FISH CULTURAL PROBLEMS IN THE OKANAGAN AREA

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OKANAGAN LAKE

Okanagan is a relatively large lake of considerable depth. While its surface waters become quite warm in late summer, its great body of deep water remains at a low temperature throughout the year and the average mean summer temperature for the lake as a whole is low.

The amount of microscopic life (plankton) in the open water is comparatively small as is also the quantity of organisms on the bottom beyond the shoreward area of rooted aquatic vegetation. The production of invertebrate organisms among the areas of vegetation along the shores is fairly abundant but these areas are limited in extent. It has been estimated that of the total shore length only about nine per cent has a rooted aquatic vegetation.

These facts indicate a limited productivity. The low average temperature means relatively slow growth and low rate of reproduction for the aquatic plants and animals, and a slow turnover of organic materials, particularly in the offshore region.

The end result of the productivity of the lake from an economic point of view is fish which are desired for commercial or sport purposes. The quantity of fish produced by a body of water depends largely upon two factors, namely, the food supply and the adequacy of the facilities for reproduction. If the food supply is large and the conditions for spawning and incubation very good, production may be potentially high and a large number of fish may be removed annually. If on the other hand one or both of the above factors operate adversely, production may be on a very low level and various measures may be necessary in order to provide an adequate surplus for the fishery. Each body of water is therefore a problem in which must be determined the productive capacity and the amount of the surplus stock that may be removed by the fishery.

It is evident that in spite of certain limiting factors a considerable number of fish of various species are produced in Okanagan lake. These occur in two more or less distinct groups, namely, an inshore population consisting of the shiners, chub, squawfish, carp, coarse-scaled suckers and sculpins, and an offshore population consisting of the fine-scaled suckers, Rocky Mountain whitefish, Eastern whitefish, kokanee, Kamloops trout and ling.

In the former group all except the squawfish feed chiefly upon small aquatic invertebrates and terrestrial insects while the squawfish is largely a fish eater when adult. In the latter group, the whitefishes are bottom feeders, the kokanee a plankton feeder and the Kamloops trout and ling fish eaters.

Although limited in extent, the shallow areas in which rooted aquatic plants

grow appear to be highly productive of fish, but of kinds which are not desired by man. It would seem that a very large amount of the primary food materials is going into the production of fish which are not utilized and there would appear to be little possibility of developing a commercial fishery because of insufficient quantities to provide a sustained yield.

When introductions are considered for the purpose of utilizing the productiveness of the shoreward areas by more desirable species it is apparent that it would be necessary to introduce either a species which fed upon the invertebrates or one which fed upon the coarse fishes. In either case it could not be a commercial fish because the total area available for such production would not sustain a profitable industry any more than will the present population. Among the sport fish there does not appear to be a species which feeds entirely upon aquatic invertebrates. On the other hand there are several species of game fishes which are predaceous upon other fish. An introduction at the present time would be inadvisable because of the lack of knowledge as to the interrelations among fish populations but the matter is of sufficient importance to warrant a very careful investigation.

The question of the reduction in numbers of the coarse fish of the shallow areas and its relation to the production of trout cannot be adequately dealt with at the present time because of lack of experimental or sufficiently extensive observational data. Whether trout would occupy the inshore areas and consume the food materials now taken by the coarse fish, were these largely eliminated, is not known, but it would seem doubtful. While the squawfish takes trout when they are readily available its chief food seems to consist of coarse fish, and as long as these are abundant its feeding activities will not likely seriously menace the trout population. To a great extent the shallow-water association does not involve the trout and would not seem to be a very significant factor in limiting their numbers.

Three species of fish occupy the deeper waters beyond the shoreward areas. These are the Rocky Mountain whitefish, the Eastern whitefish and the fine-scaled sucker. The first two are desirable for commercial exploitation but they do not occur in sufficient numbers to support a profitable fishery. They feed for the most part upon invertebrates living on the bottom of the lake, and since the present investigation has revealed a paucity of bottom organisms it is likely that the food supply is the chief factor limiting their abundance. The total absence of deep water shrimp-like forms such as *Pontoporeia* and *Mysis* may be a significant feature in the food situation, particularly in respect to the Eastern whitefish, since in eastern lakes which support commercial fisheries for this species a large portion of the food consists of these deep water crustaceans. If any further attempt is to be made to develop a commercial fishery for the Eastern whitefish, the possible introduction of *Pontoporeia* and *Mysis* should be considered. They occur in Waterton lake, Alberta, and are said to be present in certain lakes in the state of Washington, and there would seem to be every reason to expect that if introduced into Okanagan lake they would become established. Any such intro-

ductions should probably be made in the form of the eggs of these species to avoid the possibility of the introduction of fish parasites.

The fine-scaled sucker is not abundant in the lake at the present time probably because of the limited food supply as in the case of the Eastern whitefish. If the food conditions in the lake were improved it is quite likely that there would be an increase in the numbers of these suckers and it might be necessary to adopt measures to limit their numbers.

Mention has already been made of the importance of kokanee in relation to trout. It has been impossible to form an opinion as to the abundance of this fish in the lake and whether it is far from or near to a maximum population. Undoubtedly the numbers of kokanee are related to the quantity of its food supply, namely, the plankton crustacea which in Okanagan lake are not particularly abundant, although apparently comparable in species and numbers to those of such large lakes as Shuswap. The problem of increasing the plankton production of a large lake has not yet been solved, and at the present time there would appear to be no economical way in which the lake may be fertilized in order to increase the amount of open water plankton and thereby the production of a plankton feeding fish such as the kokanee. If investigation should indicate a meagre population in relation to the food supply, introductions of eggs or fry from other areas would seem to be a reasonable procedure. It is evident that a thorough knowledge of the life-history of the kokanee is essential to a well-rounded fish cultural programme in relation to trout.

The fish most desired in Okanagan lake is the Kamloops trout, because it is an excellent sport fish and is an economic asset to the extent that it attracts non-local fishermen. The difficulty of developing at the present time an exact cultural policy for the trout of Okanagan lake lies in the fact that certain necessary basic data are not yet available. The present stock in the lake, the number of young produced naturally each year, and the number of fish caught annually are unknown. In view of this lack of fundamental information the situation can be dealt with only in very general terms.

Reference may be made to conditions in Paul lake which has an area of approximately 1,000 acres. During the past five years, production has been maintained by the planting annually of 200,000 fry, natural propagation under the present programme being practically negligible. There is now an annual production of 10,000 fish taken by anglers and a spawning run of approximately 2,500 fish in Paul creek. Were conditions exactly similar in Okanagan lake there would be an angler's catch of 900,000 fish and a spawning population of 225,000 on the basis of lake area. However, conditions are not similar and Okanagan lake can not be expected to produce trout on the same scale as Paul lake, largely because the production of basic food materials such as plankton and bottom organisms is one-third to one-fourth that of Paul lake in quantity.

On the basis of a liberation of 200 fry per acre, Okanagan lake would require 18,000,000 fry. However, the food supply may be considered as only a third that of Paul lake so that an annual production of 66 fry per acre or a total of 6,000,000

should approximate the carrying capacity of Okanagan lake. There is a possibility of natural propagation, in certain years at least, supplying a portion of this amount, but at best it cannot be great with perhaps 60 per cent of the tributary streams being utilized more or less completely for irrigation purposes. If natural propagation is contributing 40 per cent of the requirement, then there should be annual introduction of 40 fry per acre, that is, a total of 3,500,000 or the equivalent. No account is taken of predators or the presence of kokanees as a food supply. There is no way in which the influence of these factors in the situation may be calculated and for present purposes they may be considered as neutralizing each other.

In 1935 the Department distributed 234,379 fry in the lake. In addition the Kelowna Rod and Gun Club has been rearing the product of 250,000 eggs in its large natural retaining ponds and liberating the fish as yearlings. No artificial feeding is necessary in these ponds and the cost of production is very small. Since it is estimated that there is a mortality approaching ninety per cent among the young fish during the first year of life in natural bodies of water, the yearlings liberated from the Kelowna ponds may be considered as equivalent to 2,000,000 fry.

If therefore the guesses made above are at all valid, the present stocking policy is approaching the lake's requirement. If the Kelowna ponds could liberate 250,000 to 300,000 yearlings annually and the Summerland hatchery distribute 500,000 to 1,000,000 fry annually, there would seem to be reason to believe that there would be an approach to the productive capacity of trout in the lake under its present conditions and that the trout fishing would be maintained at a reasonably high level.

In summary the situation in regard to the production of fish in Okanagan lake would seem to be as follows. There is a large area of relatively low productivity in the centre of the lake which is occupied by economically valuable species such as the Kamloops trout, kokanee and the whitefishes. There is a smaller area of relatively high productivity around the margin of the lake which is occupied by a number of species of no value economically at the present time. With respect to the Kamloops trout a tentative fish cultural programme has been outlined, designed to meet the existing conditions. Information concerning the kokanee is so meagre that no policy can be presented. The obvious importance of this species to trout production has been pointed out and it is possible that investigation may reveal that the kokanee production may be so managed as to provide a limited supply for human use as well as a food supply for the trout. As for the whitefishes, it seems evident that lack of food supply limits their production. If efforts to remedy the food condition were undertaken and proved successful, there might result a commercial fishery limited in extent by reason of the small size of the lake.

The utilization of the productive capacity of the marginal area of the lake presents quite a different problem. As indicated previously, it would seem that the introduction of a game fish which would feed upon the coarse fish and not destroy the trout would be the proper procedure. Three species suggest them-

selves, namely, the large-mouthed black bass, the small-mouthed black bass and the maskinonge. The first is now in Osoyoos lake and there is considerable likelihood of it eventually making its way into Okanagan lake. If it does so, there would seem to be no cause for undue alarm provided its numbers are kept within limits by angling and so not allowed to increase to such an extent as to eliminate the food supply in the form of coarse fish. It might be advisable to withhold any restrictive fishing regulations and thereby have a factor tending to restrict the numbers. In the meantime it would seem most desirable to study thoroughly the conditions now existing in Kootenay, Christina and Osoyoos lakes where black bass have become established. Furthermore, the early life history of the Kamloops trout should be studied to see whether the young get into deep water early enough to escape an active predator. Consideration of the environmental conditions in the lake might indicate that an introduction of the small-mouthed black bass would be preferable to that of the large-mouthed species. The maskinonge has a good reputation as a game fish and reaches a size large enough to eat the large coarse fish of the lake.

The first step in the study of Okanagan lake from the point of view of fish production has been a general survey from which certain facts have been recorded, and an attempt has been made to present a picture of the fish cultural problem. The next step should be a series of specific investigations along the lines indicated in this report.

KALAMALKA LAKE

Conditions in Kalamalka lake are essentially similar to those in Okanagan lake and the problems in respect to fish production much the same. Coldstream creek appears to be the tributary which is used chiefly by the trout for spawning purposes, although Oyama creek is used to some extent. From statements made by anglers it appears that this stream is subject to the same deficiencies in respect to trout production as Okanagan lake tributaries. The obvious fish cultural policy for meeting the deficiency in natural production would seem to be the establishment of an egg-collecting station on Coldstream creek, the transfer of the eggs to a hatchery somewhere in the area and the liberation of the fry throughout the lake. Under this policy, in which there would be no allowance for natural reproduction, an annual planting of approximately 500,000 fry or 50,000 yearlings would be required on the same basis of limited productivity as in the case of Okanagan lake.

WOODS LAKE

The conditions prevailing in Woods lake during the summer of 1935 were definitely unsuitable for trout production. The very low oxygen content of the deeper waters, the high surface temperatures and the enormous production of algae constitute an environment in which it would seem impossible for trout to maintain an existence. In addition there are no tributary streams suitable for spawning purposes. The stocking of Woods lake with trout would seem inadvis-

able under present conditions. The lake contains a very large population of carp, chub, shiners, squawfish and suckers, all of which are able to live in the warm shallow water. In addition the Rocky Mountain whitefish is present in some numbers. In some summers it suffers rather heavy mortalities, presumably as a result of conditions of high temperature and lack of oxygen, or of the development of toxic substances arising from the decomposition of the excessive quantities of algae.

Information has recently come to hand that kokanee have become plentiful and are providing a considerable amount of sport fishing. Individuals between two and three pounds have been taken.

If black bass should appear in Okanagan lake the species might be introduced into Woods lake where it might become successfully established by reason of the abundance of a food supply in the form of minnows and suckers.

The discovery of the causes of excessive algal growths and the development of control measures would seem to be the first essential in any sound fish cultural policy for Woods lake.

DUCK LAKE

This is a shallow body of water, with high temperatures and an excessive production of algae, and it is entirely unsuitable for trout. No constructive recommendations are offered at the present time.

BEAVER LAKE

Beaver lake, as well as the smaller connecting lakes A, B, C and D, was originally barren of fish and was first stocked with Kamloops trout in 1926 with 5,000 eggs from Lloyds creek hatchery at Paul lake. In 1927, 20,000 eggs and in 1928, 10,000 fry were transferred from the same source. Subsequent introductions were as follows: 1931, 3,000 Kamloops trout fry from Fish lake; 1933, 125,000 Kamloops trout fry from Penask lake. As has been the case in other parts of the province, the fish increased very rapidly in numbers by reason of the abundant food supply and the absence of competitors and predators. At the present time there is some indication that the lake is over-populated from an angling point of view in that the average size of the fish caught has been steadily declining. Many of the anglers are of the opinion that the numbers of freshwater shrimps and caddis larvae have decreased.

The time available for study of the lake was too brief to determine the exact condition of affairs, but if it is a case of too many trout the situation can be improved by removing large numbers of eggs for stocking Okanagan and other lakes each year and by taking out more fish by angling. The extent of natural spawning should be determined and then an attempt made to calculate the number of eggs which may be removed, leaving approximately 200 fry per acre. These figures are based on the data obtained at Paul lake, where a distribution of 175 to 200 fry per acre with practically no natural production serves to maintain an excellent fishery. By observation and experiment the annual liberation of fry

must be adjusted to the productive capacity of the lake in the matter of food supply for the trout.

CHUTE LAKE

From the data obtained on a single examination, Chute lake would appear to be much less productive than Beaver lake. This lake was originally barren of fish and was stocked as follows: In 1917, 20,000 cutthroat trout fry; 1918, 30,000 cutthroat trout fry; 1919, 7,000 cutthroat trout fry and 15,000 Atlantic salmon fry; 1924, 5,000 Kamloops trout eyed eggs; 1928, 10,000 Kamloops trout eyed eggs. Plantings with Kamloops trout eggs were continued until 1935 with the exception of 1933. Only the Kamloops trout has apparently become established, and it seems likely that the natural reproduction will maintain the stock to the carrying capacity of the lake in spite of the passage of some trout into the outlet stream.