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A SURVEY OF SCIENTIFIC RESEARCH IN FISHERIES CONDUCTED IN KAMCHATKA DURING SOVIET RULE

I. I. Luganov

The study of Kamchatka was begun considerably earlier than that of other regions of the Far East. The earliest information about the peninsula and the fish of the coastal waters was presented in a work which was written by a participant of the Second Kamchatka Expedition, S. P. Krasheninnikov, entitled A Description of the Land of Kamchatka (1755).

Scientific expeditions and individual researchers visited Kamchatka in the 19th and early 20th century. The most useful work on Kamchatka was done by an expedition of the Russian geographical society (1908-1909) in which V. L. Komarov, P. Yu. Shmidt, A. N. Derzhavin and others participated. The data on the biology of fish and other marine animals of the peninsula was presented in the transactions of the zoological division of this expedition.

With the establishement of Soviet rule in Kamchatka conditions were created for a systematic study of commercial ichthyofauna. These studies were begun by the Pacific Ocean Scientific and Commercial Station (TONS) which was organized in Vladivostok in 1925 and which became the Pacific Ocean Scientific Institute of Fisheries (TIRKh) in 1929 and which is today TINPO.* Its scientific personnel studied the commercial fish of Primor'ya, Kamchatka and the north-west coastal waters of the Bering Sea (Anadyr'). Thus, as early as the 20's I. F. Pravdii worked on the Bol'shaya River, I. I. Kuznetsov on the Kamchatka River, A. G. Kaganovskii on the Anadyr' R. and I. A. Polutov and others on the Apuk R.

The most interesting results of these studies were published in a work by I. I. Kuznetsov, Some Observations on the Propagation of Amur and Kamchatka Salmon (1928) which served as a reference book for researchers working on Pacific Ocean salmon in the thirties. However, with rare exception, the studies conducted in this period did not include quantitative data and, therefore, they did not provide the basis necessary for determining the state of the reserves or for prognosis.

Regular studies of the commercial fish in Kamchatka, mainly Pacific Ocean salmon were begun in the summer of 1932 after the organization of the Kamchatka Division of TIRKh in Petropavlovsk. M. A. Fortunatov who was the first scientific director of the division devoted a considerable amount of effort

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*Pacific Ocean Scientific Research Institute of Sea Fisheries and Oceanography. Translator

to its organization. The first scientific workers of the division were A. S. Baranenkova, V. B. Bool', D. G. Manizer, F. V. Krogius, E. M. Krokhin, V. I. Gribanov, K. I. Panin, I. A. Polutov, R. S. Semko, M. L. Al'perovich and others.

By the end of the first ten years of the existence of the Kamchatka division there were approximately 40 scientists and technicians with different specialties on the staff. All research was coordinated under a single commercial fish laboratory which, at various times, was headed by V. V. Abramov, K. I. Panin and I. A. Polutov.

Sea research in the waters of the eastern coast of Kamchatka was carried out in the early years on the schooners "Sosunov" and "Dezhenev"; at the time of the Second World War, on the cutter "Bering" and seiner "Avacha"; and in the post-war years, on the medium fishing trawler "Amatist"* and the small fishing seiner "Gribanov". In addition, scientific research vessels which were part of a long-term TINRO exploration program were dispatched regularly to study the marine period in the life /4 of salmon in the north-western part of the Pacific Ocean and to study the commercial fish of the shelf waters of Kamchatka.

During the 35-year period of its existence the directors of the division have been V. V. Zaostrovskii (1932-1933), V. I. Gribanov (1933-1937), P. A. Dvinin (1937-1939), K. I. Panin

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*Amethyst. Translator.

(1949-1955), P. G. Nikulin (1955-1959), I. I. Luganov (1959-1964) and A. K. Evdokimov from 1964.

The Kamchatka Division of TINRO has always been only a link in the overall system of the science of fisheries in the Far East; it grew and became stronger together with the growth of TINRO (Pacific Ocean Scientific Research Institute of Fisheries and Oceanography). At the present time, the division represents a large establishment in the Far East with a staff in excess of 100 scientists and auxiliary workers, three of whom have doctorate degrees and nine of whom are candidates of science.

The following laboratories have been established and are functioning: the commercial marine fish laboratory headed by I. A. Polutov (1950-1966) and T. F. Kachina), the salmon production laboratory (headed by R. S. Semko (1952-1963) V. Ya Levanidov), the Paratunka experimental laboratory (headed by E. M. Krokhin), the laboratory for the study of the marine period of life of salmon (headed by I. B. Birman), the laboratory of food supply and commercial oceanography (headed by I. I. Kurenkov) and the laboratory for the study of pinnipeds (headed by P. G. Nikulin). In the period from 1951 to 1964, the work of the laborabory on mechanization in the division was very effective (headed by N. F. Chernigin (1949-1958 and V. F. Turasov). In various years, the problems on the improvement of fishing gear was worked out by A. P. Shikalov, V. A. Maksimov, A. I. Zonov, E. D. Karakotskii, V. N. Chestnoi and others.

STUDIES OF KAMCHATKA SALMON

In the early period of the division's existence the Kamchatka fishing industry was mainly a coastal salmon fishery. The fishery of sea fish, limited mainly to the catch of herring and cod in the regions adjacent to the Kamchatka coast, was developed to a considerably smaller extent. For this reason, the main tasks before the division were the study of the biology and the conditions of propagation of Kamchatka salmon, the ascertainment of the causes of fluctuation in the magnitude of their commercial stock and the development of methods for predicting the intensity of spawning runs.

Fluctuation in the numerical strength of salmon is connected with the process of propagation, thus research was first conducted on the fresh water period of their life.

Since the biology of salmon had only been slightly studied, the need arose from the very first years to carry out field research on these fish at the places where they propagate.

In August of 1932, despite organizational difficulties, E. M. Krokhin, F. V. Krogius and A. S. Baranenkova visited Lake Dalnee in the Paratunka river basin and collected data on the biology of sockeye salmon which propagates in the lake. These studies were continued in 1933 by A. S. Baranenkova and in 1934-1935 by P. I. Orlova and V. E. Gorogodskii; from 1935 to the present time studies on this lake have been continued by F. V. Krogius and E. M. Krokhin.

In September and November of 1932 and in the spring and autumn of 1933, F. V. Krogius and E. M. Krokhin conducted studies on Lake Kuril'skoe and on the stock of sockeye salmon produced in it. The results of these studies are stated in the monograph An Outline of Lake Kuril'skoe and the Biology of Sockeye Salmon in Its Basin.

In the autumn of 1932 and the spring of 1933, /5
A. S. Baranenkova studied Lake Nachikinskoe and the sockeye which spawns in it.

During the studies on lakes Kuril'skoe, Nachikinskoe and Dalnee a visual estimate of the numerical strength of sockeye in the spawning grounds, determination of the measurements of the spawning areas, compilations of maps of spawning grounds and a determination of the survival of eggs were made for the first time.

In the 30's, in the Bol'shaya river basin, a very large number of pink salmon were spawned which comprises a considerable part of its west-Kamchatka stock. In the summer of 1933, F. B. Krogius and E. M. Krokhin began composite studies in the Bol'shaya river basin, where all species of Pacific Ocean salmon are produced. The results of their work were published in An Outline of the Bol'shaya River Basin and The Spawning Grounds of Salmon Located in It.

In 1934, studies of the Bol'shaya river basin were conducted by P. A. Dvininyi, and beginning with 1935 they were continued by him together with R. S. Semko who, with a brief interruption, has conducted observations on this basin up to

the present time. The results of the studies of R. S. Semko were published in his works entitled Kamchatka Pink Salmon and The Stocks of Western Kamchatka Salmon and Their Commercial Value.

In the spring of 1935, E. M. Krokhin and M. L. Al'perovich made a field trip in Lake Kronotskoe to study the lake and the landlocked salmon living in it for the purpose of asertaining the possibility of transforming the lake into a place for the propagation of a large stock of diadromous sockeye.

Year-round observations of coho salmon were conducted for two years in the Paratunka river basin. From the observational data in this basin as well as in other regions of Kamchatka, V. I. Gribanov published an outline of the biology of coho salmon. A. S. Baranenkova was the first to describe the fry of all species of Pacific Ocean salmon.

Thus, as a result of the field work between 1932 and 1936, a beginning was made in long-term observations in the main regions of the salmon industry; in a number of bodies of water first appraisals were made of the number of salmon spawning grounds and the sizes of the spawning areas; the characteristics of different types of spawning grounds (river, lake and spring) and the conditions existing in them for salmon production were given. In addition, a number of specific problems were studied, for example, the effect of timber-rafting on the spawning grounds in the Kamchatka R.

However, it was impossible by means of field trips to explain the causes of the fluctuations in efficiency of the natural production of salmon and to give the nature of the

dynamics of their numerical strength, i.e., to obtain the data which is necessary for making predictions. For this reason, the Kamchatka Division of TINRO proceeded to organize stationary research.

The first stationary post for the observation of sockeye production was created in 1937 on Lake Dalnee in the Paratunka river basin. Research programs of five-year duration showed that up to 150 thousand specimens of sockeye were produced in the lake and it was possible to take stock of both the spawners passing by to spawn and the downstream migrant fry. The observation post on Lake Dalnee made good progress: the first numerical prognosis of the magnitude of the spawning migration of sockeye was given as early as 1939. The thirty years of experience at the observation post (today, the Paratunka Experimental Laboratory) has shown that the selection of this body of water was a very fortunate one. A survey of the works carried out by the observation post and the Paratunka Experimental Laboratory of KoTINRO* is published in the present collection. Stationary observation posts have also been establsihed at Lake Kuril'skoe where sockeye stock of great commercial value propagates, at Karymaiskii Spring in the Bol'shoya river basin, at the mouth of the Kamchatka R. and later at Utka R. /6

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*Kamchatka Division of TINRO. Translator.

The experience of the work of the observation posts of KoTINRO showed the soundness of expanding the network of stationary observations and served as an example in the organization of Meliorative Fish Breeding Stations (RMS) of the Kamchatka Fish Breeding Establishment. The stock-taking which was made at the observation posts was included in the programs of work of the RMS. Let us consider the work of the stationary posts in more detail.

Lake Kuril'skoe

In 1940, at the suggestion of KoTINRO, the Far Eastern administration of fish conservation organized an observation post on Lake Kuril'skii. A member of the administration, V. V. Azbelev, set up a weir close to the source of Ozernaya R. for purposes of calculating sockeye spawners which spawn in the lake and its tributaries. In 1941, after the post was brought under the management of KoTINRO, research was headed by V. I. Gribanov who, together with V. V. Azbelev, made an estimate of the number of downstream-migrant fry according to a three-point system and also conducted regular observations on the structure of the stock, survival of eggs, food supply for fry in the lake and the hydrological regime of the lake. All of these observations are still being made at the present time. T. V. Egorova has been working continuously at Lake Kuril'skoe since 1949.

A prognosis of the number and age composition of sockeye in the Ozernaya R. was first made in 1940 and since that time a prognosis has been made annually.

The stock of sockeye in the Ozernaya R. which is produced in Lake Kuril'skoe is the largest on the Asiatic coast of the Pacific Ocean. The numerical strength of its sexually mature, migrating to spawn, reached 9.6 million specimens in the generation which resulted from the 1949 spawning. The sexually mature sockeye which approaches the shores, both the caught sockeye and the sockeye which passes by to the spawning grounds, has been fully taken into account for 26 years. In that time, the escapement of spawners has fluctuated from 0.3 to 4.2 million specimens. The optimal number of sockeye spawners for the basin of Lake Kuril'skoe was determined at 2.5 - 3.0 million specimens.

The Ozernaya sockeye stock is one of the most important sources of the Japanese industry in the open sea. With the effect of marine fishery, the downstream migration of sockeye towards the mouth of the Ozernaya River has been considerably reduced and, frequently, sufficient numbers of spawners do not enter the lake. As a result, the overall numerical strength of the sockeye of this stock is reduced.

On the basis of a study of the differences in the scale structure of sockeye of individual local stocks (F. V. Krogius) and parasitofauna (S. M. Konovalov) as well as observations in the sea (I. B. Birman), it was possible to explain the distribution of the stocks of Ozernaya sockeye during spawning migration to

the north-western part of the Pacific Ocean. This made it possible, annually, to take into account the catch and determine the numerical strength of sexual mature sockeye.

From the time of the conclusion of the Soviet-Japanese fishing convention, the observations and prognoses which have been made on Ozernaya sockeye have had important international value.

The main results of the research on sockeye have been stated in an article by T. V. Egorova, F. V. Krogius, I. I. Kurenkova and R. S. Semko entitled The Causes of Fluctuations in the Numerical Strength of Sockeye in the Ozernaya River and in the works of T. V. Egorova.

Among the commercial stock of Far Eastern salmon, the most understood is the Ozernaya stock of sockeye as a result of which it became possible to construct a cybernetic model of the stock, permitting the study of the dynamics of its development during different conditions of fishery and of the surrounding environment.

The Bol'shaya and Utka River Basins

In 1935, a seasonal observation post was established on a fish combine which was situated near the mouth of the Bol'shoi River; the staff (R. S. Semko, V. V. Abramov, Z. I. Petrova and others) conducted annual observations on the qualitative composition of the stock of pink salmon and other salmon. /7

For the purpose of studying the productivity of the natural spawning of salmon, a stationary post was organized in

1941 at Karymaiskii Spring (the middle reaches of the Bol'shaya River) where tens of thousands of salmon spawned. Information of the numerical strength of adult salmon and fry which were obtained with the aid of stock-taking weirs were supplemented by hydrological observations which are used to ascertain the relationship between the survival of eggs, larvae and salmon fry from abiotic conditions. The results of the studies were published in the works of R. S. Semko. In the last 10-12 years, the salmon run has been sharply reduced and the stock of large river pink salmon has lost its commercial value.

The observation post at the Utka River, situated 60 km. north of the mouth of the Bol'shaya River, was opened in 1954. The observations are directed by M. V. Dobrynina and P. V. Andrienko. At the weir, established 8 km. from the mouth of the river, the spawners of pink salmon and other salmon are considered; the magnitude of the downstream migration of fry is determined and biostatistical data on the spawners and fry of all species are collected.

The Kamchatka River Basin

In 1937, an observation post was established on the Ust'-Kamchatka fish combine to study salmon and the conditions of their production in the Kamchatka River - the largest river basin in the peninsula. Prior to 1939, I. I. Lagunov and A. I. Synkova worked there, examining lakes Nerpich'e and Azabach'e and the Elovka River. From 1939-1944, the studies were continued

by K. A. Lyamin and V. A. Rudakova, who examined the spawning grounds in the Tolbachik River - the right tributary of the Kamchatka River.

Beginning with 1948, the catches of sockeye and pink salmon in the Kamchatskii Bay were sharply reduced. The reduction in the numerical strength of salmon was noted not only in the Kamchatka River but also in other bodies of water, for example, in the Paratunka River, and was brought about, apparently, by causes which were general for the eastern coast. The reduction in the catches complicated the work of the fishing industry and, therefore, the workers at the Kamchatka Division of TINRO began to devote still more attention to the problem of the state of the stocks and the dynamics of the numerical strength of salmon. Not only was the Kamchatka Division of TINRO occupied with estimating the quantity of spawners at the spawning grounds, the expeditions of the Kamchatka Fish Breeding Establishment also took up this question, using the research methods of the division which were developed in the 30's.

In 1949, the Kamchatka River from the mouth to the village of Mil'kovo and Azabach'e Lake was studied by V. V. Azbelev and V. I. Sinyukova. I. I. Kurenkov worked there from 1951. He studied the spawning grounds, the food supply and the conditions of the feeding migration of fry to the spawning-rearing bodies of water as well as the interrelationship between sockeye fry and crucian carp which was installed in the Kamchatka River at the beginning of the 30's by I. I. Kuznetsov. I. I. Kurenkov came to

the conclusion that the widely distributed crucian carp in the river does not compete for food with the fry and cannot have a negative effect on the numerical strength of sockeye.

Since the state of the stocks of sockeye remained at a low level, a complete ban was laid on the fishing of sockeye in the Kamchatka River from 1951 to 1962 and aerial observations began to be made annually with regard to the quantity of sockeye spawners which enter the spawning grounds in the entire Kamchatka river basin.

Besides studies on the biology of salmon, studies were made on the food supply of the fry of this fish in the internal bodies of water. I. I. Kurenkov conducted an inventory of the fauna of marine organisms for bodies of water in the main regions of the Kamchatka peninsula to the river basins of the Koryakskoe uplands as well as for the Anadyr' River and other rivers of Chukotka. In the summary by I. I. Kurenkov (1967) more than 400 species of marine organisms are indicated, one third of which have been found in Kamchatka for the first time, and many species are new for science. /8

The stock-taking of salmon at the spawning grounds by means of aerial methods was first used by F. V. Krogius to determine the effectiveness of the ban on the fishing of sockeye which are propagated in the Kamchatka River. The experiment proved to be so successful that it was extended to other spawning rivers of the Kamchatka peninsula.

Prior to 1955, inclusively, observations were conducted by F. V. Krogius from a PO-2 aircraft. From 1956, the AN-2 aircraft and the helicopter have been used. To refine the results aerial photography of the spawning grounds was used. The method by which this work was conducted is described by F. V. Krogius together with A. G. Ostoumovyi who took part in the studies.

R. S. Semko participated in the flights through the western part of Kamchatka. The method of taking stock of the spawning salmon by means of aerovisual observations, the use of aerial photography and the method of processing the obtained results were worked out by A. G. Ostroumovyi; he also wrote a pertinent manual. The stock-taking of salmon by means of aerial methods was gradually perfected and is now being successfully applied to other regions of the Far East. Information on the quantity of salmon spawners at the spawning grounds obtained by aerial methods is, at the present time, fundamental to the determination of the state of the reserves of salmon stock.

In concluding the survey on the study of the fresh water period of life of salmon it must be added that all research done at the observations posts and the stock-taking of salmon at the spawning grounds are included in the program of work of the salmon production laboratory which is investigating the regularities, causes of fluctuation and productivity of the natural production of salmon.

At the present time, studies on production are being made on chum by E. T. Nikolaeva, coho salmon - Zh. Kh. Zorbidi, chinook salmon - B. B. Vronskii, pink salmon - M. V. Dobynina and sockeye salmon of the Kamchatka River - N. A. Simonova. The food relationships between diadromous salmon and fresh-water fish are being studied by L. V. Kokhmenko. M. Ya. Ievleva is conducting a study on the ovogenesis and embryogenesis of salmon. Her works provide a theoretical basis for improvement in the biotechnology of artificial propagation of salmon and in the determination of the causes of fluctuations in the productivity of natural production.

Working on the problem of the production of fish are I. A. Nosva and S. P. Belousova. Studies are being conducted on food supply, the feeding of sockeye fry and the limnologic regime of bodies of water used for rearing; the work is being done at Kuril'skoe and Azabach'e lakes. M. M. Selifonov is studying salmon fry at Lake Kuril'skoe. At the food supply laboratory, I. I. Kurenkov is studying the life cycles of fresh water plankton (Lake Dalnee) and I. M. Lenanidova is studying the composition and genesis of benthos in the bodies of water in the peninsula.

The studies of the production laboratory are of significant importance to the industry. On the basis of its own investigations and the data of the Kamchatka Fish Breeding Establishment, KoTINPO gives an annual prognosis to the Kamchatka fishing industry on the state of the salmon reserves in different regions of the peninsula.

Belonging to the cycle of research on the fresh-water period of salmon are the reconnaissance investigations of Kamchatka Lake, which stand somewhat apart, conducted for the purpose of ascertaining the spawning fund and the numerical strength of sockeye in small local stocks. Thus, the following lakes were studied: Lake Kronotskoe, lakes Ilir-Gytkhyn and Potat-Gytkhyn in the Koryakskoe Uplands, lakes Medvezh'e and Avachinskoe at the sources of the Avachi River, Lake Kambal'noe at the extreme southern end of the peninsula and Lake Tolmachevskoe at the sources of the Talmacheva River (in the Bol'shaya river basin). E. M. Krokhin, I. I. Kurenkov and A. G. Ostroumov were the most active participants in these expeditions. /9

INVESTIGATIONS OF THE MARINE PERIOD IN THE LIFE OF SALMON

Investigations of the marine period in the life of salmon attracted the attention of the Kamchatka Division of TINRO in the early years of its existence. They were begun in 1934 but were restricted to the coastal waters of Kamchatka and the Northern Kurilksii Islands but were not conducted regularly. However, K. A. Lyamin, V. A. Rudakova, R. S. Semko, V. N. Tripal'skaya and others obtained interesting results on the migrations and feeding of salmon in the sea.

The restoration and fast development of the active Japanese fishery of Pacific Ocean salmon in the open sea made it necessary to expand the work being done on the biology of salmon in the period of their life in the sea.

For an estimate of the state of the reserves and a formulation of a prognosis, annual data were necessary on the relative numbers of salmon of different species, their distribution and age composition, the number of sexually mature specimens during the spawning migration and the fishing season in the north-western part of the Pacific Ocean.

Regular sea investigations of this kind were begun in 1955 under the leadership of I. B. Birman. Other researchers taking part in the investigations were L. D. Andrievskaya, L. E. Grachev, A. S. Nikolaev, S. M. Konovalov, etc.

The general regularities in sea migrations and the year-round distribution of salmon of all species were established as a result of these investigations. The distribution of individual local sockeye salmon stock was ascertained.

At the present time, A. S. Nikolaev is developing a method for studying the distribution of salmon with the aid of hydroacoustic apparatus. The studies on the dynamics of the fecundity of salmon in ontogenesis conducted by L. E. Grachev are unique. L. D. Andrevska has studied in detail the feeding of both mature salmon and salmon fry, which made it possible to determine the interspecies relationships of these fish. Interspecies relationships of salmon were also studied on the basis of other indices: it was ascertained in particular that stocks of pink salmon in great numbers effect the rate of maturation as well as the growth of keta and sockeye (I. B. Birman and F. V. Krogius). In the studies of M. Ya. Ievleva, criteria

have been determined, based on hydrologic investigations, for the identification of fish in sea catches which mature in the year of the catch and fish which are ready to spawn only in the following year.

INVESTIGATIONS OF COMMERCIAL SEA FISH

In the 30's, the fishery of sea fish was conducted by the Kamchatka fishing industry in coastal waters. Herring, cod and flounder were the main species of the fishery; the industry needed instructions on the favourable places and times for their catch and on the size of the reserves. Therefore, the investigations of commercial sea fish in Kamchatka which were begun in 1933 were initially confined to the limits of the Kamchatka shelf and the attention of the first investigators - I. A. Polutov, K. I. Panina and M. L. Al'perovich - was turned to a study of herring, cod and flounder.

Herring

The fishing industry of Kamchatka particularly needed a definition of the reserves of herring, whose take at the beginning of the 30's comprised approximately 10% of the entire catch.

It was necessary to have an overall idea of the /10
prevalence of herring in different regions of Kamchatka and at the locations where it is fished. As early as 1932 investigations were begun on herring which had migrated to spawn in Avachinskii Bay; subsequently, investigations were started on forage herring

of Kronotskii Bay (V. B. Bool', K. I. Panin and D. G. Manizer). In 1934-1935 a study of herring was made in the regions of the herring industry on the western coast of Kamchatka - in the Kikhchikskii and Azernaya fish combines (K. I. Panin, R. A. Kostyuchenko). In these years, the first investigations were conducted on forage herring which was caught by means of active fishing gear (purse seines and drift nets) in Avachinskii, Kronotskii and Kamchatka Bays.

At the beginning of the 40's kolkhoz fisheries conducted an expeditionary catch of herring in Penzhinskii Bay. In 1943, I. A. Polutov made a trip to this region and studied the herring which was spawning there. As a result, together with A. G. Kaganovskii, he described the spawning migration conditions of herring, its size and weight composition, and also determined the possibilities of a fishery.

In those years, the main bulk of herring was taken by means of trap nets in the waters of the eastern coast of Kamchatka, particularly in Anapa and Uala bays, and in Korfa Bay where one of the largest local stocks of Pacific Ocean Herring is found - korfo-karaginskii. Participating in the study of this stock in 1938-1955 were K. I. Panin and E. I. Chestnaya.

The time, routes and sequence of migrations of korfo-karaginskii herring to different spawning grounds vary greatly according to the year, which makes the organization of a fishery considerably complex. Therefore, short-term prognoses of the migration periods of herring were extremely important to the industry. In a study published by K. I. Panin (1950), it is

shown that the spawning migrations are intimately linked with hydrometeorologic conditions; a detailed description is given of the ecologic conditions of the migrations of spawning herring to the coastal zone, the spawning conditions and the development of eggs. A method for predicting the relative numerical strength and structure of spawning stocks of herring was developed on the basis of the data on age, size and weight composition of herring. The study of the spawning herring of the korfo-karaginskii stock of 1936 was continued into the summer-autumn period in Korfa and Olyutorskii bays during the first experimental catches of herring by means of active fishing gear. Even the first studies showed considerable promise for an autumn fishery of forage herring which at the present time is very widely developed and which includes many regions of the Bering and Okhotsk seas.

The subsequent life cycle of this species of herring was traced by V. G. Prokhorov: he studied the routes of spawning, forage and winter migrations; he disclosed its wintering regions, ascertained the place, periods and regularities in the formation of commercial accumulation. In 1959, after the disclosure of the places of winter habitation of the herring in the south-eastern part of the Bering Sea, its trawling was successfully begun.

On the basis of an estimate of the productivity of spawning for a number of years and an analysis of the age structure of the stock, T. F. Kachina developed a method for determining the absolute numerical strength of the spawning

population of korfo-karaginskii herring and offered biological substantiation of the most rational use of herring, which is of important economic value.

During a number of years the zooplankton of the western part of the Bering Sea and the coastal waters of South-Eastern Kamchatka were studied in connection with the feeding of herring and other plankton-eating fish. Interesting work has been done in a study of the distribution of daily vertical migrations and the determination of the biomass of fodder plankton by N. I. Spasskii, A. K. Geinrikh, B. M. Mednikov and T. N. Mosentsova. In recent years, T. Ya. Pushchaeva has been studying the seasonal changes in fodder plankton and the feeding of korfo-karaginskii herring on larvae. /11

Cod

Cod can be good raw material for a large trawl catch and a suitable fish for kolkhoz line-trawl catch. In the 30's the fishing industry of Kamchatka set great hopes on a cod fishery. Thus, considerable attention was devoted to the study of cod.

During the entire period of the kolkhoz fishery I. A. Plutov worked on the study of cod. The results of his observations over many years were published in many works. The racial composition, size and weight structure of cod stock, migration, reserves and conditions for conducting a fishery were ascertained. It was established, by means of tagging, that cod does not make great migrations, it is basically limited to

coastal waters. In the summer, cod adheres to coastal shallow waters; by autumn, with cooling of the waters, it goes over to depths of up to 400 m. and in the spring it again returns to the continental shelf where it migrates in search of food. In contrast to Atlantic cod, that of the coastal waters of Kamchatka maintains a scattered state; it does not form dense accumulations; it frequently breaks away from the bottom, becoming more mobile, and for this reason the trawl catches are small. I. A. Polutov showed that the most resonable and effective fishing gear for Kamchatka cod is a mechanized line-trawl. V. N. Tripol'skaya who studied the feeding of cod found that the composition of its food is very diverse and is dissimilar both for region of habitation and for seasons and depends on the presence of fodder organisms in the forage sites.

Flounders

In the coastal waters of Kamchatka five species of flounders have the most commercial value: yellowfin sole, Alaska plaice, rock sole, flathead flounder and starry flounder. The region of greatest accumulation of these is the western Kamchatka shelf where intensive trawling was started in 1952 and reached its maximum in 1958.

A description of the state of the reserves of flounders and of the conditions of the fishery for the stated period is given in the works of I. A. Polutova.

As a result of an intensive fishery, the reserves of flounders on the western Kamchatka shelf were reduced, some banks

lost their commercial value. In this connection, V. I. Tikhonov carries out regular observations on flounders of the western Kamchatka shelf, particularly of yellowfin sole.

In using an origninal method for processing biostatistical data obtained over many years, V. I. Tikhonov determines the reserves of flounders and recommends an optimal size of catch. In order to determine the numerical strength of the spawning population of flounders, V. I. Tikhonov and L. A. Nikolotova use the method of taking stock of pelagic eggs.

STUDIES OF THE KOMANDORSKII HERD OF SEALS AND OTHER MAMMALS

Since 1959 the laboratory studying the seals of the Komandorskii herd has been conducting research on measures to promote the numerical growth of this valuable fur-bearing animal. An analysis of the data on the annual stock-taking of the animal and the age structure of the herd, following the conclusion of the new International Convention (1957), shows that restoration of the numerical strength of seals of the Komandorskii herd due to conservation measures was accelerated significantly. This is also confirmed by the increase in harem lairs (P. G. Nikulin).

G. A. Nesterov developed a method of killing seals by means of a curare-like preparation - ditiline, which facilitates the work of hunters and raises the quality of the skins. In recent years, the laboratory has also been conducting observations /12

on the ecology, distribution and numerical strength of sea otters of Lake Mednoe (B. V. Khromovskii) and seals in the coastal waters of Kamchatka (D. I. Chugunkov).

OCEANOGRAPHIC STUDIES AND WORK ON MECHANIZATION

Oceanographic studies in the early years were conducted, for the most part incidental to ichthyologic works, only in the coastal waters of Eastern Kamchatka, and since 1955 in the north-western part of the ocean as well, on vessels of the Kamchatka Division, the TINRO long-term exploration program and the Kamchatka administration of the hydrometeorologic service.

Since 1959 oceanographic research has been carried out by the laboratory concerned with food supply and commercial oceanography. The data obtained are used when analysing the migration of herring, Pacific Ocean salmon and cod. I. V. Davydov and A. G. Kutsykh showed that from the data on the 250-mile standard Avachinskii cross-section which intersects the Kamchatka current we can determine the temperature regime of the current hydrological year in the shelf waters of Kamchatka and predict the periods of the spawning migrations of korfo-karaginskii herring.

The personnel of the laboratory are also studying the food supply for the fish in fresh and sea waters.

The laboratory dealing with mechanization, which existed in KoTINRO from 1949 to 1963 and whose staff included N. F. Chernigina, V. F. Turasova, M. B. Gusina, P. N. Poyarkova,

A. F. Krivets and others, developed a number of mechanisms which have found wide application in the fishing industry, namely, a dual fish-pumping unit for the unloading of herring, salmon, flounders and other fish, which is applicable in anchorage conditions; the "Lemet" machine for dressing salmon, a machine for dressing flounders prior to freezing; and a vertical cooler for cooling herring prior to salting. The laboratory personnel also provided the industry with a number of useful recommendations.

The brief account of the content of the studies conducted by the Kamchatka Division of TINRO during the time of its existence testifies that the general content of the Kamchatka Division has always corresponded to the problems of the Kamchatka fishing industry. A thorough study of many years duration of salmon and other commercial fish made it possible, in the course of a number of years, to correctly determine the state of the reserves and to make prognosis for subsequent years.

The fishing industry is very heedful of the information provided by the Kamchatka Division. The five-year plans for the development of the fishing industry of Kamchatka were worked out with due consideration given to the prognosis made by the Division of the state on the reserves of the chief commercial fish. The scientific recommendations of the division are considered when working out the annual and quarterly plans for fish yield by species and region of fishery.

The Kamchatka Division of TINRO works in close association not only with the fishing industry of Kamchatka but also with the Kamchatka fish-breeding establishment. The

contributions of the division are used in the development of fish conservation measures, and the division uses the data on commercial fish which is collected by the observers and inspectors of the Kamchatka fish-breeding establishment.

Despite the reduction in the numerical strength of Kamchatka salmon, the fishery is of great importance. The Kamchatka division has been given the task of coordinating all of the studies on salmon which have been conducted by the Sakhalin, Amur and Magadan Divisions of TINRO and of presenting the data to the Soviet-Japanese Commission on Fisheries.

The scientific program of the division for 1967-1970 includes the following fundamental problems: the contemporary /13 state of Asiatic stocks of Pacific Ocean salmon, the role of the fishery and its regulations by international agreements, prediction of the numerical strength of salmon, the state of the natural reproduction of salmon, its ecology during the fresh-water period of life, the productivity of spawning and rearing reservoirs; the role of biochemical and physiological factors in the behaviour of salmon; the effect of the commercial use of Kamchatka on the natural reproduction of salmon and the measures for salmon conservation; the distribution, migration and ecology of salmon in the open sea and the structure of its stocks.

Studies on commercial sea fish will be conducted mainly on the shelf waters of Kamchatka since all of the studies in the open seas are being conducted by TINRO. A study on the

state of the reserves of bottom and pelagic fish of the shelf waters of Kamchatka and the causes of fluctuation in their numerical strength shall be continued.

Finally, considerable attention will be given to the entire complex of questions on the state and methods of improvement of the production of the Komandorskii herd of seals and sea otters.