

TRANSACTIONS

OF THE

American Fisheries Society

FIFTY-SEVENTH ANNUAL MEETING

HARTFORD, CONNECTICUT

AUGUST 8, 9, 10, 1927

Published Annually by the Society

HARTFORD, CONNECTICUT

1927

A RAPID METHOD FOR THE EXAMINATION OF LAKES AND STREAMS

DAVID L. BELDING

From the Evans Memorial and Boston University School of Medicine

In 1925 a rapid survey of the lakes and streams of Litchfield County, Connecticut, was carried out under the direction of Mr. John W. Titcomb of the Connecticut Fish Commission. The novel method of conducting the survey and the volume of information obtained at a minimum cost warrant a description of methods and results.

In the limited period of three weeks 272 streams and 100 lakes, which formed part of the drainage systems of the Housatonic and Farmington Rivers were examined. In spite of the fact that the records represent an impressionistic rather than a thorough examination, the results demonstrate that satisfactory data, suitable as a basis for further investigation and for establishing a stocking policy can be collected in a relatively short time by a competent observer using automobile transportation and stenographic assistance.

SURVEY METHODS

The country was traversed in a zig-zag fashion by automobile with the aid of U. S. Geological Survey maps. Two men were required, one to operate the automobile and to assist in obtaining the data, the other to make the necessary observations. Wherever a road crossed a stream, an observation station was numbered on the map, and a record of the natural conditions of the stream at this point was entered in a notebook under a corresponding number. Whenever possible supplementary records of the character of the stream between observation points were made. By combining the field notes at the various observation points a description of the natural condition of the stream could be obtained. Except for minor modification the nomenclature and procedures in Standard Methods for the Examination of Lakes and Streams (1) were followed in recording, arranging and filing the data. Thus the results of other investigations may be utilized for the interpretation of the statistics.

A record of each lake and stream was entered on a 11 x 8½ inch card bearing the printed form, the one for streams being given below. It was filed alphabetically

according to the name of the body of water with suitable cross indices. In this manner a summary of the value, recommendations for stocking and natural conditions may be noted at a glance and more detailed information obtained from the description, written on the back of the card. Additional information at any future time may be added or corrections may be made.

Geological survey maps were mounted on similar cards of the same size. The lakes and streams were named or numbered and the county, town, and watershed boundaries appropriately designated. Each body of water was given a map number as described in Standard Methods. Unnamed streams were classified as tributaries or feeders and were indicated by a number together with the name of the stream into which they flowed, e.g. T No. 3 Shepaug River would indicate the third unnamed tributary stream entering the Shepaug River. Brook trout waters were indicated in red, brown trout in brown, and coarse fish in green. Posted or private waters were marked in blue and polluted waters in purple. Thus a combination of red and blue would indicate waters suitable of brook trout in which public fishing was prohibited.

STREAM SURVEY

| | | |
|--------------------------|-------------------|-----------------|
| Name, Blackberry River. | Value | A ¹⁰ |
| System, Blackberry River | Brook Tr. | + |
| | Brown Tr. | — |
| | Coarse Fish | — |

County, Litchfield. Township, Norfolk and Canaan.
 Map, Sheffield 1.22, 1.23; Sandisfield 2.21; Winsted 9.1.
 Information, David L. Belding, August, 1925.
 Source, South of Crissey Pond, Norfolk. Outlet, Housatonic River.
 Length (Miles), 11½. Width (ft.), 15. Depth (ft.), ¼. Type, Meadow.
 Velocity, 73 rapid. Permanence of Flow, Copious.
 Tributaries—Number 5. Miles, 7 feeders = 5½ miles.
 Shade, Scanty. Food, Moderate. Vegetation, Considerable.
 Temperature, Water, 60; air 68.
 Water—Color, White. Turb., Clear. Bottom, Gravel and small stones.
 Pools, Numerous.
 Ponds and Dams, One pond; one dam 8 ft., upper part, broken.
 Pollution, None. Posted, No.
 Course, See general description on back of card.
 Fish—Brook trout, dace and suckers. Information uncertain as to introduction of brown trout.
 Remarks—Excellent brook trout stream. Easy fly fishing.

The results of the stream survey for Litchfield County are summarized in the following table. The application of the collected data to the problem of stream valuation and stocking is of interest.

STREAMS OF LITCHFIELD COUNTY

| | | |
|--------------------------------------|--------|-------|
| General Statistics: | | |
| Total | Number | Miles |
| Feeders | 272 | 1100 |
| Public | 1290 | 987 |
| Private | 192 | 919 |
| Polluted | 80 | 181 |
| | 16 | 55 |
| Value: | | |
| Class A | 50 | 265 |
| Class B | 84 | 323 |
| Class C | 71 | 281 |
| Class D | 60 | 203 |
| Unclassified | 7 | 28 |
| Recommendations for Public Stocking: | | |
| Brook Trout | 100 | 399 |
| Brown Trout | 41 | 204 |
| Coarse Fish | 8 | 119 |

VALUATION

The value of the different streams is estimated according to their potential production of brook trout. The classification which is based upon the natural condition of the stream and upon present and past fish production depends upon the ability of the inspector to judge correctly the value of each stream. Four classes have been arbitrarily made: A, excellent brook trout water, B, fair, C, indifferent, and D, poor or unsatisfactory. Provided a stream is of sufficient size to be worthy of consideration the classification is made irrespective of size, although a medium grade large stream would probably receive a higher classification than a small stream of the same character.

Different sections of a stream may have different values, e.g. a stream 5 miles in length may be recorded as A³B² indicating three miles of excellent brook trout water and two miles of fair. In addition on the record card a further notation indicates whether fishing is restricted, e.g. A³ (P²) denotes three miles of excellent brook trout water, of which two miles are posted. The total number of streams for any class is obtained by adding the fractional parts of those streams which have been given more than one value. In

Litchfield County one-half of the streams and 54 per cent of the mileage fall in the A and B classes. The privately controlled streams show a higher proportion, namely 70 per cent.

STOCKING

Beneath the value on the record card the species of fish recommended for the stream are entered. The species for Litchfield County comprise brook trout, brown trout and various coarse fish, such as bass, pike perch, yellow perch, pickerel, bullheads and blue gill sunfish. Since the streams are almost exclusively trout waters the coarse fish are restricted to a few large rivers. Stocking with brook trout is rarely recommended for other than A and B class streams, only one-quarter of the mileage of C class streams being judged worthy. Occasionally brook and brown trout are recommended for the same stream when natural or artificial barriers in the form of water falls and dams permit stocking with antagonistic species.

Embody (2) has formulated a table which indicates the number of 3 inch fingerling brook trout to be planted per mile in streams of various widths according to different food and pool conditions. Since the qualitative value per mile of stream, the width, prevalence of pools, and abundance of natural food were recorded according to Standard Methods, it is possible by means of Embody's table to determine the number of brook trout for planting per mile of stream.

NATURAL CONDITIONS

The best brook trout streams of Litchfield County are of the upland-meadow type, which comprises forty per cent of the total number. The poorest streams are of the torrential mountain type, in which deforestation has increased the irregularity of flow. One-quarter of the streams, chiefly the mountain type, run dry during the late summer.

The presence of pools must be considered in determining stream value inasmuch as they increase the water area and provide favorable grounds for fish, especially in periods of drought. Dams influence stocking, prevent fish from ascending streams, and by forming ponds increase the water area. Shallow unsheltered ponds injure streams by producing an abnormally high water temperature. The temperature of a stream, although in a measure dependent up-

on volume, springs, and pools is chiefly influenced by shade. The amount of shade runs a close parallel with temperature and stream valuation. There is a striking similarity in the 62 per cent of streams considered worth stocking with brook trout on the basis of their natural conditions and the 70 per cent estimated as suitable by the use of Embody's correlation temperature table.

BIBLIOGRAPHY

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2. Embody, G. C., Stocking Policy for the Genesee River System, State of New York, Conservation Department, Sixteenth Annual Report, 1926.

Discussion.

MR. ADAMS: What is the definition of a public stream in Connecticut?
 PRESIDENT TITCOMB: I will answer that. Any stream that is open to the public is called a public stream. We have not any public waters.

MR. ADAMS: It may be public when this survey is made, and it may be private later on.

PRESIDENT TITCOMB: We have it covered by applications every year, in which they state whether it is posted or not.

MR. ADAMS: If the riparian owners elected to do so they could post those streams at any time?

PRESIDENT TITCOMB: Absolutely. You cannot take away a man's private trespass rights.

DR. BELDING: You keep closely in touch with changes, do you not, Mr. Titcomb?

PRESIDENT TITCOMB: Every year, yes.

MR. BUTLER: I am very much interested in the talk given by Dr. Belding. We in Pennsylvania believe it is our bounden duty to maintain the fishing for our people, because you have a contented people when they have places to go for recreation, and when you have a contented people, you have good government. As you perhaps know, we have a Water and Power Resource Board in the State of Pennsylvania, of which I am a member, and which has authority over the construction of dams and bridges and encroachments on waters. There is also a Sanitary Water Board, which has authority over all questions pertaining to the pollution of waters. Of this board I am also a member. Many bodies of water have been created in the State of Pennsylvania. Our largest body of water in the state has been created by one of the

hydro-electric companies, covering an area of 6,748 acres, with a shore line of 55 miles. I recognized at that time that this was going to be a private fishing ground, and I offered a resolution before that board, and had it passed, that in the case of every permit granted by the Water and Power Resource Board for the impounding of waters for any except domestic purposes, the permittee would have to agree to allow the public to fish in those waters, under rules and regulations laid down by the Board of Fish Commissioners, the corporation and other persons involved. Now, that is the policy that we are carrying on in Pennsylvania, and as a result of that policy we are going to save to the fishermen many thousands of acres of water. The company who built the lake I speak of fought that very hard, but as a result of our policy of cooperation with the heads of these companies, other lakes in the state that were private have been thrown open under the same rule to the fishermen, besides twenty-seven miles of very fine streams that hitherto were private. The state itself has gone to a great deal of expense—and rightly so—in purchasing about five million acres of waste lands and waters, and we have before the voters this coming fall a bond issue of \$25,000,000—and I believe it will be passed—for the purpose of buying up all the waste lands and waters in the State of Pennsylvania that are for sale.

Now, when you come to the matter of water supplies for domestic purposes the public should be prohibited, except when the time comes that the municipality chlorinates their water or filters it; then the public may enjoy the privilege of fishing in those waters, the same as they do in other waters, without injuring the health of the people. That is what we are discussing now, and we hope to bring it about.

MR. FREDERICK C. WALCOTT (Connecticut): We have very much the same condition, on a smaller scale, here in Connecticut. On the Housatonic River there are already two steps, and a third is about to be put in. The first step is the Stevenson dam, which provides the largest body of fresh water in the state. The step going in now will be nearly twice that size, and there will perhaps be others, constituting substantial bodies of still waters. The question to be considered is to what extent the vegetation in these bodies of water will stand the drying out which occurs periodically through the drawing off of the water. At the Stevenson dam the water would probably be taken down six feet, and we feel it will seriously affect the vegetable growth on the shores, and probably the food of the fish. I would like to ask what Mr Buller's opinion is on that point.

MR. BULLER: I think it will to a certain extent. In Pennsylvania the Wallen Paupack proposition, a hydro electric dam created on the Wallen Paupack creek, is subject to fall and rise; it is about the only one in the state in connection with which that condition prevails. It is going to affect the shore line to a certain extent; nevertheless we believe

that it will constitute a great recreation and fishing ground if we keep it properly stocked with fish. No doubt it will interfere with the natural production of fish in that body of water, and also to some extent with the food, but there are many projects in the making now in Pennsylvania that will not be subject to that rise and fall. We have before us now a proposition in the northwestern part of the state known as the Pymatuning swamp dam, covering an area of 24,000 acres. That will never be a drain in the manner that the Wallen Paupack proposition will. The Wallen Paupack is a unique engineering proposition. No water will ever go over the crest of the dam, but it is carried through an aqueduct and pours over the turbines at a fall of 350 feet. It is so constructed that no matter how great the flow of water is, none of it will ever go over the crest of the dam.

MR. ADAMS: I would like to ask whether in Pennsylvania you have objection raised by the owners or these large areas to permitting the public to go on them because of the fire menace, and how that situation is dealt with.

MR. BULLER: We deal with it in this way. These waters will be open to everybody, under certain rules and regulations. Three officers patrol the Lake Wallen Paupack proposition every day, and those officers are paid by the corporation. They are fish wardens, but the corporation pays their salary, and they see that the rules and regulations are carried out. No boat will be permitted on that water except by permit. Anybody can get a permit for a row boat, sail boat or canoe. On the issue of such a permit the boat is given a number and the holder of that permit will be liable for the violation of any of the rules and regulations on that body of water. The fine is \$100, no matter what the violation is. Motor boats are entirely prohibited, because we have come to the conclusion, in Pennsylvania, that on our small bodies of waters we cannot have both motor boats and fishing.

MR. VIOSCA: The State of Louisiana has been making a general survey of her streams, but the survey is even more general than that which Dr. Belding has reported here. It was made incidentally to studies of stream pollution and other matters that were the subject of special inquiry. But the investigations have been carried on now over a period of about eleven years, and by accumulating small facts here and there we have been getting a very general ecological classification of our streams. In some of the states, that kind of work can be done in connection with their other activities, even if they do not go into it as deeply as Dr. Belding has in his particular investigation.

In connection with public water supplies for domestic purposes in Louisiana, we permit fishing in all water supply lakes of that kind. But in our state all the water supplies are chlorinated, and we have rapid sand filters; there is no such thing as taking the water and using it in

the raw state. With these filters, of course, even if there was pollution, it would not be as dangerous, in my opinion, as the thousands of people you see on bathing beaches in this section of the country. We have no such thing as typhoid in the large cities of Louisiana, and very little in the country, and the proof is that in the city of New Orleans the water which is used there is polluted by two-thirds of the United States. Of course we filter and chlorinate it.

Dr. Belding mentioned the effect of small dams on trout. I do not know anything about trout; we have no trout streams in our state. But even though small dams may be unfavorable to trout streams, might they not benefit the trout in increasing the food supply and giving better sources of supply? What is your experience in this line?

Dr. BELDING: The temperature change is too great. Of course if they were shaded ponds, it would be all right; but they are exposed in the open fields.

Dr. EMMELINE MOORE: I would like to express my great appreciation of the interpretation Dr. Belding has given to this survey in Litchfield county, and I am glad that three of us, Dr. Embody, Mr. Greeley, and I, who are actively interested in our survey in New York State, have listened to his interpretation. It is a matter of satisfaction that the surveys in the different states, if well founded may be interpretable in terms of each other. I think that is a very great gain, and I am confident that we are going in the right direction when that can be done.

PRESIDENT TITCOMB: Dr. Stillman has surveyed two of our counties. We have three counties completed, and it is a mighty good investment. We have found that we have stocked streams with trout which would not support trout. Some of you people do not perhaps appreciate the situation in a state where we either have trout streams or we have no fishing at all, or practically none. When a stream in this latitude gets to the point where the temperature is too high to support trout life, it is quite a problem to find any other fish which will stand the torrential conditions which prevail in those warmer waters. We have county wardens supporting the work of these surveys by reporting, incidentally to their travels, the water temperatures during hot weather. We have blank forms which they fill out as they cross a stream in the hot, dry weather, giving the air and water temperatures. We add these to our card records, and thus know after a time quite definitely what streams are really suitable for trout. Connecticut is fortunate in having an underground stratum of water which is a source of supply to these streams and keeps them more or less cool even during drouths.

Mr. ADAMS: There is a phase of this work that has not been emphasized, and it relates to the reclamation of former reservoirs. In the New England States, and I think throughout the whole of the United

States, there is a vast acreage of abandoned power sites that it would be possible to buy. If this land that was formerly flooded could be thus acquired, a great many dams could be restored at comparatively small cost and we could acquire permanent public fishing grounds over which the state would have absolute control. In these particular bodies of water the state could make demonstrations of what can be done by more rigid rules and regulations than are applicable under existing laws to most of our bodies of water by the elimination of winter fishing, the making of soundings in those areas, the setting aside of the natural breeding areas; the limiting of catch more rigorously than is the case in most open water—in fine, making a demonstration of what can be done by careful nursing of all the resources of a given pond.

Mr. J. B. DOZE: Our state is a plains state, sloping from four thousand feet in the northwest corner to about seven hundred feet in the southeast corner. We have three main drainage systems, the Kaw or Kansas and Arkansas rivers and the Cimarron. There is very little geological impression on the state in the way of glacial formation; in other words, the ice field did not reach Kansas except in the extreme northern part, and as a result we have no natural bodies of water. Practically every body of water we have has been created by erosion, or sand drift, or damming. The water area of the state has decreased from about 370 odd square miles to approximately 200. In order to meet that situation we created a commission known as the Forestry, Fish and Game Commission—forestry was attached to that commission in order to enable us to do some forestation. Last year we secured from the Legislature a fishing license. We sold it to the sportsman on the theory that we would take the money received from those licenses and establish public fishing grounds. Our revenue has jumped from \$70,000 five years ago to approximately \$225,000. We are in the course of constructing six lakes one of which will be 880 acres in area; the smallest will be something like 100 acres. We are spending for these purposes the money we are taking from our fishing and hunting licenses. We are offering our hunters an opportunity to have public shooting grounds in the time to come; and we are offering our fishermen public fishing grounds. When you realize that we have no public fishing outside of the coarser cat fishes, and that famous fish, the spotted channel cat—which to my mind is one of the finest fishes that swims—you can appreciate our problem. We have not taken over any present water areas; it has been the policy of the commission to create more water areas. If you are going to undertake a campaign of water impounding you should build lakes where none exist and leave as they are those that you have. You may, of course, take those over afterwards, but the pressing need undoubtedly is to create additional water areas.

Along with that proposition of creating public fishing grounds, migratory bird refuges and public shooting grounds—we have not arrived at

the public shooting grounds yet, and we will not for a few years—we have bought a large area of land around lakes. For instance, we bought a tract in Scott county in the extreme western part of the state, comprising 1,280 acres—and I want to tell you a little about that proposition. In this particular location known as Ladder Creek Canyon the Indians have a pueblo the known history of which dates back to 1620. There is a flow of spring water from the hills above that, amounting to a little over one thousand gallons a minute, and we propose putting a number of lakes in there and turning that over and making it not only a public fishing ground and a place for migratory birds, but also a state park. We are including in it this historic site; we are fencing the old pueblo, which is now all ruins, and we are leading these springs around to make different ponds. It is a long job; it will take probably longer than my lifetime to complete it, but I am glad to say the spirit of the country, particularly in the west, has gotten to the point where the people see the necessity of creating more water areas, and that is the big thing. We have got to have more water to provide our recreational facilities, and the only way to do it is to sell the idea to the people first and they will support it. When you consider that in a state like Kansas almost a quarter of a million dollars has been contributed in one year after but five years in the way of an educational campaign in this direction you will see that we have not such a big problem after all. It is largely a matter of going out and educating the people as to what we are trying to do for them.

MR. CHARLES O. HAYFORD (New Jersey): I am very much interested in Dr. Belding's statement, because I think it was in 1917 that Dr. Belding, Dr. Embody and myself spent four days studying out a program for this stream survey. I went ahead and completed ours so far as the streams go. We have in our state about four thousand miles of streams, only about a thousand of which are really adapted to trout. I feel that we have spent so much time in previous years discussing how to raise fish that it is well now to devote a little time to observing the results we get from those fish. Last year we asked the sportsmen when they took out a new license to make a report of the amount of fish they caught. Of course those figures are not accurate, but they do give some idea of what is taking place. In 1924, in a thousand miles of trout streams, they caught 168,242 trout, which is an average of 168 trout per mile. Each year since then it has been increasing, because we have put out more. Forty-four per cent of the licenses reported the results of their catch; thirty-three and a third per cent reported having caught no fish, and twenty-two and two-thirds per cent made no report whatever. It is evident, therefore, that the sportsmen are beginning to take more interest in the whole situation. In that period we have averaged planting about a million fish a year. Somewhere there is an eighty per cent loss from the time they leave the hatchery until they go into the

basket. Of course our state is small; we work on an entirely different system from that which prevails in most states, because there is no stream which we cannot reach with a truck in about six hours. We took all the knowledge the wardens in each county had, all the knowledge the biologists had, all the knowledge Dr. Embody had, and what little I had; we put it all together and started building up on it; whereupon we began to see a lot of interesting things in these different streams. The wardens are constantly checking; sometimes a warden will go up to a fisherman on the stream and count up his fish for that day. You can go out on a stream today and you will find one man will have three fish and another will have sixteen; you go along the stream three or four miles and you find they have not more than one or two in their basket. It seems to me that before we can arrive at anything very definite we have three important factors to consider: First, develop the hatchery to meet the conditions of your state. Second, you have to find out what results you get, and if you are not getting results you have to make a change somewhere, because if you do not there is going to be a lot of trouble. Now, where the trout ran 168,000, the bass report comes in at 121,320; in other words, they are practically catching a bass for every bass we put out. You take the pickerel—and we do not produce these in the hatcheries, but do stock them from the reservoirs. The pickerel catch was 190,829. Of course these are all given by counties; I am simply giving the totals. But it is very interesting each year to study the figures from the respective counties, having in mind the number of fish we are planting. I think that alone is going to help us a great deal in New Jersey. We hope as soon as we get a little further ahead to put a biologist to work on both the stream and the pond culture in the hatchery with a view to trying to eliminate a lot of the things that are going on now.

MR. DOZE: There is just one thing I want to suggest there: we find that screening off the small bass from the larger ones does not save the bass. Our loss in the bass is from the fingerlings eating each other, not from the adults eating the small ones.

PRESIDENT TYCUMB: Perhaps I could clear up one point on that Twin Lake proposition. All the bass of Connecticut are introduced species. They were introduced some sixty or seventy years ago, both the large-mouthed and the small-mouthed; and this lower Twin Lake had the large-mouthed bass introduced about fifteen years ago. Previous to that time the bullhead fishing was very fine. They have cleaned out all the bullheads. It seems to be an admirable place for them, too.

MR. BULLER: The black bass in the waters of Pennsylvania were also introduced there. While we have no lakes in our state except very small ones, we have noticed that in every lake into which the black bass has

been introduced, the black bass have destroyed the formerly splendid bullhead, yellow perch and pickerel fishing, and besides, it affords very little fishing of itself. That is true of every small lake we have in Pennsylvania. I am continually discouraging people from stocking small bodies of water with black bass, and trying to confine their distribution in the State of Pennsylvania, as far as I can to our rivers.

PRESIDENT TYRCOMB: I am very glad you brought up that question. We are wandering from the subject but I want to agree with you in every word you have said; and it applies to all of New England and New York State. They have ruined some trout lakes so that they never can come back. We cannot get good bass fishing to supply the sportsmen as they want them, because the bass requires more cubic feet of water per fish than any other species I know of. Besides, we are depriving the multitude of people who like this pond and lake fishing of the opportunity to get quantities of food fish—simply to cater to a limited number of anglers who want the game fish. We have to guard against extending that damage any further than we have already done, particularly with the smaller bodies of water. Of course in the south the small ponds will support bass and produce quite considerable quantities of them, but here in the north they will not do it.

DR. BELDING: Will you state whether your remarks include both the small-mouthed and the large-mouthed?

PRESIDENT TYRCOMB: I include both species.

THE FOOD OF MINNESOTA FISHES WITH SPECIAL REFERENCE TO THE ALGAE

PATIENCE ELLIS KIDD

A survey of the food of certain Minnesota fishes was carried on at Big Sandy Lake, Aitkin County, northeastern Minnesota, during June, July, and August, 1925. Big Sandy Lake is formed by Sandy River which empties into the Mississippi River. Its contour is broken by long projecting peninsulas and several islands composed of glacial and modified drift. At its outlet is a government dam.

METHOD OF WORK

Four collecting stations were located on beaches of fine sand and gradual slope; (A) south shore of Webster Bay, (B) north shore of Davis Bay, (C) northwest shore of Webster Bay, and (D) southwest shore of Webster Bay. In June the vegetation zone was fifty yards from the shore, but by the middle of August the water level had receded so far that the distance was only ten yards. The lowering of the water level undoubtedly affected the food supply.

Ten collections totaling 349 fish were made between June 13 and August 21, 1925. During June and July five collections were made at station A. During August two were made at station A and one each at the other three. Seven collections were taken between 9 and 10:00 P. M. and three between 4 and 5:00 P. M. The weather varied from cool to very warm and as a rule the water was calm. The greater part of the fish were taken with a medium-meshed seine, but a few were caught by hook and line. The fish were mostly small. Immediately after capture the fish were placed in 6 per cent formalin. Later the stomach and intestine were removed and preserved in formalin.

For study a single mount was made from the stomach or intestinal contents of each fish. The material in each mount was listed, each individual plant or animal being recorded. The algae were determined as to species, the animals only as to genus. Glycerine was added gradually to the mount and thus it was possible to keep the original mounts for future reference. A single mount for small or young fish would represent the entire contents of the digestive tract, with larger fish it might represent as low as one-fiftieth. For this reason the results are only qualitative.