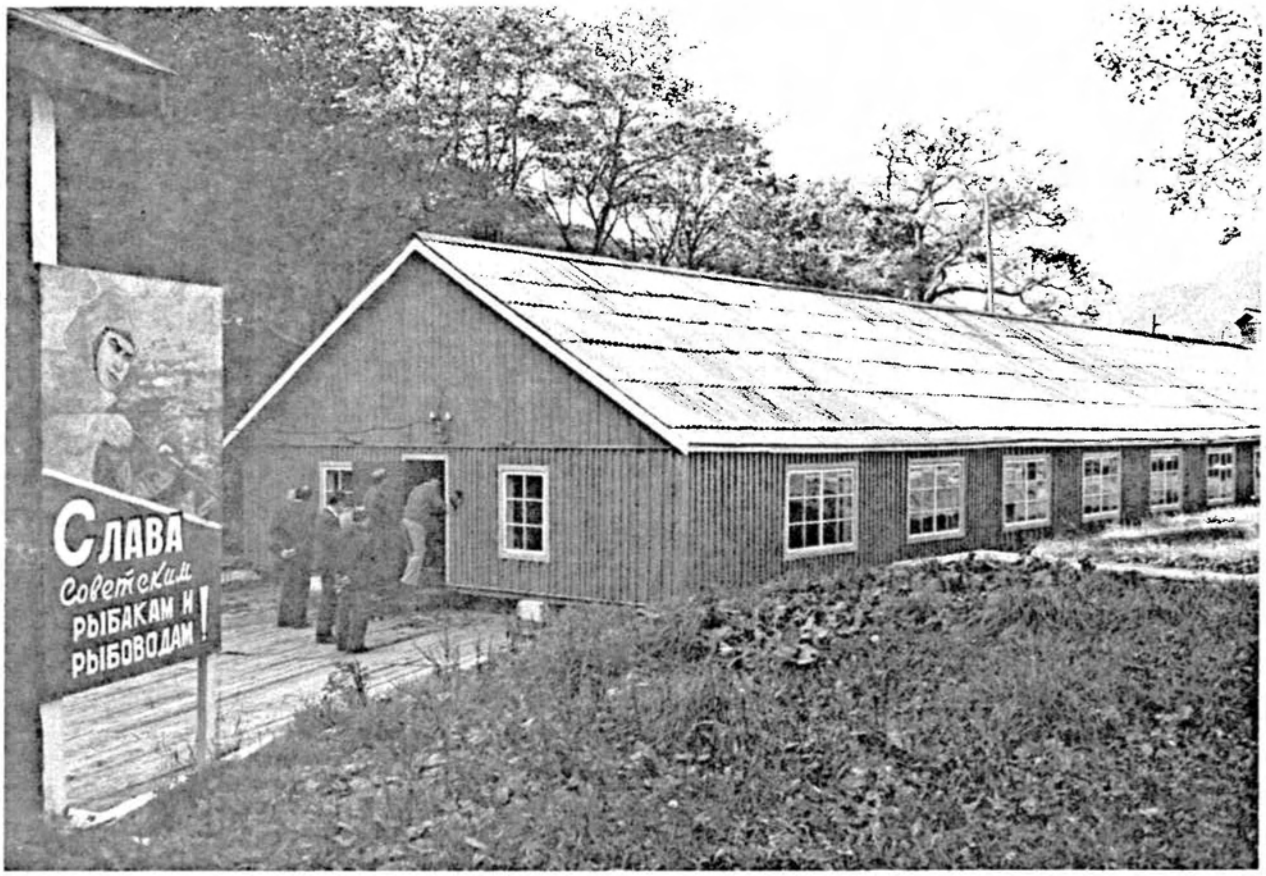

Figure 19.--Entrance to a covered alevin-nursery raceway at Kalinin Hatchery. Gravel filter bed lies under the boardwalk.

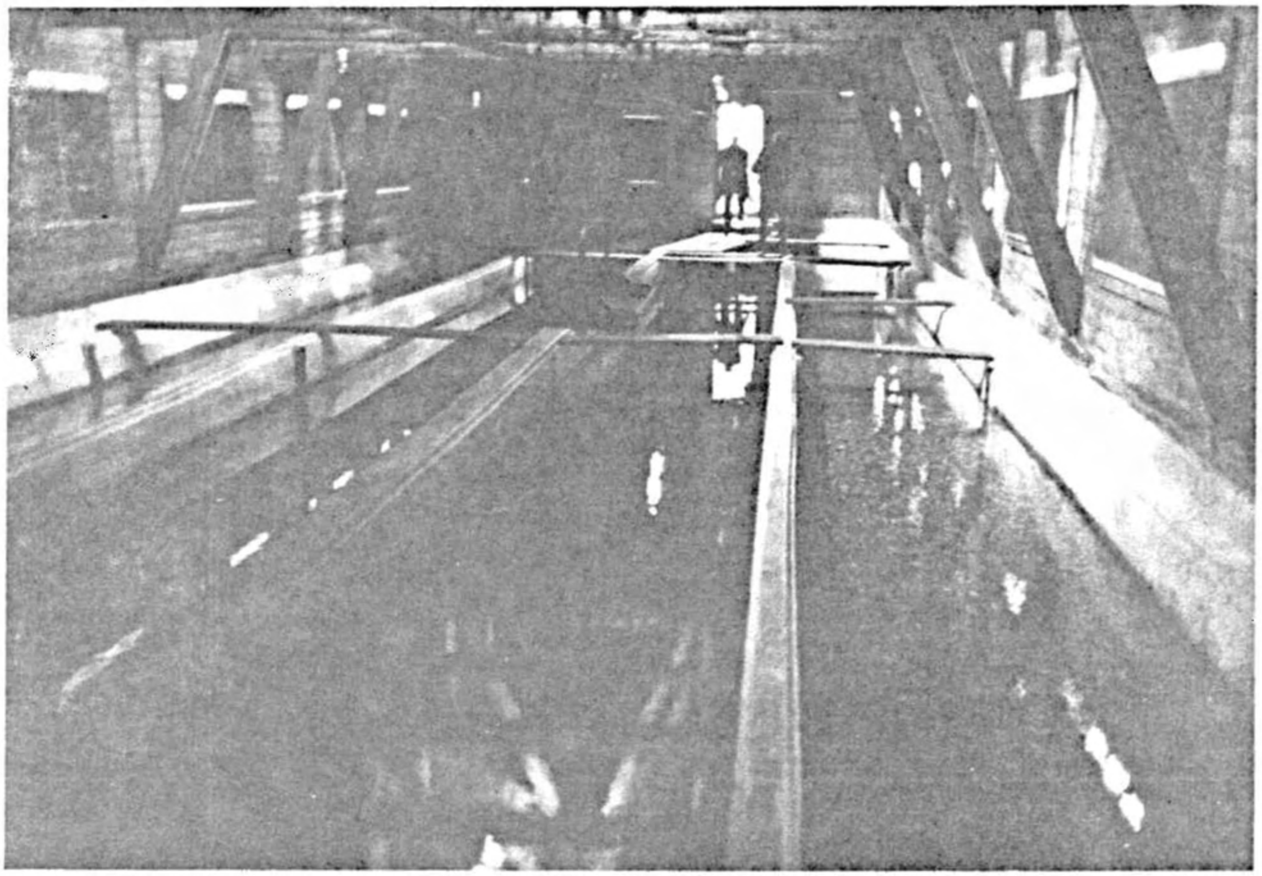

Figure 20.--Interior of covered gravel-lined alevin-nursery raceways at Kalinin Hatchery.

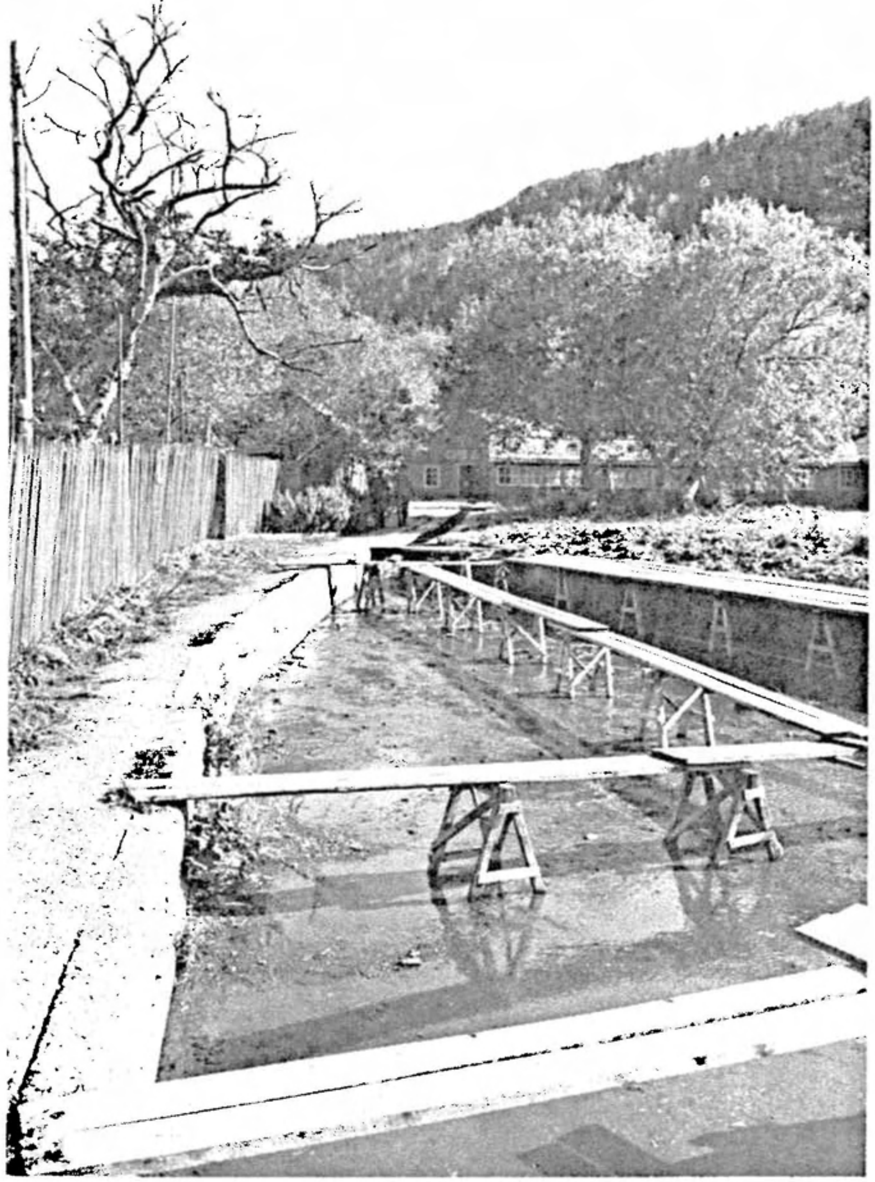

Figure 21.--Entrance to the feeding raceways from a covered alevin-nursery raceway at Kalinin Hatchery.

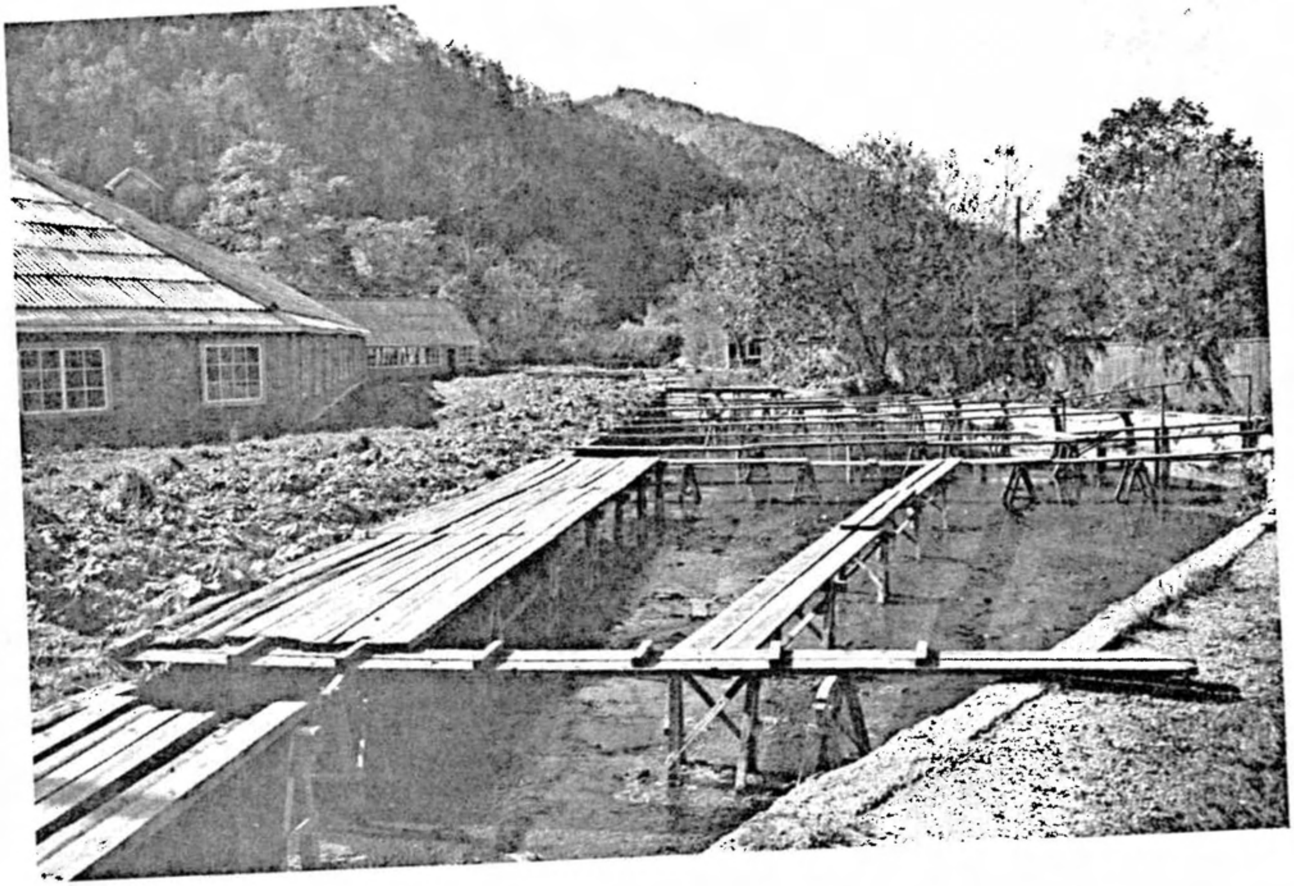

Figure 22.--Feeding raceway (looking downstream) at Kalinin Hatchery.

Figure 23.--Experimental feeding ponds at Kalinin Hatchery.

hatchery. Saprolegnia is controlled with a 1:10,000 dilution of malachite green, and soft-shell disease is prevented with a 0.5% solution of formalin. Every 10 days, incubators are dipped for 3 min in either malachite green or formalin. Dipping the incubator racks into the solutions does not release chemicals into the water system.

Mortality of chum salmon eggs during development is less than 4.5%, and mortality between hatching and release averages 2.2%. Mortalities during development in pink salmon hatcheries are nearly twice as high as mortalities during development in chum salmon hatcheries.

The fry are released in May when ocean temperatures are the same as river temperatures (but not below 3°C) and food abundance in the ocean is high--usually when most of the wild fry migrate out of the river. When fry weigh 800-900 mg, they are anesthetized, fin clipped, and released from the hatchery.

Only chum salmon indigenous to the Kalinin River have been used at the Kalinin River Hatchery (see page 134 of Population Genetics of Fishes by Yu. P. Altukhov, 1974; Translation Series No. 3548, Department of Environment, Vancouver Laboratory, Vancouver, B.C., Canada).

The proportion of female chum salmon returning to the Kalinin River Hatchery is increasing possibly because the Soviets use more eggs and sperm from late spawners than from early spawners. The Soviets (and Japanese also) have reported that selectively breeding early arrivals produces more males and selectively breeding late arrivals produces more females. The genetics of this situation is not clear.

The full-time staff at the Kalinin Hatchery consists of 46 people. During the spawning season, 20 fishermen are also hired. Six employees have university degrees; four employees have technical degrees. The operating cost is 180,000 rubles (about $450,000); 85% of this is salaries. Mean monthly wage is 250-300 rubles ($750).

Lesnoe River Hatchery (Pink Salmon)

About 32,000 pink salmon supply 38 million eggs, the capacity of the Lesnoe River Hatchery. (The mean fecundity of the pink salmon in the USSR is only 1,200 eggs per female--lower than fecundity of pink salmon in Alaska and Canada, which averages 1,700-2,000 eggs). The incubation system of the Lesnoe River Hatchery (Fig. 24) is identical to the incubation system of the Kalinin Hatchery. In fact, all the hatcheries on Sakhalin Island are the same except for the feeding raceways. All the hatcheries use the same kind of incubators; roofed, gravel-lined alevin-nursery raceways (Figs. 25-27); malachite green treatment; etc. At all the pink salmon hatcheries, fry are not fed before release. Therefore, fry are released directly from holding facilities at the outlet of the alevin-nursery raceways (Fig. 27). The highest return rate of pink salmon to the Lesnoe Hatchery is 10.4%; the average return rate is less than 2%. The Lesnoe River hatchery is operated by 20 full-time employees at an operating cost of 67,000 rubles ($170,000).

Besides operating a hatchery on the Lesnoe River, the Soviets intensively manage 30 km of spawning grounds on the river (Fig. 28). They allow 400,000-500,000 pink salmon spawners into the area. Escapements have ranged from 300,000 to 1,000,000 pink salmon.

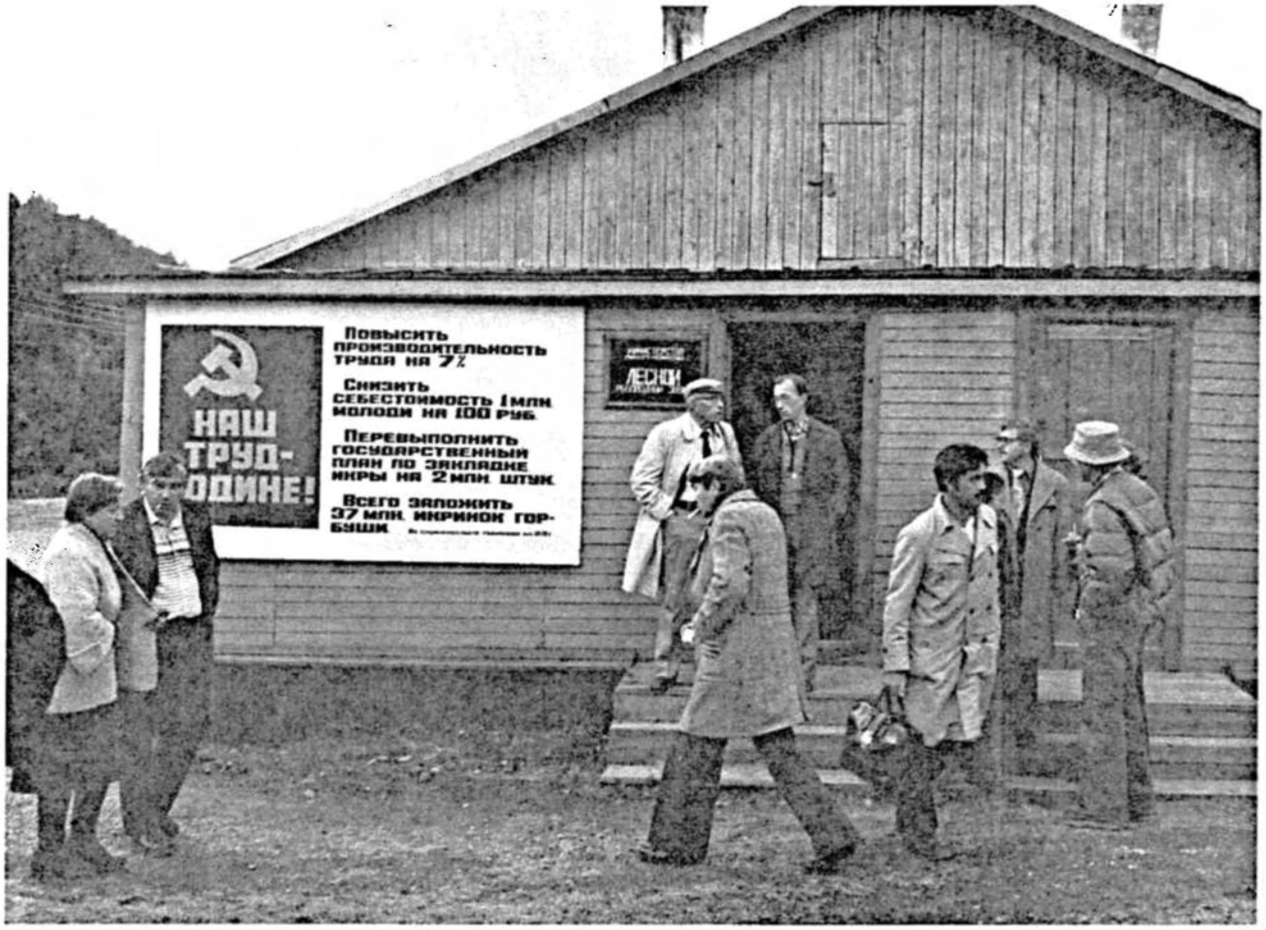

Figure 24.--Headquarters of Lesnoe Hatchery.

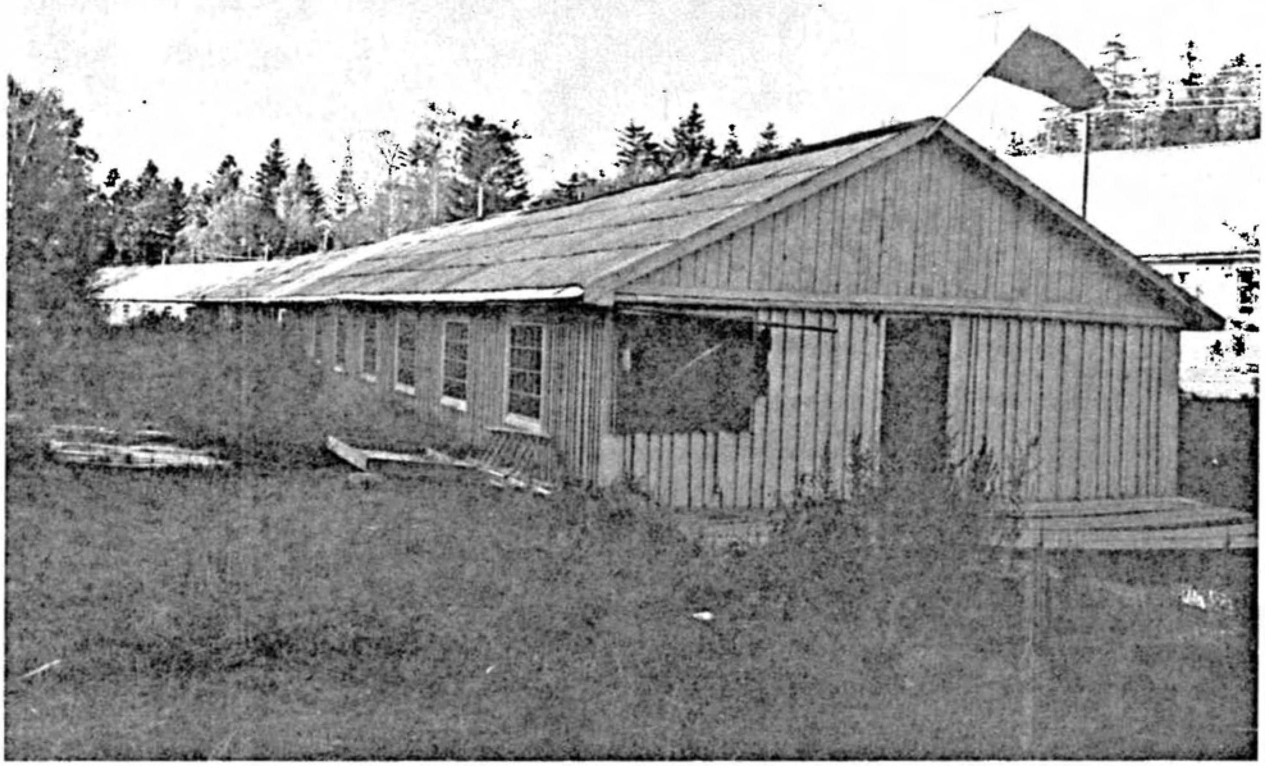

Figure 25.--Covered alevin-nursery raceways at Lesnoe Hatchery.

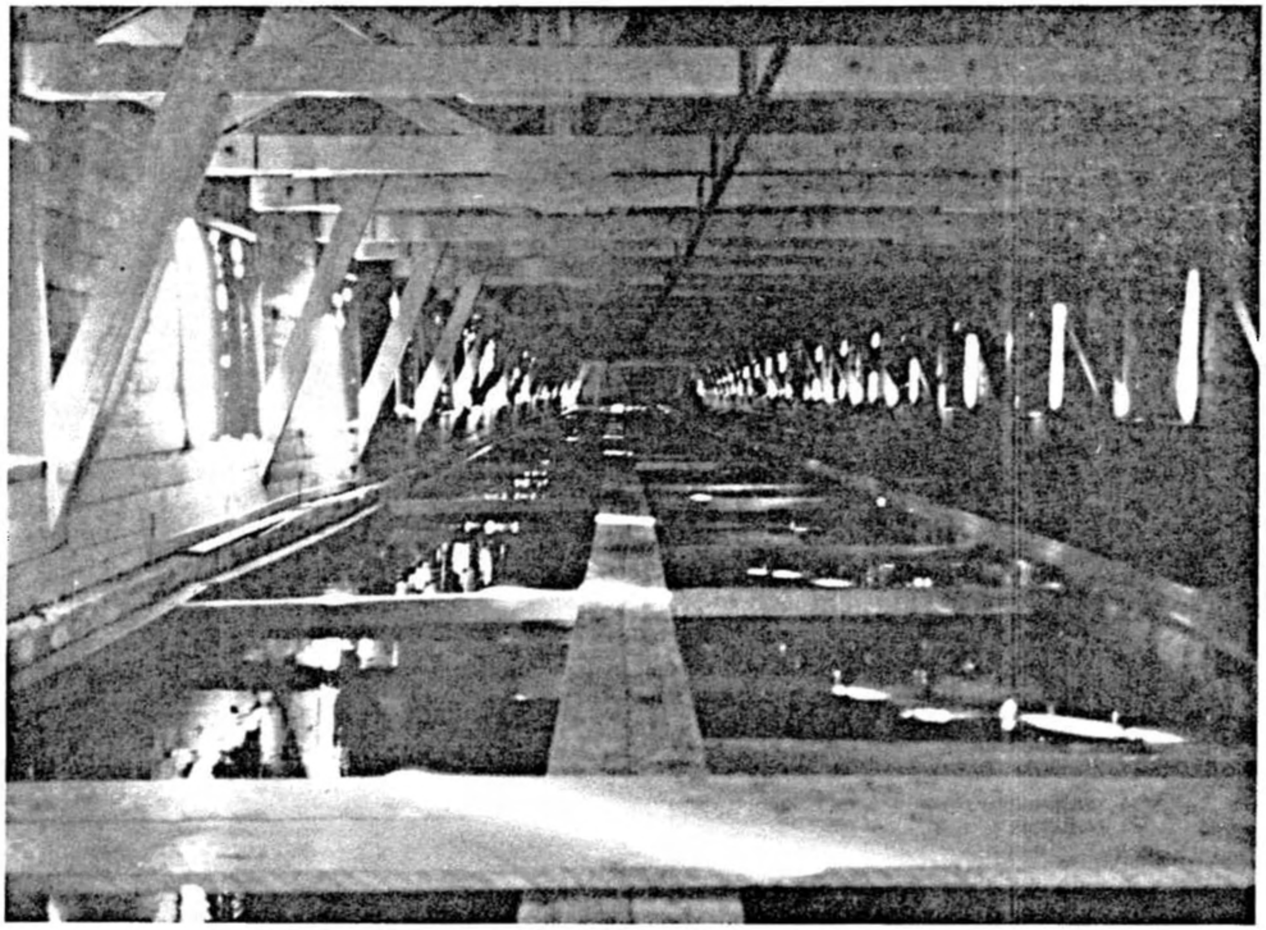

Figure 26.--Interior view of the covered alevin-nursery raceways at Lesnoe Hatchery.

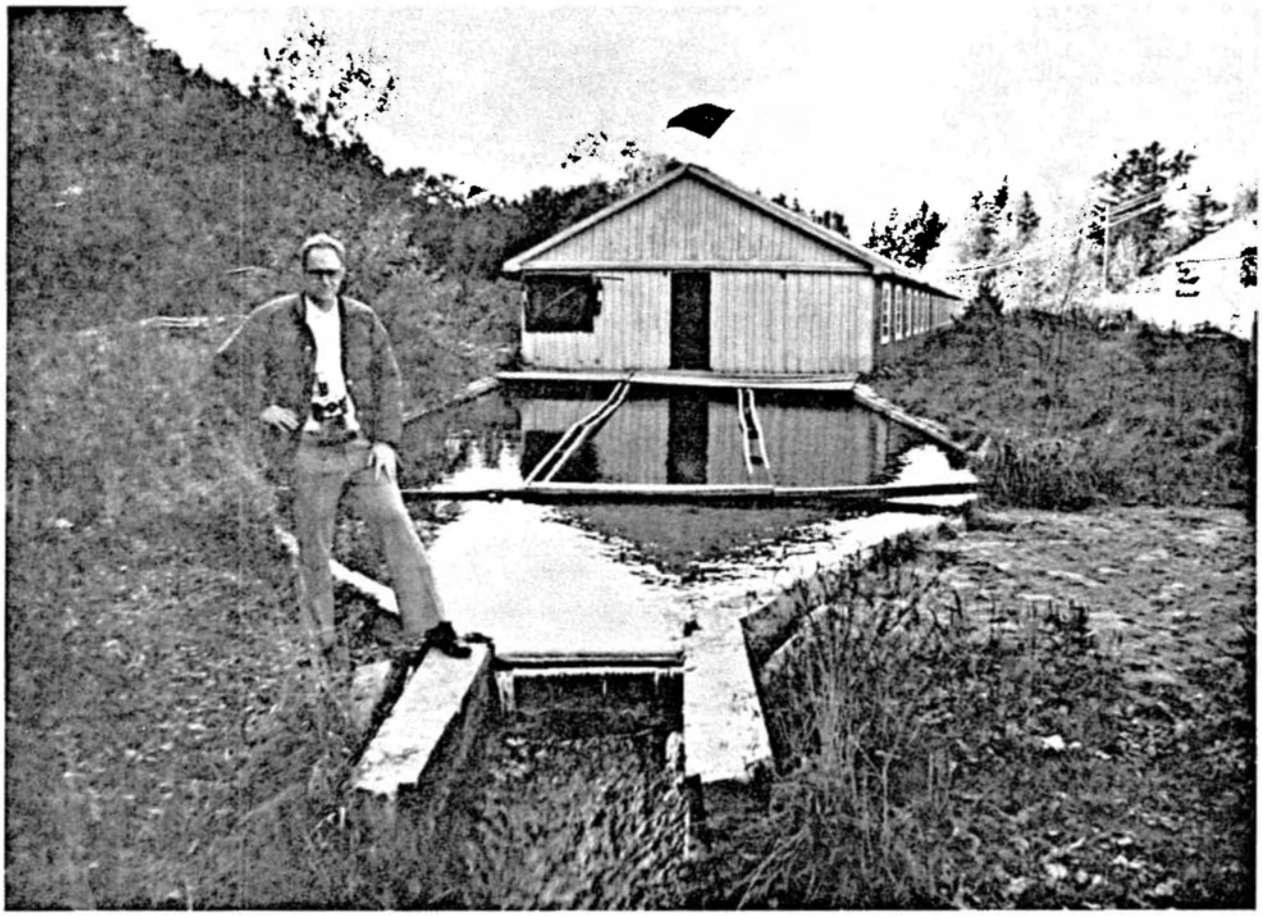

Figure 27.--Outlet of covered alevin-nursery raceways at Lesnoe Hatchery.

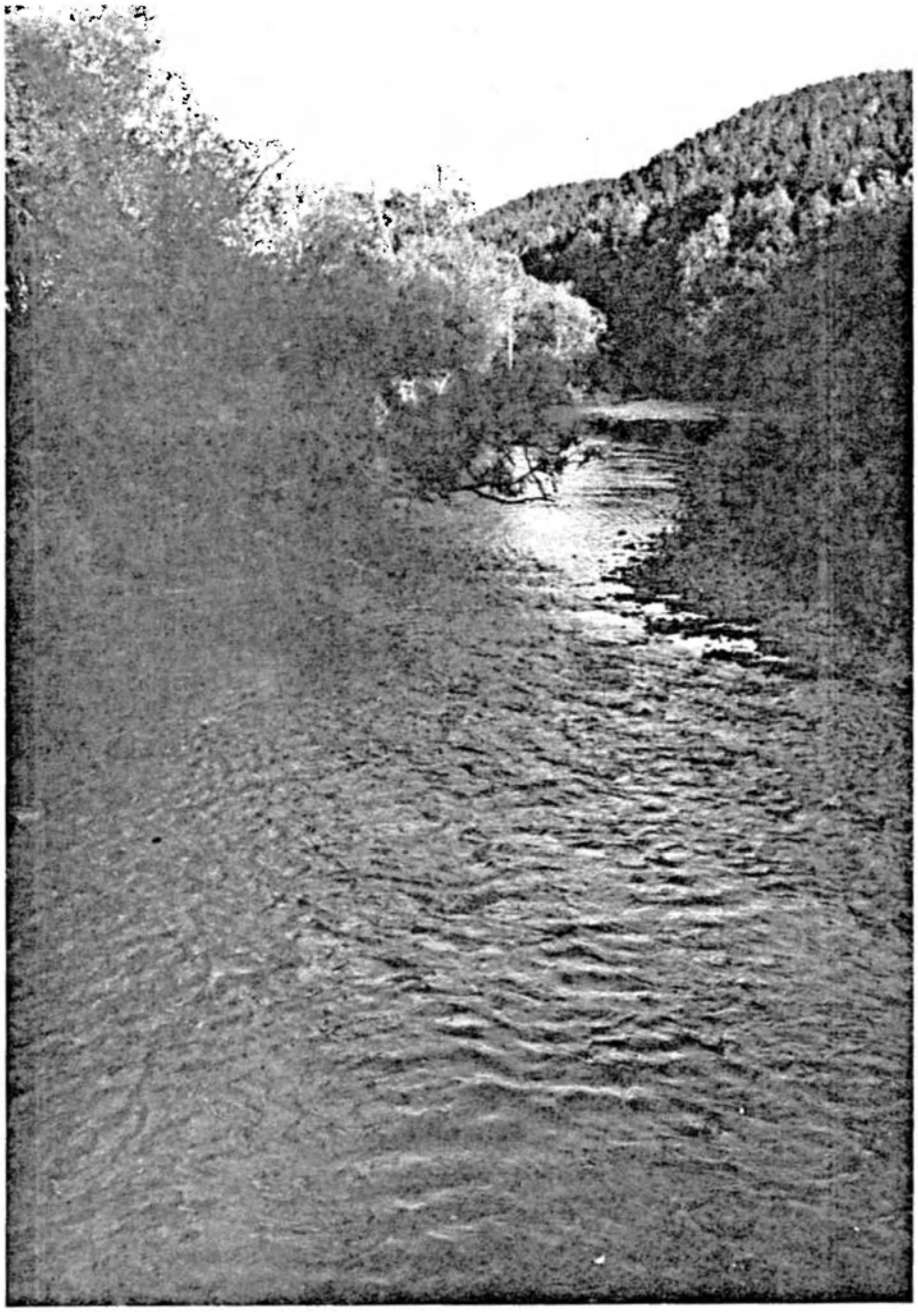

Figure 28.--Lesnoe River, a productive pink salmon river.

Predation on fry by char, Salvelinus spp., is a problem in the Lesnoe River. The Soviets have netted 600 kg of char in the river since 1964 and have noticed no decline in the char population.

Transplantation of Pink Salmon to Northwestern USSR

The Laboratory of Hatchery Reproduction of Salmon has been involved in a massive effort to establish pink salmon runs in European USSR. Since 1956, 190 million (nearly 10 million a year) pink salmon fry have been transported primarily from Sakhalin hatcheries to release sites in rivers flowing into the Barents and White Seas.

Returns of the transplanted pink salmon have been sporadic. Only one even-year transplant provided a sizeable return. In 1960, 88,000 pink salmon returned to the general area of release. During all other even years, only several fish to less than 2,000 fish returned. Returns of odd-year pink salmon were only slightly better until 1973, when nearly 200,000 fish returned to the sites of release. In 1975 and 1977, about 200,000 fish returned.

Although homing behavior of the returning adults is erratic and establishing viable runs in any one system has been difficult, the Soviets plan to continue transplanting large numbers of fry and eggs for several more years. Pink salmon have been entering Norwegian rivers during odd years since 1973--the Norwegians call them "Russian salmon."

SAKHALIN FISHING INDUSTRY

The leader of Sakhalinrybvod (Sakhalin Fishing Industry) briefed the United States and Canadian participants at a special meeting at their headquarters in Yuzhno-Sakhalinsk. A very large world map

(Fig. 29) with positions of all the various Soviet fishing vessels and fleets covered a whole wall of the room.

Fishing is the leading industry in Sakhalin. About 30% of the Soviet factory ships in the Far East unload at Sakhalin ports, and the remainder unload at Primorie ports. Kholmsk, on the west coast of Sakhalin Island, is the main base for ships of Sakhalinrybvod. The fishing fleet based on Sakhalin Island catches about 850,000 metric tons of pollock, salmon, herring, hake, cod, flatfishes, saury, and mackerel per year--about one-third of the total catch of all the Far East fleets.

Pollock account for a large portion of the catch at Sakhalin Island--230,000 metric tons. Pollock are frozen beheaded on the factory ships. The livers are canned, and the roe is salted for caviar.

Salmon were very scarce in the USSR in 1978: only 37,000 metric tons of salmon were caught. Thirty-three thousand metric tons were pink salmon; most of the remainder were chum salmon. Very few of the other salmon species were caught. Usually about 100,000 metric tons of salmon are caught in the Far East fisheries, and a catch of 37,000 metric tons is considered very small.

Twenty percent of the salmon catch is salted; the rest, canned. The heads and fins are saved for special soups (salmon fin soup is called oukha). The eggs are salted for caviar, and the testes are frozen whole.

Catches of herring were also lower in 1978 than in previous years. Stocks of herring in the Okhotsk Sea were badly depleted, and the fishery had been closed. These stocks are recovering and the Soviets hope to resume fishing herring in the Okhotsk Sea in 2 to 3 yr. Some

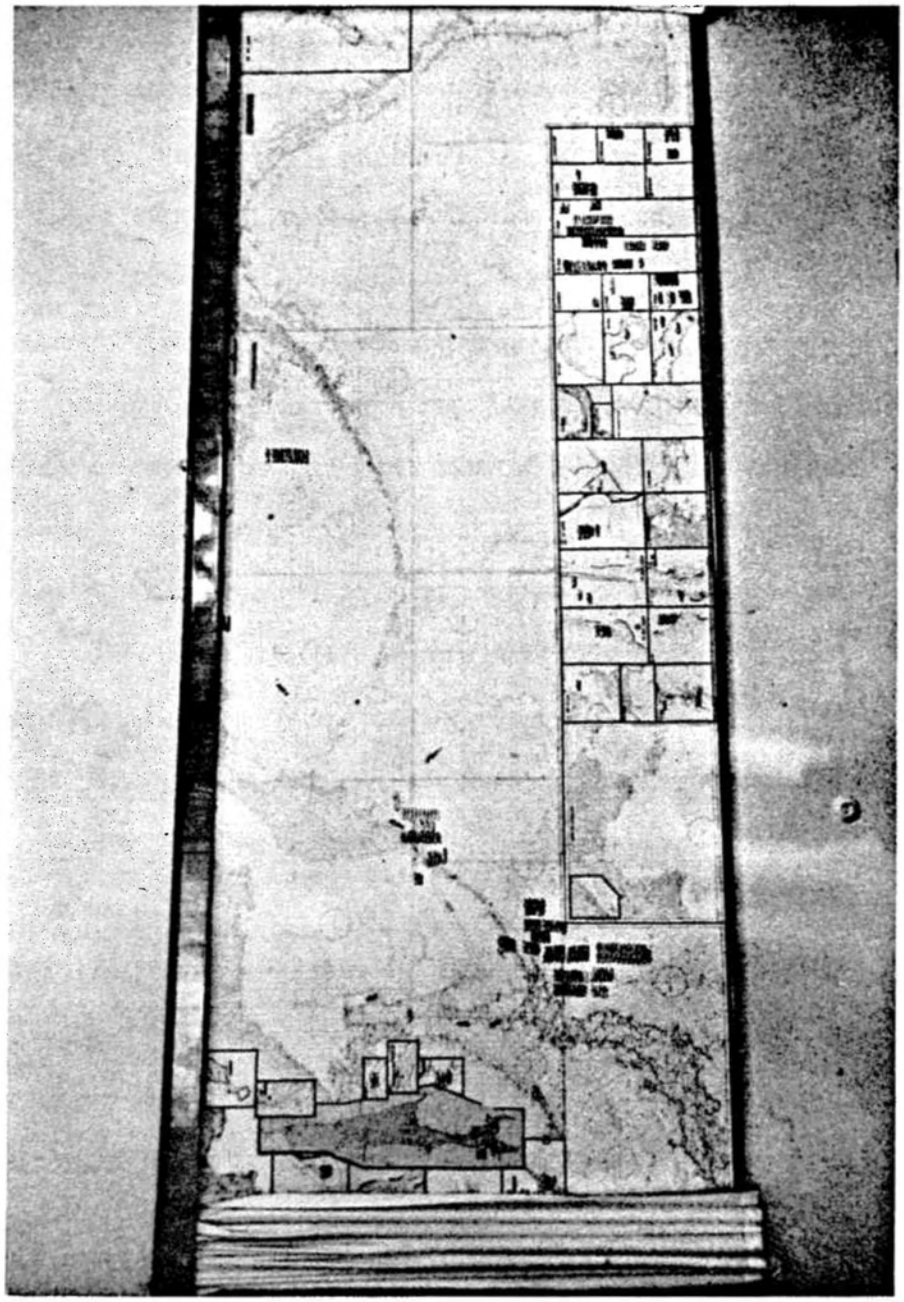

Figure 29.--Chart in the Sakhrybprom headquarters showing present location of Soviet fishing vessels.

herring were caught in the Sea of Japan, but this fishery is small and very closely monitored by TINRO scientists.

Soviet catches of hake, cod, and rockfish have been greatly reduced because of the 200-mile limit off the United States and Canadian coasts.

The fishing industry branch at Vladivostok, in cooperation with TINRO scientists, operates 85 vessels for evaluating the high-seas fisheries: 70 vessels for long-term forecasts and 15 vessels for short-term forecasts.

The Soviets plan to increase the catch to 900,000 metric tons by 1983, as well as improve the quality of the products.

We toured the Sakhalinrybvod processing plant in Yuzhno-Sakhalinsk (Figs. 30 and 31). The majority of the facilities at this plant were devoted to smoking fish. Much of the canning and freezing is done at sea on factory ships. During our visit they were preparing and smoking mostly brined pink salmon and some herring and flatfishes.

The Sakhalinrybvod personnel treated us to several lavish seafood banquets (Figs. 32 and 33), which usually lasted a minimum of 3 h. A home economist designed the recipes and supervised preparation of the food. A great variety of dishes was prepared from salmon, squid, sea cucumbers, scallops, crab, cod, flatfishes, seaweed, salmon testes, and of course, caviar. Caviar was made from the eggs of sturgeon, pink salmon, chum salmon, shad, pollock, cod, and sea urchins. Deep fried pink salmon testes and a combination dish of sea cucumber and seaweed (Laminaria) were two of my favorites.

Figure 30.--Preparing brined pink salmon for smoking.

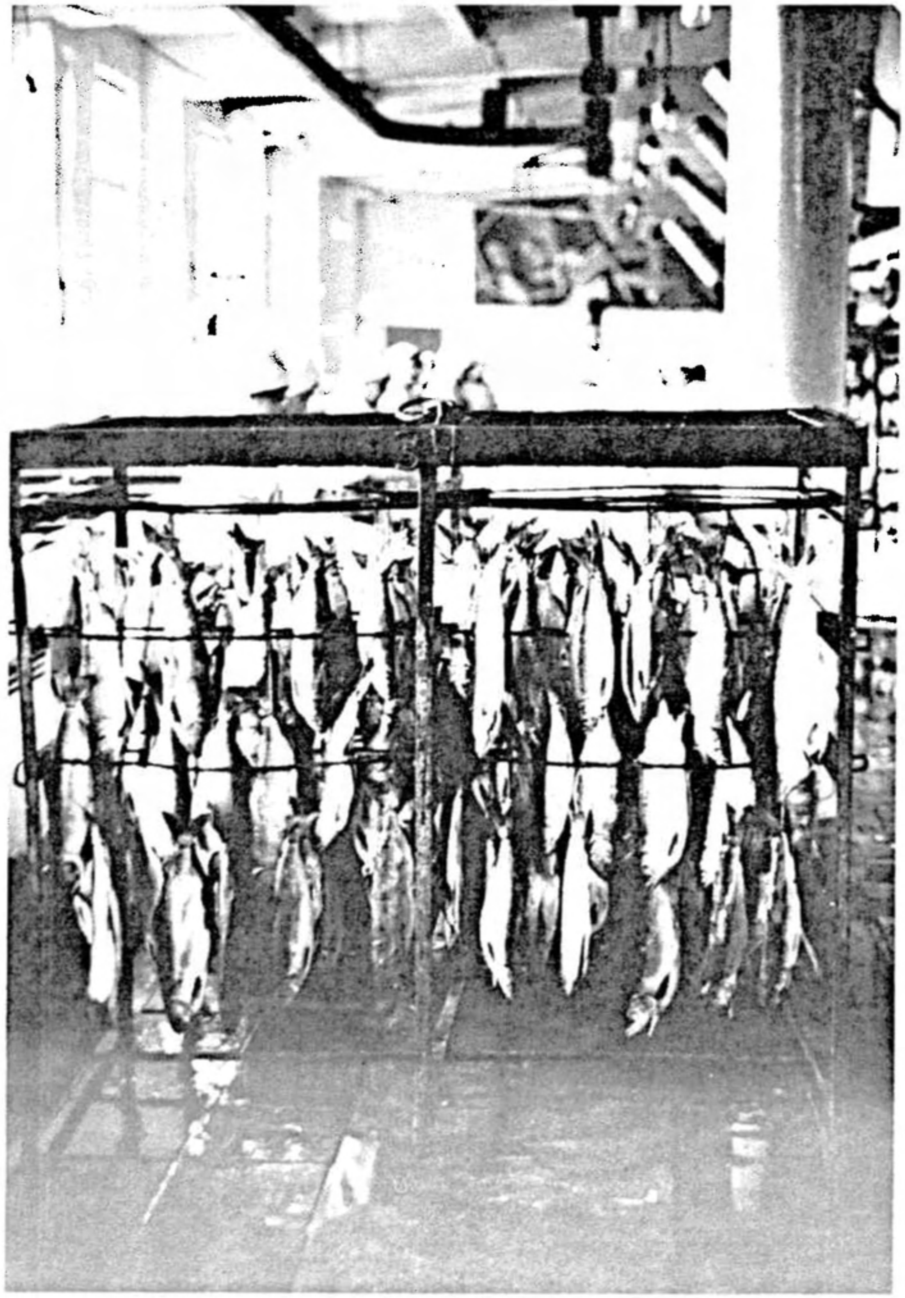

Figure 31.--Pink salmon ready for the smoker.

Figure 32.--Mayor of Yuzhno-Sakhalinsk, Director of Sakhalinrybvod, Soviet translator, and Clint Atkinson (leader of the U.S. participants) at seafood banquet.

Figure 33.--Seafood banquet sponsored by Sakhalinrybvod (Sakhalin Fishing Industry) for foreign participants of the conference at Yuzhno-Sakhalinsk.

We toured a large Sakhalinrybvod retail store (Fig. 34) in Yuzhno-Sakhalinsk that was literally a supermarket devoted to fishery products. Some of the many products available were canned seaweed (Fig. 35) (the Russian word translates into a more palatable "sea cabbage") and salmon that was frozen, jellied, breaded, smoked, salted, or canned.

JAPAN

Clint Atkinson, former Fisheries Attaché at the American Embassy in Tokyo, and James Johnson, the present Fisheries Attaché, recommended a tour of research facilities and hatcheries in Japan. The tour was approved by the Japan Fisheries Agency. Mr. Yoshihiro Aoki of the Japan Salmon Resources Preservation Association arranged the tour, which was coordinated through the Alaska State Asian Office by Mr. Yoshio Katsuyama, Director. Mrs. Mitsuko Arakaki of the Alaska State Asian Office made me a set of cards (one for each day) with my itinerary, including train stations, times, transfers, car and seat numbers, hotels, and people's names and phone numbers printed in both Japanese and English. These cards were invaluable for a newcomer to Japan traveling alone in areas where English is not understood.

Niigata

At Niigata, a stopover on the way to the USSR, we briefly visited the Japan Fisheries Agency Japan Sea Regional Fisheries Research Laboratory--a laboratory mainly involved in research on sardine, mackerel, jackmackerel, yellowtail (Seriola sp.), squid, and snow crab. The laboratory is also involved in some high-seas research on salmon.

Figure 34.--Retail market for fishing products of Sakhrybprom.

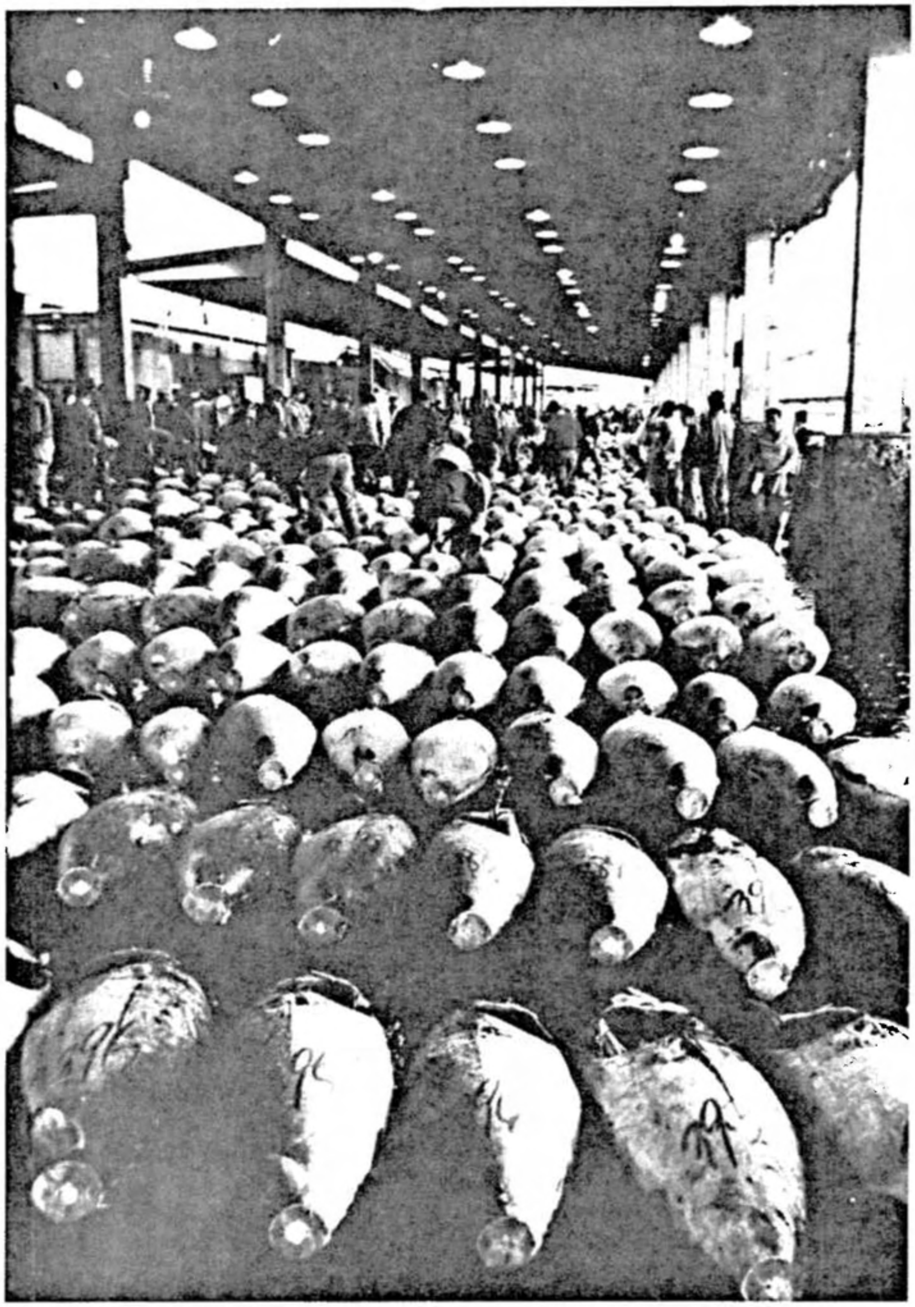

Figure 36.--Tuna ready for auction at the Tokyo Fish Market.

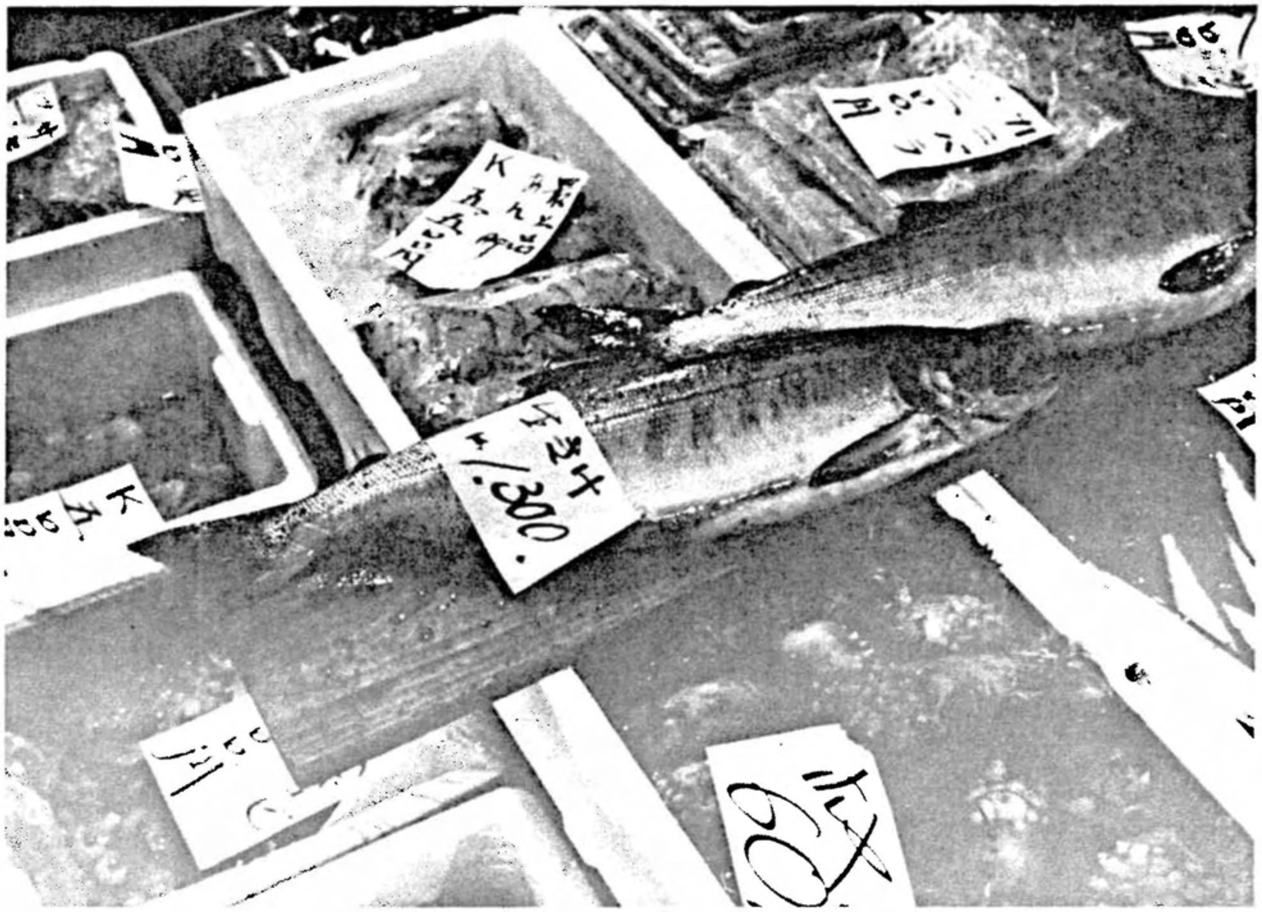

Figure 37.--Chum salmon for sale at the Tokyo Fish Market.

With Dr. Fujio and two of his graduate students, I visited the Tohoku Regional Fisheries Research Laboratory (Japan Fishery Agency) at Matsushima Bay. This laboratory has major research divisions in aquaculture (salmon, seaweed, shrimp, scallops, abalone), demersal fisheries, shellfish, oceanography, and off-shore studies of salmon.

There are intensive aquaculture activities in Matsushima Bay and navigation is difficult. Bamboo poles are so dense that from a distance the bay looks like it is overgrown with reeds (Figs. 38 and 39). The poles keep nets for Nori (seaweed) culture just off the bottom to protect the plants from sea urchins--a serious predator. Crops are harvested 5 to 6 times each season, beginning in late November. Fungus infections of Nori are troublesome in this area.

In the summer of 1977, an unusual, very serious outbreak of paralytic shellfish poisoning occurred from cultured scallops in Matsushima Bay. The bay was closed to harvest until late fall and the local scallop industry was a financial disaster.

Scientists at the Tohoku Laboratory are studying the diet of salmon in the nearshore marine areas and culture of salmon in net-pens. The pen-culture activities are unusual because of the high water temperatures in this area.

In December, the Tohoku Laboratory received 6 million chum salmon eggs from a hatchery on Hokkaido Island and in March the fry were transferred to net pens, 20 m x 20 m and 2-5 m deep. No freshwater was piped into the pens. In mid-May, 4 million chum salmon were released, 200,000 of which were fin clipped. Water temperature was 15°C at time of release. Local wild chum salmon in the area were

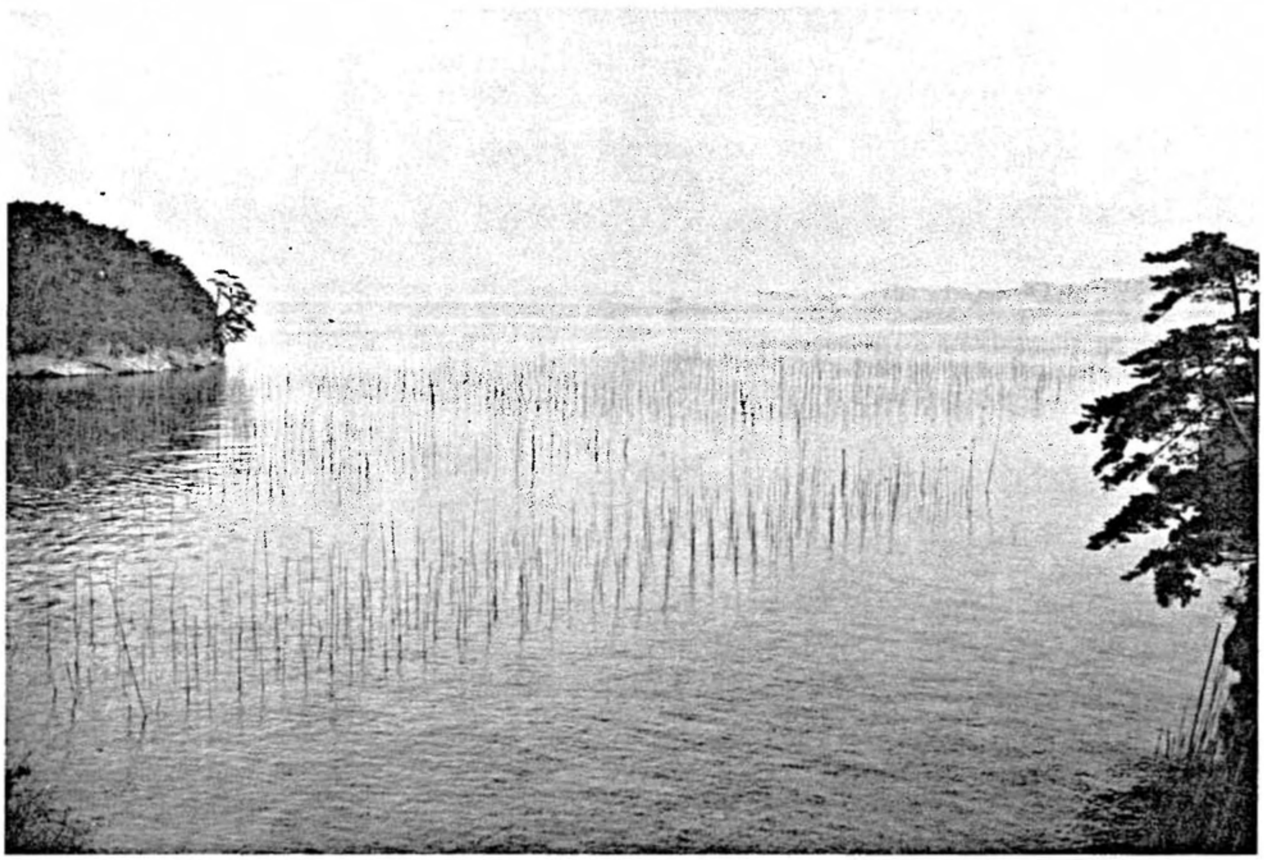

Figure 38.--Bamboo poles for suspending nets for seaweed (Laminaria) culture off the ocean bottom, Matsushimi Bay near the Tohoku Regional Fisheries Research Laboratory at Sendai.

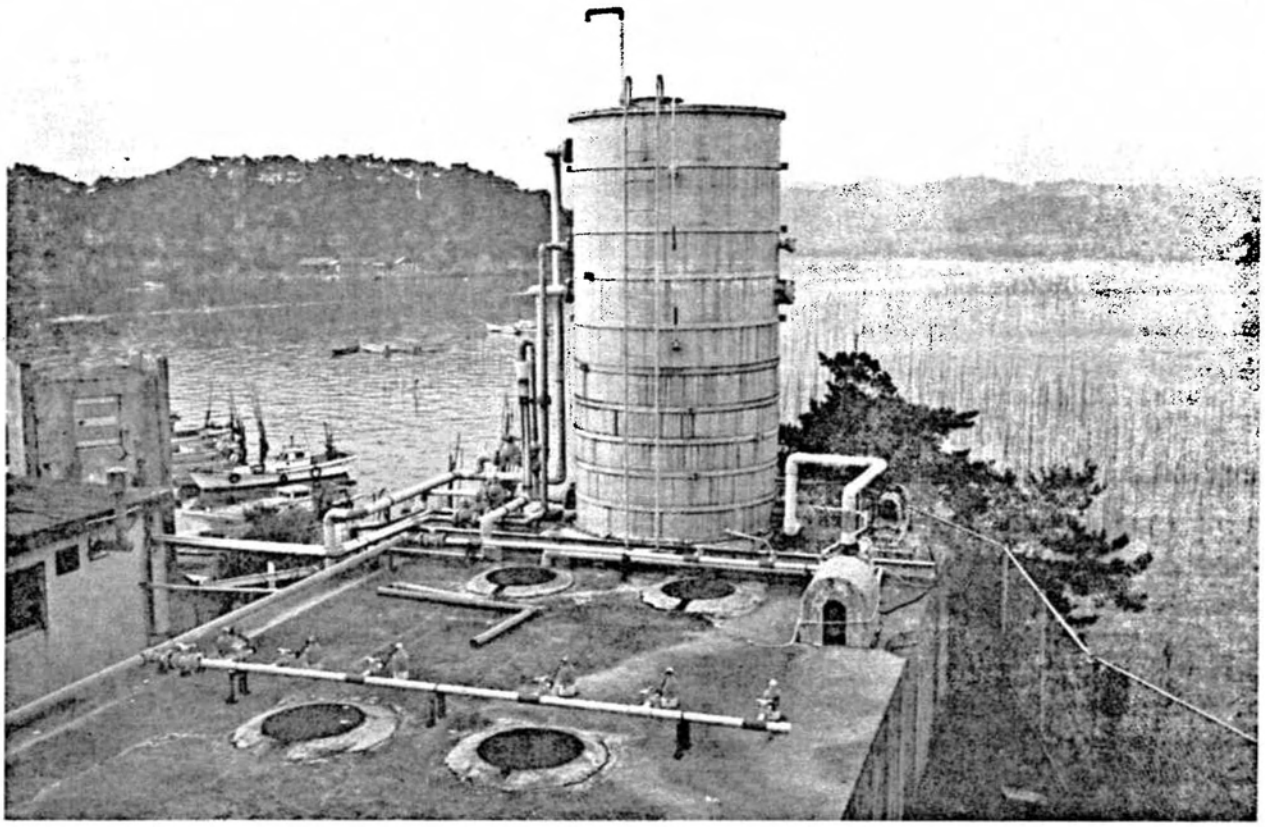

Figure 39.--Seawater storage and filter system at Tohoku Regional Fisheries Research Laboratory (Japan Fishery Agency) at Sendai.

12 cm long; the reared chum salmon were 10 cm long at release. Very few of the reared chum salmon returned. One-half of the hatchery fry returned as 3-year-olds; the remainder as 4-year-olds.

Some chum salmon in the net-pens were held over the summer. Water temperatures in the bay reached 27°C! The chum salmon stopped feeding, but contracted no disease. When water temperature decreased in the fall, the fish resumed feeding.

Because of the poor return from this experiment, scientists at the Tohoku Laboratory have changed their research emphasis to development of pheromones that could improve homing of transplanted stocks.

Miyako and Vicinity--Honshu Island

Mr. Chikara Iioka, Chief of the Shimohei Branch of Iwate Prefectural Fisheries Experiment Station, met me at the railway station. We visited the Miyako fish market, Tsugaruishi Hatchery, and the Yamada Bay Experiment Station.

Chum salmon and yellowtail (*Seriola* sp.) were the main species being unloaded on the dock at the Miyako fish market. We saw three fin-clipped chum salmon that came from the net-pen experiments at Yamada Bay (Fig. 40). I took some scales from some small chum salmon that Mr. Iioka said were probably 2-year olds (they definitely were 2-year olds). These small chum salmon make up about 10-15% of the chum salmon returns in this area.

The Tsugaruishi Hatchery, one of the oldest of 19 salmon hatcheries on the coast of Iwate Prefecture, has been in operation for

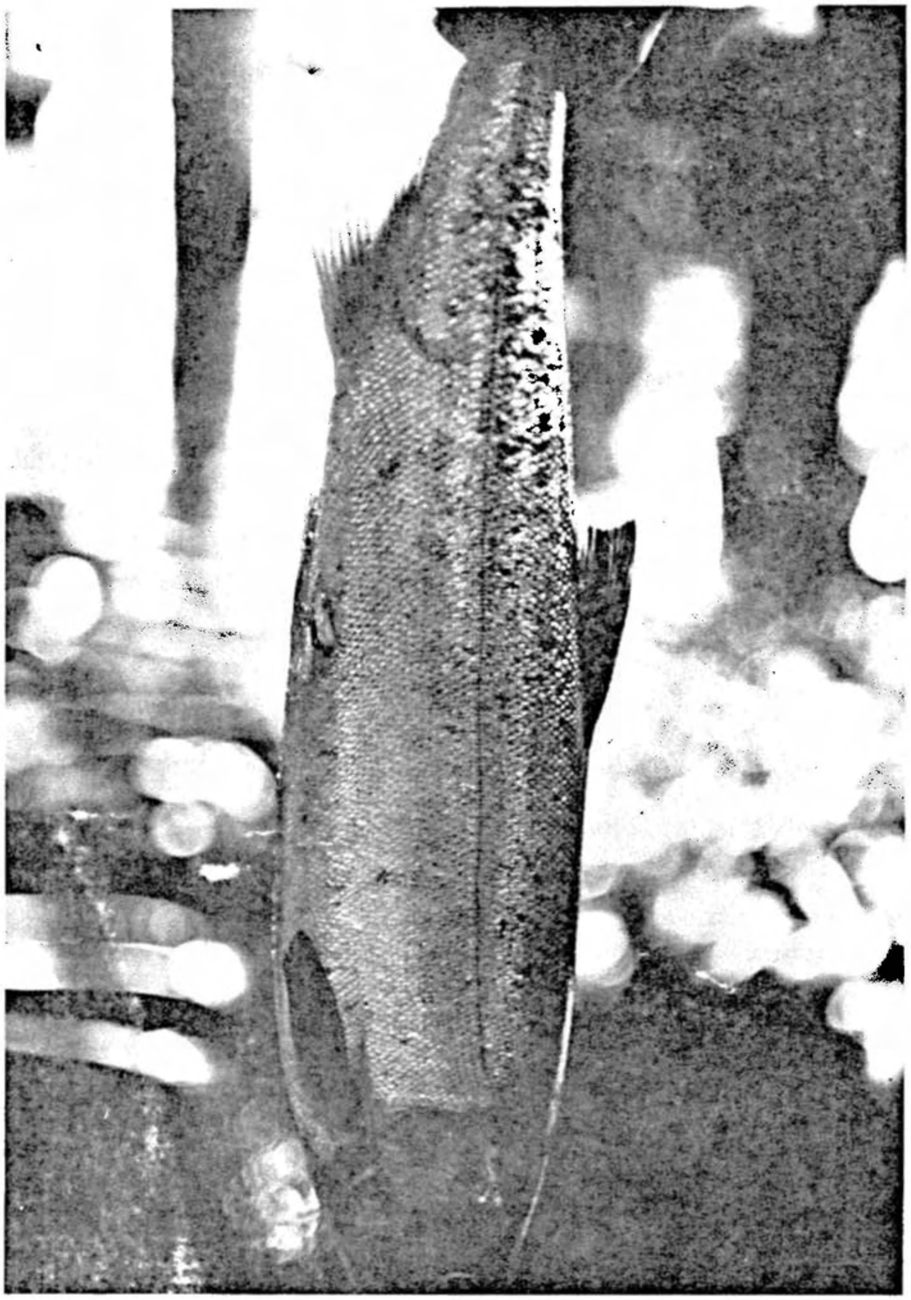

Figure 40.--A fin-clipped two-year-old chum salmon at Miyako Fish Market.

70 years. In 1977, 79,000 chum salmon returned to the Tsugaruishi River, and 100 million eggs were taken. Twenty million of these eggs were sent to another hatchery. The mean return of chum salmon to the Iwate Prefecture hatcheries is 0.972%.

Free-style incubators, which hold 500,000 eggs per unit, are used in the Tsugaruishi Hatchery. Eyed eggs or alevins are transported by buckets to the gravel-lined cement raceways. Gravel is placed on screens suspended above the bottom forming a two-layered alevin nursery area that nearly doubles the capacity of the hatchery to produce fry (Figs. 41 and 42).

Last year the Tsugaruishi Hatchery began rearing chum salmon in 30 m diameter sea pens for 50-60 days. The water source for the hatchery is upwelling groundwater, which is 10°C year round.

In the Iwate area, 2-year-old chum salmon are a relatively large percentage of the chum salmon returns. Large males and females are selected for brood stock; two-year-olds are not used for breeding. The 1965 and 1969 brood years produced a very high percentage of 4-year-old fish. Also, the return of 2-year-olds shows a strong 4-yr cycle!

Mean Age Composition of
Recent Chum Salmon Returns in the Iwate Area

Age (yr)	2	3	4	5
Percent	10-20	20-40	50-60	<4

Scallops and seaweed are intensively cultured in Yamada Bay and, like Matsushima Bay, navigation looks hazardous (Fig. 43). In 1973,

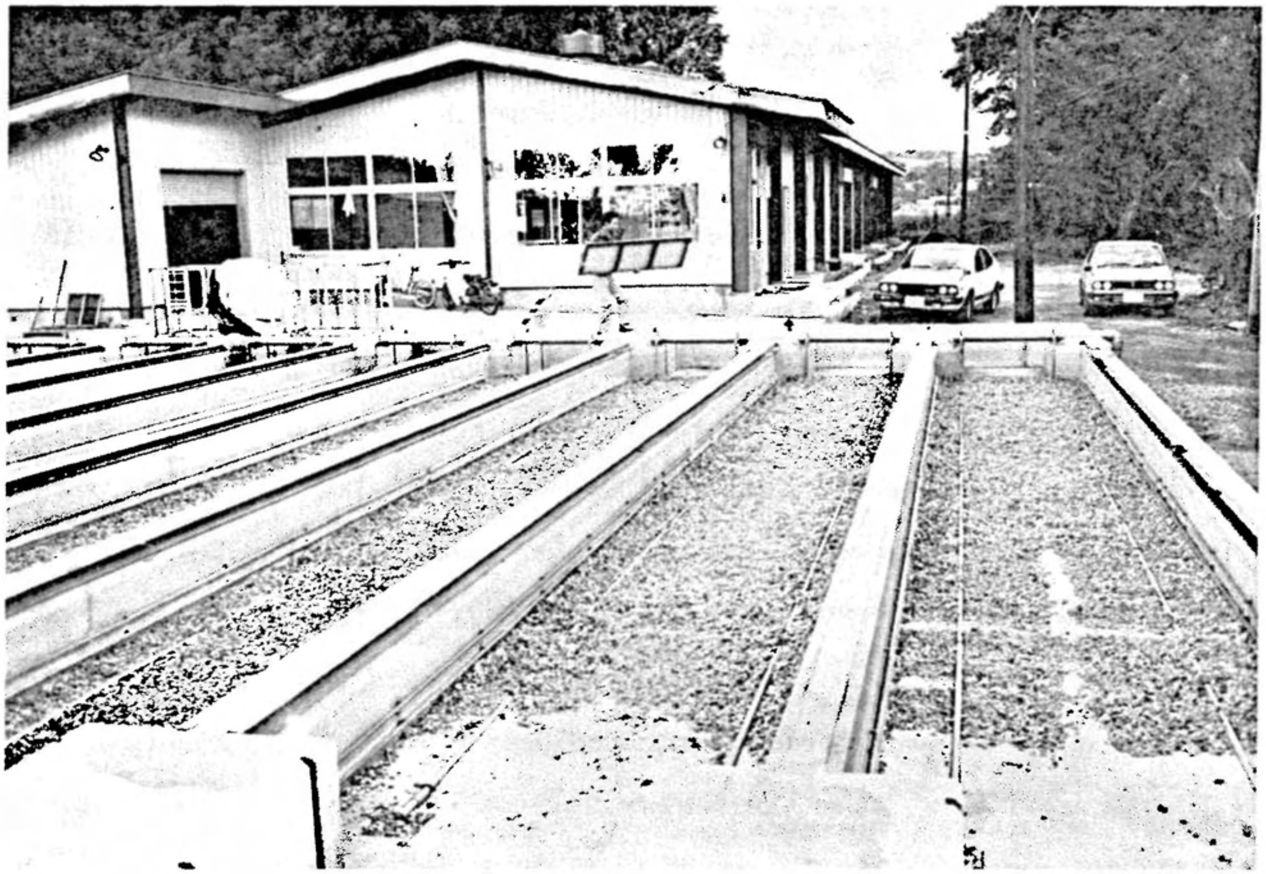

Figure 41.--Tsugaruishi Hatchery and gravel-lined alevin-nursery raceways. Note pipes for upwelling flow.

Figure 42.--Rack for providing dual gravel layers in the alevin-nursery raceways at Tsugaruishi Hatchery.

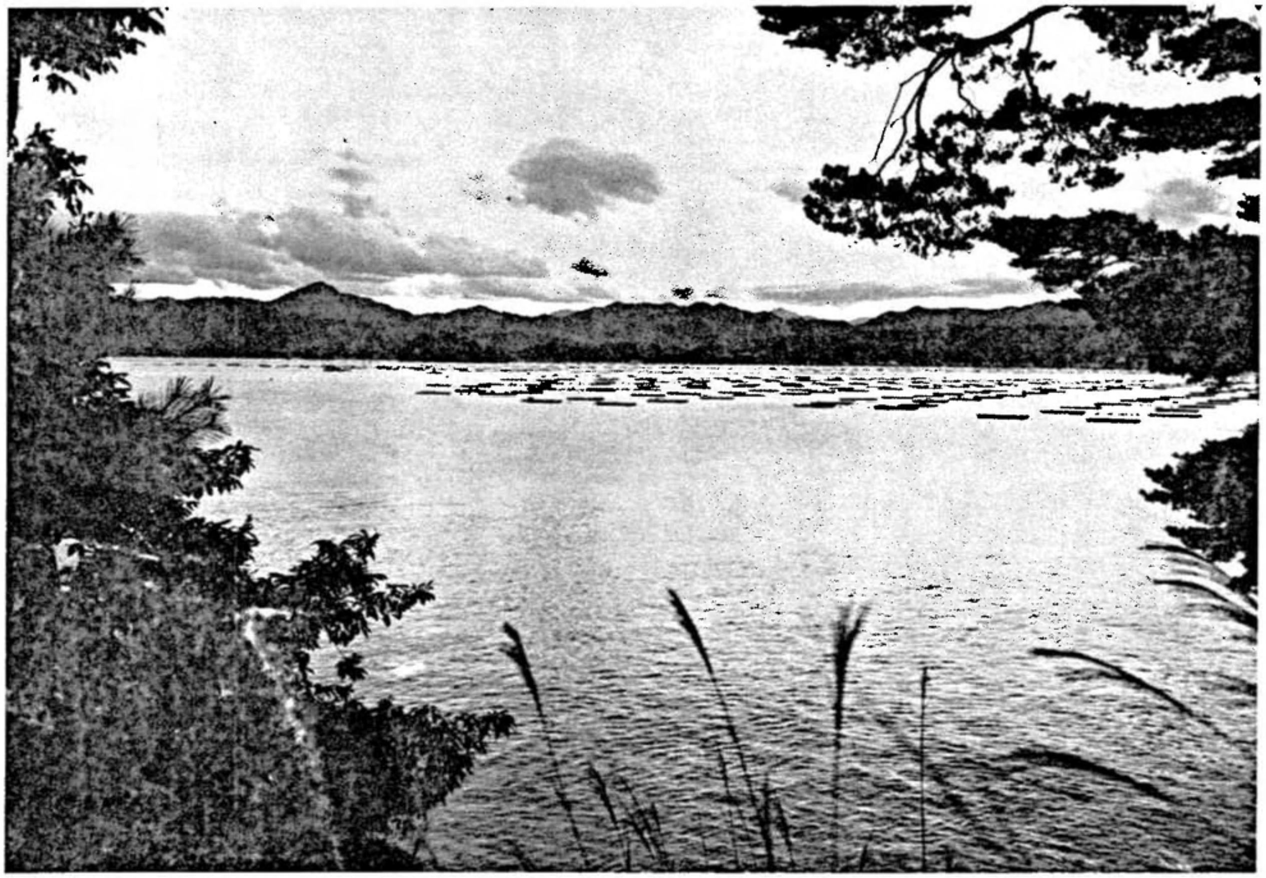

Figure 43.--Rafts for scallop culture in Yamada Bay (near Miyako) in front of the Iwate Prefectural Fisheries Experiment Station.

Mr. Iioka began studying the rearing of chum salmon in sea pens in Yamada Bay. The Orikasa River (Yamada Bay) stock of chum salmon is reared in 55 m diameter, 10 m deep net pens. Conditions for release into the bay of the fry from the pens seem to be ideal when the water temperature is 11°C.

Ocean Survivals of
Chum Salmon of Various Release Sizes

Brood year	Size at release (g)	Survival (%)
1972	4	1.8
1973	10	7.3
1974	4	1.9
1975	--	--
1976	8	--

In 1978, large numbers of marked 2-year-olds were being recovered from 1976-brood experiments. Mr Iioka thought that the survival of older age groups in that brood would also be high.

Hokodate and Vicinity--Hokkaido Island

Dr. Fumio Yamazaki and his graduate student Teruyuki Nakanishi from the Faculty of Fisheries, Hokkaido University, guided my visits in the Hokodate area. We visited the Hokkaido University, the Yakumoh Hatchery, and the Hokkaido Institute of Mariculture.

The fisheries school at Hokkaido University is only for upperclassmen and graduate students and is divided into four major groups: biology, chemistry, food technology, and fishing technology. Each group is divided into laboratories, e.g., Laboratory of Embryology and Genetics. Biology has 7 laboratories, chemistry and food technology each have 5 laboratories, and fishing technology has

13 laboratories. Six hundred students attend the university; 100 of them are graduate students.

All of the laboratories at Hokkaido University are well-equipped with the finest in Japanese technology. Some of the items I noticed were scanning and regular electron microscopes (JEOL[1]), a scale projector (Nikon[1] model V-16A), an atomic absorption spectrophotometer (Hitachi[1]), and a polyphoto unit (Nikon[1]) with two camera bodies mounted on the same microscope for simultaneous black-and-white and color photography. The only foreign scientific equipment I saw regularly in Japan was an Australian salinometer.

Dr. Yamazaki and his students are involved in studies on hybrids, chromosomes, gene activation of enzymes, and production of androgynous and gynogynous fish. The Japanese, and the Soviets, are interested in the production of gynogynous fish because of their fondness for caviar.

The Yakumoh Hatchery produces the fourth largest chum salmon run on Hokkaido Island (Fig. 44). The return to the Yakumoh River last year was 40,000 chum salmon.

Two-year-old chum salmon are rare here and on Hokkaido Island, in general, and usually represent less than 3% of the return of any brood. However, during the past 20 yr, the average age composition has been getting younger.

Mean Age Composition of Recent Chum Salmon Returns
at Yakumoh Hatchery

Age (yr)	3	4	5
Percent	30	50	20

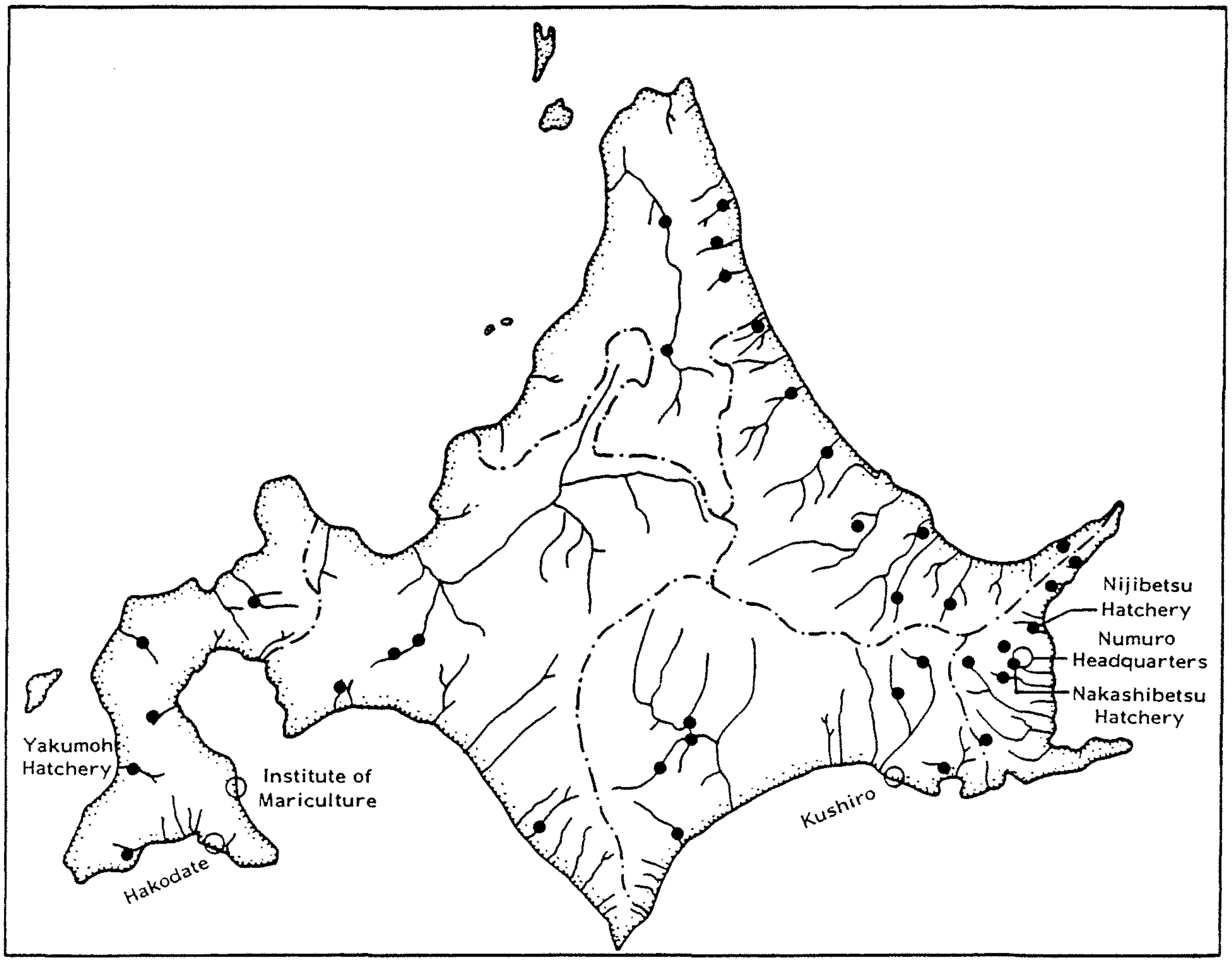

Figure 44.--Distribution of salmon hatcheries and streams on Hokkaido.
Black dots indicate locations of hatcheries.

The ratio of males to females has also been changing to favor males. The change in age composition is thought to be related to feeding the fry and causing them to mature early (which favors males). The Japanese, like the Soviets, report that experiments in selecting early spawners for brood stock produced a higher percentage of males. The tendency for early spawning is also highly heritable. Another interesting observation was that when food abundance in the nearshore areas was high, the brood produced a larger percentage of males.

The gamete collection facilities of the Yakumoh Hatchery are 2 km above tidewater. The river is blocked to passage of salmon at this point by a bamboo weir (Figs. 45-48). The main hatchery facility is 15 km farther up river.

During 1976 and 1977, unseasonally high water washed the weir out and chum salmon ascended the river to spawn. Chum salmon spawners were even swimming into the feeding ponds at the hatchery; poachers and bears created many problems.

Hatchery managers here (as well as at all other hatcheries that I visited in Japan and the USSR) believe springwater to be essential for a successful chum salmon hatchery. The water source for Yakumoh Hatchery is several springs (Fig. 49) that vary in temperature from 7.2° to 7.8°C.

The Yakumoh Hatchery has a capacity of 23 million eggs. Although four types of incubators were in use, this hatchery was rapidly converting to the free-style type that holds 500,000 eggs (Fig. 50). Eyed eggs or alevins are hauled in buckets to covered alevin nursery raceways where steel trays hold additional alevins above the

Figure 45.--Bamboo weir and fish trap on the Yakumoh River.

Figure 46.--Fish collection trap on a side channel of the Yakumoh River.

Figure 47.--Transporting chum salmon to the gamete collection facility on the Yakumoh River.

Figure 48.--Fertilizing eggs at the gamete collection facility on the Yakumoh River.

Figure 49.--Springwater source for the Yakumoh Hatchery.

Figure 50.--Modified Atkins incubators at Yakumoh Hatchery.

bottom of the raceway as in the Tsugaruishi Hatchery. Each raceway holds a total of 23,000 fry/m^2: 15,000 fry/m^2 on the lower level and 8,000 fry/m^2 on the upper level on the steel trays (Figs. 51 and 52).

The fry voluntarily enter the feeding raceways and are fed for three months, but any one fry is fed for one month (Fig. 53). Fry leave the raceways on their own volition and weigh 0.8-1.2 g at migration.

By changing the method of maintaining water flow in the feeding raceways, personnel at the Yakumoh Hatchery have reduced the need for water from 100-150 l/min to 80-100 l/min and have eliminated the need for gravel. Water entering through 2-mm diameter holes from the bottom, sides, and top (Fig. 53) keeps food suspended and fry spread out. More fry can be kept in this system than in a system with straight laminar flow: 12,000-15,000 fry/m^2 versus 8,000-10,000 fry/m^2. The water is 80 cm deep in the feeding raceways. The bottom of the raceways is sloped 0.5%.

Mean survival of chum salmon produced at Yokomah Hatchery has increased from 1.3% in 1963 to 2.2% in 1978.

We stopped briefly at the Hokkaido Institute of Mariculture--a laboratory devoted to solving problems in the culture of seaweed, crabs (including king crab), scallops, clams, shrimp, and rockfishes (*Sebastes schlegeli* and *Hexagrammos otakii*).

Kushiro and Vicinity--Hokkaido Island

Mr. Yoshiaki Sanbonsuga, an algologist on the staff of the Hokkaido Regional Fisheries Research Laboratory (Japan Fishery

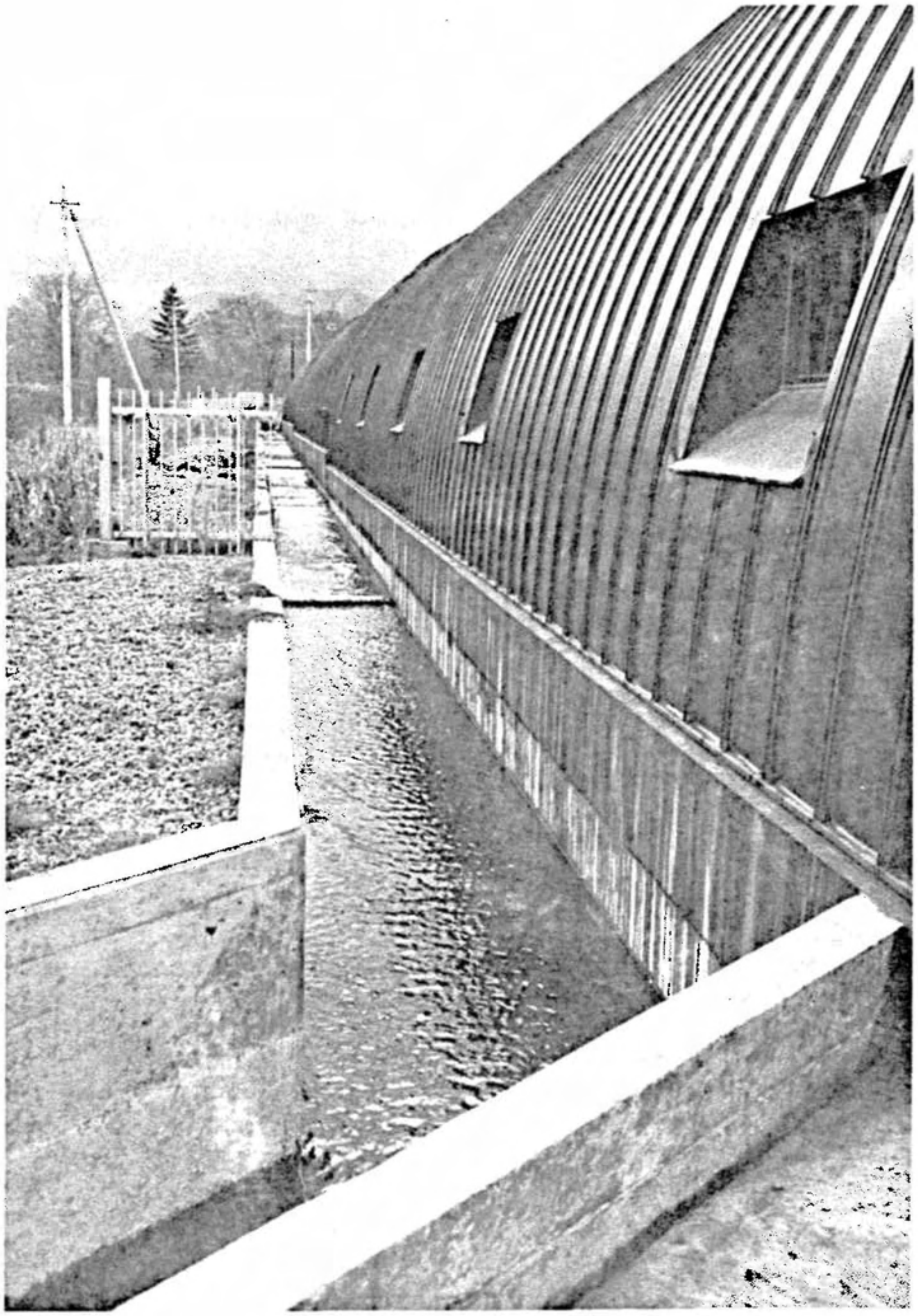

Figure 51.--By-pass and flood channel next to the covered alevin-nursery raceways at Yakumoh Hatchery.

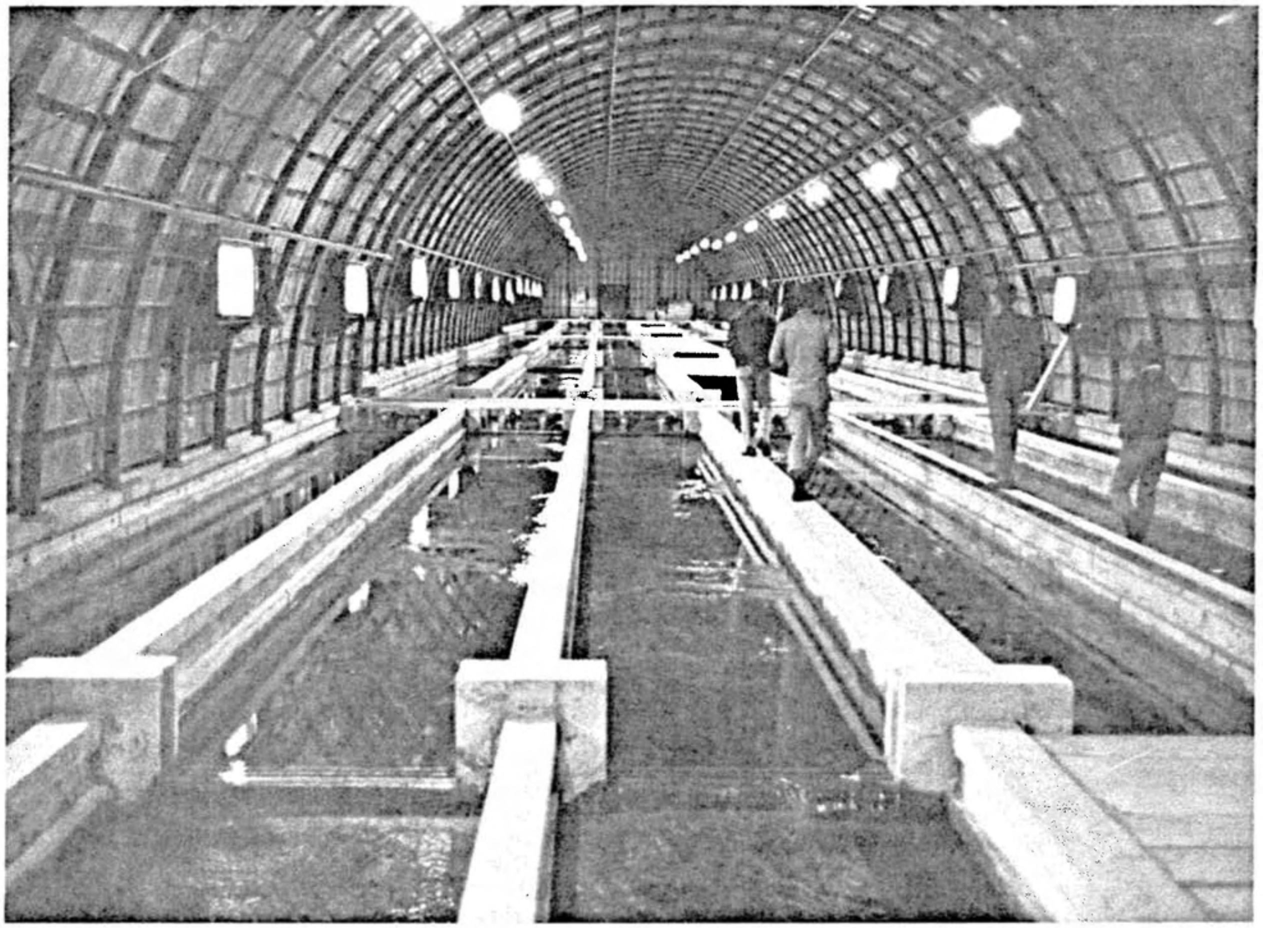

Figure 52.--Interior of the covered alevin-nursery raceways at Yakumoh Hatchery.

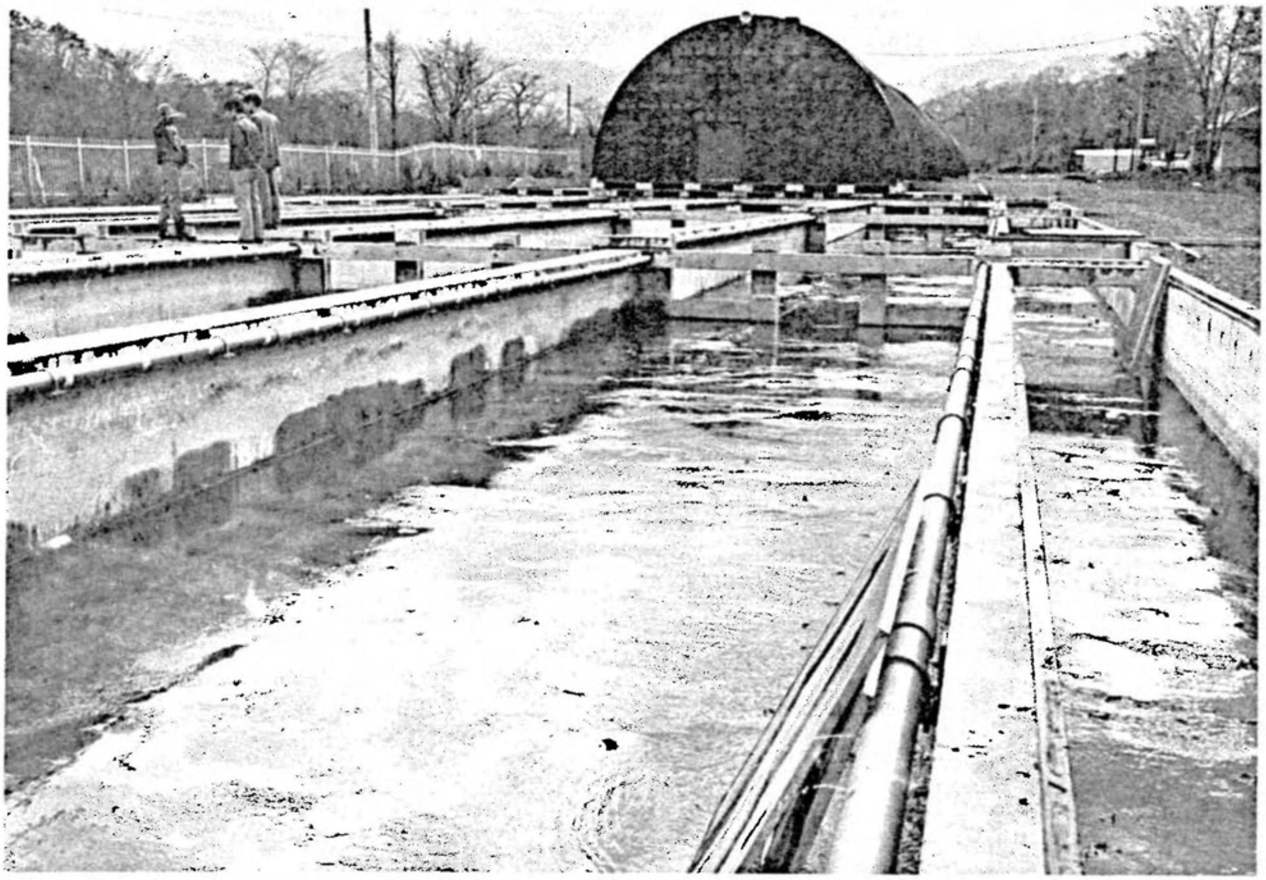

Figure 53.--Feeding raceways below the covered alevin-nursery raceways at Yakumoh Hatchery. Note the upwelling and lateral water jets (the water system is only partly on).

Agency), escorted me on a tour of fisheries facilities in the Kushiro area including his laboratory (Fig. 54), the Nemuro District Headquarters of the Hokkaido Salmon Hatchery, Nakashibetsu Hatchery, and Nijibetsu Hatchery.

Dr. S. Okubo, Director of the Nemuro District Headquarters, listed three factors mainly responsible for the improvement of chum salmon hatchery returns in this area (mean marine survival is 2%): 1) improvements in technology, 2) feeding fry before release, and 3) time of release. Because sea ice forms on the coast of Hokkaido in this area, fry are not released until the ice breaks up and temperature and food abundance increase. Parasites (Ciliata) on the gills of chum salmon fry have caused some trouble in the Kushiro area, but the infestation is controlled with malachite green.

The Nakashibetsu Hatchery may be the largest (75 million eggs) hatchery in Japan (Fig. 55). Located about 50 km upstream from the sea, the hatchery has a springwater source (4.5°-8.0°C). Three full-time employees and 10 seasonal aides operate this facility.

Two types of incubators are used in the Nakashibetsu Hatchery: an improved Atkins[1] type with 120,000 eggs/box and a 30 l/min water flow, and a free style incubator with 500,000 eggs/box and a 50 l/min water flow (Figs. 56 and 57). The covered alevin raceways are lined with gravel (5 cm deep, Fig. 58) and have a water depth of 10 cm and and an alevin density of 15,000/m^2. Water is kept shallow to prevent migration of alevins. As the alevins mature, the water is gradually deepened.

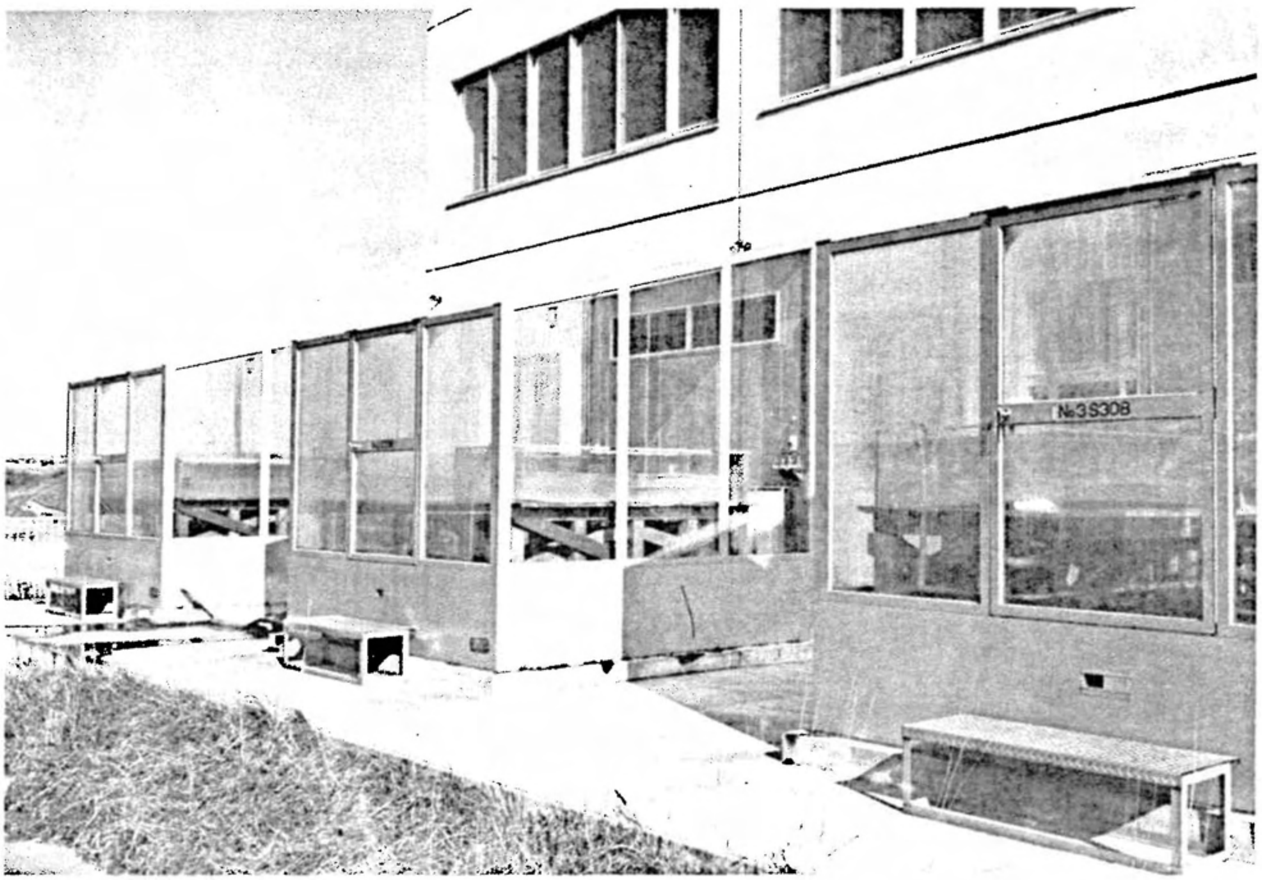

Figure 54.--Greenhouses for experiments with seaweed (Laminaria) at Hokkaido Regional Fisheries Research Laboratory.

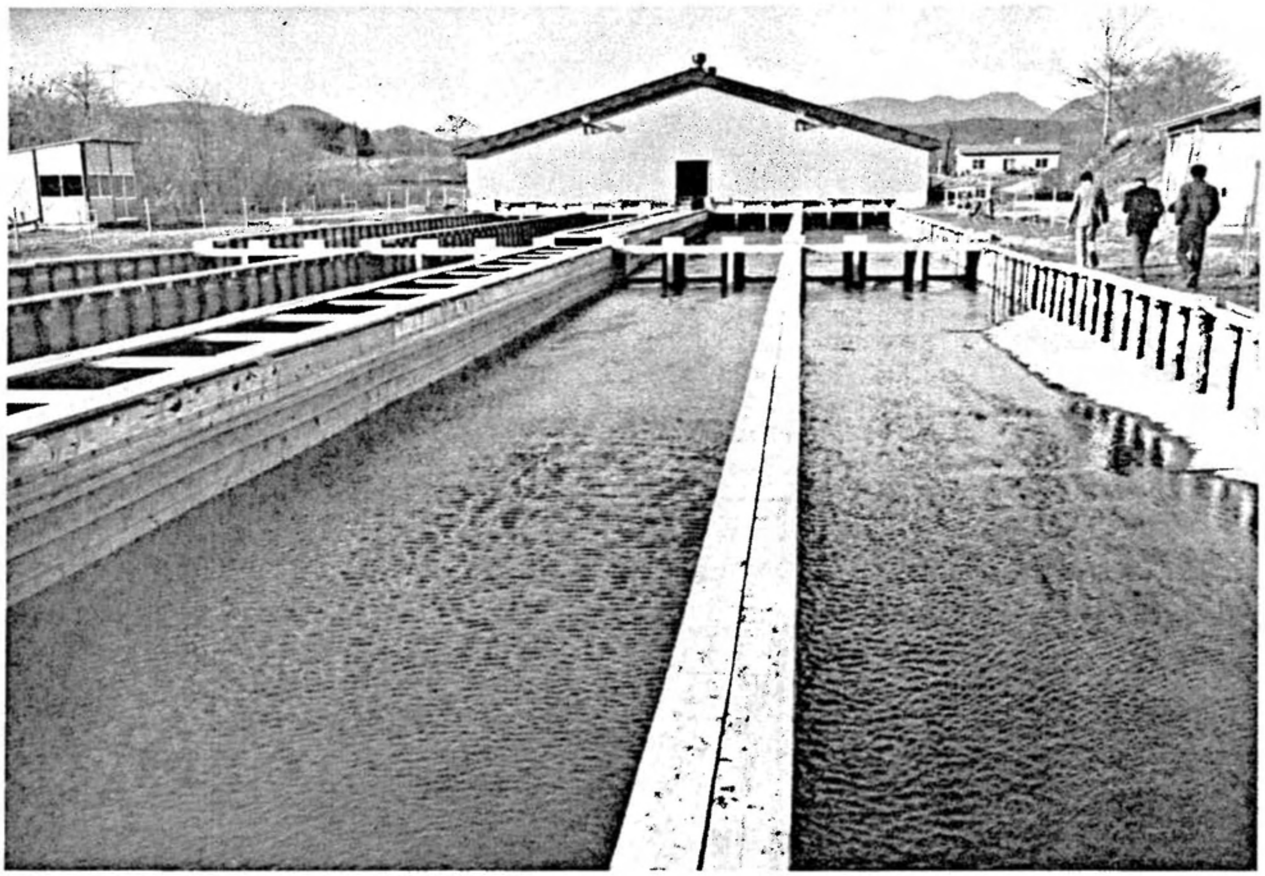

Figure 55.--Feeding ponds and the covered egg- and alevin-incubation facilities at Nakashibetsu Hatchery.

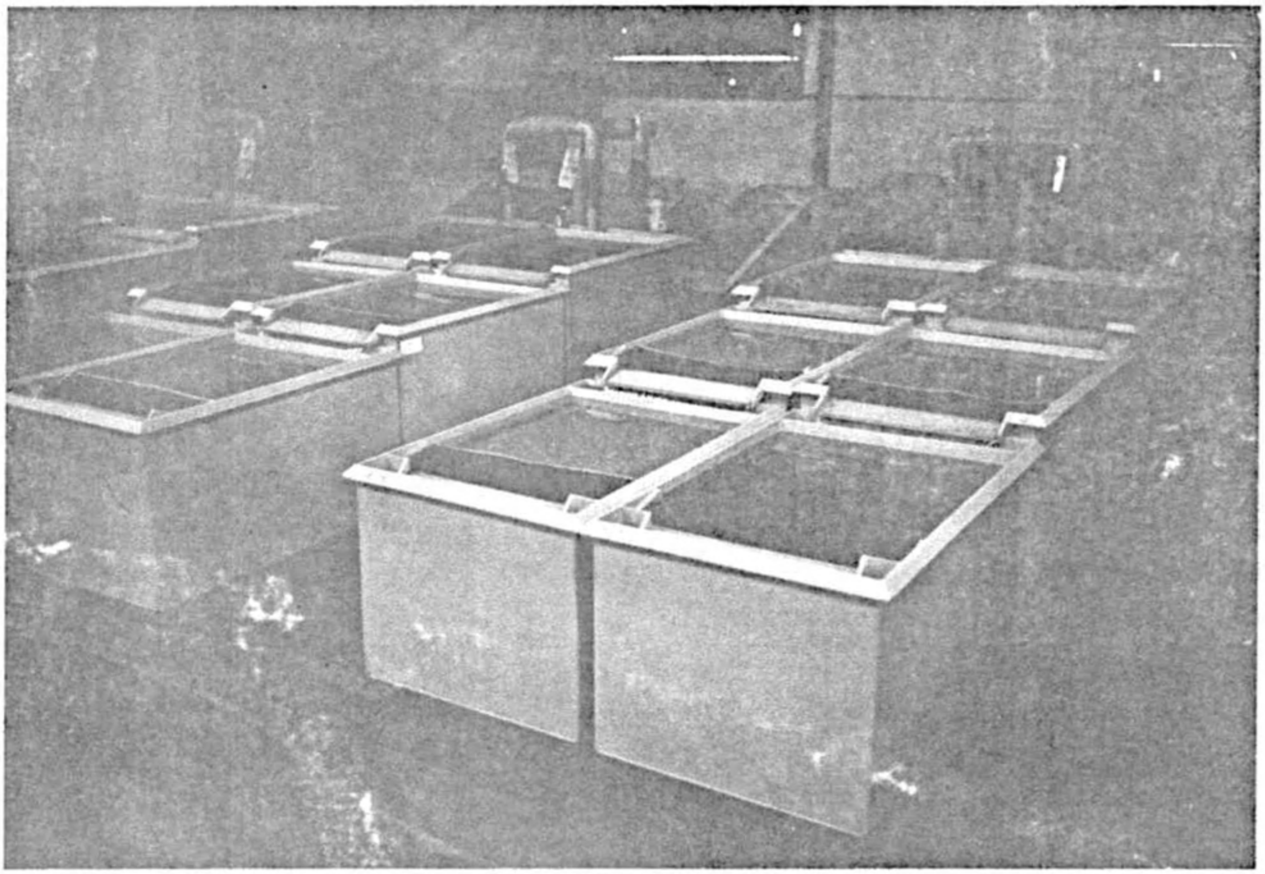

Figure 56.--Free-style incubators with a capacity of 500,000 chum salmon eggs at Nakashibetsu Hatchery.

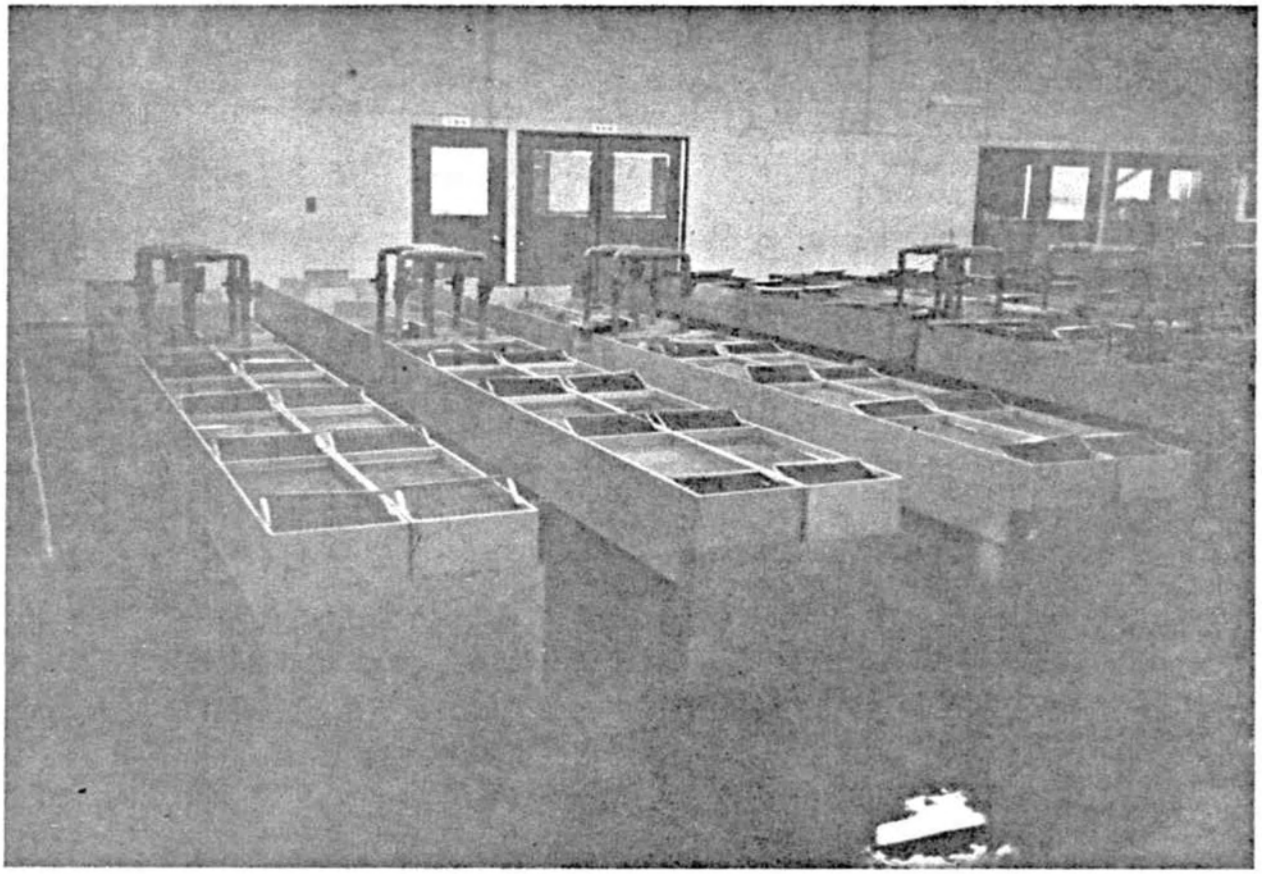

Figure 57.--Improved Atkins incubators with a capacity of 120,000 chum salmon eggs at Nakashibetsu Hatchery.

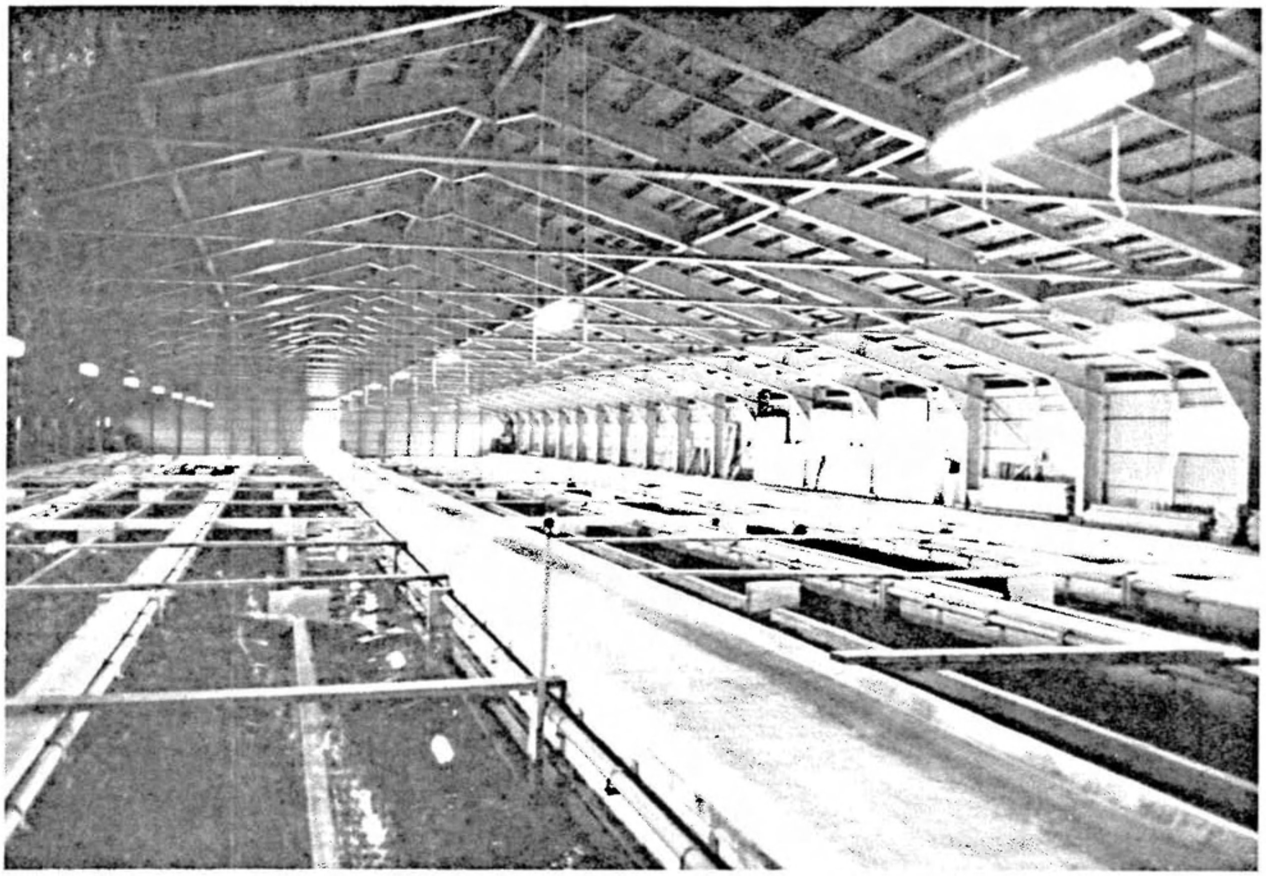

Figure 58.--Interior of the covered, gravel-lined alevin-nursery raceways at Nakashibetsu Hatchery.

Eyed eggs and/or alevins are taken from the incubators in buckets and placed in the alevin raceways. Location of the eggs in the raceway is determined by age of the eggs. Eggs taken the earliest are placed in the downstream areas of the raceways because these eggs will hatch first and the fry will migrate into the feeding raceways first. If these older eggs were placed in the upper end, the emigrating fry would trigger a migration of younger alevins before the alevins were ready to feed.

Fry voluntarily migrate into the open feeding-raceways. The Nakashibetsu Hatchery uses the same 3-way water jets that the Yakumoh Hatchery uses. Total mortality from egg to release at the Nakashibetsu Hatchery is 15%.

The Nijibetsu Hatchery (Figs. 59 and 60) was started in 1890. The water source, a large spring that stays within 1 C° of 9°C year around (Fig. 61), produces 40 metric tons of water per minute. Two to three million pink salmon eggs are incubated in this hatchery in odd years, and new construction will increase capacity to 95 million eggs. Infectious hematopoietic necrosis (IHN) introduced at this facility from a shipment of Alaskan sockeye salmon eggs in 1972 (Fig. 62) destroyed a developing sockeye salmon program, and now the Japanese are trying to develop an anadromous run of sockeye salmon from local kokanee stock. So far, very few anadromous sockeye salmon have returned from these releases, and the returning sockeye salmon have been very small--1.2 kg.

Figure 59.--Incubation facilities at Nijibetsu Hatchery.

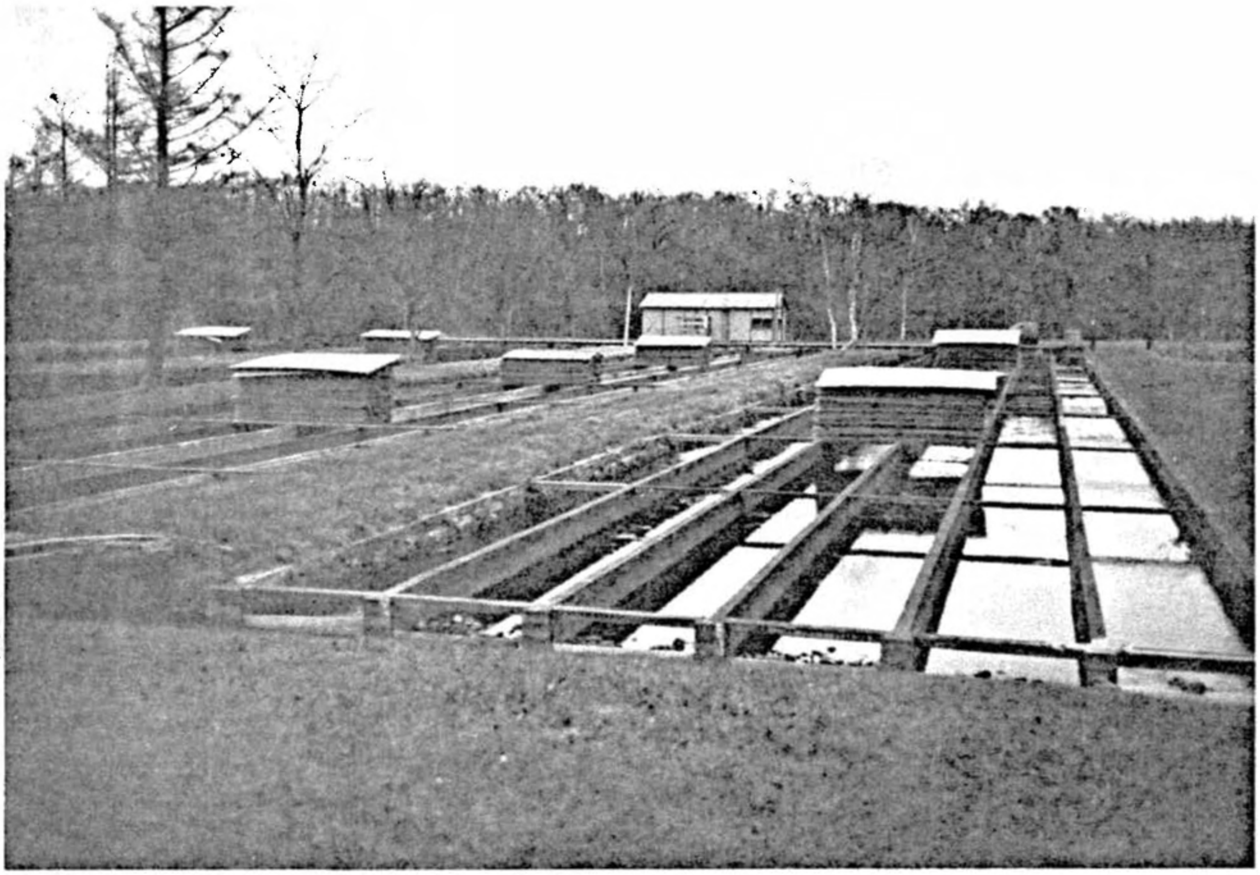

Figure 60.--Gravel-lined alevin-nursery raceways at Nijibetsu Hatchery.

Figure 61.--Source of springwater for Nijibetsu Hatchery.

Figure 62.--The pond at Nijibetsu Hatchery where the IHN outbreak occurred after introduction of Alaska sockeye salmon.

The IHN virus has spread from this hatchery to kokanee stocks in lakes on Hokkaido Island and to rainbow trout in lakes on Honshu Island. In 1977, the IHN virus was reported in cherry salmon on Hokkaido Island. Chum salmon are suspected to be potential carriers of the virus. Chum salmon, pink salmon, and coho salmon are not known to be susceptible to the disease.

SUMMARY

The economic philosophy and realities in the USSR and Japan are so different that some comparisons of their salmon culture and research methods are meaningless. Nevertheless, both countries have the same long-term goal--to increase their returns of salmon. How they achieve this goal is of interest to us because our long-term goal is essentially the same.

One of these questionable comparisons concerns the labor used to run a hatchery. In the USSR at the Kalinin Hatchery, 46 full-time and 20 temporary employees operate a facility with a capacity of about 100 million eggs. In Japan at the Nakashibetsu Hatchery on Hokkaido Island, 3 full-time and 10 temporary employees operate a facility with a capacity of 75 million eggs.

Both Soviet and Japanese hatcheries primarily produce pink salmon and chum salmon. In the USSR, 70% of the hatchery capacity is devoted to pink salmon and 30% to chum salmon, whereas in Japan, most of the hatchery capacity is devoted to chum salmon.

The USSR "inherited" its hatchery system on Sakhalin Island from Japan about 30 years ago; therefore, there are many similarities in basic procedures. Both countries use alevin nursery raceways that are cement and gravel-lined. These raceways are placed side by side under one roof. In the USSR, alevins distribute themselves on the gravel after hatching from stacked tray incubators placed directly on the gravel. In Japan, eyed eggs that are raised in separate incubators are carried in buckets to the nursery raceways and are distributed on the gravel.

In Soviet hatcheries, density of chum salmon alevins on the gravel varies between 25,000/m^2 and 30,000/m^2, and the density of pink salmon alevins varies between 30,000/m^2 and 42,000/m^2. In the Japanese hatcheries I visited, density of chum salmon alevins on the gravel was about 15,000 alevins/m^2 or about 23,000 alevins/m^2 if additional trays were suspended above the bottom.

In chum salmon hatcheries, water in the alevin nursery raceways flows into concrete feeding raceways which are usually gravel-lined. Some of the Japanese feeding raceways are bare concrete with upwelling, lateral, and overhead jets of water. Both countries feed chum salmon fry for 3 months (any one fry would be fed for one month) and the fry weigh 1±0.2 g when they are released. The Soviets release fed fry during the peak of the wild fry migration or when the river and estuary temperatures are equal and above 3°C. Fed fry leave most Japanese facilities on their own volition and food production, temperature, and shore ice conditions are monitored in the estuaries.

Pink salmon hatcheries in the USSR and Japan do not have feeding raceways because the fry are not fed before they go to sea.

In chum salmon hatcheries in both USSR and Japan, springwater is considered an essential ingredient for success. In pink salmon hatcheries, river water and sometimes springwater is used.

Both countries are experimenting with short-term rearing in sea pens of chum salmon, cherry salmon, and coho salmon. The Japanese have more experience with net-pen culture than the Soviets because the Japanese have been doing it longer (since 1973).

In spite of the similarities between salmon culture activities in USSR and Japan, the overall philosophy of pink salmon and chum salmon production in the two countries is quite different. The Japanese allow very little natural spawning. They block off the rivers with bamboo weirs and capture all the chum salmon and pink salmon. The eggs are used in hatcheries and in caviar. The reasons the Japanese do not allow natural spawning are all related primarly to people problems. First, many of the rivers were, and many still are, polluted, but perhaps more important is the high density of people on the islands and the probability that naturally spawning fish on shallow riffles would be poached. A chum salmon is a prized item for table fare in Japan.

On the other hand, the Soviet Far East is not densely populated, and they depend on natural spawning for 90% of their pink salmon and chum salmon production. Even on rivers where hatcheries are located, natural spawning is encouraged and managed.

If a large return of salmon to a Japanese hatchery results in fertilized eggs that are surplus to the incubation capacity of the hatchery, these excess eggs are given to nearby hatcheries that have space for them.

In the USSR, most fish that are surplus to the needs of the hatchery spawn naturally in the river. The Soviets have transplanted eggs from one hatchery to another, but recently they have transplanted fewer eggs based on advice from their scientists dealing in population genetics.

The advanced technology and instrumentation readily available to Japanese scientists is impressive. Each of the three Japan Fisheries Agency's Regional Fisheries Research Laboratories that I visited had a scanning electron microscope and at least one electron microscope. Sophisticated light microscopes, photomicrography units, calculators, and computer equipment were also abundant. Facilities at the three Japanese universities that I visited were equally well equipped with the latest technology.

The Soviet TINRO facility at Yuzhno-Sakhalinsk seemed spartan compared to Japanese facilities. The microscopes at TINRO were functional but not sophisticated, and calculators and computer equipment were noticeably absent. Computer facilities and specialized laboratory facilities are available at TINRO headquarters and the Far East Service Center (USSR Academy of Sciences), both at Vladivostok. In spite of this noticeable difference in readily available technology, Soviet fishery scientists are very competent, broadly educated, and well-versed in the fishery literature of other nations. They were also very open and eager to exchange information.

Hopefully, the world political situation will allow more international meetings like the Conference on the Biology of Pacific Salmon. Fishery resources would surely benefit.

FOOTNOTE

[1] Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Appendix Table 1.

LIST OF PARTICIPANTS

International Conference on Biology of Pacific Salmon

Yuzhno-Sakhalinsk, 3-13 October 1978

Participants from USSR

1. Ministry of Fisheries of the USSR

   (Moscow, Rozhdestvenski bulvar, 12)

   1. Nikiforov, D. G.
   2. Verbitskaya, I. N.
   3. Smetannikova, T. I.

2. All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO)

   (Moscow, V. Krasnoselskaya, 17)

   4. Moiseev, P. A.
   5. Aronovich, T. M.
   6. Markevich, N. B.
   7. Kazarnovsky, M. Ya.

3. Pacific Research Institute of Marine Fisheries and Oceanography (TINRO)

   (Vladivostok, Shevchenko str., 4)

   8. Konovalov, S. M.
   9. Pushkaryova, N. F.
   10. Bushuev, V. P.
   11. Potievsky, E. G.

12. Boyarkina, L. G.
13. Didenko, A. P.
14. Tumanov, V. P.

4. Kamchatka Branch of Pacific Research Institute of Marine Fisheries and Oceanography (KoTINRO)
   (Petropavlovsk-Kamchatski, Naberejnaya str., 18)

15. Birman, I. B.
16. Lagunov, I. I.
17. Kurenkov, I. I.
18. Vronsky, B. B.
19. Bugaev, V. F.
20. Nikolaev, A. S.
21. Nikolaeva, E. T.
22. Selifonov, M. M.
23. Grachev, L. E.
24. Kurenkov, S. I.
25. Basov, Yu. S.
26. Chebanov, N. A.

5. Magadan Branch of Pacific Research Institute of Marine Fisheries and Oceanography (MoTINRO)
   (Magadan, Nagaevskaya str., 51)

27. Kostarev, V. L.
28. Semenov, K. I.

6. Sakhalin Branch of Pacific Research Institute of Marine Fisheries and oceanography (SakhTINRO)

(Yuzhno-Sakhalinsk, Karl Marks street, 51)

29. Girenko, V. N.
30. Abramov, G. L.
31. Zhulkov, A. I.
32. Shershnev, A. P.
33. Efanov, V. N.
34. Horevin, L. D.
35. Chupahin, V. M.
36. Ruhlov, F. N.
37. Kovtun, A. A.
38. Ivanov, N. M.
39. Sabiton, E. N.
40. Pushnikova, G. M.
41. Safronov, S. I.
42. Fedotova, N. A.
43. Zverkova, _. _.
44. Kochnev, Yu. P.
45. Kochneva, Z. P.
46. Vyalova, G. P.
47. Tabunkova, V. D.
48. Okunev, L. E.
49. Shaev, Yu.
50. Sorochan, V. F.
51. Kaev, A. M.

52. Deryabina, T. P.
53. Alekhovich, A.
54. Kolganova, T. I.
55. Balkovskaya, A. A.
56. Horevin, L. D.
57. Horevina, N. B.
58. Rudnev, B. A.
59. Ardavichus, A. I.
60. Kaeva, V. E.

7. Amur Branch of Pacific Research Institute of Marine Fisheries and Oceanography (AoTINRO)

   (Khabarovsk, Volochayevskaya str., 76)

   61. Rosly, Yu. S.

8. Far East Zonal Ichthyopathological Inspection of Ministry of Fishing of the USSR (DZII)

   (Yuzhno-Sakhalinsk, Karl Marks str., 51)

   62. Zolotareva, I. M.
   63. Kulyapin, E. V.
   64. Tsoi, N. N.
   65. Trunin, V. Yu.
   66. Zaborina, O.
   67. Kulagin, Ye. V.

9. Moscow State University (Moscow, Leninskie gori)

   The Department of Biology.

   68. Smirnov, A. I.

10. The Institute of General Genetics of the USSR Academy of Science

(Moscow, Profsoyuznaya str., & 7)

69. Altukhov, Yu. P.

70. Salmenkova, E. A.

11. VNIIPRKh

Moscovskaya oblast, Dmitrovskiy rayon, P/O Rybnoye

71. Kanidyev, A. N.

12. ZIN (Leningrad)

72. Klukanov, V. A.

73. Dorofeeva, Ye. A.

13. TsNIITEIRKh

(Moscow, Arkhipova str., 4/2)

74. Shestakova, I. G.

14. The Institute of Marine Biology of the Far East Science Center

(Vladivostok, 100-years of Vladivostok, str. 159)

75. Maksimovich, A. A.

76. Kartavtsev, Yu. F.

77. Blohina, T. B.

78. Ostrovsky, V. I.

79. Romanov, N. S.

15. The Institute of Biology and Soil Studies

(Vladivostok, 100-years of Vladivostok street, 159)

80. Semenichenko, A. Yu.

16. Glavrybvod

(Moscow, V. Krasnoselskaya str. 17)

81. Menshikov, A. P.

17. Amurrybvod

(Khabarovsk, Amurskij bul'var 41)

82. Kalinin, B. K.

18. Kamchatrybprom

(Petropavlovsk-Kamchatskij)

83. Inigin, V. E.

19. Okhotskrybvod

(Okhotsk)

84. Pyn'ko, A. G.

20. Primorrybprom

(Vladivostok)

85. Zarubova, A. M.

86. Antipina, T. V.

21. Sakhalinrybvod

(Yuzhno-Sakhalinsk, Akademicheskaya str., 29)

87. Sanin, N. A.

88. Lubaeva, O. S.

89. Larionov, Yu. V.

90. Tabakov, R. M.

91. Filippova, G. V.

92. Sokolova, L. V.

93. Kuznetsova, V. D.

94. Polozova, L. K.

95. Grishin, A. F.

96. Boeva, N. V.

22. Sakhrybprom

(Yuzhno-Sakhalinsk, Kommunisticheskiy prospect, 76)

97. Drozdov, Ye. P.

98. Noskov, A. A.

99. Biletskaya, V. I.

100. Moroz, I. L.

101. Gololimskiy, Yu. L.

102. Lebedev, V. I.

103. Solodovnik, P. P.

104. Sushentsov, V. N.

105. Grigoryev, N. V.

106. Nepomnyachaya, Z. G.

107. Romanov, A. V.

23. Sakhrybakkolhozsoyuz

(Yuzhno-Sakhalinsk, Karl Marks str., 51)

108. Tep, A. Ya.

109. Slaboy, I. S.

110. Kolipura, Yu. G.

111. Furiev, G. N.

112. Khoruzhik, Ye. L.

113. Magdeburov, I. F.

114. Kirpicheva, L. N.

24. Hatchery of Sakhalin region

115. Mitrofanenko, L. A.

116. Biykin, A. S.

117. Dentukh, B. I.

118. Btstrova, L. Ya.

119. Petrova, G. A.

120. Kasynsky, G. P.

25. Amurrybprom

(Khabarovsk)

121. Kolyuzhin, Yu. V.

26. Kamchatrybprom

(Petropavlovsk-Kamchatsky)

122. Druzhinin, V. P.

27. Daltechrybprom

(Vladivostok)

123. Molotkov, V. T.

28. Dalryba

(Vladivostok)

124. Kushker, N. I.

125. Kovtun, Yu. F.

29. Sechenov's Institute of physiology
    (Leningrad)
    - 126. Bondareva, V. M.
    - 127. Rusakov, Yu. I.

30. The "Komsomolskaya Pravda" Correspondent
    - 128. Stroev, A. F.

31. T V Correspondent
    - 129. Vakhrushev, R. P.

Participants from U.S.A.

1. Alaska Department of Fish and Game
   (Anchorage, Alaska)
   - 1. Krasnowski, Paul V.
     Research Project Leader

2. National Marine Fisheries Service, Auke Bay Laboratory
   (Auke Bay, Alaska 99821)
   - 2. Helle, John H.
     Fishery Research Biologist

3. Oregon Aqua Foods, Inc.
   (Springfield Road, Oregon)
   - 3. McNeil, William J.
     General Manager

4. Oregon State University, Department of Microbiology
   (Corvallis, Oregon)
   4. Fryer, John L.
      Professor and Chairman

5. Tavolek
   (Redmond, Washington 98052)
   5. Amend, Donald F.
      Director of Research

6. US-USSR Marine Resources Co.
   (Nakhodka 24, Primorski krai, USSR)
   6. Stevens, Michael

7. University of Alaska
   (Seattle, Washington)
   7. Atkinson, C. E.
      Adjunct Professor

8. University of Alaska, Institute of Marine Science
   (Fairbanks, Alaska)
   8. Nishiyama, Tsuneo
      Assistant Professor

9. University of Washington, College of Fisheries
   (Seattle, Washington)
   9. Donaldson, Lauren R.
      Professor Emeritus

Participants from Canada

1. Environment Canada, Fisheries Service

   (Vancouver, British Columbia)

   1. Sandercock, F. K.

      Chief, Enhancement Operations

      Salmonid Enhancement Program

   2. Zyblut, E. R.

      Senior Management Biologist

      North and Central Coast Division

2. Fisheries and Marine Service

   Freshwater and Anadromous Fisheries Management

   (St. John's, Newfoundland)

   3. Pippy, John H. C.

      Program Head

   Pacific Biological Station

   (Nanaimo, British Columbia)

   4. Bell, Gordon R.

      Microbiologist

      Head, Fish Health Program

Participants from Japan

1. Tokai University

   (Shizuoka, Japan)

   Faculty of Marine Science and Technology

   Department of Fisheries Science

1. Ichihara, Tadayoshi

   Professor

Institute of Oceanic Research and Development

2. Iwashita, Mitsuo

   Director

SECRETARIAT

1.	Nazarova, L. G.	VNIRO
2.	Ryazantsev, Yu. B.	VNIRO
3.	Laskov, S. N.	TsNIITEIRKh
4.	Tsoy, Chen Kho	TsNIITEIRKh
5.	Kuvshinnikova, N. I.	VNIRO
6.	Yakovitskaya, G. V.	VNIRO
7.	Tumanov, V. P.	TINRO
8.	Yun, N. G.	TINRO
9.	Tolokneva, O. V.	TINRO
10.	Stroikov, Yu. P.	TINRO
11.	Safina, G. P.	TINRO
12.	Shchyrov, V. A.	TINRO
13.	Frolov, B. A.	TINRO
14.	Muratov, V. V.	TINRO

Appendix Table 2.

LIST OF REPORTS PRESENTED AT THE
INTERNATIONAL CONFERENCE ON
THE BIOLOGY OF THE PACIFIC SALMON

1.	P. A. Moiseev	The main trends of investigations of Pacific salmon.
2.	I. B. Birman	Long-period fluctuations of salmon abundance and the determining factors.
3.	S. M. Konovalov	Main problems of Pacific salmon population biology.
4.	T. Nishiyama	Two main factors of Pacific salmon in oceanic life stage: water temperature and food.
5.	F. V. Krogius	Growth of young sockeye and fluctuations of primary production in the lake Dalneye.
6.	J. H. Helle	Trends in age and size and early marine growth of some stocks of chum salmon in North America.
7.	T. Ichihara	Behavioral characteristics of adult chum salmon in the coastal Hokkaido as revealed by ultrasonic biotelemetry.
8.	A. A. Maximovich, G. A. Petrova	Radiated diploid gynogenesis in humpback salmon.

9.	E. R. Zyblut	Canada's salmon fisheries on the Pacific coast.
10.	B. B. Vronsky	The state of the Far Eastern salmon stocks.
11.	A. R. Fredin	Trends in North Pacific salmon fisheries.
12.	V. L. Kostarev	Measures to increase the stocks of Asian salmon
13.	N. F. Pushkareva	Natural reproduction and status of stocks of the Primorie pink salmon.
14.	M. M. Selifonov	Immature red salmon: fishing is unreasonable.
15.	T. V. Antipina	Measures for conservation and increasing of salmon stocks in the Primorie waters.
16.	A. P. Shershnev, A. I. Zhulkov	Influence of lumbering of the hydrological regime of spawning rivers and natural reproduction.
17.	Yu. P. Altukhov, G. D. Riabova, A. A. Goncharova, A. Yu. Titova	On factors of stationary distribution of lactate dehydrogenase and phosphoglucomutase allele frequencies in the sockeye population of the lake Azabachye.
18.	E. A. Salmenkova	Biochemical genetics of pink population.
19.	Yu. S. Rosly	Structure of populations of Amur salmon and efficiency of reproduction.
20.	L. E. Grachev	Methods for forecasting salmon runs and reliability of forecasts.

21.	S. Pennoyer, K. Parker	Review of Alaska salmon fisheries.
22.	E. F. Nikolaeva	On differentiation of the Far Eastern chum stocks.
23.	V. N. Efanov, L. D. Kharevin, V. M. Chupakhin	Methods for short-term forecast of the intensity of pink salmon runs.
24.	V. F. Bugaev	Ecology of freshwater period of life and differentiation of sockeye populations in the basin of the Kamchatka river.
25.	N. A. Chebanov	Materials on the assortative crossing and the role of sex ratio during the spawning period of Pacific salmon.
26.	A. S. Nikolaev	Application of photogrammary in ichthyofauna survey of sockeye lakes of Kamchatka.
27.	D. Stokner	Artificial raising of sockeye productivity.
28.	A. I. Smirnov	Salmon Asian object of acclimatization.
29.	M. Iwata	Behavioral notes on the seaward migration of chum salmon fry.
30.	I. I. Kurenkov, S. I. Kurenkov	Red salmon (Oncorhynchus nerka Walb.) in Kamchatka: possibility of the formation of a new stock.
31.	S. I. Kurenkov	Structure of population of kokanee of Kronotskoe lake.

32.	E. A. Dorofeeva, V. A. Klukanov, A. I. Gorshkov	Taxonomy position in relationships of Pacific salmon.
33.	N. S. Romanov	Peculiarities of cranial anatomy of Far East salmon in postembryonic ontogenesis.
34.	P. V. Krasnowski	The use of machine processes of scale analysis for prediction of local stocks.
35.	N. B. Markevich, S. E. Diagilev, V. S. Agapov	Formation of the local populations of salmon on the European part of the USSR (in the area of the southern coast of Kolsky peninsula).
36.	L. R. Donaldson	The Fern lake studies.
37.	A. N. Kanidyev, E. A. Kamynin	Factors of increasing the efficiency of salmon culture.
38.	N. A. Sanin, F. N. Rukhlov	Biotechnique of Pacific salmon.
39.	F. K. Sandercock	Recent expansion in artificial production.
40.	W. J. McNeil	Artificial propagation of salmon in Eastern North Pacific. Status and outlook.
41.	L. R. Donaldson	Accelerating the growth of Pacific salmon with optimum temperatures, diets and stock selection.
42.	F. N. Rukhlov, O. S. Lubaeva	On the efficiency of the Sakhalin pink salmon hatcheries.

43.	Yu. S. Basov	Acceleration of development and growth of coho salmon by means of geothermal waters.
44.	V. P. Bushuev	Intensification of hatchery salmon reproduction.
45.	S. M. Konovalov, V. I. Ostrovsky	Peculiarities of age structure of subisolates of sockeye (Oncorhynchus nerka Walb.) in the first generation.
46.	J. L. Fryer	Infectious diseases of cultured salmonids in the Pacific North West of the USA.
47.	G. R. Bell	The investigation and assessment of infectious diseases of salmon in the Pacific region of Canada.
48.	D. F. Amend	Methods of preventing and controlling infectious diseases of salmonids along the Pacific coast of the USA.
49.	I. M. Zolotareva	Diseases of salmon eggs and juveniles and their control measures at Sakhalin hatcheries.
50.	A. A. Maximovich	Secretion and biological role of hydrocortisone and insulin at the late stages of spawning migration of Pacific salmon.
51.	A. A. Kovtun	Artificial breeding of the Sakhalin autumn chum in terms of its population structure.

52.	E. G. Potievsky	Main trends and tasks of studies of infectious diseases of some mariculture objects in the Soviet Far East.
53.	F. K. Sandercock	The increase of bioproductivity of lakes.
54.	R. Pressey	Improvement of salmon spawning and rearing areas in Washington, Oregon and California.

Figure 1.--Location of major cities in USSR and Japan that were visited on this trip.

Figure 2.--Dr. Peter Moiseev delivering opening address at the Conference on Biology of Pacific Salmons.

Figure 3.--Paul Krasnowski (Alaska Department of Fish and Game) and Soviet translator presenting paper at the Conference on Biology of Pacific Salmons.

Figure 4.--Dr. McNeil, Dr. Kartavtsev, and Dr. Altukhov in a discussion during a break between meetings.

Figure 5.--Dr. Lagunov and Dr. Birman at city square in Yuzhno-Sakhalinsk.

Figure 6.--Mayor of Yuzhno-Sakhalinsk and his staff proposing a toast at a reception for the foreign-conference participants at city hall.

Figure 7.--Goals of the TINRO group at Yuzhno-Sakhalinsk.

Figure 8.--Location of salmon hatcheries on Sakhalin Island. See table 1 for name, species, and egg capacity of the hatcheries.

Hatchery		Hatchery	
1.	Ado-Tymovsky	10.	Taranaysky
2.	Pobedinsky	11.	Vatutinsky
3.	Buyuklovsky	12.	Sokolnikovsky
4.	Pugachovsky	13.	Yasnomorsky
5.	Sokolovsky	14.	Kalinin
6.	Bereznikovsky	15.	Urozhayny
7.	Lesnoe	16.	Aynsky
8.	Okhotsky	17.	Kurilsky
9.	Anivsky	18.	Reydovy

Figure 9.--Entrance to Kalinin Hatchery.

Figure 10.--Trap-weir and gamete-collection facility on the Kalinin River.

Figure 11.--Chum salmon congregating at the trap-weir on the Kalinin River.

Figure 12.--Killing and sorting chum salmon at Kalinin River trap-weir.

Figure 13.--Source of springwater for Kalinin Hatchery. Gravel filter beds are visible in the lower portion of the photograph.

Figure 14.--Gamete-collection facility at Kalinin Hatchery.

Figure 15.--Fertilizing eggs at the gamete-collection facility at Kalinin Hatchery.

Figure 16.--Soviet egg-incubation device. A stack of 10 racks of pink salmon eggs at Lesnoe Hatchery.

Figure 17.--Interior of covered gravel-lined nursery raceways for raising alevins at Kalinin Hatchery.

Figure 18.--A covered alevin-nursery raceway at Kalinin Hatchery. Drs. Moiseev and Altukhov in the background on the left.

Figure 19.--Entrance to a covered alevin-nursery raceway at Kalinin Hatchery. Gravel filter bed lies under the boardwalk.

Figure 20.--Interior of covered gravel-lined alevin-nursery raceways at Kalinin Hatchery.

Figure 21.--Entrance to the feeding raceways from a covered alevin-nursery raceway at Kalinin Hatchery.

Figure 22.--Feeding raceway (looking downstream) at Kalinin Hatchery.

Figure 23.--Experimental feeding ponds at Kalinin Hatchery.

Figure 24.--Headquarters of Lesnoe Hatchery.

Figure 25.--Covered alevin-nursery raceways at Lesnoe Hatchery.

Figure 26.--Interior view of the covered alevin-nursery raceways at Lesnoe Hatchery.

Figure 27.--Outlet of covered alevin-nursery raceways at Lesnoe Hatchery.

Figure 28.--Lesnoe River, a productive pink salmon river.

Figure 29.--Chart in the Sakhrybprom headquarters showing present location of Soviet fishing vessels.

Figure 30.--Preparing brined pink salmon for smoking.

Figure 31.--Pink salmon ready for the smoker.

Figure 32.--Mayor of Yuzhno-Sakhalinsk, Director of Sakhalinrybvod, Soviet translator, and Clint Atkinson (leader of the U.S. participants) at seafood banquet.

Figure 33.--Seafood banquet sponsored by Sakhalinrybvod (Sakhalin Fishing Industry) for foreign participants of the conference at Yuzhno-Sakhalinsk.

Figure 34.--Retail market for fishing products of Sakhrybprom.

Figure 35.--Canned "seaweed" on the shelf at the Sakhrybprom retail store.

Figure 36.--Tuna ready for auction at the Tokyo Fish Market.

Figure 37.--Chum salmon for sale at the Tokyo Fish Market.

Figure 38.--Bamboo poles for suspending nets for seaweed (Laminaria) culture off the ocean bottom, Matsushimi Bay near the Tohoku Regional Fisheries Research Laboratory at Sendai.

Figure 52.--Interior of the covered alevin-nursery raceways at Yakumoh Hatchery.

Figure 53.--Feeding raceways below the covered alevin-nursery raceways at Yakumoh Hatchery. Note the upwelling and lateral water jets (the water system is only partly on).

Figure 54.--Greenhouses for experiments with seaweed at Hokkaido Regional Fisheries Research Laboratory.

Figure 55.--Feeding ponds and the covered egg- and alevin-incubation facilities at Nakashibetsu Hatchery.

Figure 56.--Free-style incubators with a capacity of 500,000 chum salmon eggs at Nakashibetsu Hatchery.

Figure 57.--Improved Atkins incubators with a capacity of 120,000 chum salmon eggs at Nakashibetsu Hatchery.

Figure 58.--Interior of the covered, gravel-lined alevin-nursery raceways at Nakashibetsu Hatchery.

Figure 59.--Incubation facilities at Nijibetsu Hatchery.

Figure 60.--Gravel-lined alevin-nursery raceways at Nijibetsu Hatchery.

Figure 61.--Source of springwater for Nijibetsu Hatchery.

Figure 62.--The pond at Nijibetsu Hatchery where the IHN outbreak occurred after introduction of Alaska sockeye salmon.