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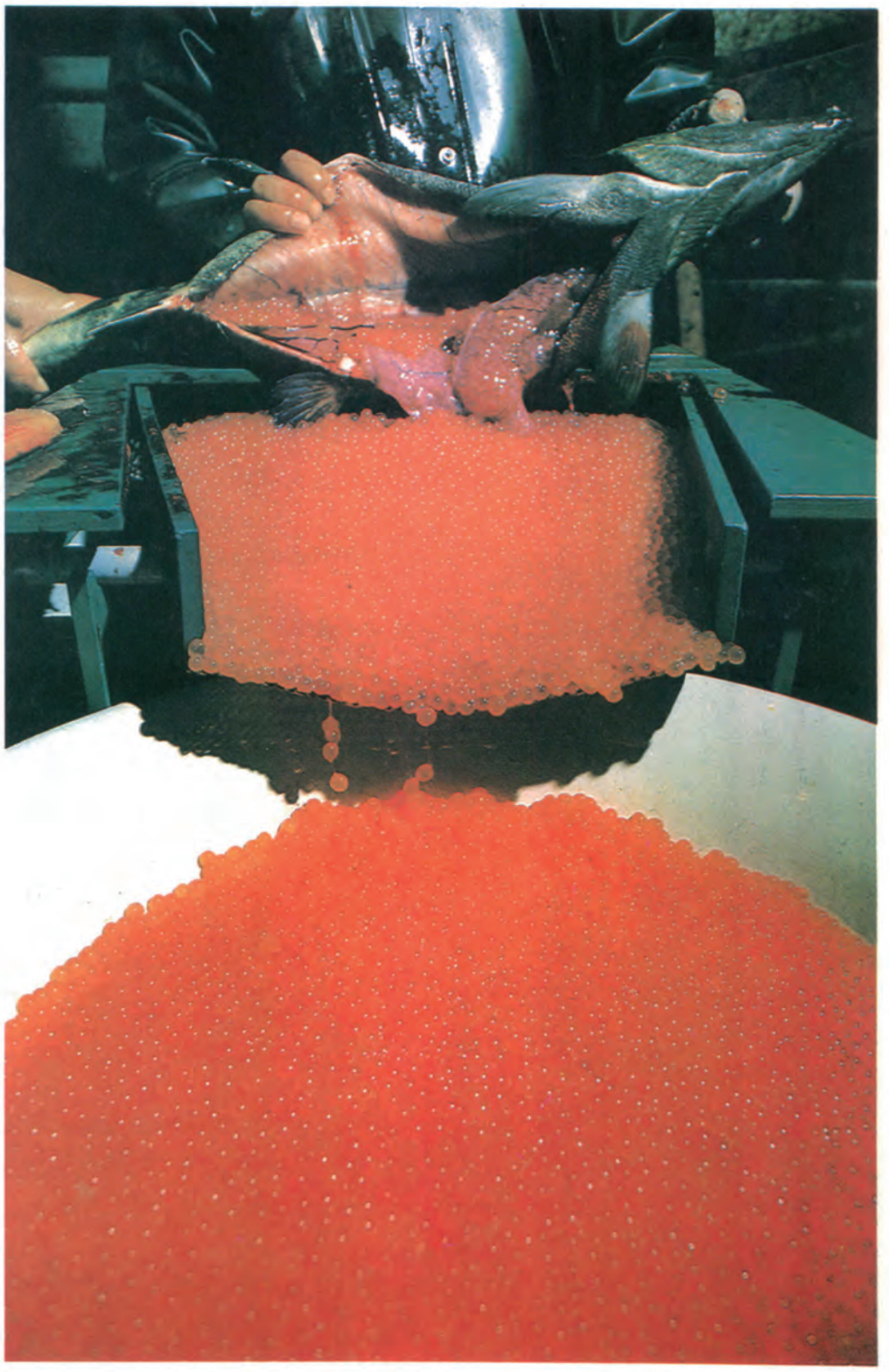
EFFORTS FOR SURVIVAL

Can we maintain balance between exploitation and protection?

— Natural salmon resources —



In recent years Japanese salmon fishery, free fishery in the open sea has been on the decrease. On the other hand, coastal fishery, which relies heavily on the propagation of resources by artificial incubation and liberation has been on the rise. The decline in open sea fishery has resulted from the worldwide establishment of 200-mile economic zones and the severe catch control placed on anadromous fishes. Seen in a broad perspective, however, Japan is now actively tackling the problem of developing salmon fishery based on the idea of increasing resources by raising the homing rate of salmons liberated after artificial incubation the practice of which is now highest in the world.

In the fall of 1979 as usual, a large school of salmons, most of which are chum salmons (*Oncorhynchus keta*), returned to the coastal waters of Japan to ascend rivers of their birth. As of November 20, the number of salmons which had returned to the coastal waters exceeded 19 mil. This is all-time record in the history of Japanese salmon fishery.

Some people feel sorry for the male and female salmons struggling with their last strength to ascend mountain streams but perhaps it is a mistake. The salmons are only trying to carry out the essential task for the continuation of the species by instinctively finding their native rivers after coming back from the distant ocean and returning to their specific spawning ground.

They are continuing thier brave efforts for survival. The scene in fact can be seen as the climax of a long and fascinating journey.

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Salmon have been the object of fishing since early times. Salmon were formerly the staple food of the natives of Siberia and Alaska, serving as an important source of animal protein.

At present, salmons in the northern hemisphere are one of our most important fishery resources. Every year 500—600 thousand tons of salmons are caught, all over the world with the United States, Canada, the Soviet Union and Japan as the main countries conducting salmon fishery.

Salmon fishey has developed making the best use of salmon's unique mode of life; that is, their habit of never failing to return to the river of their birth for spawning after having reached maturity while migrating over vast areas in the ocean.

¿Puede la humanidad desarrollar equilibradamente la pesca mediante los recursos del salmón?

En el otoño de 1979, un numeroso banco de salmones, en su mayoría de la especie de carnada (Oncorhynchus keta), volvía a las aguas costeras del Japón para iniciar su ascenso hacia sus ríos de origen. El 20 de noviembre, el número de salmones que volvió a las aguas costeras alcanzó los 19 millones, una cifra que marcó un récord en toda la historia de la pesca del salmón en Japón.

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Actualmente, la pesca del salmón en mar abierto ha venido decreciendo en peso. Por el contrario, la efectuada en aguas costeras derivada de la incubación artificial y posterior liberación de los peces, ha estado en aumento. La disminucion de la pesca en mar abierto, es resultado de la adopcion mundial de las 200 millas de mar patrimonial y el estricto control para la captura de las especies de anadromos. Mirando más hacia el futuro, sin embargo, Japón está tratando de combatir tal problema en forma muy activa desarrollando la pesca del salmón mediante el incremento de su población, elevando la tasa mundial de salmones producidos por incubacion artificial.

Est-ce que l'humanité peut développer les pêches de façon équilibrée avec les ressources de saumon?

En automne 1979 également, un large banc de saumons, la plupart des saumons communs (Oncorhynchus keta), est revenu dans les eaux côtières du Japon pour remonter leurs rivières d'origine. Le 20 novembre, le nombre de saumons revenus dans les eaux côtières était plus de 19.000.000. C'est un record jamais atteint dans l'histoire des pêches au saumon japonaises.

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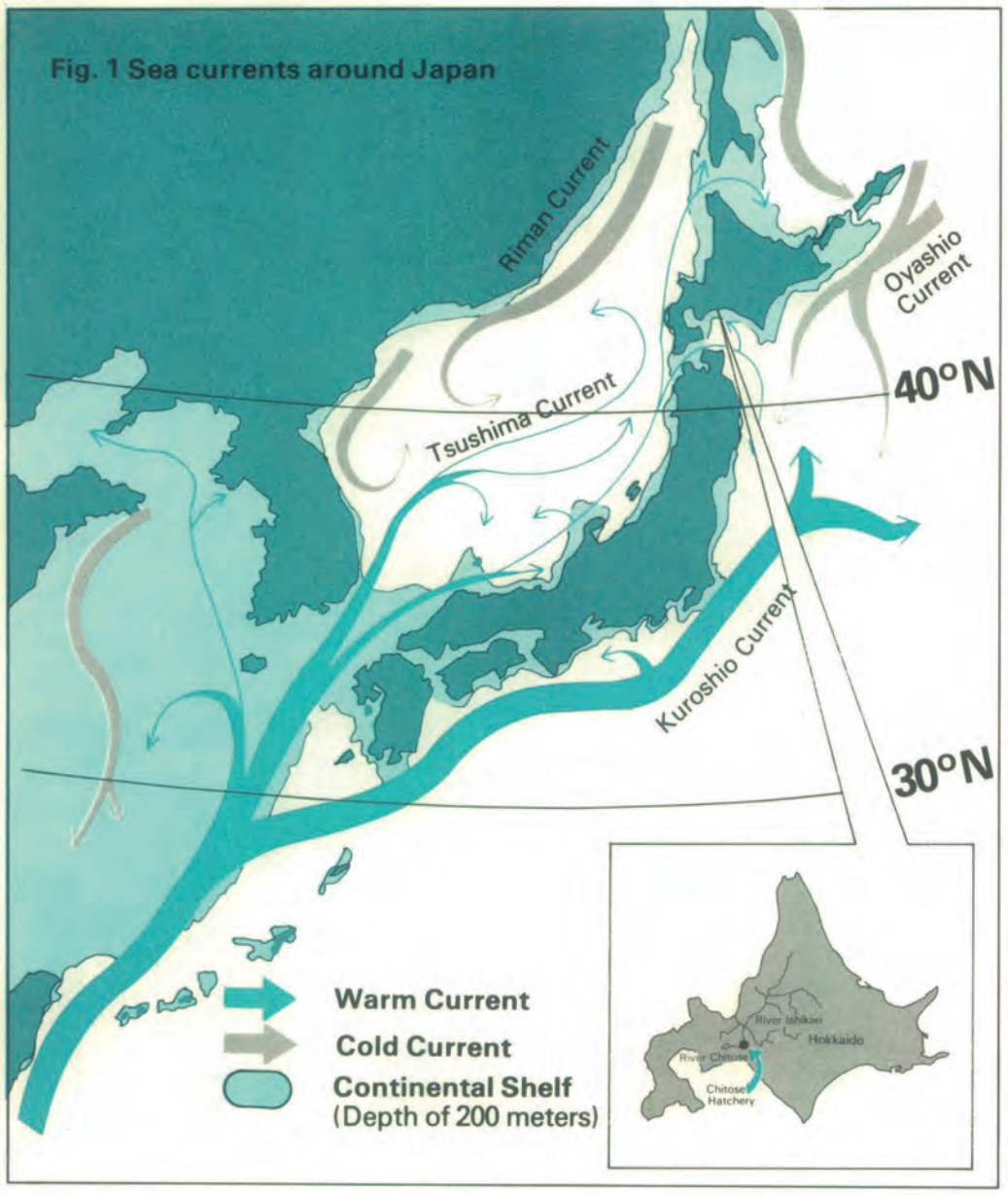
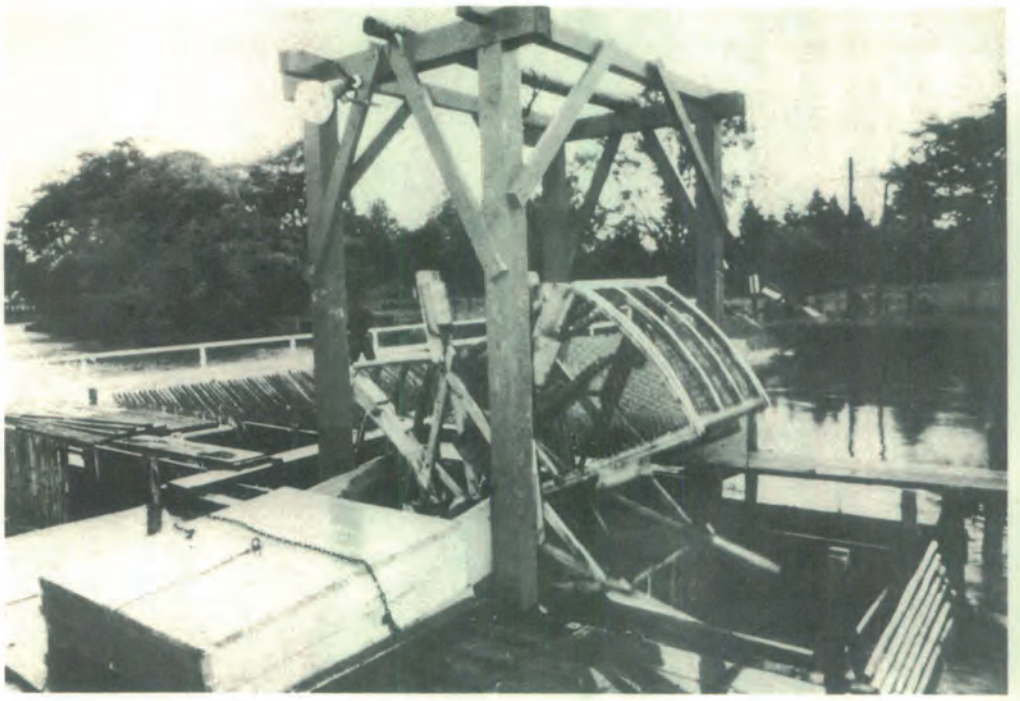
Dans la pêche au saumon actuelle, la pêche dite libre par-dessus bord dans la haute mer a vu son tonnage décroître. D'un autre côté, la pêche côtière qui progresse concuremment avec la propagation des ressources par incubation artificielle et libération a augmenté. La baisse des pêches en haute mer provient du fait de l'établissement des zones économiques de 200 milles et du contrôle sévère des prises de poissons anadromous. Cependant, tenant compte des grandes perspectives, le Japon s'occupe activement à l'heure actuelle du problème de développement des pêches de saumon basées sur l'accroissement des ressources en stimulant le taux de retour des bancs de saumons le plus élevé au monde grâce à l'incubation artificielle.





This water wheel is called an "Indian water wheel", and was made in 1887 by imitating a fishing gear used by the American Indians. For nearly one century this water wheel has been in operation catching salmons to be used for progagation in the river Chitose, Hokkaido.

The river Chitose, originating from a volcanic lake, flows through virgin forests into the central plains of Hokkaido, and empties into the Sea of Japan after joining the larger river Ishikari downstream. At a site about 80 km up from the mouth of the river a red tower has been constructed in the center of the river, and a large water wheel turns there constantly. In the river, fences are set up from bank to bank on both sides of the water wheel. Therefore, salmons which have ascended the river, in an attempt to reach the spawning ground located further upstream, will rush into a narrow waterway where the water wheel is rotating, and will be caught in its mantle.
About 10 km up river from this water wheel, the Chitose Branch of the government-managed "Hokkaido Salmon and Trout Hatchery" is situated by the riverside. This Hatchery was established in 1888, having the longest history among the 38 hatcheries in Hokkaido.

Salmon Propagation Projects in Japan

We must think carefully about the mode of life of salmon

The homing instinct of salmon has been known since early times. In Japan, it is a historical fact that around 1764 a junior warrior (samurai) in a district on the coast of the Sea of Japan succeeded in raising the breeding coefficient as well as doubling the number of salmons ascending the river by conserving a natural spawning ground. Throughout history, the propagation of salmon had always been under the providence of nature, but since the beginning of the Meiji era, with the introduction of artificial incubation techniques from the United States, fishermen began to play an active role in the propagation of salmon resources.

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In 1888, a central national hatchery (the present Chitose Hatchery) was established in Hokkaido, and a research system thus became integrated, resulting in the establishment of an artificial incubation project. Since then, salmon incubation projects have continued until now, primarily by national hatcheries in Hokkaido, and by private hatcheries in many districts of the Main Island.
The present condition of incubation projects in Japan are summarized in Table 1:
For about 90 years since the 1890's, when salmon propagation projects got into full stride, the course of development of incubation projects has never been smooth until the present. Epochmaking events in the history of its development are summarized in Table 2:

During the hundred-year history of salmon hatching , there was a period when technological development continued on a fundamental level and there was also an inactive period when incubation projects had gone into a slump due to a decrease in the number of salmons ascending the river.
The salmon spends most of its life in the boundless ocean, and its life cycle ends after a long migration period of two to five years. In order to achieve effective artificial propagation of resource, it was necessary to see to several essential factors; technology, operation system and economy and to systematize these three comprehensively. With the advancement of techniques for incubation and liberation developed over many years of efforts by the persons concerned, the coordination of the techniques with social and economic aspects resulted gradually in concrete fruits for the incubation and liberation projects.
[1] By enactment of the "Aquatic Resources Conservation Law" in 1951, the foundation of salmon (mainly chum salmon) and trout propagation projects was formalized as follows:

- The incubation and liberation of fry, having high public interest, are to be conducted with government expenses, and the government is to subsidize privately managed facilities as well.
- Coastal fisheries which profit from the propagation projects must bear a part of the expenses for incubation and liberation projects.
- Some of the rivers which salmons ascend, shall be designated as "propagation rivers", and the conservation of waterways for ascending must thus be undertaken.
- Capture of salmons in the inland waters is prohibited. Only a limited number of adult salmons for the purpose of propagation can be caught, according to project specifications.

Table 1

District	Managing body	No. of hatcheries	Incubation ability (Unit: thousand eggs)	Liberation ability (Unit: thousand salmons)
Hokkaido	Government	37	943,500	338,300
	Hokkaido	3	70,000	30,500
	Private	61	159,900	96,020
	Subtotal	101	1,173,400	464,820
Main Island	Private	124	465,106	378,747
Total		225	1,638,506	743,567

(The fiscal year 1978)

Table 2

Environmental conservation of the ascending rivers
(Continued since the previous age)

↓

1888: Establishment of the Central Hatchery. Establishment of projects.

↓

1951: Enactment of "Aquatic Resources Conservation Law"

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The 1960's:
1 Investigation into the actual facts regarding the decrease in the number of juveniles, mainly of chum salmon, in the rivers was advanced by a follow-up survey.
2 Rearing by feeding and timely liberation was started.
3 In order to secure adult salmons and eggs, catch control in coastal waters was begun.

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The 1970's:
1 Number of liberated fry was increased year after year.
2 Rearing by feeding in the sea was begun.
3 Besides chum salmon, research and measures for the expansion of incubation and liberation of masu salmon, pink salmon and red salmon were started.

Fig.2 Number of liberated fry of chum salmon and corresponding return rate (Hokkaido)

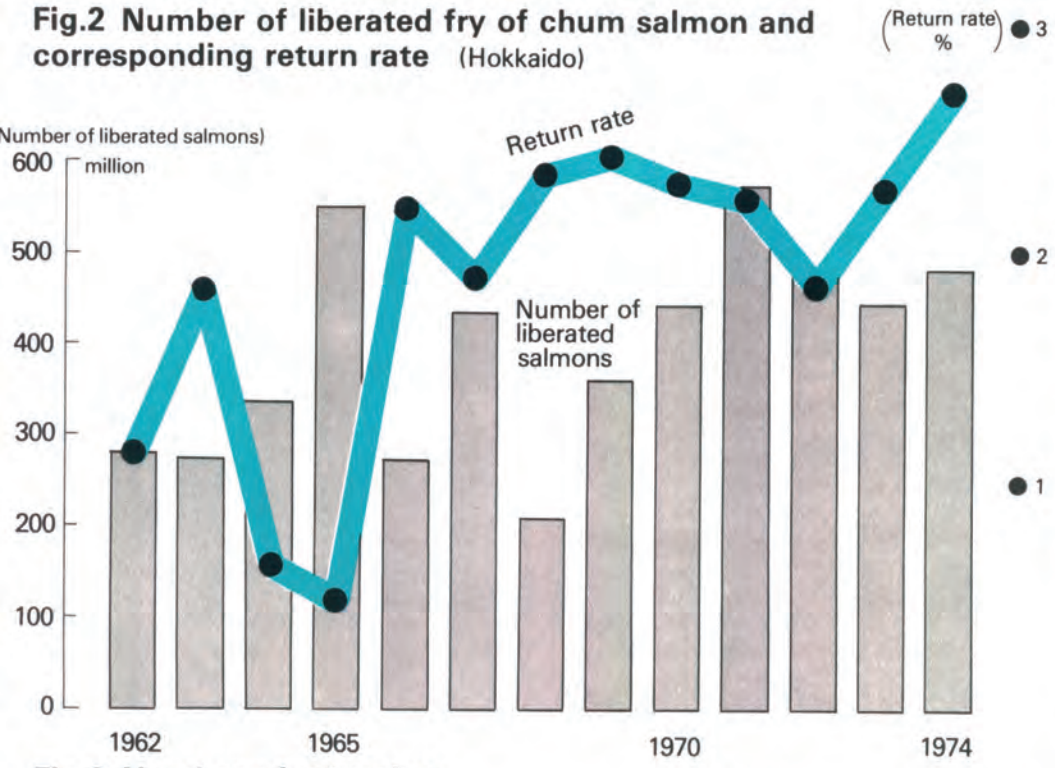
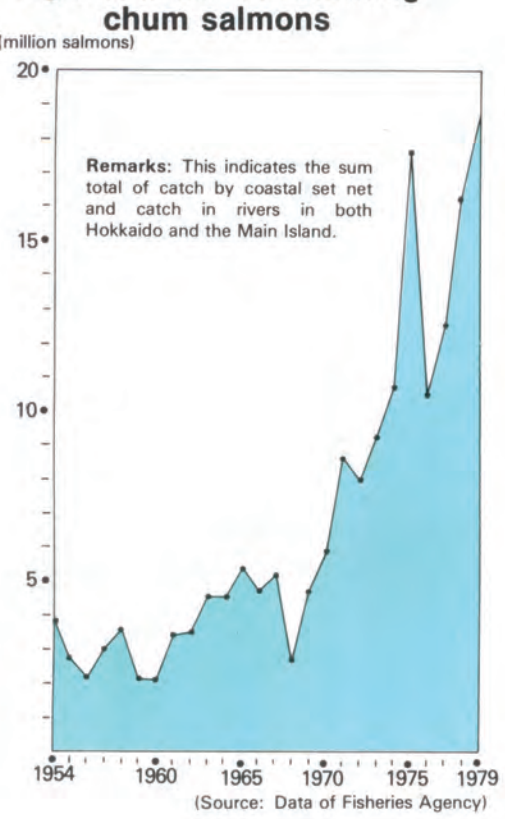


Fig.3 Number of returning chum salmons



(Source: Data of Fisheries Agency)

[2] Based on the results of ecological studies on salmons in rivers and coastal waters, incubation techniques have been improved and new techniques such as timely liberation have been employed. Especially, since 1962, liberation of strong fry after having been reared with feed for a given period after hatching has been carried out, and thus the natwral decrease rate during the descent to the sea has been reduced.

These technical developments have raised the homing rate of adult salmons (Fig. 2), and since 1970 the number of salmons coming to coastal waters has increased remarkably.

[3] A balance must be kept between depletion by catch in coastal waters and reproduction by propagation. In order to allow enough adult salmons to ascend the river, it is necessary to control the catch in coastal fishing grounds. For this purpose, the following measures of regulation have been taken:

(1) Any kind of fishing in the waters of specified estuaries is prohibited.
(2) A limitation is placed on the distance from the coast at which stationary nets can be set.
(3) Fishing season in coastal fishing ground is sometimes shortened or shifted according to the ascending conditons of salmons.

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An examination into the changes in the number of chum salmons of Japanese origin which returned to the coastal waters indicates that the total catch in coastal waters and rivers was at a level of 6—8 million salmons at the end of the nineteenth century. However, with the exploitation of fishing grounds, the catch has decreased, and since the beginning of the twentieth century it has decreased to less than 5 million salmons.

Since about 1967, liberation of fry after rearing by feeding for a given period has been generally practiced and subsequent liberation of healthy fry began resulting in a bigger catch after three years. In 1974, the number of salmons coming back to the rivers reached 11 million which corresponds to the highest number for the period from 1880 to 1890 when only natural spawning in the rivers was occurring. At present, it can be said that regarding chum salmon we have entered into a stage where the resources are completely propagated by artificial methods. (Fig. 3)

It is not possible, however, to increase the resources indefinitely. Propagation of the resources of anadromous fishes is limited by the basic productivity of the river. Expansion of human social activities and development of industries have deteriorated the living environment of salmons and have sometimes destroyed their living conditions completely. The following "modernization phenomena" are fatal to salmons:

- **Reduction or drying up of river waters by irrigation works.**
- **Cutting off the fishway by construction of dams.**
- **Water pollution by industrial wastes.**
- **Disappearance of coastal forests (fish-gathering forest) by land development.**
- **Modification into straight water courses by river improvement projects.**

The future tasks of salmon propagation projects are to conserve water resources and natural environments for better ecosystems for anandromous fishes.

go de la historia un producto de la providencia de la naturaleza, pero desde el advenimiento de la Era Meiji se ha logrado acelerar dicho proceso con la introduccion de técnicas de incubacion artificial ideadas en los Estados Unidos.

El salmón pasa la mayor parte de su vida en las profundidades del océano, terminando su ciclo vital al cabo de dos a cinco años. Para realizar la propagación artificial de la especie, fuè necesario preparar sistemáticamente las condiciones técnicas y económicas. Con el desarrollo de las técnicas de incubación y liberación después de muchos años de esfuerzos, tal coordinación de sistemas empezó a dar gradualmente buenos resultados.

Proyecto de propagación de salmones en Japón

El instinto que el salmón tiene de volver a su lugar de origen se conoce desde tiempos inmemoriales. En Japón se conoce un hecho ocurrido en 1764, cuando un joven samurai que vivía en un distrito costero del Mar del Japón, que habiendo conservado el estanque natural de desove del pez logró elevar el coeficiente de reproducción y duplicar el número de salmones que ascendían las corrientes de sus rios de origen.

La propagacion del salmón ha sido a lo largo de la historia un producto de la providencia de la naturaleza, pero desde el advenimiento de la Era Meiji se ha logrado acelerar dicho proceso con la introduccion de técnicas de incubacion artificial ideadas en los Estados Unidos.

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Projet de propagation du saumon au Japon

L'instinct de retour au point d'origine du saumon est connu depuis les temps anciens. Au Japon, il y un fait historique qui souligne ce phénomène, ainsi aux alentours de 1764, un jeune guerrier (samurai) dans les parages de la côte longeant la mer du japon qui s'occupait durant ses loisirs de l'elevage naturel des fraies de poissons a réussi a augmenté le coefficient d'élevage et aussi à doubler le nombre de saumons remontant les rivières jusqu'à la source.

Tout au long de l'histoire, la propagation du saumon fut le fait de la providence, mais depuis le commencement de l'époque Meiji, la propagation des ressources de saumon fut essayée en introduisant les techniques d'incubation artificielle provenant des Etats-Unis.

Le saumon vit la plupart du temps dans l'océan sans limites, et son cycle de vie s'arrête au bout d'une longue période de deux à cinq ans. En vue de réaliser la propagation artificielle des ressources, il était nécessaire de mettre au point des conditions techniques, systématiques et économique puis de les unifier. Par suite du progrès des techniques d'incubation et de libération grâce aux nombreuses années d'efforts des personnes concernées, la coordination des techniques aux points de vue social et économique fut poursuivie, et il en résulta progressivement des réussites concrètes pour le projet d'incubation et de libération.

Mere production increase based on artificial incubation would be risky.....

A remark by Mr. Ei-ichi Sakano, Director of the Chitose Branch, Hokkaido Salmon and Trout Hatchery

Because Japanese rivers are short and the basin areas are narrow, rivers have been easily subject to the influences of urbanization and industrialization. Consequently, a dramatic development of artificial spawning techniques was necessary. This is a countermeasure taken inevitably by the country which is blessed with vast land areas like Canada, Alaska or Siberia.

I must call your attention to the fact that a primitive Indian water wheel is still at work in nearly the same form as 90 years ago.

We have confirmed by long experience that this capture apparatus is best fitted to the conditions of this particular river.

In each capture site, a fishing gear suitable for its unique conditons has been adopted, and a fish keeping method in which injury or fatigue to the adult fish is avoided has been devised.

As to artificial incubation, the important point of this technique is to follow the fish's natural hatching conditions as far as possible, i.e., to intercept light, to avoid vibration and to reduce stress.

We are studying how far salmon resources can be increased by artificial incubation projects. In other words, we are studying how much "interest" (increase of resources) can be yielded by the best use of "the principal" (basic productivity of nature).

A lot of knowledge about salmons remains to be discovered. Therefore, production increase by means of artificial incubation would be risky, if it is based merely on the thought of so-called "factory production efficiency".

After transpacific migration of over 100,000 km

Returning

Salmon fisheries in the coastal waters of Japan are broadly divided into two types.
(1) Offshore fishing boat fishery by which a school of salmons coming to the adjacent seas in their feeding migration from spring to early summer (May to June) are caught. A drift gill net is used as the main fishing method, but longline is also used in some fishing grounds.
(2) Waiting-type fishery by which a school of mature salmons coming back for spawning from autumn to early winter (September to November) are caught in the coastal waters. A large set net is used as the main fishing method, and the next most frequently used method is small set net. The use of drift gill net in coastal waters is completely prohibited by the fisheries policy, and use of fixed gill net is also prohibited except in a few limited districts.

The total lanidng of salmons and trouts during the fiscal year 1978 in Japan, based on official statements, is as follows:

(1)	Catch by pelagic and offshore fisheries in the northern high seas and offshore waters of Japan	43,000 tons
(2)	Catch by coastal fishery	60,000 tons
(3)	Import	46,000 tons
	Total	149,000 tons

This indicates a supply structure in which each of the three sources, pelagic and offshore fisheries, coastal fishery and imports each account for about one third of the supply. Out of the catch by coastal fishery, 57,000 tons are landed by large and small set nets.

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Salmons (mainly chum salmon) caught by coastal set net in Hokkaido and the Tohoku districts have been called "Akiaji" (autumn salmon) since old times. They come into the coastal waters of Japan from September to December, but the time differs slightly according to the origin of salmons. The migration routes of the schools of salmons inferred from surveys based on liberaton of tagged salmons are as shown in the figure below. That is, schools of salmons which approach from the North Pacific Ocean will come to the east coast of Hokkaido after traveling south along the Kuril Islands. After that, they go south or west heading for their own mother rivers. (Fig. 1)

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The photographs show scenes of fishing and landing by large salmon set net.
Salmon set net employs a type of net called "Otoshi-ami" (stationary net with a trap). The structure of this fishing gear consists of a main net and leader net, with the main net consisting of three parts; (1) a swimming ground net, (2) a funnel (upward slope net), and (3) a trap net (box type bag net). As regards the trap net, there are two types: trap nets which are stationed only at one side of the main net, and the other where trap nets are stationed on both sides. The upper margins of both nets shown in figures 2 and 3 are fixed in the surface layer of the sea. In recent years, however, the net has been set also in deeper waters of 50—60m depth, in the salmon set net fishing grounds of Hokkaido. In Hokkaido, there are many days of bad weather during the winter season. In order to conduct fishing while overcoming severe weather and geographical conditions, a new type of fishing gear in which the trap net is set in the mid-layer of the sea has been developed in place of the former surface-layer type and has been put into practical use. Catch rate by mid-layer type set net is considered to be higher than that by surface set net because of the depth of the swimming layer of salmons and their behaviour after they enter into the net. Besides, the fishing work has been made easier by the introduciton of machines such as winchs.

Fig. 2 Set net with one-sided trap net

Fig. 3 Set net with two trap nets

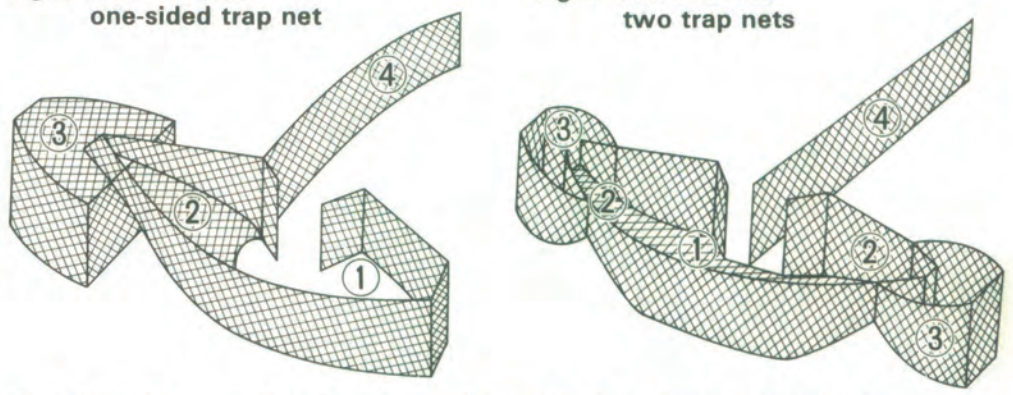
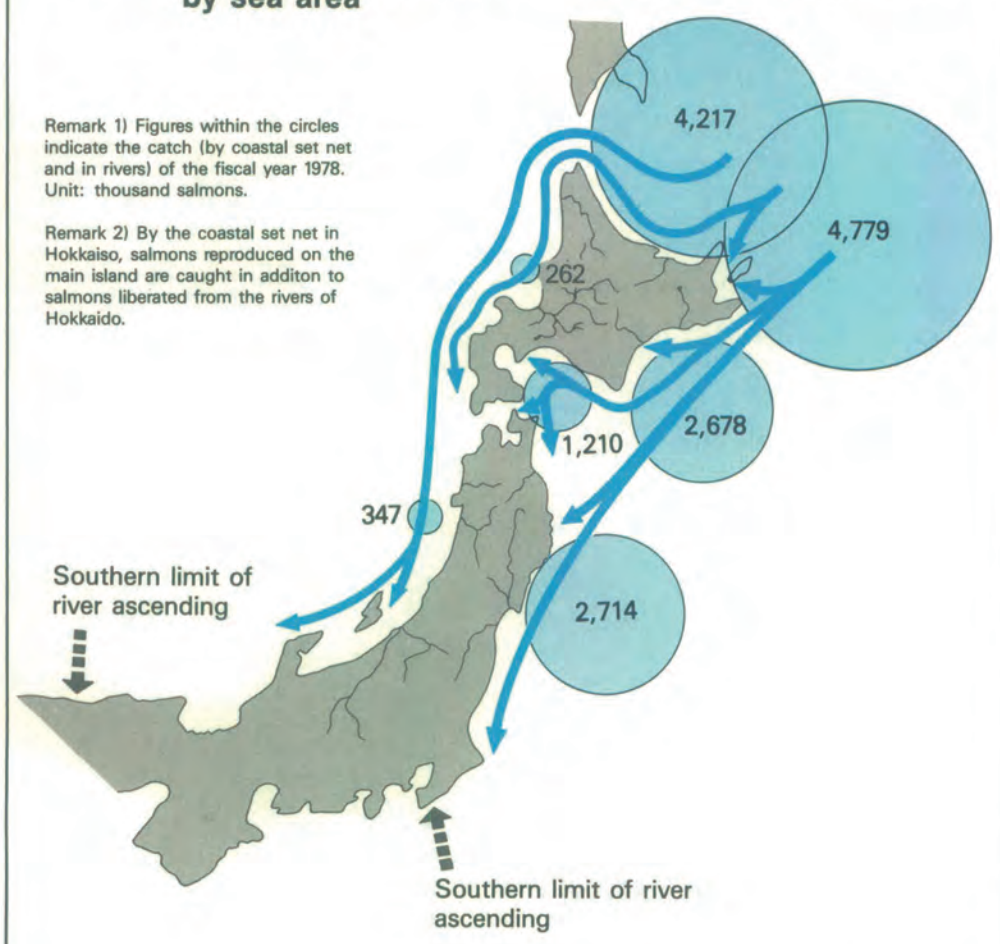


Fig. 1 Migration routes of salmons and catch conditions by sea area



(Source: Data of Fisheries Agency)

La pesca del salmón en aguas costeras en Japón, puede dividirse en dos grandes tipos.

(1) La pesca en barcos mar adentro, por medio de la cual son capturados los salmones que se acercan a las costas en busca de alimentos (de mayo a junio).

Generalmente es utilizada una red de arrastre, aunque también llegan a utilizarse en ciertas áreas extensas líneas.

(2) Pesca de espera, por medio de la cual un banco de salmones en plena madurez es capturado cuando vuelve río arriba, al desove, con la utilización de una red fija como práctica general, seguida de otra más pequeña.

La utilización de redes de arrastre en las aguas costeras está completamente prohibida por los códigos de pesca, y las redes rastreras verticales que permiten pasar las cabezas de los peces pero que los sujetan de las branquias cuando intentan escapar, también están prohibidas, a excepción de un distrito muy limitado.

Les pêches de saumon dans les eaux côtières du Japon peuvent être classées approximativement en deux sortes.

(1) La prise de poissons, au large par des bateaux de pêches à la recherche des bancs de saumons venant dans les mers adjacentes et en alimentant la migration depuis le printemps jusqu'au début de l'été (mai à juin). Le filet à la traîne est utilisé principalement comme méthode de pêche, mais la ligne longue est aussi utilisée dans certains secteurs de pêche.

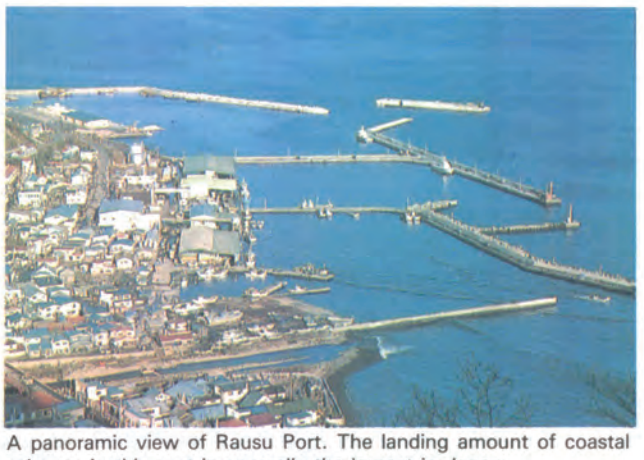
(2) La pêche du type à attente par laquelle un banc de saumons de taille revenant pour la ponte est pris dans les eaux côtières. Un grand filet est généralement utilisé comme méthode de pêche suivi d'un petit filet.

L'emploi du filet à la traîne dans les eaux côtières est tout à fait interdit par la police des pêches, et l'utilisation d'un filet fixe est aussi interdit sauf dans un secteur limité seulement.

to Their Native Place

Salmon set net is operated under the management of juridical enterprises, fisheries cooperative associations or private management bodies. This photograph shows a producers' union organized by seven coastal fishermen. They are operating the fishery by hiring "a fishing boss and his team" from other prefectures and by using their own sons as apprentices. The fishing boss is a professional fisherman having his own subordinates who makes a percentage contract with the management body having the set net rights and is responsible for the planning and setting of fishing gear and supervision of fishing.

Yamaha Fishing Boat, DX-199-OA Type. This is a fishing boat of 19.9 gross tons used for salmon set net fishing. Four boats are in operation in Hokkaido. Unsurpassed in cruising ability (especially in speed and balance), they are valued highly by each shipowner.



A panoramic view of Rausu Port. The landing amount of coastal salmons in this port is generally the largest in Japan.

The fish market of Rausu Port. After being caught into the market, fishes are sorted according to the species, sex, degree of sexual maturation and size, and then they are sold by auction.

Net hauling. In the main fishing season, several thousand salmons enter the net in a day. Thus, salmons must be transferred into a fish hold with a landing net which is lifted, as shown in the photograph, by a power-driven winch. The fish hold of the Yamaha Fishing Boat DX-199-OA type can accommodate 6,000 salmons (about 2 tons).

Conformity to the Natural Life Cycle

Chum salmon does not descend the river again to the sea after spawning. Both female and male die after completely using up all their strength. The dead body is eaten by birds or other wild animals and it is restored to the ecosystem of the river after being resolved into organic substances by decomposition.
When spring comes and the snow starts to melt, these organic substances begin to flow out into the mountain streams and become the nurtriments for various kinds of aquatic organisms. These aquatic organisms are eaten in turn by descending fry of the next generation.
Artificial incubation and liberation projects for salmon must be planned so as to conform to this subtle natural life cycle. Here, an annual schedule for an artificial incubation and liberation project is introduced taking chum salmon (Oncorhynchus keta) in Hokkaido as an example.

1. Capture in rivers

Chum salmons which were born in Hokkaido come back to the coastal waters searching for their mother rivers when August comes. They ascend the river from September to November. Because the ovary is not yet mature at the time when they have just begun to ascend the river, in the past they were caught at a capture facility constructed in the middle or upper stream areas after waiting for a natural maturation. At present, however, since long-term preserving techniques have been established, they are also caught in the downstream areas.
The most widely used fishing method is to catch them alive by means of a fish trap, but in some places beach seine is also used in the downstream portions below a weir constructed in the lower course or the middle course of the stream. At present, the aforementioned Indian water wheel capture apparatus is only at work in a single place in Chitose.

2. Fish preservation

Immature adult salmons are reared in an artificial pond or in the river partitioned at two places, upstream and downstream. The water of the preserving pond is kept at a good living condition by a natural stream or by a forced circulation method, and nearly the same speed of water curent as in the natural condition is maintained. Moreover, a sufficient amount of dissolved oxygen is also maintained by sprinkling the pond with water, and direct sunlight is intercepted with a sunscreen.

3. Egg-taking and insemination

Adult salmons used for egg-taking and insemination are killed by striking them on the head. Immediately after the death, the abdomen of the female salmon is cut open and egg are gathered in an egg receptacle. When eggs from four to six salmons are taken in a receptacle, spematozoa pressed out from more than two male salmons are poured on the eggs. After that, they are mixed well, and are kept quiet after stirring and adding clear water. By this addition of clear water, fertilization is induced.
About 30 to 60 minutes after the insemination, the egg begin to absorb water and the eggs membrane becomes hard. The eggs thus become resistant to pressure, and they are transferred to the incubation room.

4. Artificial incubation

During incubation, eggs go through a process which includes appearance of eyes, selection and hatching. For a period of 60 days before hatching, they are reared in running water (at 8°C) within an incubator. Formerly an Atkins-type incubator in which eggs are layered on a drainboard was used, but since several years ago, a box-type incubator (free incubator) which can accommodate 500 thousand eggs per incubator has been widely used. Because the speed of growth of eggs is greatly affected by the temperature of the incubation water, the temperature must be controlled precisely, and moreover, since eggs are sensitive to light and physical stimulus, any kind of shock must be avoided as much as possible.
After the appearance of eyes, unfertilized eggs (white eggs seen in the photograph) are removed.

5. Rearing

(1) Method for rearing in fresh water:
Rearing of fry after hatching is carried out in the following two steps: rearing in a sac-fry raceway and feeding in a rearing pond. The sacfry raceway is a long and narrow waterway constructed indoors. Small pebbles are spread on the bottom, and rearing water depth of 25—30cm is maintained by running water. As in a natural spawning ground, alevins lie hidden in dark places among the small pebbles taking nutriens from the yolk sec. Fifty days after hatching, some alevins begin to swim and to eat planktons and larvae of midge.
Fry which have begun to feed by themselves are led into an outdoor rearing pond, and they are brought up into strong fry by feeding with artificial food.
(2) Method for rearing in the sea:
At present, this method is being propagated mainly in the Tohoku district.
Fry brought up in a freshwater hatchery for a certain period are transferred into a fish preserve net set in the sea, where their growth is promoted by feeding, and they are liberated at the period in the spring when natural young salmons would begin to migrate from the coastal waters to the open sea.

6. Liberation

Fry are liberated according to the descending time appropriate to each water system. Fry will descend the river by their own efforts; however, when an obstacle such as a system to pump up water for agricultural irrigation purposes is present, measures to tranport them to a safe area and to liberate them there are also taken.

De conformidad con el Ciclo Natural de la Vida

Un proyecto de incubación artificial y liberación de salmón debe planearse de acuerdo con su delicado ciclo natural de vida.

Aquí se muestra un programa anual para la incubación artificial del salmón de carnada (Oncorhynchus keta) en la isla de Hokkaido como ejemplo.

Conformité du cycle de vie naturel

Le projet de libération et d'incubation artificielles du saumon doit être planifié de manière à être conforme à son cycle de vie naturel subtil.

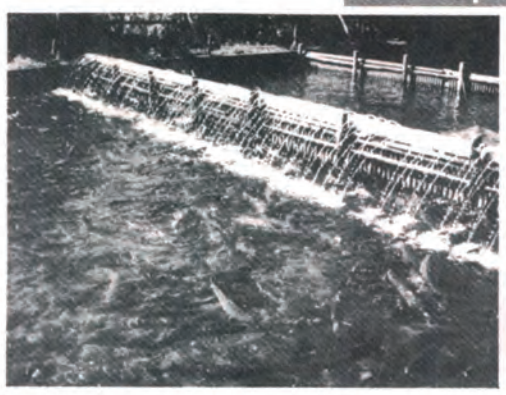
On trouvera ci-après un tableau annuel du projet de libération et d'incubation artificielles du saumon commun. (Oncorhynchus keta) à Hokkaido comme exemple.

1. Capture in rivers

Relation between the life cycle of chum salmon and artificial incubation projects

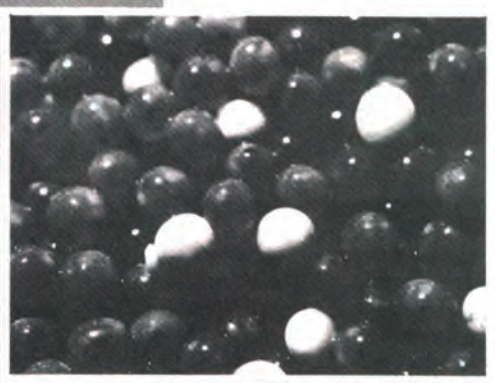
Season (Hokkaido)	Life cycle	Biological stage		Artificial incubation project
September ~ January (Major season: October ~ November)	Return to the coastal waters	Salmon	• Sexually matured salmons of 2 to 5 years old. Frequency distribution by year class is shown as 4 years old>3 years old>2 years old>5 years old.	Capture in the river → Temporary preservation
	Asceding the river		• Generally, salmons ascending the river early in the season spawn in the upper stream, and those ascending later in the season spawn in the downstream areas. • Places where the bottom material is stone or pebble and water is clear are selected as natural spawning grounds. • Spawning grounds are greatly affected by natural conditons, especially by yearly and seasonal variations in water supply.	Egg-taking → Insemination
October ~ January	Spawning ↓ Fertilization	Egg	• The number of eggs produced by one female chum salmon is about 2,700. Eggs are laid in two to three separate portions.	Artificial incubation
January ~ April	Living in the fresh water	Alevin	• The alevin is a hatched larva still attached to the yolk sac. It stays between pebbles as it takes nutrients from the yolk sac. • Fry begin to swim out and take food actively as it swims in the river.	Rearing by feeding
March ~ June (Major season: April~May)	↓ Descending to the sea	Fry	• Fry live in a complicated food chain. With the beginning of descending stage, a change in feeding habits takes place. This change corresponds exactly to the appearance of certain food organisms. The living environment of the river exerts an important influence on the survival rate. • Fry entering into the sea stay in coastal waters for a while and adapt themselves to life in the sea water. In Hokkaido, fry at this stage are found from March to early July.	Liberation
	Leaving the coast			

2. Fish preservation

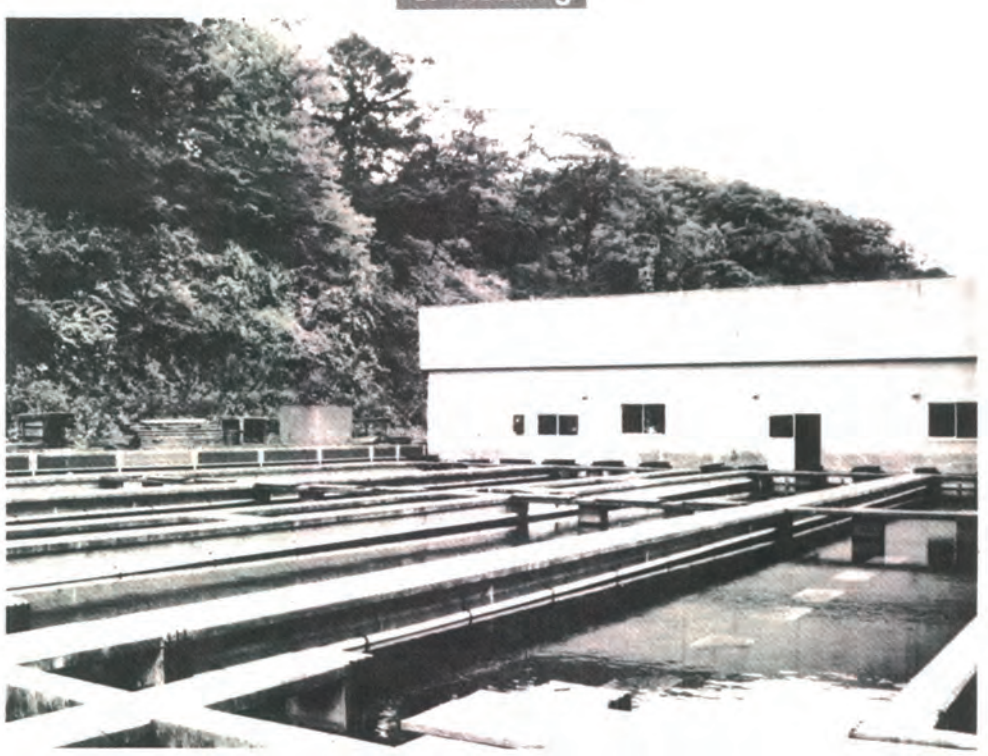


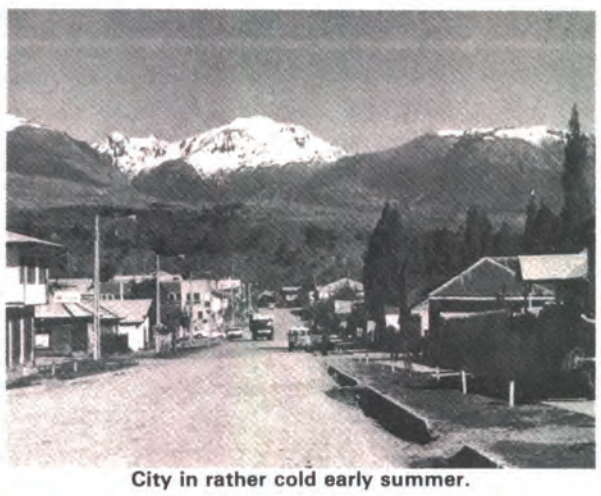
3. Egg-taking and insemination

4. Artificial incubation

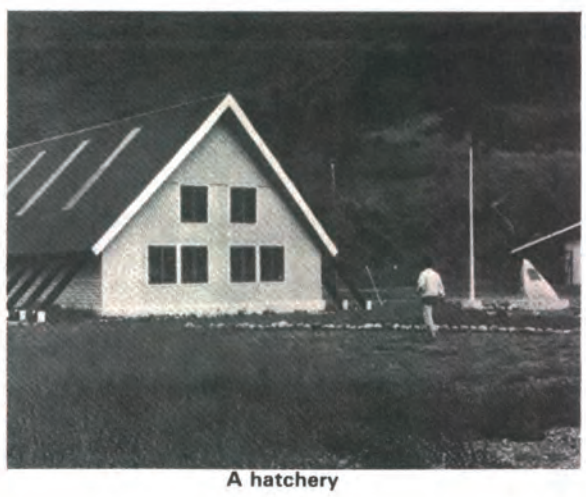


5. Rearing





City in rather cold early summer.



A hatchery

Can we Succeed In Imprinting?

A project transplanting chum salmon from the northern hemisphere into the southern hemisphere is now being forwarded under an international cooperation between the governments of Japan and the Republic of Chile.

Salmon propagation is a theme with high possibilities for the development and advancement of shallow sea fisheries in Chile, but this is, biologically and ecologically, a unique task which poses the following difficult problems:

- **Can transplanted salmons adapt to altered environment in which the four seasons have been reversed between the northern hemisphere and the southern hemisphere?**
- **Is the Humbolt Current which diverges toward the pole and moves into a wide area suitable as a living environment for salmons?**

These questions can not be solved in an apriori manner. The answers must be obtained through experiment, that is by actual transplantation.
This project has its origin in an on-the-spot survey for the promotion of international fishery by Dainihon Suisan-kai (Japan Fisheries Association) in 1969. After that, technical assistance for the salmon propagation project was requested by the Chilian Government to the Japanese Government, and in 1972 technical cooperation on a governmental basis was undertaken.
From 1972 to 1978, Japan continued to provide materials to Chile, and to dispatch experts each time an individual request was made. In addition, since 1974, salmon eggs have continued to be transported from Japan,followed by artificial incubation, and a total of about 8 million fry have been liberated into the river Rio Simpson located in southern Chile. At present, however, the return of adult salmons has not been confirmed.
Accordingly, the Japanese Government dispatched an investigatoin mission in November of 1978. Based upon their investigation report, a master plan for an aquaculture project was formed. As a result, problems of chum salmon transplantatoin projects and the methods of proceeding with this plan in Chile were discussed once again by the two governments, and an agreement was reached just recently to change the cooperation method from the former "dispatching of experts on an individual case basis" to "cooperation on an overall project basis". This transplantation project was started by relying on the homing instinct of salmon and by depending on the advanced techniques for artificial incubation and liberation used in Japan. However, in order to make this project successful with high probability, adaptation of the incubation and liberation techniques to the local conditions, consolidation of the survey system, and intensification of the cooporation system between the two countries in enforcing this project had to be realized.

At present this project is being conducted with the aim of developing model of aquaculture, mainly of salmons, based upon the following important points:

(1) Advancement of local incubation techniques for more reliable liberation and establishment of local management systems.
(2) Ecological survey of the rivers and countermeasures for deaths due to predators.
(3) Surveys on the proper time and site for liberation of fry.
(4) Surveys on sea conditions in the coastal waters.
(5) Establishement of a survey system and securement of mobility means for locating returning salmon.
(6) Research on transplantable species other than chum salmon, etc.

* * * * * * * * *

Chile, situated in the southwest part of the South American Continent, is a long and narrow country extending north and south from 18° to 56° S Lat. The present fisheries include: (1) meal fishery in the northern part mainly catching anchovy, sardine and horse mackerel, (2) trawl fishery in the central part catching merluza, and (3) small-scale fishery in the southern fjord area gathering shellfishes and sea urchins. The Chilian Govenment has shown a great interest in finding measures for the fishermen engaging in small-scale fishery in the southern region, and the chum salmon propagation project has been considered as one of the potential measures to promote the economy of small fishing villages.

Actualmente se está llevando a cabo un proyecto para el transplante del salmón de carnada del hemisferio norte al hemisferio sur, bajo cooperación internacional entre Japón y Chile.

Este proyecto de trasplante está fundamentado en el instinto del salmón por volver a sus lugares de origen y dependiendo de las técnicas avanzadas para la incubación artificial y liberación desarrolladas en Japón. Pero para lograr que el proyecto arroje resultados satisfactorios, deben hacerse con anticipación las adaptaciones técnicas correspondientes a las condiciones ambientales locales, amén de un estudio de las mismas y la intensificación de la colaboración y sistemas de cooperación entre los dos países.

Al momento, está siendo llevado a cabo el desarrollo de un modelo de acuacultura principalmente para el salmón, tomando como fundamentos básicos los siguientes puntos:

(1) Mejoramiento de las técnicas locales de incubación para una liberación más segura y confiable y el establecimiento de un sistema administrativo.
(2) Una investigación ecológica en los ríos y la toma de medidas preventivas al daño o depredación de carnívoros.
(3) Estudio del mejor sitio y tiempo para la liberación de las crías.
(4) Estudio de las condiciones marítimas en las aguas costeras
(5) Establecimiento de un sistema de investigación y aseguramiento de una fuente móvil de energía para el rastreo del salmón que retorna.
(6) Investigación de otras especies trasplantables además del salmón de carnada.

Le projet de transplantation du saumon commun de l'hémisphère nord à l'hémisphère sud est maintenant en cours sous la coopération internationale entre les gouvernements du Japon et de la République du Chili.

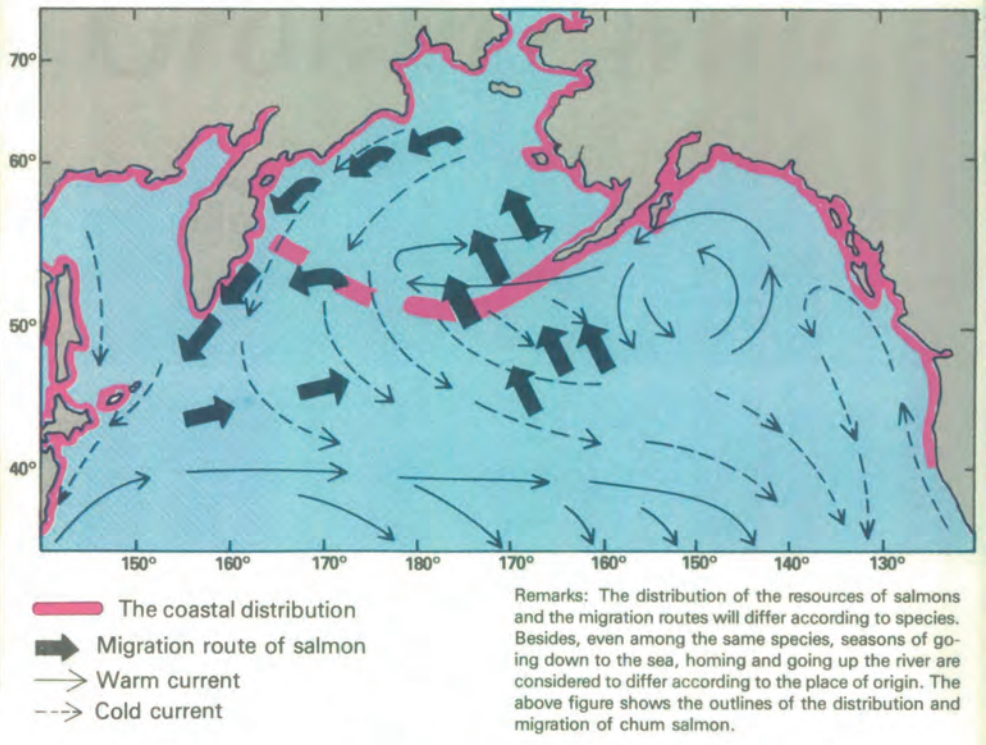
Ce projet de transplantation a débuté en se basant sur l'instinct de retour au point d'origine du saumon et en dépendant sur les techniques japonaises perfectionnées pour la libération et l'incubation artificielle. Mais, afin de faire aboutir ce projet avec un pourcentage de réussite très probant, l'adaptation des techniques d'indubation et de libération aux conditions locales, l'efficacité du système de surveillance, et l'intensification du système de coopération entre les deux pays pour mener à bien ce projet doivent être accomplis.

A l'heure actuelle, ce projet est en progression et vise au développement d'un système d'aquaculture modèle principalement du saumon en se basant sur les points importants suivants:

(1) Amélioration des techniques d'incubation locale afin d'obtenir une libération plus sûre et l'établissement d'un système de contrôle.
(2) Etude écologique dans les rivières et contremesures pour les dommages par les carnivores.
(3) Etude dans le temps et sur place pour la libération de la fraie
(4) Etude sur les conditions marines dans les eaux cotières.
(5) Mise au point d'un système d'étude et sécurité de la puissance mobile pour rechercher le saumon revenant au point d'origine
(6) Recherches sur les espèces transplantables autres que le saumon commun, etc.

Chum salmon fry just after incubation.

Fig. 1 Figure showing the coastal distribution and migration routes in the North Pacific Ocean of chum salmon originating in Japan



Remarks: The distribution of the resources of salmons and the migration routes will differ according to species. Besides, even among the same species, seasons of going down to the sea, homing and going up the river are considered to differ according to the place of origin. The above figure shows the outlines of the distribution and migration of chum salmon.

Salmons Propagated by Incubation and Liberation in Japan

The family Salmonidae includes the following four genera:
Genus *Oncorhynchus*
Genus *Salmo*
Genus *Salvelinus*
Genus *Hucho*
Out of these genera, the following six species of the genus *Orcohynchus* are found in the North Pacific Ocean and have commercial value as fishery resources.
The salmons caught by commercial fishery are the species which go through anadromous migration, and at present in Japan several species including, firstly chum salmon, then pink salmon and masu salmon are propagated by artificial egg-taking, incubation and liberation.

Salmones propagados por incubación y liberación en Japón.

La familia de los salmónidos incluye los siguientes cuatro géneros:
Género *Oncorhynchus*
Género *Salmo*
Género *Salvelinus*
Género *Hucho*

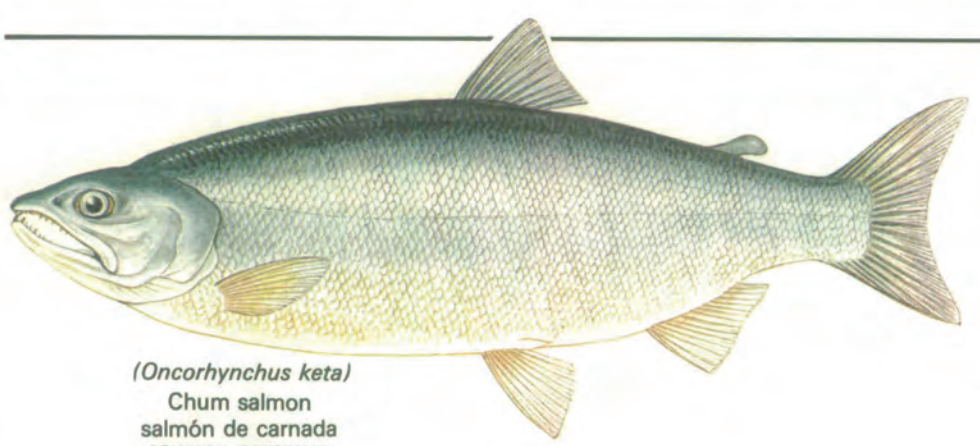
Aparte de los mencionados, existen otras seis especies del género Oncorhynchus como el salmón de carnada *(Oncorhynchos keta),* salmón rosado *(O. gorbuscha),* salmón rey *(O. tshawytscha),* salmón-trucha *(O. trucha asalmonada) (O. masou),* salmón plateado *(O. kisutch)* y salmón rojo *(O. nerka),* que están distribuídos en áreas del Océano Pacífico Norte y tienen un importante valor industrial como fuente de pesca.

Los salmones objeto de la pesca son las especies anadromas o de migración anadrómica, siendo actualmente producidos y propagados en forma artificial en Japón, primordialmente el salmón de carnada.

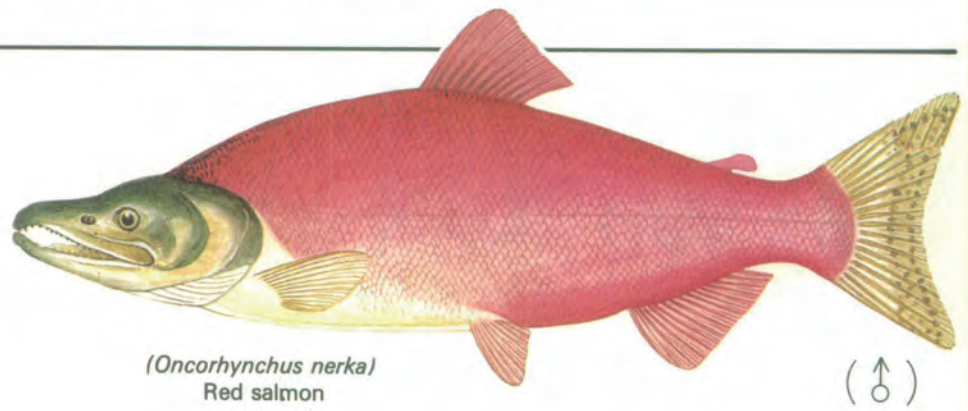
Saumons propagés par incubation et libération au Japon

La famille Salmonidae comprend les quatre catégories suivantes:
Genus *Oncorhynchus,*
Genus *Salmo,*
Genus *Salvelinus,*
Genus *Hucho*
Dans ces catégories, six espèces de Genus Oncorhynchus c.a.d., saumon commun *(Oncorhynchus keta),* saumon rose *(O. gorbuscha),* saumon royal *(O. tshawytscha),* saumon masu *(O. masou),* saumon argenté *(O. kisutch),* et saumon rouge *(O. nerka),* sont répartis dans l'océan Pacifique du nord et ont une valeur industrielle comme ressources de pêches.

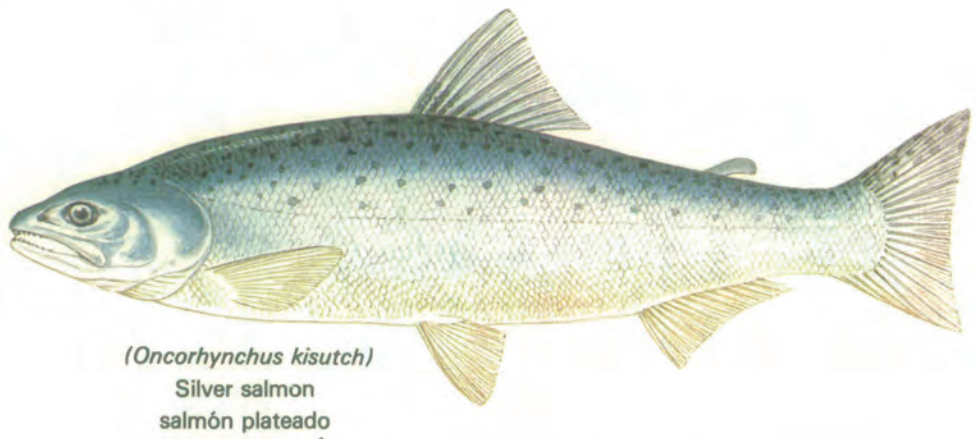
Les saumons qui font l'objet des pêches sont les espèces appartenant au type à migration anadromous et en ce moment au Japon certains saumons y compris d'abord le saumon commun sont propagés par recueil de fraies, incubation et libération artificielles.



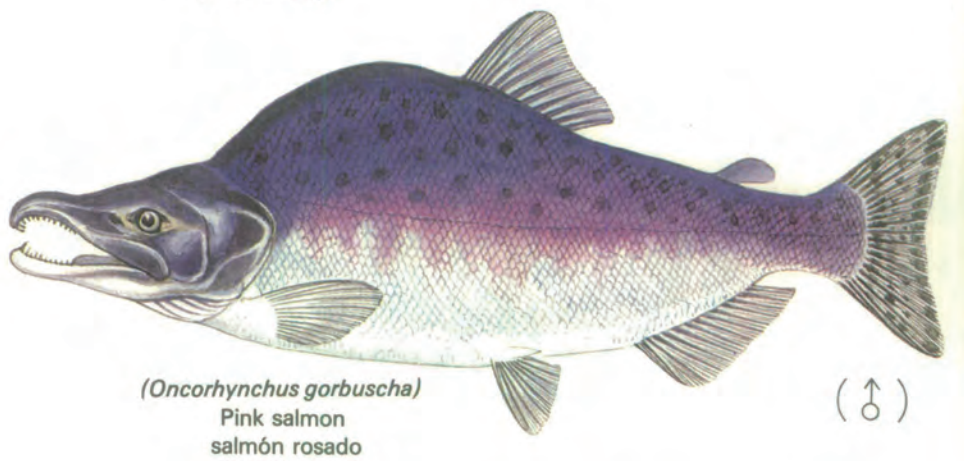
(Oncorhynchus keta)
Chum salmon
salmón de carnada
saumon commun



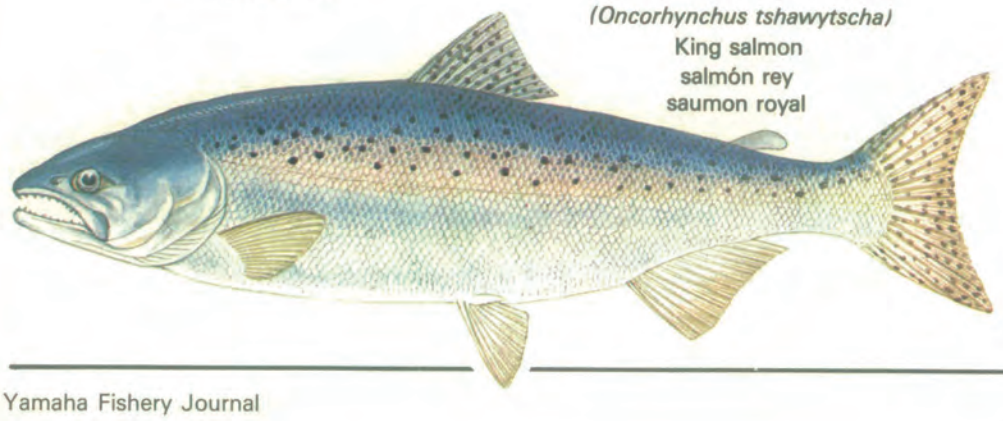
(Oncorhynchus nerka)
Red salmon
salmón rojo
saumon rouge



(Oncorhynchus kisutch)
Silver salmon
salmón plateado
saumon argenté



(Oncorhynchus gorbuscha)
Pink salmon
salmón rosado
saumon rose



(Oncorhynchus tshawytscha)
King salmon
salmón rey
saumon royal

(Oncorhynchus masou)
Masu salmon
salmón-trucha
saumon masu