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STUDY OF THE FISH AND FISH FOOD ORGANISMS OF THIRD SISTER LAKE

by

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The purpose of this study is outlined below.

I. Fish Study

A. To ascertain the qualitative and quantitative constituents of a balanced and presumably maximum fish population in a lake.

B. To test the quantitative methods of "gill netting" and "marking" in determining a fish population.

II. Food-organism studies

A. To study quantitatively the invertebrate (fish food) organisms of a lake containing a balanced fish population.

B. To study quantitatively the invertebrate (fish food) organisms during and after the removal of all fish.

C. To study the fish food organism population during and after the introduction of other fish.

III. Relation of fish to food organisms

A. To study the relation between food-organisms present and those actually taken by the fish.

Third Sister Lake is a small, oval-shaped lake in the tract known as Saginaw Forest, near Ann Arbor, Michigan. The area of the lake is nearly 10 acres and the maximum depth is 60 feet. The lake has little shoal area and the lake bottom gradieht is steep on all sides. There is one inlet--a small intermittent stream that is dry most of the year. The outlet is through a marsh at the west end of the lake. A road across the marsh makes a complete fish barrier, except at times of very high water, which occur in the late winter months.

The lake is owned by the University of Michigan and is under the control of the Department of Forestry. This problem was undertaken with their permission and guarantee that no other conflicting program concerning the biology of the lake would be permitted until the present work was completed.

Preliminary work on the problem was started in October, 1938. From that time until January, 1939, many samples were taken and various methods of sampling were tested in order to obtain a general idea of the materials and situations that were to be encountered in the work. In January, 1939, at the time of the fellowship grant, survey work was begun on a definite schedule and the work has continued with but few interruptions from that time until the present.

Divisions of the Problem:

I. Fish Study.

Third Sister Lake has not been stocked with any species of fish, as far as can be determined, nor has it been fished other than on rare occasions for about seven years. As indicated previously, this lake has no inlet connected with any permanent body of water and the outlet contains water for only a short time during the spring. At this time the

water temperature is near freezing and the fish are inactive. Therefore, the fish population is confined to the lake and the chance of an immigration is extremely small. For this reason it is presumed that we are dealing with a maximum and stable fish population.

This population is chiefly a largemouth bass-bluegill-bullhead population, although there are at least eight other species of fish in the lake.

With this excellent opportunity for a population study, tagging operations were started last summer, 1939, and about 650 fish were marked in the following three months. Two trap nets were kept in continuous operation all summer, and a gill net was set under the ice last winter (1939), the latter net yielding 4 fish in 169 hours set. Due to the extremely soft bottom and steep slope, it is not possible to seine in the lake. The returns from the tagging of the fish in the lake, although very incomplete, indicate that we are dealing with a very large population of bluegills.

The experience of the past year indicates that by far the best way to take fish from this lake for tagging operations is to take them by hook and line. Although this method is even more selective than the trap nets, it results in many more fish. Both methods of taking fish are being used to give a more complete picture of the fish population.

The trap nets averaged about 8 fish per 24 hour set for the entire summer, while hook and line fishing averaged about 16 fish per hour--the size range of fish being about the same for each method. The ratio of bluegills and bass taken was about the same for hook and line as for the trap nets; the trap nets, however, took many bullheads and a few of each of the other species of fish, whereas the hook and line fishing did not. Gill nets were not used as many fish are killed in the gill nets

and it is desirable to maintain the fish population at as near a balance as possible. No more fish are being killed than necessary for some phase of the work. Jaw tags were used on all fish and the mortality traceable to tagging operations was small. Four fish were recovered carrying tags that had been placed on them from four to six years ago. Scales of these were checked to determine the age and growth rate and the growth rate was found to be very low. One nine year old 9" bluegill had grown 1 1/2" in the last six years. Other fish showed a similarly slow growth. Interpretation of the results of the food studies and temperature data indicate that some factor other than these must be the cause of the slow growth. This is an important point to be considered in future work on this project.

II. Quantitative and Qualitative Analysis of the Fish Food Present in the Lake

A. Plant Inhabiting Forms

Relatively little quantitative work has been done in attacking a fish food problem from this angle, the chief reason being the lack of any method of quantitatively collecting plants without a large loss of the invertebrate food organisms. A procedure for the taking of representative plant samples by the plant-hook method has been developed, and although there is a loss of organisms from the sample, this has been kept at a minimum by standardizing methods of collection and collecting equipment. This loss, while not negligible, has been made a constant so that any error introduced in this manner is minimized. The method used consists of throwing a plant-hook into a dense bed of vegetation and vertically pulling the plants to the surface, where they are caught in a screen before being lifted from the water. The screen is used as it was found

that most of the organisms lost in raising the plants are washed off as the plants leave the water. The plants are then thoroughly washed to remove all organisms and these organisms then preserved for further qualitative and quantitative examination.

The type of plants, depth from which they were collected, and the location in the lake are all recorded. These data, along with the fish food data, are expected to be of value in determining future or modifying present methods of lake survey and management toward a maximum and sustained fish population.

B. Bottom Sampling

Bottom sampling is carried out in conjunction with the plant sampling. The collections made by both methods are taken at the same time from the same general area. This gives a more complete representation of the fish food present than either method alone could do. In planning the sampling in this way, it was expected that the bottom sampling method, which is a standard means of collection, would act as a check on the plant sampling method, a new and relatively untried method. It was found, however, that it cannot act as a check, as the organisms taken by one method are not the same either quantitatively or qualitatively as taken by the other. This seems to indicate that neither method alone is sufficient to give a true picture of the invertebrate fauna of a lake. This being true would indicate that present survey methods of determining fish food supplies are not inclusive enough, and if further work bears out the findings to date, a modification of present methods to include plant collections for the determination of plant inhabiting fauna should be instigated to give a more complete picture of the potential food supply.

In taking the bottom samples, the standard 1/13 square meter Peterson dredge and the 1/4 square foot Ekman sampler are used. In connection with these a crane has been developed which has greatly facilitated the taking of bottom samples, plankton samples, temperatures, etc.

Bottom samples are washed immediately after being taken to remove all organisms, which are then picked from the remaining debris and preserved for further study.

To date 145 invertebrate food organism samples (plant and dredge) have been studied. This is an average of 12 per month for the duration of this work. With the experience of the past year and the aid given by an N.Y.A. student in sorting the organisms from the debris, the number of samples collected has been increased to 16 per month--equally divided between the two methods of sampling. These samples are taken at regular intervals throughout the month and are taken at representative areas in the lake so that a more or less true representation of the invertebrate fauna of the lake is obtained.

III. Fish Food Studies

This part of the work is being done to determine the relationship between food organisms present and those actually utilized by the fish. This information is important as it will indicate whether or not data obtained by present survey methods can be considered as an index to fish production. Incomplete studies indicate that certain organisms often considered as indices are not justifiably so.

The food studies are done by making an analysis of a representative number of fish each month (about 50). During the first part of the work

the nets were used exclusively to supply fish for food samples. As nets alone were not dependable to furnish adequate numbers of fish for this work, samples were taken by hook and line. The use of hook and line method supplied fish with full stomachs (95% of fish taken had stomach contents, while less than 50% taken by nets).

The removal of fish by nets for stomach examination cannot be justified unless the nets are emptied several times each day. Every effort is being made to remove as few fish as possible from the lake in order to maintain a maximum and balanced population for the duration of the problem. About 170 fish have been removed from the lake for food study analysis. The stomachs are removed from the fish within 20 minutes after capture. This is necessary as digestion takes place so rapidly when the water temperature exceeds 21°C, that if the fish are allowed to remain much longer than half an hour before removal of the stomach, digestive action makes identification of stomach contents difficult or impossible. During the winter months an elapse of several hours makes little difference. The stomachs are placed in 80% alcohol and bottled for further study. The fish taken for food studies are all weighed, measured, sexed, and a scale sample taken. These scale samples will be used in determining the age classes and growth rate of individuals of such a maximum population.

IV. Chemical Analysis and Temperature Records

A complete chemical analysis series is made at two-week intervals. Tests are made at 10' intervals for dissolved oxygen, carbon dioxide, phenolphthalein alkalinity, methyl orange alkalinity and pH. At the same time these tests are made, a complete series of temperatures are recorded at 3' intervals from surface to bottom.

From the results of the dissolved oxygen tests and temperature recordings, the region in which fish are able to feed is determined and consequently that area of this type of lake which is producing available fish food. The chemical stratification closely follows the thermal stratification, and as there are probably no fish in Third Sister Lake that are able to feed below the thermocline, that area is of small value in food production. The only time that such an area supplies food to the fish of the lake is during diurnal migrations of such organisms as live in the depths or during emergence periods of aquatic insects. The emergences are of short duration and consequently of small value in the annual food cycle of the lake.

V. Vegetation Survey and Map

As much of the productivity of this lake in terms of fish is indirectly concerned with the vegetation, complete and accurate aquatic vegetation maps and surveys are being made. These maps will indicate the area occupied with each species of plant in the lake. As different species of plants vary greatly in the volume and species of invertebrate fish food produced, it is important to know the area occupied by each species of plant when computing the food supply. The productivity of each plant species is being determined as far as possible. These data, when completed and compiled, should be of value as a general index to the productivity of other lakes.

Evidence based on incomplete data indicates that more than 85% of all food consumed by Third Sister Lake fish is directly traceable to the plant zone. This percentage is probably higher than in lakes having more shoal area, but this method of determining fish food in terms of plant productivity offers an attack to the problem of lake productivity that has been slighted in most survey work.

VI. Parasite Examination

No extensive work has been done on the parasites of the fish of this lake as this is outside of the scope of the problem, except as it might be a limiting factor of the fish population. It is believed, however, that the parasites of these fish are not a factor in limiting the population.

The only parasites that assume any important proportions are a larval fluke (Neascus vancleavii?) that is encysted on the heart of many of the bluegills. This parasite is of doubtful detrimental effect on the fish as most fish carry from a few to 100 or more without showing any harmful effect on the fish. The other parasite found is a myxosporidian infestation that appears as a sore on the sides of the fish soon after the spawning season and persists until the middle of August. There is a slight mortality which appears to be due to this disease. About three-eighths of the fish have some sign of this disease. Several fish bearing sores were tagged and recovered later in the season nearly or entirely recovered from the disease.

Future Work on the Project

The work, as has been outlined, is expected to continue along the same general line as at present until data for two complete years are at hand. This will give at least one full year's data from the time collection methods have been organized properly and standardized. The lake will then be poisoned and all fish removed. By the time of poisoning, sufficient netting and tagging experiments will have been completed to make an estimate of the population as determined by tagging, and to indicate the value of different types of gear in taking fish in this type of lake. The poisoning of the fish will give a complete and accurate check on this method of estimation of a fish population.

This point will mark the termination of the study of food selectivity of the fish population. The collections of food organisms will continue for a period after the poisoning to determine the effect of poisoning directly, and also the influence of the removal of the fish on such an invertebrate population.

The fish removed will be utilized for data concerning a balanced and maximum population such as is being dealt with. Following an interval of time to allow for the establishment of a balanced invertebrate population, other fish of the original species will be introduced and the effect of this new population on the invertebrate population will be studied.

Summary

The work to the present time has indicated that Third Sister Lake is very rich in invertebrate fish food organisms and also supports a very large population of fish.

The condition factor of the fish is about normal but the growth rate is very slow, e.g. 1 1/2" in 6 years. The bluegills seldom exceed 9". As the food supply does not seem to be a limiting factor in the lake, and the chemical-physical factors are well within the range of tolerance for normal growth, some other factor must account for the slow growth and failure to attain large size.

From the results of gill net, trap net, and hook and line fishing, it is evident that under the conditions encountered in Third Sister Lake the most effective method of taking fish is by hook and line. Some method of obtaining a number of fish quickly at all seasons of the year is badly needed in this work. Gill nets injure the fish; trap nets are not consistent; hook and line fishing fails completely at times.

Plans are being made to test the advisability of taking fish by small local applications of rotenone. If such a method could be controlled, it would greatly simplify the taking of fish samples for food studies and growth rate.

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