Northwest and Alaska Fisheries Center Processed Report*

ARTIFICIAL RECRUITMENT OF PACIFIC SALMON IN JAPAN, REPUBLIC OF KOREA, AND THE SOVIET UNION

A Report of Travel:

June and July 1976

by

William J. McNeil

JANUARY 1977

U.S. DEPARTMENT OF COMMERCE
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National Marine Fisheries Service
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*This report does not constitute a publication and is for information only. All data herein are to be considered provisional.

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A Report of Travel:
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This report summarizes my observations on artificial recruitment of Pacific salmon in the far east during June and July 1976. In the course of my travels I had the pleasure of discussing salmon programs with hatchery managers, fisheries scientists and administrators, educators, government officials, and industry spokesmen. My trip was divided into five segments--(1) northern Honshu Island, (2) Hokkaido Island, (3) Republic of Korea, (4) Tokyo, and (5) eastern U.S.S.R.

I am indebted to many individuals who made my trip possible. I will not list each of them individually here, but the principal organizations that hosted my visits are: (1) Northern Honshu--Iwate Prefecture and Miyako Fisheries Cooperative; (2) Hokkaido--Hokkaido Prefecture, Abashiri City, and Hakodate City; (3) Republic of Korea--Office of Fisheries and Fishing Industry; (4) U.S.S.R.--Ministry of Fisheries and Pacific Scientific Research Institute of Fisheries and Oceanography (TINRO).

Figure 1 shows the areas I visited. My itinerary is outlined below:

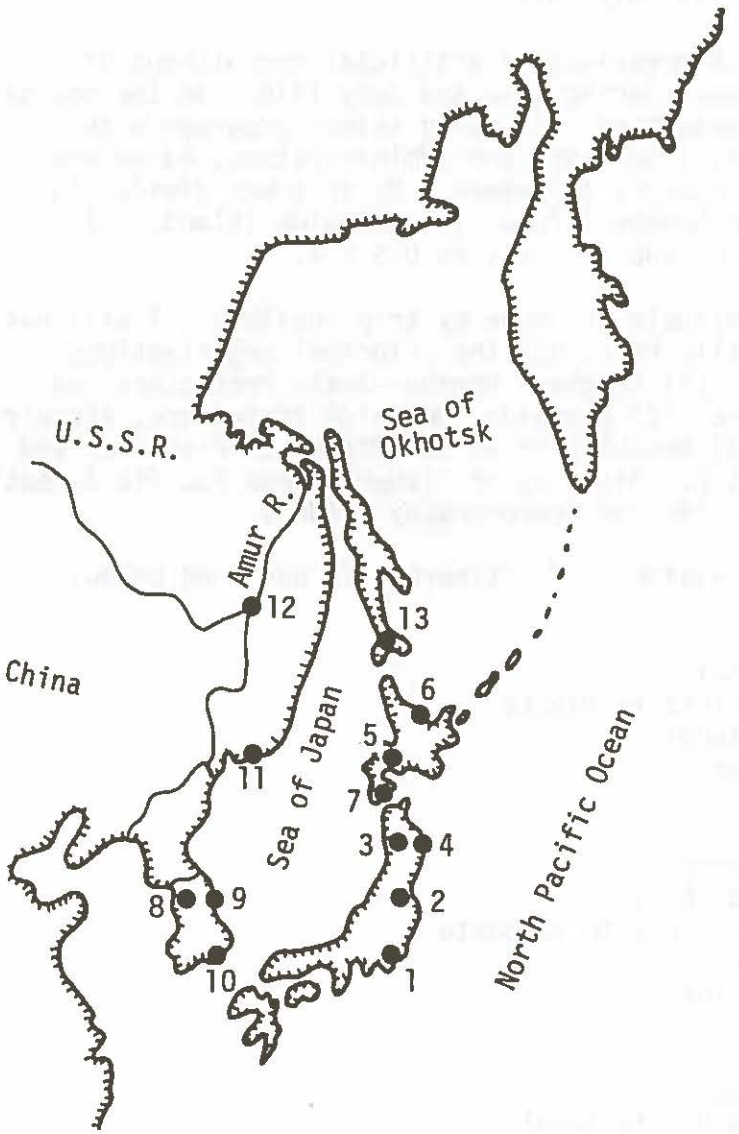
1. Honshu Island:
   - June 3--Tokyo to Sendai
   - June 4--Sendai to Morioka to Miyako
   - June 5--Miyako to Otsuchi
   - June 6--Otsuchi to Tokyo

2. Hokkaido Island:
   - June 7--Tokyo to Sapporo
   - June 8--Sapporo to Abashiri
   - June 9--Abashiri to Chitose to Hakodate
   - June 10--Hakodate area
   - June 11--Hakodate to Tokyo

3. Republic of Korea:
   - June 12--Tokyo to Seoul
   - June 13--Seoul to Samchok to Seoul
   - June 14 - Seoul to Busan
   - June 15 - Busan to Seoul
   - June 16 - Seoul to Tokyo

4. Tokyo (June 17 and 18)

5. U.S.S.R:
   - June 19 & 20 - Yokohama to Nakhodka
   - June 21 - Nakhodka to Khabarovsk
   - June 22 - Khabarovsk to Yuzno-Sakhalinsk



Legend

1. Tokyo-Yokohama
2. Sendai
3. Morioka
4. Miyako
5. Sapporo
6. Abashiri
7. Hakodate
8. Seoul
9. Samchok
10. Busan
11. Nakhodka
12. Khabarovsk
13. Yuzho-Sakhalinsk

Figure 1.--Principal sities and localities visited in the far east.

June 23-28--Sakhalin Island
June 29--Yuzno-Sakhalinsk to Khabarovsk
June 30--Khabarovsk to Nakhodka
July 1-3--Nakhodka
July 4 and 5--Nakhodka to Yokohama

I traveled on official business for National Marine Fisheries Service with my wife, Fran, and Mr. Bob Palmer of the Alaska Governor's Office until June 17. Professor Ryhuei Sato, Tohoku University, traveled with our small group to northern Honshu (June 3-6) and Mr. Wallace Hublou, Oregon Fish and Wildlife Commission, and Mr. Yoshio Katsuyama, Alaska State Office in Tokyo, traveled with us to Hokkaido (June 7-11). I traveled alone in the U.S.S.R., returning to the United States on July 6.

HONSHU

Tokyo (June 3)

Some general comments concerning the Japanese salmon hatchery program were noted in a discussion with Mr. Yoshihide Uchimura, Director General of the Japanese Fishery Agency, before our departure from Tokyo for northern Honshu and Hokkaido.

The Fishery Agency actively supports continued expansion of the Japanese salmon hatchery program, but questions concerning the best means to finance new facilities have not been fully resolved. Furthermore, the more successful chum hatcheries use spring water, and most of the good spring water sources have already been developed for hatchery use.

A joint-venture hatchery project between Japan and the U.S.S.R., to be located on Sakhalin Island, has been approved by higher authorities in Japan and the U.S.S.R. The site is now being selected. If successful, the project could lead to future joint ventures between Japan and the U.S.S.R.

Sendai and Morioka (June 3 and 4)

Dr. R. Sato, Professor of Fisheries at Tohoku University, greeted our party at the Sendai railroad station, and we enjoyed dinner with the Sato family. On the morning of June 4, Professor Sato made arrangements for us to accompany one of his graduate students, Mr. Narusei, to an abalone hatchery on Matsushima Bay. The hatchery produces more than 1 million year-old abalone annually for stocking in Matsushima Bay.

We rejoined Professor Sato later in the morning for a train ride to Morioka, capital of Iwate Prefecture, and we were greeted there by officials of the Prefecture. We learned that the 30 private salmon hatcheries that operate in Iwate Prefecture released approximately 130 million juvenile chum salmon in 1975, but production probably exceeded

this number in 1976. Approximately 1 million adult chum salmon are harvested each autumn in coastal trap nets. Plans are being developed for substantial expansion of private hatcheries in Iwate. Of the 30 existing hatcheries, 15 are operated by fishermen's cooperatives and 15 (mostly smaller hatcheries) by individuals.

The exchange of technical information between Japan and the U.S. was discussed. Our Iwate hosts favored two new initiatives to facilitate exchange--an international technical conference on artificial recruitment of salmon to be held alternately in North America and Asia, and an exchange of hatchery technicians on long-term assignments lasting several months. Anchorage, Alaska was suggested as a location for the first of a series of technical meetings because of its easy access by air from Asia and North America. It is my belief that steps should be taken to implement these excellent suggestions, and I will encourage such initiatives.

Our group, guided by Mr. Mitsugi Sato, Vice-Chief of Fisheries Promotion Section for Iwate, departed Morioka for Miyako in automobiles provided by the Prefecture.

Miyko and Vicinity (June 5)

This eventful day included visits to three chum hatcheries and a salmon experiment station. We were greeted by Mr. Kaichi Miura, Master of Miyako Fisheries Cooperative, at the Tsugarushi Hatchery near Miyako-City. Mr. Miura and Mr. M. Sato, explained how they are able to release 90 million chum fry from a hatchery designed for 30 million eggs. The high level of production is made possible by the availability of mature eggs from October through January. The hatchery process involves three steps--(1) eyeing the eggs in incubators, (2) rearing the alevins in gravel-lined raceways, and (3) rearing the fry in concrete raceways. Each step requires 30-45 days at a constant water temperature of 10°C, thus the approximately 120-day period of spawn taking allows three crops of chum salmon to be processed annually through the hatchery.

The Tsugarushi Hatchery has been modernized in recent years. Gravel-lined raceways have been used for alevins for about 15 years, and the fry have been fed prior to release for the past 5 years. Fry emerge voluntarily from gravel-lined concrete raceways (depth of gravel about 2-3 cm) which are covered with recessed lids to shield alevins from light and protect them from predators. Eyed eggs are suspended in the water column on screen trays. Alevins drop through the trays and repose on the gravel substrate in darkness until most of their yolk is absorbed and the fry emigrate from the raceway.

Fry from each gravel-lined raceway migrate downstream to an open concrete pond where they are fed a prepared diet for about 30 days. Young fish emigrate from the hatchery through a flume which empties into the nearby Tsugarushi River, where returning adults are captured and spawned artificially.

Water is pumped from a shallow aquifer that yields water at a constant 10°C. Electric pumps are used, with backup from a standby diesel generator which starts automatically whenever a power outage continues for 3 minutes.

Several years ago, Mr. Miura conceived a plan for a "salmon festival." Surplus males are released into the river and participants in the festival are allowed to catch the surplus fish by hand. Last year the festival attracted 30,000 participants from as far away as Osaka.

It is only a short distance from the Tsugarushi Hatchery to the Yamada Salmon Experiment Station (Figure 2a). Mr. C. Iioka, Scientist in Charge, took us by boat to floating pens (Figure 2b) where pink and chinook salmon are raised in captivity in salt water. The chinook salmon are from Dr. Lauren Donaldson's hatchery at the University of Washington. These fish are now 3 years of age and weigh up to 3 kg. They will be used as brood stock.

The principal project at the experiment station since 1973 concerns short-term rearing of chum salmon. Juveniles are placed in a large net (see Figure 2a) measuring 55 m in diameter by 10 m deep which is capable of holding up to 5 million fish. The fish are fed for 50 days and released. Growth of penned chum juveniles compares favorably with juveniles in the bay; however, survival to adult has been somewhat lower for penned fish than for unpenned fish. The reasons for this are not readily apparent, and work is continuing to gain further understanding of factors affecting survival and homing.

We next visited the Origasa Hatchery (Figure 3a), which is a short distance from the Yamada Experiment Station. This very modern facility is a scaled-down (10 million fry production) version of the Tsugarushi Hatchery. One full-time employee operates the Origasa Hatchery. Eyed eggs are placed on trays overlying gravel-lined raceways (Figure 3b) as at Tsugarushi and Otsuchi Hatchery which was our last stop for this day.

We were greeted at the Otsuchi Hatchery by the Superintendent, Mr. Maewa. One of the early hatcheries on Honshu, Otsuchi has been modernized in recent years. Capacity of the new addition to Otsuchi (Figure 4a) is 20 million fry. Several million additional fry are also produced in the old hatchery (Figure 4b).

On our visit to hatcheries in Iwate we saw some of the most modern hatchery facilities in the far east. Government and industry leaders in

Figure 2a.--Yamada Salmon Experiment Station. Large net pen drying in foreground is used for feeding chum juveniles.

Figure 2b.--Feeding chinook salmon at Yamada Salmon Experiment Station.

Figure 3a. Origasa hatchery showing hatchery building, gravel-lined raceways for alevins, and feeding ponds (foreground).

Figure 3b.--Egg tray suspended in raceway at Origasa hatchery.

Figure 4a.--New addition to Otsuchi hatchery.

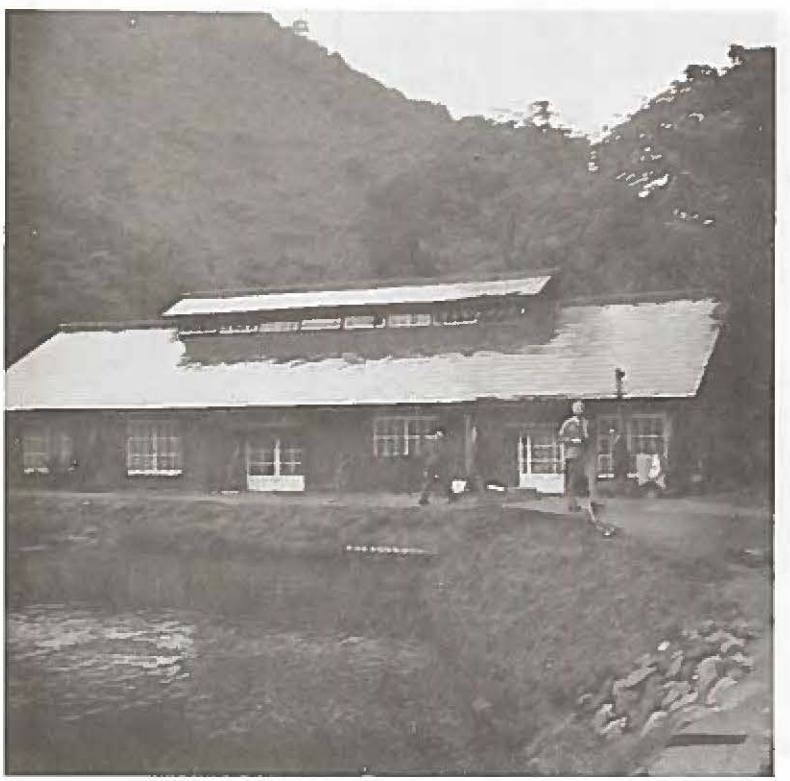


Figure 4b.--Old hatchery building at Otsuchi.

Iwate appear to be committed to the goal of modernizing and enlarging facilities, upgrading skills of technicians, and improving technology.

High capacity upwelling boxes are used for eyeing eggs. The use of screen trays for hatching eggs in gravel-lined raceways was observed only at hatcheries in Iwate, where raceways are seeded at densities ranging from 10,000 to 15,000 alevins per m^2. The raceways measure 1.8 m wide and typically operate with a water depth of 30 cm and a waterflow of 4 to 5 liter/sec.

Return to Tokyo (June 6)

The entire day was devoted to travel by car and train from Otsuchi to Tokyo. Professor Sato left us at Sendai.

HOKKAIDO
Sapporo (June 7)

Our party arrived at Chitose Airport from Tokyo in the morning, where we were greeted by representatives of the Hokkaido Prefecture Fisheries Department. We were driven to the governor's official residence in Sapporo, where we met with The Honorable Naohiro Dogakinai, Governor of Hokkaido, and the Honorable Shiro Shibata, Vice Governor of Hokkaido. These gentlemen are ardent supporters of the salmon hatchery program on Hokkaido and desire to encourage a close working relationship on hatchery technology with the U.S.

The afternoon of June 7 was devoted to discussions of technical aspects of hatchery programs with Dr. Kazuhiko Nishino, Director of Hokkaido Salmon Hatchery, and Mr. Osamu Kuwata, Director of the Hokkaido Prefecture Hatchery Program. The following highlights of conversations are taken from my notes:

1. Hokkaido Salmon Hatchery is the division of the Japanese Fishery Agency which is responsible for all hatchery planning in Japan as well as policy on allocation of eggs to private and public hatcheries. The Hokkaido Salmon Hatchery also allocates the harvest of mature fish and spawn taking in rivers to specified cooperatives and operates 36 hatcheries on Hokkaido Island.

2. Private and prefecture hatcheries are concentrated on west coast of Hokkaido Island. Prefecture hatcheries function primarily as egg distribution facilities in support of private hatcheries. Many of the eggs distributed by prefecture hatcheries originate from federal hatcheries on the east coast of Hokkaido.

3. There was a return of 15 million adult chum salmon to Hokkaido in 1975, representing an overall marine survival of 2.3% of the number of juveniles released from hatcheries.

4. The number of juveniles released from hatcheries has doubled in the past 10 years, and marine survival has also increased.

5. Increased survival of hatchery fish is attributed to improved technology, especially short-term rearing to control time of release.

6. Highest marine survival on Hokkaido Island (up to 5%) occurs in the area around Abashiri, which faces the sea of Okhotsk on the north side of the island. Lowest marine survival (1% or less) occurs along the west coast facing the Sea of Japan. Survival is intermediate along the Pacific shore.

7. On Honshu Island, marine survival of hatchery chum salmon averages about 1% on the Pacific (east) shore and about 0.6% on the Japan Sea (west) shore.

8. There are no official estimates of the number of Japanese hatchery fish intercepted by the Japanese mother ship fishery, but it is conceded that 2 to 3 million could be caught annually.

9. Interception of Honshu fish by Hokkaido fishermen is minimized by differences in timing of migrations, with most Honshu fish passing through Hokkaido waters after termination of fishing on Hokkaido. Marking and tagging studies indicate that no more than 200,000 Honshu chum salmon are caught by Hokkaido fishermen.

10. There is no official forecast of the expected size of the chum harvest on Hokkaido in 1976, but about 12 million fish seems to represent the expectation of knowledgeable observers. The Japanese would like to have a harvest of 18 million chum salmon on Hokkaido in 1980!

11. Release of juvenile chum salmon from Hokkaido hatcheries had been running about 500 million annually in recent years, but production was boosted to 750 million in spring 1976. Hokkaido hatcheries are expected to handle 1,200 million chum eggs by 1980.

12. The Japanese have used gravel-lined raceways for incubating alevins at Hokkaido Hatcheries for about 20 years. They are now experimenting with alevin incubation techniques that use smooth substrates, but feel that gravel is superior.

13. Some Japanese transplantation experiments have suggested only a modest reduction (about 10%) in rate of return of adults when compared to nontransplanted stock. However, under some circumstances transplanted stocks have adapted very slowly, especially when transplanted to rivers which have had no natural fish.

14. The Japanese have not detected genetic change in hatchery stocks from studies of phynotypic characteristics. They have not undertaken studies to evaluate changes in genotypes.

15. The usual spawning procedure at Japanese hatcheries is to mate 5 females with 2 males in a common receptacle. Selection of smallest (youngest) and largest (oldest) maturing fish is avoided.

Abashiri and Vicinity (June 8)

Our party departed Chitose Airport for Membetsu, where we were greeted by prefecture officials. We drove to the Iwaobetsu River (Figure 5a) a small coastal stream east of Abashiri City. The local fishermen's cooperative operates an egg-taking station at the mouth of the river, which flows into the Sea of Okhotsk. A federal hatchery (Figure 5b) with a capacity for 50 million eggs (35 million chum and 15 million pink) adjoins the egg-taking station.

The first adult salmon (a male pink) of the 1976 season entered the holding pond while we were visiting Iwaobetsu. This was the earliest date on record that a fish had entered the Iwaobetsu River, and the Hatchery Superintendent, Mr. K. Kamguchi, was very pleased that our visit coincided with the beginning of his 1976 run of fish.

The Iwaobetsu Hatchery experienced heavy runs of pink and chum salmon in 1975. The gravel-lined raceways are housed to afford protection against cold weather. Feeding ponds have only limited capacity, and juveniles are allowed free access to the sea. Water for the hatchery comes from the river. A heat exchange system makes use of warm spring water to heat river water for hatchery use. Water is delivered to the hatchery by gravity.

From Iwaobetsu, we drove to the Shari River en route to Abashiri City. We stopped briefly at the Shari River catching station, which has a low-profile weir similar in design to the one on the Iwaobetsu River (Figure 5). These weirs are selfcleaning and relatively free of maintenance. Adult masu salmon were being collected at the Shari catching station. Pink and chum salmon also migrate into the Shari River. Approximately 75 million eggs (mostly chum) are spawned annually at the Shari catching station, of which 50 million are incubated at the federal Shari Hatchery and 25 million are shipped elsewhere. In 1975, eggs from Shari River chum salmon were shipped to Washington State.

We proceeded upriver several km from the Shari catching station to the Shari River Hatchery, which handled 90 million eggs in 1975. Approximately 40 million of these were eyed and shipped to other hatcheries.

The Shari River Hatchery has an excellent supply of 8-10°C spring water. The major factor limiting expansion of the hatchery is lack of level ground.

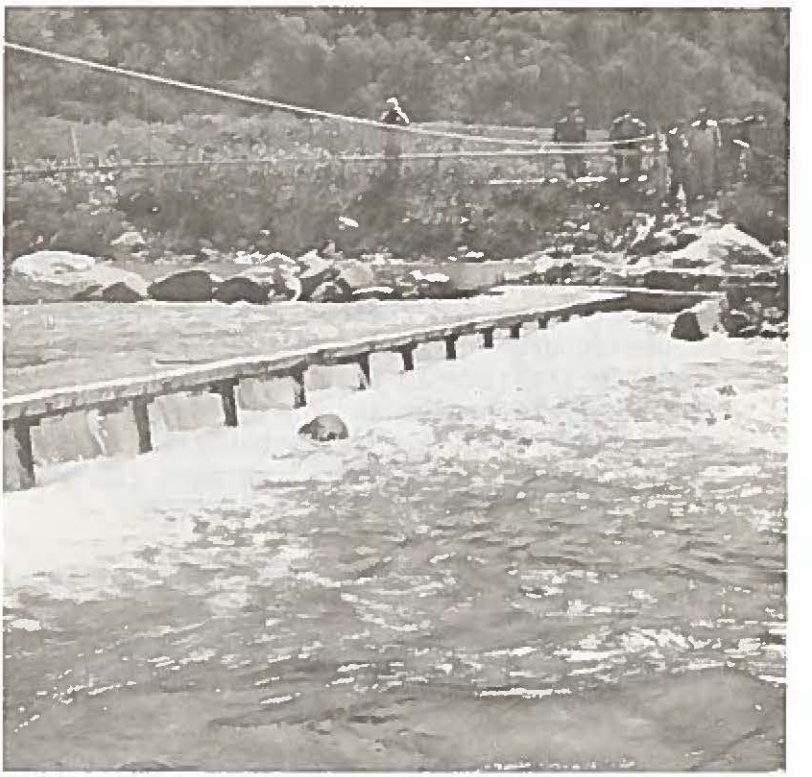


Figure 5a.--Weir on Iwaobetsu River. Salmon enter flume on right bank.

Figure 5b.--Main entrance to Iwaobetsu hatchery.

Gravel-lined raceways are stocked with 15,000 chum alevins per m^2 at the Shari Hatchery. Depth of gravel is 10 cm, which is deeper than we had seen previously. Alevins are transferred manually from egg incubators to the gravel-lined raceways. The raceways are out-of-doors and are covered with boards to shield alevins from light and protect them from predators. Feeding ponds downstream from the raceways are 35-40 cm deep and have gravel bottoms.

Our final visit on June 8 was the Abashiri Hatchery, which is located in the city. This hatchery has a much different design than others that I visited during my trip to the far east. Incubators are housed in a two-story building, which is supplied with city water. Only vertical tray incubators, similar to Heath incubators, are used. Chum eggs are seeded at 10,000 eggs per tray in 10-tray tiers. Total egg capacity of the hatchery is 20 million. Fry are held in trays until they complete absorption of their yolk. They are then transferred to outside tanks, held for 3 days, and then trucked to nearby Lake Abashiri and released.

Excellent returns have been experienced at Lake Abashiri. Runs of 70,000 adult chum salmon are typical. Last year 150,000 adults were handled at the Lake Abashiri Weir. We learned that a second federal hatchery, located on a small tributary stream to Lake Abashiri, also releases chum fry into the lake. Time was too limited for us to visit this second hatchery, but photos showed that it used gravel-lined raceways for alevins. Its capacity was said to be 10 million eggs. There apparently has been no evaluation of the relative contributions of the two hatcheries to the runs returning to Lake Abashiri.

Chitose and Vicinity (June 9)

We returned by air to Chitose in the morning of June 9 and visited the mayor's office before driving to the Chitose Hatchery. Mr. Eiichi Sakano, Director of the federal Chitose Hatchery, provided a detailed explanation of hatchery techniques at Chitose.

The Chitose Hatchery is supplied with 8°C spring water and has a capacity for 30 million eggs. A variety of incubation devices are used, including tray incubators of the type seen at Abashiri. However, at Chitose, they rely primarily upon large boxes with upwelling flow through densely packed eggs (up to 550,000 chum eggs per box). Eyed eggs are transplanted to gravel-lined raceways by scattering them on the gravel surface.

Gravel is up to 5 cm diameter and forms a single layer. Eyed eggs are seeded at densities of 12,000 to 13,000 per m^2. Approximately 5 liters/sec of water flows through each 1.8 m wide raceway at a depth of 20 cm. Each raceway is 50 m long and contains about 1.2 million alevins.

I asked if there was evidence of malformed yolks where alevins were held in Abashiri-type vertical tray incubators. The answer was that incidence of malformed yolks was higher in the tray incubators than on gravel but that survival of fry was similar for each procedure.

Eggs for the Chitose Hatchery come mostly from Chitose River stock, but some eggs are imported from the Abashiri region. Returns of transplanted fish are reported to be almost as good as for stock native to the Chitose River.

After emigrating from gravel-lined raceways, fry enter feeding ponds where they are fed hourly by hand in early March. Frequency of feeding is gradually reduced to 4 or 5 times daily in April. Most fingerling chum salmon emigrate from the feeding ponds from early April through May. In practice, the young fish are free to leave the feeding ponds at any time, but they remain voluntarily to feed as long as artificial foods are provided. The usual practice is to stop feeding in mid-April to encourage the fish to emigrate (Figure 6). This is a normal procedure at other federal hatcheries on Hokkaido as well as at Chitose.

Experiments are underway at Chitose to compare marine survival of early and late emigrating chum juveniles. This work was started 3 years ago, and the results have not yet been evaluated. Mr. Sakano believes that improved marine survival will result mostly from improvements in knowledge about feeding and timing the release of juveniles.

Hakodate and Vicinity (June 10)

From Chitose, we traveled by air to Hakodate. While in Hakodate, we discussed operation of government and private hatcheries with Mr. F. Kamo and Mr. K. Horikoshi of the Economic Department of Hakodate City. Eleven hatcheries (eight private, two federal, and one prefectural) operate in the Oshina region around Hakodate. These hatcheries collectively release about 50 million chum juveniles annually, and there is a plan to expand production to 65 million by 1980. Approximately 60% of the fish are presently produced by private hatcheries, and future growth is expected to come mostly in the private sector. Of the eight private hatcheries now in operation, two are showing a profit from sale of carcasses and other sources of income which include assessments collected from commercial fishermen and small government subsidies. Private hatcheries have operated in the Oshina region for only four years, and the six hatcheries which are not yet profitable are expected to become selfsustaining (i.e. show a profit) in the near future.

Eggs are distributed to various public and private hatcheries in the Oshina region in accordance with a plan approved by the Fisheries Agency, which owns all salmon eggs. Of the 50 million chum juveniles presently

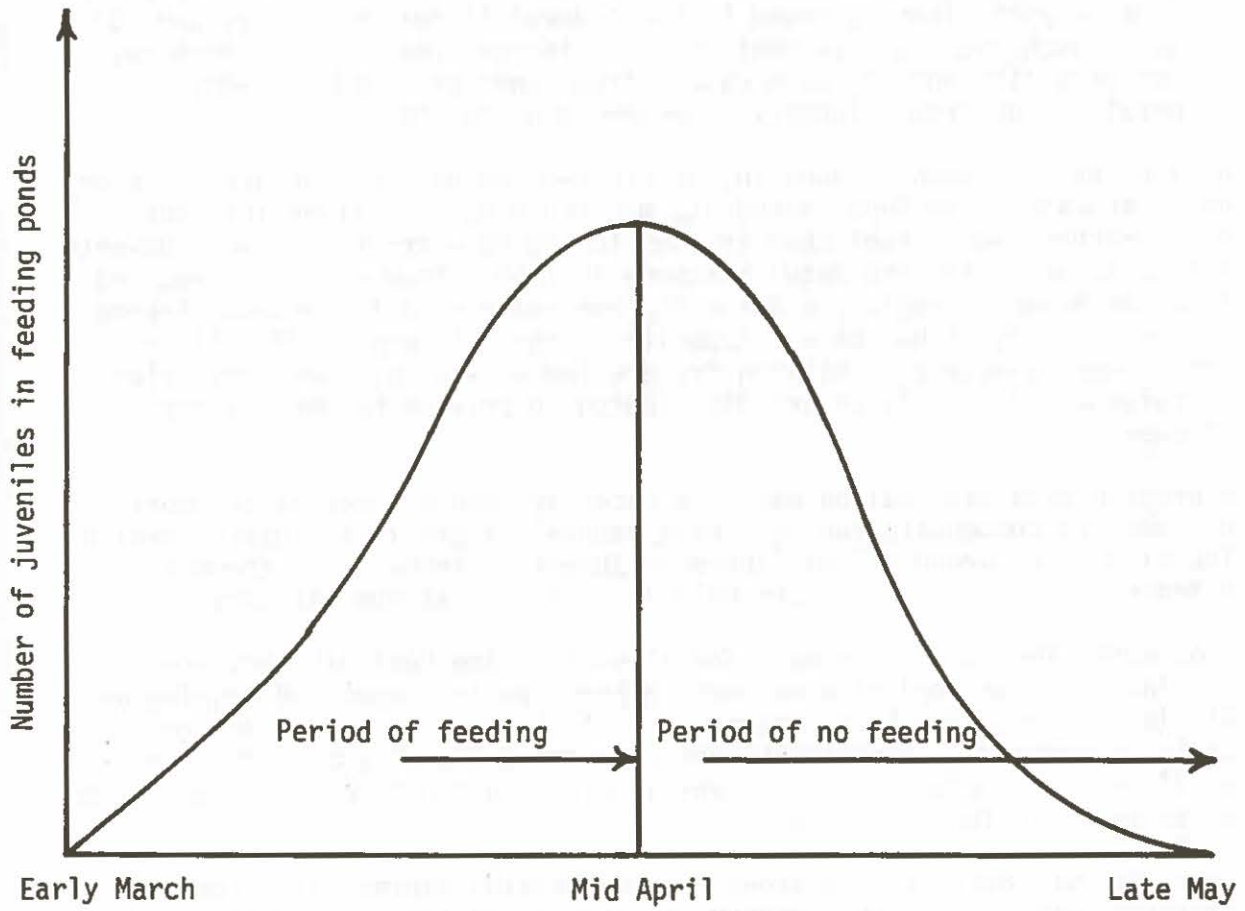


Figure 6.--Period of occupancy of feeding ponds by chum juveniles at Chitose hatchery.

produced, 15 million originate from eggs imported from the Abashiri region and 35 million from local stocks.

To summarize, basic regulations that govern operation of private hatcheries in Japan include the following principal points: (1) all eggs are owned by the federal government; (2) eggs are stocked in private hatcheries in accordance with plans approved by the federal Fisheries Agency; and (3) private hatcheries receive most of their income from sale of carcasses of hatchery fish and, in some cases, from funds provided by fishing cooperatives or from voluntary assessments on catches.

During the afternoon of June 10, we visited the Mori Prefectural Hatchery near Hakodate. The Superintendent, Mr. Uchiyama, explained that the Mori Hatchery was established in 1956 for rainbow trout, but was converted into a salmon (chum and masu) hatchery in 1969. Chum eggs are imported from the Abashiri region, and the fry are released into various streams in the vicinity of Hakodate. Capacity of the hatchery is 20 million eggs. Approximately 10 million fry are fed at the Mori Hatchery prior to release and 10 million are distributed to private hatcheries for release.

A program with masu salmon has only recently been started at the Mori Hatchery to compensate for declining natural stocks in the Oshina region. The plan is to produce 5 million masu juveniles annually at the Mori Hatchery. Masu brood fish are held in captivity at the hatchery.

Procedures for incubating eggs and alevins at the Mori Hatchery are similar to those used at government hatcheries in Oregon and Washington. Alevins are released from incubators as "swim-up" fry into concrete tanks or raceways. Alevins are not provided a gravel substrate--the usual procedure elsewhere in Japan--in order to minimize the accumulation of sediment on the substrate.

From the Mori Hatchery, we drove to the Hokkaido Marine Cultivation Research Laboratory. This modern, well-equipped laboratory was constructed in 1972 for research in mariculture. Dr. R. Yuuki, Laboratory Director, described work at the laboratory and showed us the facility. Research projects are underway on many forms of seaweeds, marine invertebrates, and marine fishes.

Hokkaido University, School of Fisheries (June 11)

Prior to our departure from Hakodate for Tokyo, we enjoyed a brief visit with staff members of the Faculty of Fisheries of Hokkaido University. Projects related to salmon aquaculture are primarily in the areas of disease pathogens and genetic control of sex of salmonid fishes. The faculty hopes to become more involved with work on capacity of coastal waters to support increasing numbers of juvenile salmon released from hatcheries.

REPUBLIC OF KOREA
Seoul (June 12)

I traveled to South Korea in the company of my wife and Mr. Palmer. We were greeted at Tempo Airport near Seoul by representatives of the Korean Office of Fisheries and the fishing industry. We enjoyed a visit with Admiral T. Y. Shin, Director General, and members of his staff during the afternoon. Arrangements were made for us to depart Seoul for the Japan Sea Coast by auto the next morning to visit the Samchok Hatchery.

Samchok Hatchery (June 13)

We left Seoul at an early hour and arrived at the Samchok Hatchery in early afternoon. Samchok Hatchery is located in Kangwon Province. The hatchery stream supplies between 20 and 230 liters/sec and is spring fed. Water temperature warms to 18°C in summer and cools to 7.5°C in winter.

The Samchok Hatchery is located upstream from a water storage reservoir. Water from the reservoir is used for agriculture, and there is little surplus to manage the hatchery stream for anadromous fishes. Salmon from the Samchok Hatchery are released, therefore, in the Oship Chun River near the town of Samchok, a distance of 11 km from the hatchery. The Oship Chun River has a small run of native chum salmon which spawn in October and November.

Because eggs from native chum salmon are in short supply, coho salmon eggs have been shipped from the United States to the Samchok Hatchery in numbers varying between 0.2 and 1.2 million per year since 1970. These transplants have not been successful.

Samchok Hatchery uses technology which was developed for coho and chinook salmon in the United States. Alevins are incubated in open troughs and tanks without a gravel substrate. Juveniles are fed an artificial diet for about 90 days before release.

Busan (June 14 and 15)

As guests of the Office of Fisheries, we visited laboratories and offices of the Fisheries Research and Development Agency and the Korea Fishing Training Center. Busan is the principal base for the Korean high seas fishing fleets which operate throughout the world. The Research and Development Agency sponsors programs in oceanography, resource assessment, aquaculture, gear and vessel equipment, and processing and provide advisory services to the industry. There are six branch offices to the research and development Agency in addition to headquarters in Busan.

The Korea Fishing Training Center works in close cooperation with the United Nations. The curriculum is divided into four major courses of study: (1) deep sea; (2) coastal; (3) ship-jack; and (4) radio. Trainees from 22 countries have attended courses taught at the center.

Before leaving Busan, we visited a processing plant operated by the Korea Wonyang Fisheries Company, Ltd. Quality of fishery products from this plant is very high. Much of the production is distributed within the United States.

TOKYO
(June 16-19)

We returned to Tokyo on June 16. My wife and Mr. Palmer returned to the United States on June 17. I completed arrangements on June 17 through the Soviet Embassy to visit the U.S.S.R. On June 18, I accompanied Mr. Yoshio Katsuyama, Director of Alaska State Office in Tokyo, to the Japan Salmon Resource Preservation Association (SRPA). Our discussion of Japanese hatchery programs with Mr. Y. Aoki and Mr. K. Arai of the SRPA and Mr. D. Misawa, Director of Federation of Japan Salmon Fisheries Cooperative Associations, confirmed many of my observations and conclusions from my recent visits to northern Honshu and Hokkaido Islands.

The SRPA serves as a "bridge" between government and private hatcheries. There are approximately 100 private hatcheries on Honshu and 53 on Hokkaido. There are also 36 federal and 3 prefecture hatcheries on Hokkaido. Thus, there are 182 salmon hatcheries in Japan.

The SRPA planning is based on the assumption that total egg capacity of Japanese salmon hatcheries will almost double above present levels and reach 1.8 billion (1.2 billion for Hokkaido plus D.6 billion for Honshu) by the early 1980's. However, these figures have not yet been accepted by the Fisheries Agency. Association spokesmen were of the opinion that future expansion of hatchery production would be more rapid on the private than the public sector. The goal of an expanded hatchery program is to increase the coastal harvest of salmon to an average of 20 million adults annually by the mid-1980's. The current goal, which was exceeded by 50% in 1975, is to produce a coastal harvest of 10 million salmon annually. Based on personal observations, I believe that the Japanese can achieve a goal of 1.8 billion eggs for artificial recruitment. An eventual harvest of 20 million adults could be affected by the capacity of marine waters to grow salmon, but there are no strong indications that the Japanese have approached an upper limit to the carrying capacity of marine waters. Returning runs have continued to increase linearly with increased hatchery production of juvenile salmon.

Some additional points covered during my visit to the SRPA office in Tokyo include: (1) releases in spring 1976 from Hokkaido hatcheries included about 750 million juvenile chum salmon; (2) SRPA officials believe that transplantation of salmon stocks is still somewhat experimental. The general indications are that transplantations involving nearby streams are more likely to be successful than those involving distant streams. Hokkaido stocks have not adapted well to Honshu; (3) SRPA has distributed funds to private hatcheries for the past 25 years. There is no obligation for private hatcheries to repay these funds, which originate primarily from the federal government; (4) The southern limit of chum hatcheries in Japan is presently Toyama Prefecture (Sho and Jintsu Rivers), but the Japanese expect to reestablish chum further to the south. The historic range of chum salmon included Kyushu Island; (5) Japanese hatcheries depend largely on spring or well water, but experiments on heat exchange techniques to warm river water for hatchery use are currently under way.

The SRPA representatives expressed interest in salmon aquaculture in North America. Their questions centered mainly on six topics; (1) success of transplants and importance of proximity of donor and recipient streams; (2) government support for private hatcheries; (3) structure of groups operating private hatcheries; (4) design of deep matrix incubators and use of artificial substrates such as AstroTurf; (5) transplantation of Japanese chum eggs to Washington State; and (6) possible joint programs between Japan and the United States on artificial recruitment of salmon.

U.S.S.R.

I departed Yokohama on a Soviet passenger ship on June 19 and arrived in Nakhodka on June 21. Dr. Stanislov Konovalov, Director of TINRO, and Dr. Valery Buschev greeted me upon my arrival. From Nakhodka, I accompanied Dr. Konovalov on an overnight train ride from Nakhodka to Khabarovsk on the Amur River. Dr. Konovalov described planning that is underway for a series of international workshops on fisheries subjects.

Khabarovsk (June 22)

The train arrived in Khabarovsk shortly before noon. In the afternoon, I was taken on a tour of the city and the surrounding area. I was introduced to one of my interpreters, Nadine Yun, at the Khabarovsk Airport. Ms. Yun and I departed for Yuzno-Sakhalinsk, the largest city on Sakhalin Island, by air. We were greeted at the airport in Yuzno-Sakhalinsk by Dr. Vladimir Girenko, Chief of Sakhalin TINRO, Dr. Felix Ruchlov, Director of Laboratory of Salmon Culture (TINRO), Dr. Valery Efanov, Director of Laboratory of Natural Reproduction of Salmon, and Mr. Nikolai Sanin, Deputy Chief of Sakhalin Fish Inspection Board. Mr. Sanin is in charge of salmon hatcheries on Sakhalin and Kuril Islands.

Yuzno-Sakhalinsk (June 23)

My day began with a visit to the main laboratory of Sakhalin TINRO. Dr. Girenko introduced me to several of his key staff members and briefed me on the organization and programs of Sakhalin TINRO. Their staff of 109 persons, including support personnel, will be expanded to 127 employees in 1977. Eight laboratories are included in the Sakhalin program: (1) Laboratory of Natural Reproduction of Salmon [9 scientists]; (2) Laboratory of Salmon Culture [6 scientists]; (3) Laboratory of Oceanography and Commercial Sea Fish [15 scientists]; (4) Laboratory of Commercial Sea Weeds [4 scientists]; (5) Laboratory of Sea Seals [4 scientists]; (7) Laboratory of Commercial Fishing Methods [4 scientists]; and (8) Laboratory of Economics [3 scientists].

The Laboratories of Salmon Culture and Economics have only recently been established, and their scientific staffs will be expanded in the near future.

After my preliminary introduction to Sakhalin TINRO, I spent time in informal discussions with Drs. Efanov and Ruchlov and members of their staffs. Dr. Efanov described planning of research on natural reproduction of salmon. This work places considerable emphasis on questions such as distribution, migration, and population dynamics of salmon.

Dr. Ruchlov outlined planning for research on artificial recruitment of salmon which parallels very closely NMFS planning in Alaska. Areas of comparable emphasis include incubation methods, feedlot methods, and studies on carrying capacity of natural nursery waters. The Soviet Acadamy of Sciences carries on active basic and applied research in salmon genetics, so TINRO has no immediate plan to emphasize genetics. Nevertheless, Dr. Ruchlov and his staff share our interest in maintenance of genetic variability in hatchery populations. They identify as high priority the need for more knowledge which will lead to proper mating procedures in hatcheries.

The Laboratory of Salmon Culture is expected to grow from a staff of 6 to 30 scientists. Immediate emphasis will be placed on three problems; (1) development and evaluation of biotechniques for artificial recruitment of coho and masu salmon; (2) analysis and evaluation of existing pink and chum hatchery program; and (3) investigations on egg and larval stages of pink and chum salmon, with the possibility of introducing improvements in technology.

The Soviets are developing plans to introduce chinook salmon from Kamchatka to Sakhalin Island. They are also evaluating marine survival of hatchery-produced pink and chum salmon through a massive marking program. Approximately 3.5 million marked pink and 1.5 million marked chum salmon were released from selected hatcheries in spring 1976. Marks include removal of ventral, adipose, and dorsal fins.

Present rates of return of hatchery-produced pink (1.3%) and chum salmon (0.4%) to Sakhalin hatchery streams are lower than the Soviets believe they should be. There is evidence that fish returning to Sakhalin are intercepted by foreign fisheries on the high seas, but the rate of exploitation of Soviet stocks by foreign fisheries has not been adequately evaluated.

During the afternoon I had a productive visit with Mr. G. K. Poliakov, Chief of Sakhalinribprom, six of his deputies, Dr. Girenko, Dr. Ruchlov, Dr. Efanov, and Mr. Sanin about salmon hatchery programs in North America and Asia. Mr. Poliakov expressed considerable interest in use of hatcheries for rehabilitation of salmon fisheries. We discussed the condition of North American and Asiatic stocks and factors responsible for depletion of salmon. There was much interest in current planning for hatcheries in Alaska and results of pilot projects. I was asked to explain my ideas about hatchery methods. There was a general feeling that open exchange of technical information between the U.S.A. and U.S.S.R. could benefit both of our countries.

Bereznyakovsky Hatchery (June 24)

Departing Yuzno-Sakhalinsk by auto in the morning, I traveled to the southeastern coast of Sakhalin Island in the company of Dr. Ruchlov, Mr. Sanin, and Mr. Myron Fedory-shyn, an interpreter. We were greeted at the Bereznyakovsky Hatchery by the Superintendent, Mr. P. Deptuch.

The Bereznyakovsky Hatchery is among the earliest hatcheries constructed on Sakhalin. Constructed by Japan in 1924, it has a long history of artificial propagation of pink and chum salmon. Mostly pink salmon have been released in the past 2 years, with 53 million pink fry released in 1975 and 55 million in spring 1976. Only 0.5 million chum fry were produced in spring 1976.

The Bereznyakovsky Hatchery is located 90 km from salt water on a tributary of the Naida River. Water flows by gravity from a spring at the rate of 70 to 100 liters/sec. Winter water temperature is about 0.6°C. Fry emerge from gravel-lined raceways during the period when fry emigrate from natural spawning streams on southern Sakhalin. Most fry emigrate unfed, although the hatchery does have an earthen pond for feeding.

Eggs are hatched at the head of gravel-lined raceways and the alevins distribute themselves downstream over the gravel. Newly fertilized eggs are placed on screen trays measuring 35 cm by 35 cm. Water is directed upward through the trays by a system of baffles placed across the upper area of a raceway. Alevins pass through the trays and distribute themselves over gravel downstream from the trays. The gravel is fairly small and forms a shallow bed 2-3-cm deep. Water depth is 32 cm.

The hatchery is housed and windows are shuttered to exclude light. The hatchery has two sections in series, each consisting of three parallel raceways about 100 m long. Alevins are stocked at densities up to 30,000/m^2 of gravel. A typical raceway is 2 m wide and receives 15 liters/sec of water.

The weir for collecting spawners is located 14 km downstream from the hatchery. Even though fish migrate upstream 76 km from the estuary to reach the weir, there is very little natural spawning area available to them in the Naida River, which has a low gradient and sandy streambed.

Egg-to-fry survival was 97% for the 1976 brood year. Fry are offered food, but pink salmon mostly emigrate without feeding. Chum fry are likely to remain and feed, and small schools were still present on the date of my visit, even though feeding had been terminated several weeks earlier. The principal diet consists of fish eggs (primarily pollack). The Soviets are testing formulated dry diets from Japan.

We drove into the mountains after leaving the Bereznyakovsky Hatchery to inspect natural spawning areas of pink salmon. The Soviets use their hatcheries to supplement production of pink and chum salmon on many hatchery streams. They rely primarily on natural recruitment to support the pink fishery and on hatchery production to support the chum fishery. Sakhalin Island has many excellent pink salmon spawning streams, and the natural stocks generally are in good condition.

Yuzno-Sakhalinsk (June 25)

The day was spent in conference with about 30 scientists and technicians from Sakhalin, Amur, and Kamchatka Branches of TINRO and from Sakhalin hatcheries. The discussions continued for about 7 hours. My notes include the following highlights:

1. Condition of natural populations of salmon in Sakhalin-Kuril district

Pink populations are generally in good to excellent condition with exception of some streams on west side of Sakhalin. Chum populations are depleted.

2. Role of hatcheries in Sakhalin-Kuril district

Hatcheries are used to supplement pink production but generally to support chum production.

3. Condition of natural populations of salmon in Amur Basin

Pink, summer chum, and autumn chum are at about 35% of historic abundance.

4. Condition of natural populations of salmon in Kamchatka

Sockeye are about 10-15% of historic levels. Pink and chum populations are also very depressed. Coho and chinook populations are generally in good condition.

5. Hatcheries on Kamchatka

Two experimental hatcheries are in operation. The main goal of management is to restore natural populations rather than to establish artificial populations.

6. Hatcheries in Amur Basin

There are 4 autumn chum hatcheries with a combined capacity of 100 million eggs.

7. Hatcheries on Sakhalin

There are 18 operational hatcheries, including 2 in the Kuril Islands. In spring 1976, 800 million pink and chum juveniles were released (about equal numbers of each species). Most hatcheries have a capacity of over 20 million. Only 3 or 4 hatcheries produce less than 20 million fry.

8. Hatcheries on Okhotsk Sea Coast

There are no existing hatcheries, but a chum hatchery is being planned for the Magadan area.

9. Joint venture hatcheries with Japan

One hatchery is in planning for Sakhalin. It will have a capacity for 30 million eggs and be used primarily for research. Two additional joint venture hatcheries are being discussed for Okhotsk Sea Coast and one for Primore Region of Japan Sea Coast.

10. Transplantation of salmon

Most transplantations have not been evaluated or properly documented. Pink salmon transplanted from Sakhalin to northwest U.S.S.R. have shown return rates as high as 10%. A transplant of pink salmon from Kuril Islands to Sakhalin produced good results. Pink transplants are generally more successful than chum transplants. Masu salmon can be transplanted with good success.

11. Marine survival of hatchery fish

Pink salmon from hatcheries on east coast of Sakhalin experience two to

three times higher rate of return to hatcheries than chum salmon from hatcheries on the west coast of Sakhalin. Highest return rates are from hatcheries in Kuril Islands.

12. Spawning procedures at hatcheries

There are no standard procedures. Undersized and weak fish are not used for brood stock.

13. Variation in marine survival of chum salmon

Return rate (escapement only) for chum salmon averaged 0.38% at west coast hatcheries and 0.54% at east coast hatcheries. Other information suggests that wild fish return at a higher rate than hatchery fish.

14. Hatchery design

In planning new hatcheries, the Soviets are examining the possibility of using shorter gravel-lined raceways for alevins than at present, with possible reduced flow rates per raceway.

Discussions during the day of June 25 were continued into the evening with a smaller group. The principal subject during the evening discussion was the Soviet-Japanese hatchery project being planned for the west coast of Sakhalin. The Soviets consider this project to be of high priority.

Principal mission of this first Soviet-Japanese hatchery will be research and development. Some proposed research areas include: (1) methods for holding spawners and collecting and fertilizing eggs, (2) methods of feeding fry, including formulation of diets, (3) optimum time of release of juveniles and qualitative indices for determining time of release, (4) methods to prevent and cure diseases, (5) methods for marking fry, (6) optimum capacities of hatcheries for various salmon species, (7) new hatchery biotechniques, (8) influence of environment on survival in natural waters, (9) distribution of salmon at sea, (10) mechanisms of regulation of age and size at maturity, (11) acceleration of growth and development; and (12) genetic selection and hybridization.

The proposed joint venture research hatchery will have a capacity for 30 million eggs (25 million chum, 3 million pink, 1 million masu and 1 million coho). Buildings will provide over 7,000 m^2 of space for research, administration, fish culture support, living quarters, and other support activities. There will be approximately 1,100 m^2 of covered channels for eggs and alevins and 3,000 m^2 of outside pond area for feeding juveniles.

It has been proposed that the scientific component of the hatchery staff include 29 persons (9 scientists and 20 support personnel). Disciplines are to include genetics, physiology, ecology, hydrochemistry, and pathology. An additional staff of 22 persons would be required to operate the hatchery, including 4 specialists. Thus, a total of 51 persons would be assigned permanently to the facility.

Three sites are under consideration for the proposed Soviet-Japanese hatchery. One proposed site is on the Pioneer River, where there is little development at present. A second proposed site is a small existing hatchery (7 million eggs) which is a satellite operation of the large Kalinin Hatchery. The third proposed site is the Yasnomorsky Hatchery which presently has a capacity for 15 million eggs.

Kholmsk and Vicinity (June 26)

I visited three chum salmon hatcheries in the company of Dr. Ruchlov, Mr. Sanin, Mr. Fedory-Shyn, and Ms. Yun near the city of Kholmsk on the southwest coast of Sakhalin Island. The area very much resembles coastal regions of Oregon and Washington, with small rivers and creeks.

The well-known Kalinin Hatchery was our first stop. Total capacity of the Kalinin Hatchery is 85 million chum eggs. The hatchery is divided into 4 units with capacities of 35, 25, 15, and 10 million eggs. Mr. T. Kochetkov, Superintendent, guided us through his hatchery complex and described its operation. He vividly recalled an earlier visit by another American fisheries specialist, Mr. Clint Atkinson.

General layout and operation of the Kalinin Hatchery is very similar to the Bereznyakovsky Hatchery. However, somewhat larger gravel (about 5 cm in diameter) is used to line raceways at Kalinin than at Bereznyakovsky. The Kalinin Hatchery uses about 70 liters/sec of spring water (3.5°C in winter and 7°C in summer) plus supplemental river water. Fry raised in colder river water emerge later than fry raised in spring water.

The weir is located near tidewater several kilometers downstream from the hatchery. Eggs are taken from late-August to mid-October, but the returning run continues into November. In 1975, 171,000 adult chum salmon were handled at the weir. The weir site is shown in Figure 7a and the main entrance to the Kalinin Hatchery in Figure 7b.

Chum alevins are stocked at densities up to 30,000/m^2 of gravel substrate. Fry are fed for about 60 days and released in May. Egg-to-fry survival has averaged about 96% in recent years. Average weight of juveniles at time of release varies from 600 to 1,000 mg.

From Kalinin we drove northward toward Kholmsk, stopping at the Yasnomorsky Hatchery (Figure 8)--one of the candidate sites for the Soviet-Japanese research facility. Yasnomorsky is one of the smaller Soviet hatcheries, with a capacity of 15 million chum fry.

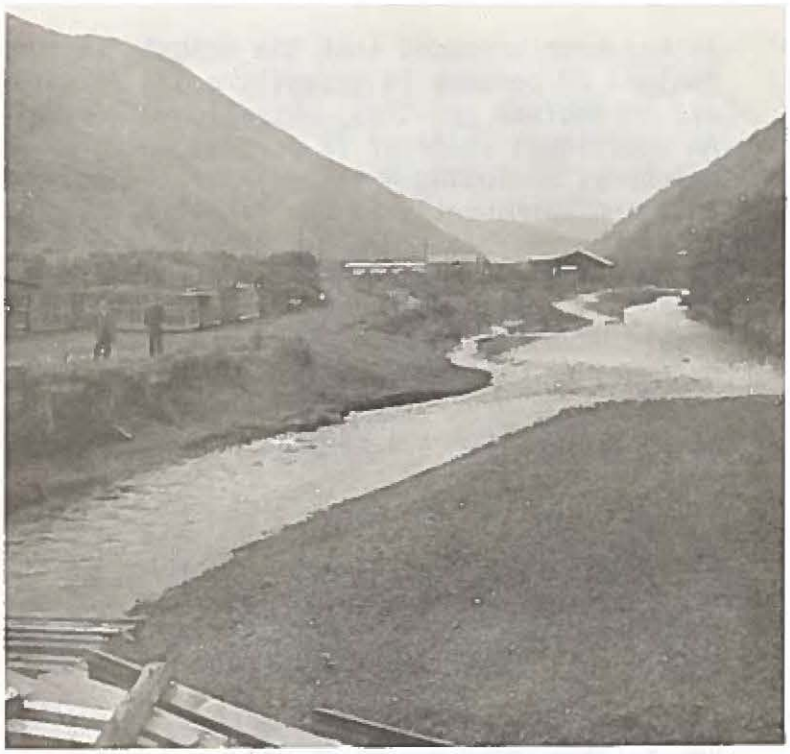


Figure 7a.--Weir site on Kalinin hatchery stream.

Figure 7b.--Main entrance to Kalinin hatchery.

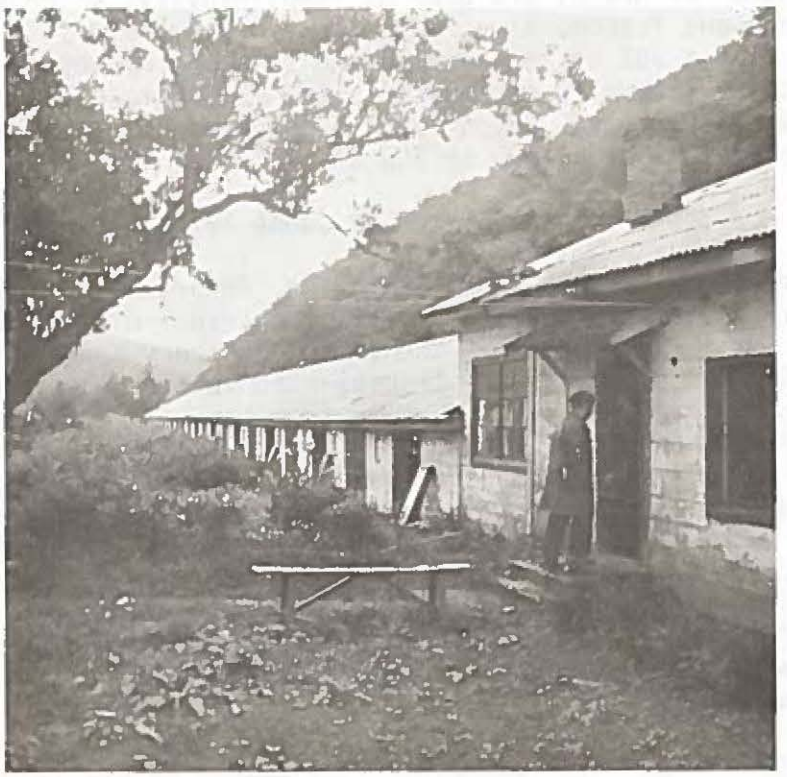


Figure 8.--Yasnomorsky chum salmon hatchery.

Both spring and river water are used at the Yasnomorsky Hatchery. Water temperature drops to 0.5°C in winter. Spawning starts in late August or early September. The general layout and operation of the hatchery is similar to Kalinin, except that chum alevins are stocked at densities up to 36,000/m^2 of gravel. A typical gravel-lined raceway is 140 cm wide, has a water depth of 24 cm, and is supplied with 20 liters/sec of water.

Our final visit of the day was to the Sokolnikovsky Hatchery, another chum facility with an egg capacity of 20 million. Stocking densities of 23,000 alevins/m^2 of gravel are used at Sokolinkovsky, which is lower than at Kalinin and Yasnomorsky. Water for the hatchery is obtained from springs (about 30% of the supply) and from the nearby stream (Figure 9). The hatchery stream is managed to allow 10,000 to 30,000 chum salmon to spawn naturally. Juveniles are released from the hatchery in May at an average weight of 600 to 700 mg.

Lesnoi Hatchery (June 27)

In the company of Dr. Ruchlov, Mr. Sanin, Mr. Fedory-Shyn, and Ms. Yun, I returned to southeast Sakhalin to visit the Lesnoi pink hatchery (Figure 10). In 1975, workers at the Lesnoi Hatchery spawned 40 million pink eggs. Many of the pink eggs transplanted to the White, Barents, and Baltic Seas in western U.S.S.R. came from Lesnoi. According to Mr. Sanin, transplantation of pink salmon to the Baltic is a more recent endeavor than to the White and Barents Seas. To date there have been no remarkable successes in the Baltic, but there is a good possibility that Sakhalin pink salmon have become established in the White and Barents seas. Sakhalin hatcheries continue to provide about 9 million pink eggs annually for transplantation to western U.S.S.R., and about 5 million of these originate from the Lesnoi Hatchery. There have also been transplantations of salmon from Sakhalin hatcheries to the Caspian Sea, but this work is limited to chum salmon.

Mrs. Karmen Knyazeva, Superintendent of the Lesnoi Hatchery, hosted our visit and explained operations at the Lesnoi Hatchery. Although chum salmon were raised at Lesnoi in earlier years, the emphasis is now on pink salmon. Annual return of pink salmon spawners (escapement only) to the Lesnoi River (Figure 11) ranges between 300,000 and 1,000,000 adults. There are 140,000 m^2 of natural spawning gravel, and the hatchery operators attempt to achieve a density of 2 pink spawners per square meter in addition to eggs taken for artificial recruitment. Collection of eggs for the hatchery is delayed to the latter segment of the run to insure a good distribution of natural spawners and to produce hatchery fry which do not emigrate too early for good survival at sea.

Gravel-lined raceways are stocked at densities up to 35,000 alevins per square meter, but densities of 30,000 per square meter are preferred. Approximately one million marked pink fry were released from Lesnoi in spring 1976 as a part of a large-scale hatchery evaluation program on Sakhalin Island.

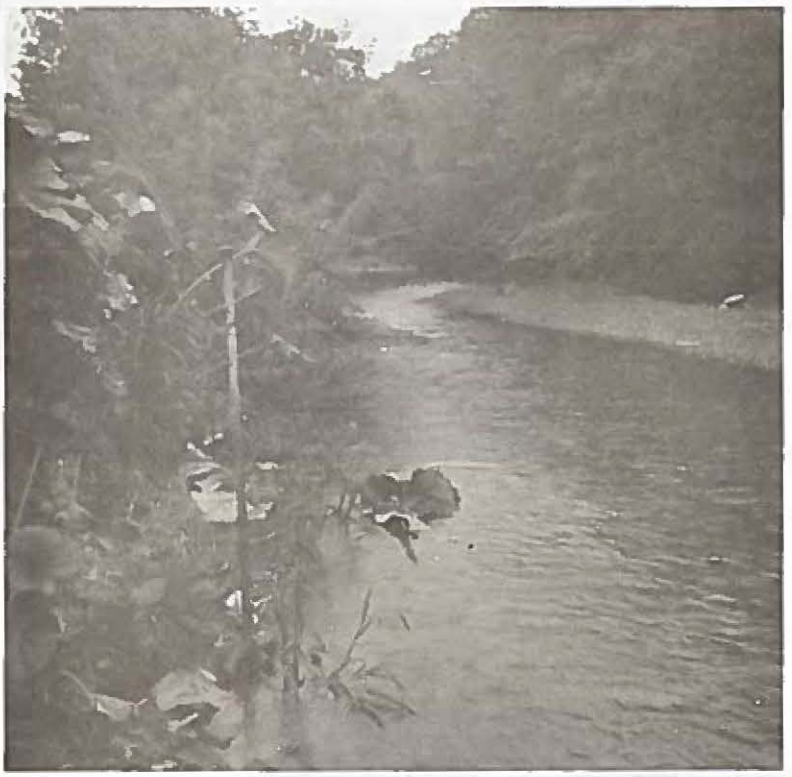


Figure 9.--Stream for Sokolnikovsky chum hatchery is managed for natural recruitment.

Figure 10.--Main building housing gravel-lined raceways at the Lesnoi hatchery.

Figure 11.--The Lesnoi river is intensively managed for natural recruitment of pink salmon.

Yuzno-Sakhalinsk (June 28)

This was my last day on Sakhalin Island. My time was devoted in part to a review of status of artificial and natural recruitment of salmon in North America for the benefit of my Soviet hosts.

My Soviet hosts provided some photos of hatchery operations which I am incuding here to clarify questions on hatchery design. The five hatcheries that I visited are believed to be typical of other Soviet pink and chum hatcheries which I did not visit. Figures 12 and 13 are inside views of two hatcheries. Figure 14 shows pink salmon alevins reposing on the surface of gravel substrate. Figure 15 shows avoidance of chum salmon alevins to sand and attraction to gravel.

Khabarovsk (June 29)

Accompanied by Ms. Yun, I departed Yuzno-Sakhalinsk by air in late morning and arrived in Khabarovsk in early afternoon. Dr. Yurii Rosly, Director of Laboratory of Salmon Biology for Amur Branch of TINRO, greeted us upon our arrival at Khabarovsk Airport. Dr. Rosly kindly described TINRO programs in the Amur Basin.

The Amur Branch of TINRO includes four laboratories (1) Laboratory of Salmon Biology, (2) Laboratory of Freshwater Fishes, (3) Laboratory of Fish Food Productivity, and (4) Laboratory of Limnology.

The TINRO staff numbers 100 persons in the Amur Basin, including those who operate three research vessels assigned to TINRO Amur Branch.

The Soviet government operates four salmon hatcheries on tributaries to the lower Amur River, with a combined capacity of 110 million autumn chum eggs. They are (1) Udisk Hatchery on the Amgun River (25 million eggs), (2) Gurski Hatchery on the Gur River (10 million eggs), (3) Teplovsk Hatchery on the Bizo River (50 million eggs), and (4) Bidjansky Hatchery on the Bidjan River (25 million eggs).

The Laboratory of Salmon Biology engages primarily in research on chum and pink salmon. Masu salmon occur in the Amur, but this species is of minor importance. Major areas of study include (1) variability and structure of salmon populations, (2) fishery dynamics of populations of salmon, (3) biotechniques of hatchery rearing of salmon, (4) biology of freshwater life of salmon.

Nakhodka (June 30-July 2)

My train from Khabarovsk arrived in Nakhodka in mid morning. Drs. M. Ajushin and V. Buschev greeted me and Ms. Yun at the depot and accompanied us to our hotel. We discussed TINRO programs in the Primore region.

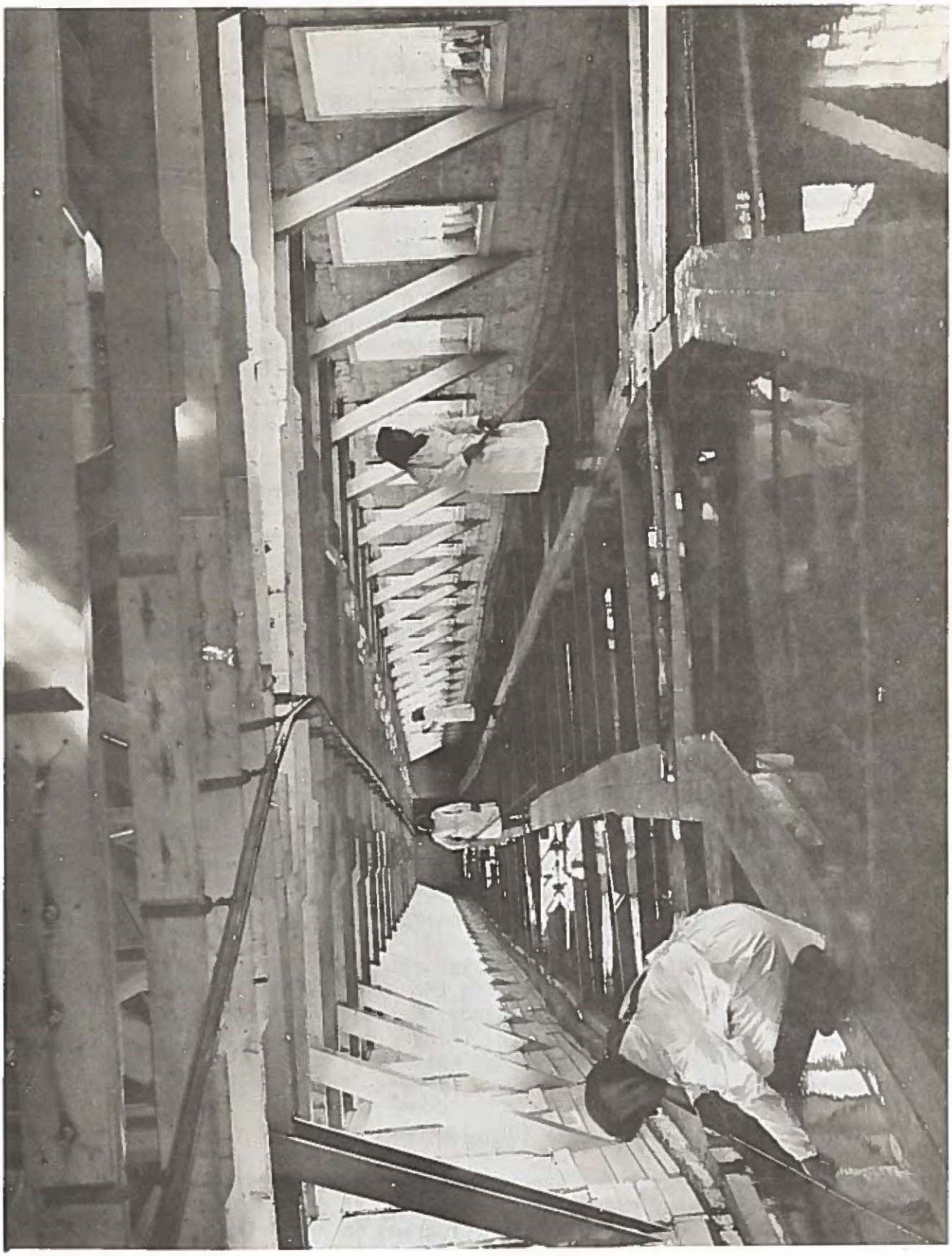


Figure 12.--Inside view of typical Soviet pink and chum hatchery. (Courtesy of Dr. F. Ruchlov).

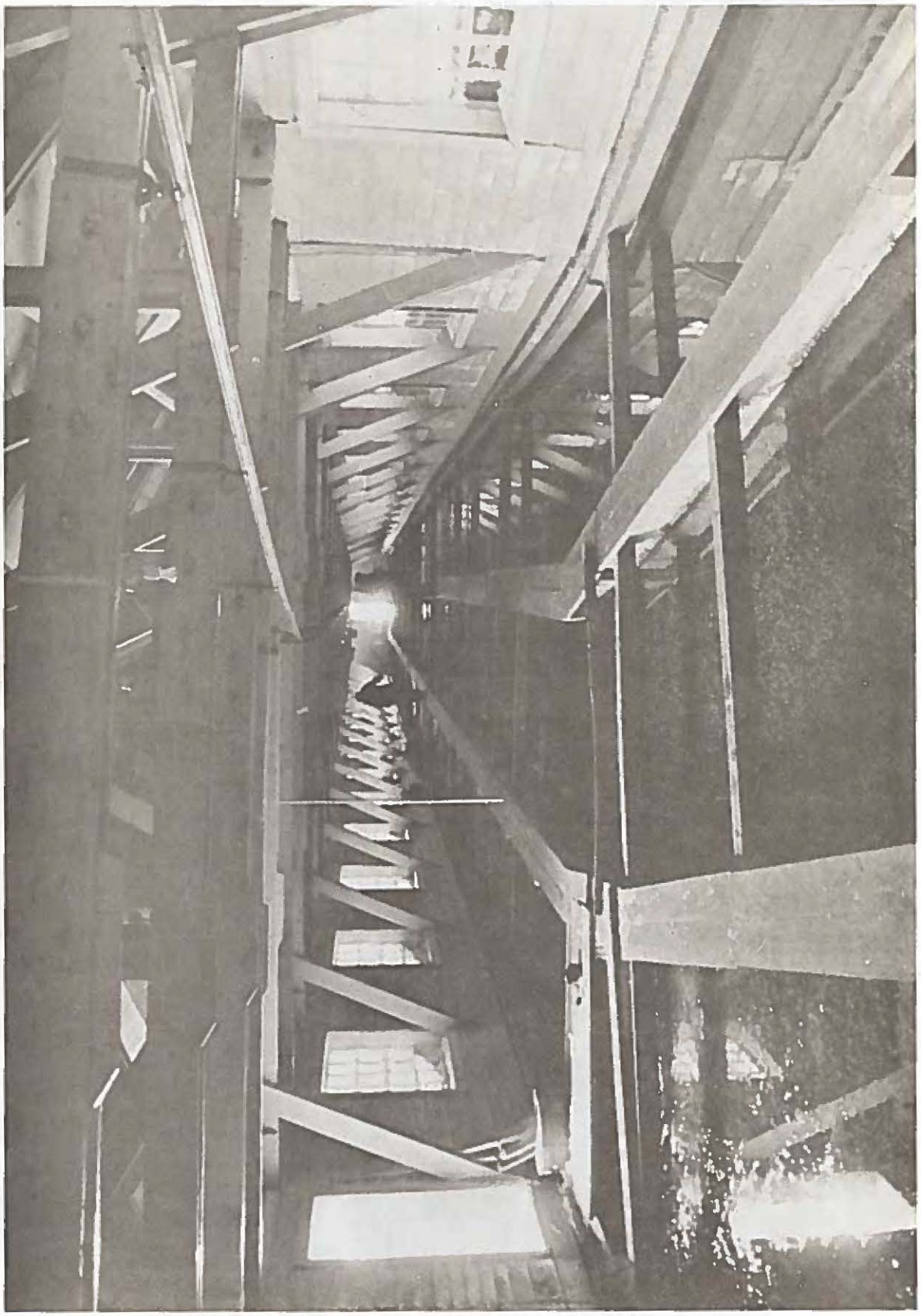


Figure 13.--Inside view of Lesnoi pink hatchery.
(Courtesy of Mrs. L. Knyazeva).

Figure 14.--Typical concentration of pink alevins in gravel-lined raceway of a Soviet hatchery. (Courtesy of Dr. F. Ruchlov).

Figure 15.--Aviodance of chum alevins of sand substrate in hatchery raceway. (Courtesy of Dr. F. Ruchlov).

Plans are being developed for a salmon research facility on the Kievka River about 30 km east of Nakhodka. The proposed facility will use geothermal water to control temperature. Primary mission of the facility will be to develop and evaluate hatchery technology for several species of salmonid fishes in the Primore Region. At least four species will be investigated--coho, chinook, and masu salmon and a species of Hucho. There is also a possibility that the "Kamchatka salmon," a species of Salmo, will also be studied. Scientific staff will include four persons in the beginning but may be increased to 10 at a later date. Some of the early scientific work being planned for the Kievka River facility includes genetic research. Two specialists, including Dr. Buschev, will study biochemical systematics of salmonid fishes, with special emphasis on hybridization.

One purpose of using heated water at the Kievka River facility is to accelerate growth in order to produce zero-age smolts. Smolts weighing 15-20 g each will be transported to coastal rearing ponds receiving pumped salt water.

Dr. Ajushin, who is Director of Laboratory of Mariculture for the Primore Region, described other TINRO initiatives in aquaculture. His laboratory has a 12-member scientific staff and is presently giving high priority to scallop culture. Young scallops are raised artificially for stocking fishing grounds with encouraging success.

My final day in the U.S.S.R., July 2, was spent aboard a Soviet fishery research vessel (Figure 16) in the Sea of Japan. The weather was beautiful and the sea was calm. It was a relaxing way to end my trip to the U.S.S.R. which had involved a full and productive schedule of travel, meetings, and informal discussions. On July 3, I boarded a Soviet passenger ship en route to Yokohama on the first leg of my return to the U.S. I arrived in Seattle on July 6.

POSTSCRIPT

During my trip I was able to confirm that substantial progress is being made with programs of artificial recruitment of pink and chum salmon in Japan and the U.S.S.R. The 10-year moving average of artificial recruitment of juvenile pink and chum salmon from Japanese and Soviet hatcheries (Figure 17) tells a story of what has occurred and provides insight into probable future growth of ocean ranching of salmon in the western Pacific.

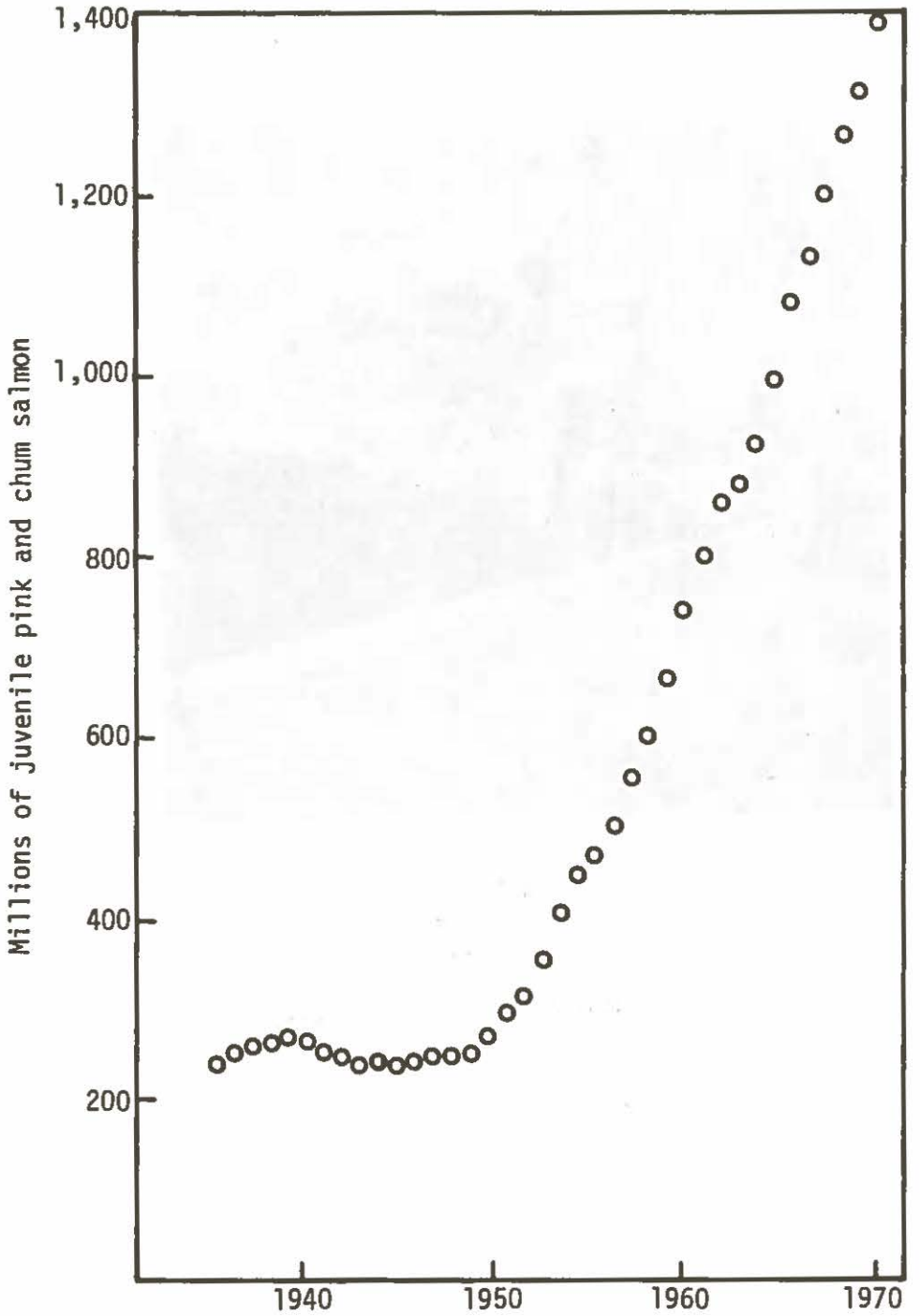


Figure 17.--Ten-year moving average of number of juvenile pink and chum salmon released from hatcheries in Japan and the U.S.S.R.

Figure 16.--Soviet fisheries research vessel in port at Nakhodka, U.S.S.R.