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HYDRO CONSTRUCTION IN SIBERIA AND PROBLEMS OF THE FISHING INDUSTRY

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In the last ten years, hydro-development on rivers of Siberia has proceeded on a large scale. Excellent supplies of power in Siberia are available on the rivers Irtysh, Ob, Enisei and Angara. This involves a basic reconstruction of the fishery resources of these rivers which amount to around one million centners in total fish catch.

Construction of hydro-stations in Siberian rivers adversely affects the reproduction both of the migratory and resident fish populations, and consequently the condition of their stocks.

In July 1952, on the Irtysh in the Ust-Kamenogorsky area, the first large reservoir in Siberia, approximately 80 km long and up to 2-3 km wide, was built. In the first year after construction of the dam, there appeared below it sturgeon, sterlets, inconnu, dace and other fish. Sturgeon and inconnu belong to the resident local forms of those migrating species which spawn in the Black Irtysh but winter within the limits of the reservoir. Down below the GES these species of fish are now almost gone. To establish new stocks, it will be necessary to rear them artificially in the Ust-Kamenogorsky and Shulbinsky reservoirs. The number of other resident fish, migrating to the dam from below, last year had to a certain extent become somewhat reduced in number and stabilized.

The Bukhtarminsk GES, now under construction, is located on a tributary of the upper Irtysh and will raise the level of Lake Zaisan by 5 m. This means the flooding of the vast Zaisan Valley, and the first bench above the bottomland now becomes the shore of the new basin - the Bukhtarmin-Zalsansky reservoir with an area of 550,000 hectares. The filling of the dam area commenced in 1958, and will be completed in about ten years. (P. F. Martekhov. Hydro-construction on the Irtysh and the problem of fish management. Trudy Tomsk University, Vol. 131, 1955.)

At the end of 1956, the Novosibirska GES flooded the channel of the Ob. In the summer of 1957, a level of 106 m above the base of the dam was reached; in the spring of 1958, the height was 107 m and in the autumn the reservoir had filled to the 110 m mark. In 1959, it should rise to 113.5 m. After flooding the river to Obsk, the basin had taken away around 40% of the spawning grounds of sturgeon and over 50% of the inconnu. This means a corresponding loss in production of the stocks of these valuable migratory fish unless special measures are taken to artificially propagate them. (B. G. Iloganzen and A. N. Petkevich. Hydrobiological and fish management characteristics of the upper Ob in connection with hydro-development. Trudy problemykh Tematicheskikh Soveshchany Zoologicheskovo Instituta AN SSSR, Paper 7, 1957.)

In 1957, immediately below the face of the dam there were observed large accumulations of sturgeon, inconnu and sterlets, for whom the structure presented an obstacle in their journey to the spawning grounds above, a favourite place for wintering-over and feeding. Among them were wounded fish (Hucho, inconnu, sturgeon) migrating from the reservoir over the spillway section of the dam. (A. N. Petkevich. Condition and prospect of the fisheries utilization of the Novosibiersky Reservoir GES. Tezisy dokladov XII otchetnoi Nauchnoi sessii Zapadno-Sibirskovo filiala AN SSSR, Novosibirsk, 1958.)

At the present time construction is planned of a reservoir on the upper Ob Kamensk. After it is built it will become possible to irrigate by gravity the arid regions of the fertile Kulundinsky steppes and build up the rich
fishing of the Barabinsky lakes, which at the present time are at a very
unfavourable reduced level (more recently accompanied by a rise in mineral con-
tent and increase in winter freezing, which has resulted in a decrease in the
fish stocks and a decline in the fishery). Irrigation of the lakes will thus
bring into being in the steppe area a series of new basins - canals and lakes
with artificially-stabilized levels, maintained at optimal level. In these
lakes great importance lies in the fish cultural-acclimatization measures
adopted, but the catches can be doubled and built up to 150,000 centners of fish
per year.

In the case of the anticipated hydro-construction in the lower Ob, further
serious problems arise to face the fishing industry. (B. G. Ioganzen, B. K.
Moskalenko and A. N. Gundraizer. Fish basins in the Ob River and the possible
effect on them of the projected Nizhneobski GES. "Conference on the biological
basis of the fishing industry", Tomsk, 1956). The Nizhneobsky GES will be the
lowest in the utilizable waterfalls in the Ob-Irtymsky hydro-electric system.

The Krasnoyarsky GES, now being constructed on the Enisei and also the
Angarski GES, will not affect the migratory fish. The reservoir of the
Krasnoyarsky GES will have a considerable depth (average depth - 36.9 m; maxi-
mum - 100 m).

Built on the Angara, the Irkutsky GES has established a reservoir,
representing a bay in Lake Baikal 74 km long (in the valley of the Angara River).

The Bratsky reservoir will represent a basin, extending along the Angara
for 529 km, with a maximum depth of 110 m and an average depth of 40 m.

In the solution of questions concerning the influence of hydro-develop-
ment on the fishing industry and on the development of fish cultural-biological
[p. 23] schemes for the reservoirs in Siberia the following scientific institu-
tions have been active: on the Ust-Kamenogorsky and Bukhtarminsky GES - the
Zoological Institute of the Academy of Science of Kazakhsky SSR; on the Novo-
Sibersky GES - the Barabinsky Division of VNIORKh; on the Kamensky GES - the
Barabinsky Division of VNIORKh and Tomsk University; on the Hizhneobsky GES -
Tomsk University and the Ob-Tazoovsky Division of VNIORKh; on the Krasnoyarsky,
Irkutsky and Bratsky GES - the Siberia Division of VNIORKh in association with
Irkutsky University (for the Upper Angarsky GES). These agencies are studying
questions on the means of building up the fish stocks in the reservoirs, the
operation of fish cultural establishments, particularly in the reservoir zones,
and the restoration of the commercial fishing industry.

Only in the Irtysk and Ob GES dams were the migrations of anadromous
fish blocked from the spawning grounds, the feeding and wintering areas. In the
case of the Salekhardsky section of the Nizhniobsky GES installation, which cut
off almost all the spawning grounds of the migratory fish (besides the cisco
and smelt), a gigantic fish hatchery has been provided, since in the lower Ob
from above the dam go not only the mature fish for spawning but also a mass of
young whitefish to feed in the flooded valleys. Evidently this migration will
continue. In the passage of these fish to the upper waters a new colonization
of the reservoir by whitefish, inconnu, and sturgeon will take place, and local
stocks of these valuable fish will develop. For the passage of fish over the
Salekhardsky GES dam a fish lifting device and 2-3 by-pass fish canals are
planned which will take care of the local conditions in the lower Ob.
With regard to the southern section of the Nizhneobsky GES (Narykara) and also the construction of the hydro stations on the upper Ob and Irtysh, the installation of special fish-passing devices will be unnecessary for the following reasons: firstly, some of the migrating fish (whitefish) have found a natural spawning area in the left branch of the lower Ob, and secondly, the migrating fish whose spawning grounds are located in the upper sections of the river are not able to negotiate the fast water below the hydro-station.

In connection with the mass-accumulation of commercially valuable fish below the Novosibersky GES dam, it is planned to re-establish in the dam a spillway opening in the fish-elevating sluice. This sluice will have practical importance since fish cultural stations will not be required and will not be constructed below the Baturinsky GES.

The loss, caused by hydro-construction on the reproduction of stocks of valuable migratory fish in the Ob basin, must be compensated by artificial propagation. In the upper Ob and Irtysh it will be necessary to establish sturgeon and inconnu hatcheries, on the middle Ob and the left branch of the lower Ob - several whitefish hatcheries.

The construction of these hatcheries was proposed at the same time as the building of the Ust-Kamenogorsky and Novosibersky GES, but until now this has not yet been done. The situation appears to be quite unusual, for in the face of an appreciable reduction in spawning areas of sturgeon and inconnu, nothing has been done to develop their commercial propagation on a scale which will assure in the future an increase in the catches of these valuable fish. In 1956 it was demonstrated that sturgeon and sterlets can be reared by artificial means (with application of hypophisarnykh injection) in the Novosibersky (A. N. Petkevich and R. I. Setsko. An experiment in the artificial propagation of Siberian sturgeon in the upper Ob region. Skornik "Coveshchanu po biolo-gichiskim ocnovam rybnovo khoziaistva", Tomsk, 1956) and Tobolsky (N. P. Votinov. Artificial reproduction of sturgeon on the Irtysh. Doklady VII Hauchnoi Konferentsii Tomskovo unta. Vip. 3, 1957) areas but even in the early 1930's studies were undertaken on a commercial scale under fish culturist B. G. Chalikova on the rearing of Coregonids, mikes and geled by a method not requiring running water at the mouth of the Tem River.

The hatcheries, erected in the upper and middle sections of the Ob or in its tributaries to aid in the rearing of migrating fish, could, with the subsequent construction of new dams lower down in the river, be changed to propagate resident forms of suitable species of fish in order to replenish annually the stocks in the reservoirs. In order to increase the effectiveness of fish culture, it is necessary to rear the young for 1 to 2 months. This requires the construction at the hatcheries of adequate rearing areas in the form of fenced-off bays and ponds for the purpose of rearing food organisms.

In the operation of fish-lift installations and also in order to divert the schools of fish from the upper outlets it is necessary to use electric barriers. First of all it will be necessary to study the reaction of Siberian migratory and resident fish to electric fields of different strengths.

The presence, within the groups of migratory species, of resident forms indicates the complete possibility of creating in future in each reservoir, separate stocks of valuable sturgeon and salmonoid resident fish, which will have a limited migration within the confines of the reservoir.
Reservoirs under construction for GES will differ not only in their individual features but also in their methods of operation. At the same time they possess, in a general way, the same characteristics as all the rivers which flow into the North Arctic Ocean.

The reservoirs will be characterized by a greater heating of water than prevails in the rivers, an almost stable summer water-level condition and a gradually dropping level during the winter period with a consequent exposure and freezing through of the marginal zone. The mineralization of the water will be somewhat greater than under present river conditions, which determines the increased production of plankton. In the Novosibersky and some other reservoirs, a so-called blooming of the water may take place, unfavourable to fish development and pure-water relationship. To overcome this, it is necessary to adopt appropriate measures. (K. S. Guseva. "Water bloom", its causes, forecast and preventive measures. Trudy Vsesoiuznovo hydrobiologicheskovo obschestva, T. 4, 1952.)

The oxygen regime of the reservoir in the main part will be favourable for fish throughout the year but the bays and other quiet-water areas may be deficient in oxygen. Therefore one must anticipate that in the reservoirs the regular migration of fish will not continue which may be reflected in the commercial fishing maps.

Protection must be assured against pollution of the reservoirs and the inflowing streams by effluents from industrial plants and contamination from the products of logging. Complete clearing of forest refuse must be finished not later than the latter part of August.

In some reservoirs, for example in Bratsky and particularly in Krasnoyarsky, the yearly draining of the shore zones, the freezing of them and the winds in the surf area will hinder the development of higher aquatic vegetation. Because of the scarcity of aquatic plants the propagation of phytoplankton feeding fish will be limited. In order to increase production of the most valuable of these (bream, Leuciscus) arrangements must be made for artificial spawning grounds in a vegetative substrate.

For the autumn-spawning lake whitefish, the water level conditions are most unsuitable in the Krasnoyarsky reservoir (draw-down of level from October to May, 11-15 m); it is unsatisfactory also in the Bratsky reservoir. In the Irkutsky reservoir it can be considered close to normal. Therefore in the first two reservoirs, it is not possible to plant lake whitefish.

As indicated by experiments in other regions, the feeding conditions for fish in reservoirs can be quite good. In the unregulated parts of the Irtysh, Ob, Enisei [p. 25] and Angara the zooplankton develops in very small quantities. With the formation of reservoirs the biomass of zooplankton is greatly increased at the expense of the phytoplankton. In composition the benthos varies a great deal both qualitatively and quantitatively, as a result of the creation of new hydrological conditions, silting processes, etc.

In order that in the shortest time a feeding basis for valuable planktonic species may be developed, it is necessary, in the first year of filling the reservoir, to arrange for the introduction in the Bratsky reservoir of Epischura and Macrohektopus from Baikal (a distance from the place of discharge, by water, of 200-250 km) but in the Krasnoyarsky reservoir - mysids and pontiporea from
the lower part of the River Enisei (a distance by air of 2,030 km) or of the Baikal form (a distance by air of 1,200 km). The same thing may have to be done also in some of the other reservoirs.

Great care must be taken in planning the development of fish populations in future reservoirs, initial plans for which must be made even prior to completion of the dam. In the natural course of stabilization of the ichthyofauna in the reservoirs its qualitative composition will not at all meet the needs of the fish industry since undesirable and quickly maturing species (perch, ruff, etc.) always predominate. These fish are characterized, as is well known, by a high specific fertility and an ability to become acclimatized quickly. In order to avoid their mass reproduction and to develop primarily stocks of commercially utilizable and highly valuable species, it is necessary to undertake a whole series of measures with regard to the intensive fishery development of the reservoirs, involving both fish culture and plantings.

Most of the fish in the reservoirs can be divided into two groups. One of them requires protection — pike, chub, carp and roach, the other, suppression — perch, ruff (fast-maturing fish, which are competitors in the feeding of valuable benthic forms). The roach must be placed in the first group, considering it as a chief food of pike. For the production of the desirable fish it is necessary to prohibit fishing for 1-2 years prior to the beginning of filling up the reservoirs and for 1-2 years after filling. For the suppression of fish of the second group it is also necessary to begin 1-2 years prior to filling of the reservoir and then to continue to conduct operations systematically and intensively.

After the establishment of the reservoirs and the resulting development in them of fish stocks the annual catch will increase appreciably as a result of the growth in fish production and the increasingly greater expanse of fishing ground. In the Ust-Kamenogorsky and Verkhneobsky reservoirs the catches will be approximately 10 times greater than under former conditions in the unregulated zone; in Krasnoyarcky — 8 times; in Irkutsky and Bratsky — 6 times; in Bukhtarmin-Zaisansky — 4 times; in Nizhineobsky — 3 times.

The projected fish production of the reservoirs will vary from 7 to 50 kg/hectare. Altogether from eight reservoirs this means an increase of approximately 4 times in the catches. Thus, as a result of the hydro construction the fish industry of Siberia can obtain additionally more than 760,000 centners, i.e. almost double the present yield of the territory of Siberia.

To assure adequate catches an extensive fish cultural and transplantation program must be undertaken. In the reservoirs it is planned to propagate sturgeon, sterlets and their hybrids, Coregonus alburnus, lake whitefish (C. peled), Baikal omula (C. autumnalis), chera (C. nasus) and certain other whitefish, breams and carp. As a result, conditions will be created for the most complete utilization of the stocks of plankton and benthos and the cropping of the maximal possible production through the growth of non-predatory fish. In the majority of the reservoirs a sufficient number of predators of local fauna will be present, but in isolated cases it may be expedient to propagate pike perch.

Each reservoir will have its own population of native and introduced species of fish. As to [p. 26] which of these various species will be there in the future will depend not only on the reproductive conditions but also on the techniques of fish culture.
The creation of commercial fish stocks in the reservoirs according to their age and the availability of sexually mature fish will take a varying number of years.

In order to accomplish the necessary fish cultural transplantations in the reservoirs, it is planned to construct the required hatcheries and rearing ponds.

It is necessary to note that the construction of fish cultural facilities is separate from the building of hydro-electric stations. The Council for Natural Economy of the districts and territories of Siberia can and must change this situation, in order that the interests of the fishing industry in regard to hydro-construction will be fully maintained.

The work involved in the re-establishment of the fisheries in the reservoir areas must be commenced prior to the actual dam construction. Of great importance is the clearing of the bottom and the preparation of future netting areas. Taking into account the great extent of the Siberian reservoirs, it is necessary to give heed to the technical difficulties inherent in the appropriate clearing. As was apparent from the clearing of the banks of Novosibersky reservoir, the willows (Salix), cut down at the roots, in the course of 1-2 years develop an extensive young growth. In recent years after the filling of the reservoir, clearing of all the earlier prepared netting areas has had to be repeated. The fishing gear and the commercial fleet must be re-organized to meet the requirements of the reservoirs. In connection with the establishing again of a commercial fishery it is necessary to take into account that the shores, built from soft material in the first years of the reservoirs' formation, can break down again (as much as 15 lineal metres per year).

Hydro-construction introduces into the fisheries picture many serious additional problems of biological, technical, economic and organizational character. Accordingly, it is only right that those involved in the fishing industry should present to the power engineers their own requirements regarding the desired water level conditions required at certain seasons, the arrangement of the electric barriers, fish-ways, etc. There should be a complete study of all the questions involved and their solution with the greatest economic effectiveness. In order to accomplish this, it is expedient to create in connection with Siberian department of the Academy of Science of U.S.S.R. a special co-ordinated centre for the study of all questions relating to hydro-construction in Siberia.

The Scientific Fishery Research Institute of Siberia must actively participate in the solution of whatever questions hydro-construction development may present to the fishing industry.