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No. 224

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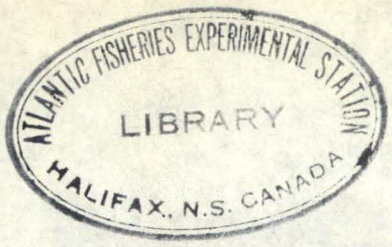

FISHERIES RESEARCH BOARD

OF CANADA

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Pacific Biological Station, Nanaimo, B.C.

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When the white men "took over" the management of the natural resources of the North American continent from the Indians they found the lakes, streams and seas teeming with fish, the forests and prairies abounding with game and fur-bearing animals and timber of untold wealth. This great resource, built up through thousands of years, was treated as a single inexhaustible crop waiting for the harvester to come along and reap it for his own gain. The idea of a sustained yield, of annual crops from biological resources, occurred to only a few of the early pioneers, but the word "inexhaustible" drowned any protest. Now, as a result of the complete lack of a businesslike attitude toward these natural assets, the present generation faces virtual bankruptcy in wild life production. Fortunately the present generation wants to do something about it. What can it do?

There are at least three major considerations that must be investigated under a wide variety of environmental circumstances and for a large number of species before a satisfactory solution of the problem of wild life production can be obtained. (1) Just how much wild life can nature produce, unassisted, on a unit area of land or water, if given, of course, a fair chance. (2) How much can be removed from year to year as a crop and still allow sustained production. (3) How much help can be given to aid production without making an entry on the debit side of the ledger.

* The figures given in this paper are only approximate and are not intended for publication.

Industry has learned that research pays and government authorities must also be prepared to invest heavily in scientific investigation before wild life production on a secure basis can be assured. When such fundamental problems as those listed above have been settled then, and only then, should it be decided how much fish and game the individual sportsman may be allowed to harvest. The old method of reckoning the consequences after the kill must go; a better method is that of the well-managed farm. It is indeed strange that a sensible attitude should have taken so long to develop in nations noted for business ability, but perhaps it has been due to the peculiar, hypnotic effect of that word "inexhaustible".

Five years ago the Biological Board of Canada, which is charged with scientific fisheries investigation in the Dominion, employed the writer to begin a study of a trout population in an attempt to find an approximate answer to the three problems set out above. It is perhaps timely that the main results for one body of water are now available when so much interest is being taken in wild life management. Since very few people have any idea of what goes on under the surface of a trout lake it seemed desirable to present a concise account of the data that have been obtained.

Paul lake, near Kamloops in central British Columbia, was selected for the study because of certain natural advantages that it possessed for a scientific investigation. The lake is situated at an altitude of 2600 feet in the "dry-belt" of the Pacific hinterland; it is typical of hundreds of lakes in the interior of British Columbia and the States of the north-west. The lake is about three and one-half miles long and half a mile wide; its surface covers a thousand acres and it averages one hundred feet in depth. The outlet is screened to prevent the fish from getting into irrigation ditches and there is only one important tribu-

tary entering the lake into which the fish migrate in the spring of the year for the purpose of spawning.

The lake originally contained no fish of any kind owing to the presence of high falls below the outlet which prevented natural immigration. It was richly supplied, however, with organisms such as freshwater shrimps, snails, leeches and aquatic insects on which trout feed. The Dominion Department of Fisheries stocked the lake in 1909 with the Kamloops variety of rainbow trout. From the single relatively small planting the stock grew and multiplied to such an extent that the Department was able to establish a hatchery on the tributary to the lake in 1922 and to use the eggs of this popular variety of trout for stocking other bodies of water. Meanwhile a fishing lodge was built, a good motor road was opened up and people came from the surrounding district and all parts of the world to enjoy the excellent fishing. Owing to the heavy drain by the sportsmen and the great demand for the eggs, depletion began to appear and it developed serious proportions in 1930 after two dry years had cut down the natural production of fry in the creek.

Up to the time when the study was started in 1931 no one had determined accurately how much "seed" should be returned to a lake where hatchery operations were being carried on, in order to keep up the stock of fish. One of the first problems, therefore, was to lay down a consistent stocking policy. In 1927 Dr. G.C. Embody of Cornell University had outlined a stocking policy for streams and this information was drawn upon in determining the size of the planting to be made in Paul lake. After making a complete biological survey, which merely means taking stock of the aquatic set-up, the food supply and the fish, it was decided that the annual seeding should be 200,000 fry or 200 fry per acre.

This seeding has been carried out as planned for the past five years. At the same time studies have been made of the food supply and the food of the trout, the fishing drain and the number of fish that enter the creek to spawn each spring. When all the information is gathered together it affords a very comprehensive picture and gives a definite answer to the pertinent questions: how many fish will a given amount of water support, how big a crop can be removed and is management worth while.

Owing to the great variability in the size of trout it is better to answer the first question in terms of weight rather than numbers. One way of determining the productivity of a lake is to measure the amount of fish it yields each year. For the past few years Paul lake has produced on the average approximately 10 pounds of trout per acre. The supply of food organisms in the lake at the same time amounted to about 150 pounds, live weight, per acre. It therefore took about 15 pounds of these animals to produce one pound of trout and to maintain a breeding stock of the animals themselves. It was observed that when the production of trout fell below 8 pounds per acre there seemed to be a surplus of food but when it rose to above 12 pounds per acre the food supply began to decrease. In order to strike a balance between the food supply and the amount of trout it is necessary to keep production somewhere between 8 and 12 pounds per acre. This is what has been termed a low yield, low cost type of crop.

The discussion might be made clearer if translated now into terms of numbers. Out of the planting of 200,000 fry placed annually in Paul lake only 10,000 $\pm$ 1,000 or about 5 per cent have reached the legal size of 8 inches. The bulk of this heavy loss is due to the yearlings eating the fry and fingerlings. Nevertheless the secret of the success of the whole program depends on the fact that cannibalism controls to a certain extent the number of fish that reach the legal

size, and it is believed that the extent of cannibalism is in turn partly controlled by the amount of food available. Cannibalism also insures that the fish that do survive are of a healthy, vigorous, fighting type.

The fish attain the legal size at the end of their second summer when the anglers begin to thin them out by fishing, and, by the end of the season, October 31, only 7,500 may be left in the lake. The next year about 4,000 are caught, leaving 3,500. The following year, when they are three years old, about 1,500 may be caught, leaving 2,000. The survivors are either caught during the course of the next four years or they may die a natural death after spawning. Tagging has shown that some of the trout of Paul lake live to be eight years old, but there seems to be a heavy mortality, particularly among the males, after spawning.

If the remainders of the eight main year-classes in the lake are added together it gives an approximate idea of the total number of fish over the legal size. This is sometimes referred to as the "head" or abundance of trout. In this case the sum works out to about 25,000 fish or 25 fish per acre. It was found that a head of 25 fish per acre yielded the average angler an average catch of 5 fish per average fishing day of five hours. An experienced fisherman, however, could easily catch his limit of 15 fish on a favourable day during ten hours fishing. A head of 25 trout per acre may be said to provide fishing that is described as good whereas a head of less than 10 fish per acre would provide fishing that borders on the point where even an angler's patience gives out.

The quality or attractiveness of the fishing depends largely on the average and maximum size of the fish caught. During the spring months the average size of the trout caught in Paul lake is about a pound and a quarter, the size being determined chiefly by the large number of two-year-olds in the catch; later in

the season when the yearlings begin to come in the average size is slightly less. Many of the four and five-year-olds, however, will tip the scales at four or five pounds. Approximately one average fisherman in fifty would be lucky enough to strike and land one of these "big ones". The secret of a good fishing lake is to have enough small fish to keep up the angler's interest and enough large ones to give him something to "tell the boys about". If a person is really anxious to catch a big trout and can obtain the confidence of a resident angler in British Columbia he can usually discover some secluded lake where real monsters live. There is a lake in southern British Columbia where a 48-pound Kamloops rainbow was actually caught and weighed. Even if the stomach of this fish had been filled with lead or stones, as anglers have been known to do, it would still have been a big trout because it measured 48 inches.

The second question is: how big a crop can be removed without interfering with the breeding stock? The male Kamloops trout mature for the first time anywhere from one to six years, the majority at three years of age; the females mature for the first time from two to six years, the majority at three or four years of age. It is evident that while the fishermen are thinning out the stock they may also catch a large number of maturing and mature fish, but where production is controlled this is really not a very serious matter. It so happens that the ratio between the total number of fish caught at Paul lake and the number that escaped to spawn each year has averaged about 5 to 1. This ratio undoubtedly depends on such things as the intensity of the fishing, the depth of the lake and the nature of the food supply, and it would be expected, therefore, to fluctuate from year to year and from one body of water to another.

The average number of individuals in the spawning run has been about 1,500 fish. Owing to the fact that a large number of males mature at two years

of age, there are a few more males than females in the run. Usually there are about 600 females. The mature females carry about 2,500 eggs, or roughly 1,000 eggs per pound, but under normal circumstances all of the eggs are not collectible owing to certain technical difficulties in ripening and stripping the fish; a collection of one million eggs would be a reasonable expectation from the Paul lake run. If 200,000 fry are required to keep up the stock it leaves a clear gain of at least 700,000 fry after making due allowances for normal mortality in the hatchery. The surplus can then be used to build up depleted stocks elsewhere. A preliminary study has shown, however, that if the seeding were left entirely to nature it would require practically all of the fry produced by the run to keep up the stock.

In this type of lake where a definite annual seeding is always assured very heavy fishing can be allowed. The breeding stock could be cut down to four or five hundred head without endangering the future supply of young. The chief danger lies in the possibility that there will not be enough fishing to thin out the stock sufficiently to protect the food supply. The key to the maintenance of a high average size is the rate at which the fish are thinned out by the anglers. If less than 2,500 of the yearlings are removed then the extra survivors may deplete the food supply; on the other hand, if more than 2,500 are removed then a greater amount of food is left to increase the growth rate. Most sportsmen gasp at the suggestion that fishing can actually be encouraged rather than curtailed, but overstocking is a far greater danger than understocking in a well-managed lake.

The third question is the one asked by the tax-payer: is the cost of this management justified? The answer is definitely in the affirmative. Kamloops trout fry are worth about three dollars per thousand and the Paul lake planting

costs about 600 dollars. It has been conservatively estimated that the amount of money brought into the Kamloops district from the outside, as a result of the Paul lake attraction, comes to about ten thousand dollars per year. This represents a considerable return to those catering to the anglers. In addition local residents derive a good deal of enjoyment from the fishing provided and the surplus eggs produced are in themselves worth over two thousand dollars. On the whole the venture seems to be extremely worth while. Whether management programs of this type would be justified for other lakes, however, must be decided by a study of the merits of each body of water. Such a decision can only be made after adequate surveys and experiments have been carried out, which means investment in research.