Camb.
Glou.
B.B.H.
Dr.Walford

File

Albatross III

Project Leaders

March 6, 1947.

Aquatic Biologist, Acting in Charge, North Atlantic Fishery Investigations.

Seminar on March 20th.

I am enclosing a copy of the ALBATROSS III program which we are going to discuss at the next seminar. I hope that each of you will have an opportunity to look this program over critically, and I also hope that each of you will feel free to make suggestions regarding anything in it from the general arrangement to the details of the problems. The list of problems is by no means complete. I am depending on you to add to them, because each of you know the problems which are most urgent in your particular investigation.

Before the seminar I hope to have time to elaborate considerably on the sampling design for Problem No. 1. I want to get our ideas together on this, and then arrange for a session with Dr. Bliss. I hope we can arrange such a meeting with Dr. Bliss some time in April. If any of you have any other statistical problems which you feel should be discussed, please bring them up for discussion at the seminar, and send down a copy which we can forward to Dr. Bliss, so he can study the problem beforehand.

Quarterly reports are due shortly after the seminar. I presume that we should make them as brief as possible, and I would suggest as a guide that you make them about the same length as those for the last quarter. I think it would be well to have these available at the seminar and discuss them briefly.

Mr. Higgins and possibly someone from the Administrative Office in Chicago are planning to visit Boston on or about March 20th. The principal purpose of their visit will be to go over the final plans and specifications of the ALBATROSS III. They may want to attend the seminar and again their plans may conflict with the seminar date. I will let you know as soon as possible, but, lacking any specific information, I am planning to hold the seminar as scheduled.

WILLIAM F. ROYCE

Enc.

WFR/efg

W47-3

PROGRAM OF RESEARCH TO BE CONDUCTED WITH THE ALBATROSS III

THE OBJECTIVES OF FISHERY RESEARCH AND THE FUNCTION OF THE FWS

Studies of populations of animals, both in nature and in the laboratory, indicate that nearly all animal populations tend to increase until they use up the space and food supply available. At this point (the average of cyclical changes, if any), the natural death rate balances the recruitment (production of young). As animals are removed by man fewer will die a natural death and more space and food will be available for younger individuals to use. However, it is possible to remove enough to make it impossible for the remaining adults to provide enough young to use completely the space and food. When we consider a fish population, it is apparent that the maximum production from a stock of fish may be realized only by catching just enough to lower the population numbers to a level at which the maximum recruitment takes place. If our objective is a maximum sustained yield then it is obvious that we may fish a stock of fish either too little or too much.

It is the objective of our North Atlantic fishery research:

1. To know the current condition of the fisheries and to discover and evaluate the causes of fluctuations in yield.
2. To develop for each fishery the fishing methods and practices that will provide the maximum continuous yield compatible with sound economic practice.

It is the general function of the federal government to act as the research, advisory, and coordinating agency wherever several states or nations are concerned with a common conservation problem.

Woods Hole Laboratory
Manuscript Report Number
47 - 3

It develops knowledge of the whole fishery resources rather than of merely inshore segments. It promotes the fullest and most widespread use of the commercial fish catch and the achievement of the highest standard of quality of the fishery products. The New England fisheries are an interstate and indeed an international problem.

In the case of the North Atlantic fisheries, the Fish and Wildlife Service is the only U.S. Agency engaged directly in fishery research on the offshore banks. The other agencies concerned are the government agencies in Canada and Newfoundland. Other research on oceanography and general fishery problems which is carried on by several organizations usually applies only indirectly to the North Atlantic fishery problems.

The Fish and Wildlife Service must not only acquire the knowledge of our fishery resources and develop methods of obtaining the maximum continuous yield but it must put the methods into effect. It can do this by publicizing the knowledge and by demonstrating the application of the methods. It has no regulatory powers over fisheries in Continental United States.

THE STATE OF KNOWLEDGE OF THE NORTH ATLANTIC FISHERIES

The several stocks of North Atlantic fish are used in varying degrees. The haddock fishery which has been the most important one in New England for two decades or more has reached the lowest level of abundance in over thirty years. Our present knowledge indicates that this level can be raised and production increased by proper conservation methods. These methods have been recommended but not adopted.

The rosefish fishery on the New England banks which was started only about 1935 has reached a peak of production and begun to decline. Because of a scarcity on closer grounds, a greater proportion of rosefish are being taken on the Nova Scotian banks. Studies on this fishery have been underway about four years and necessarily have been limited to phases which could be conducted ashore. We have accumulated much background information but do not know whether production is greater or less than the possible recruitment.

The yellowtail flounder production on southern New England banks reached a peak of over 60,000,000 pounds in 1942 and declined to only 20,000,000 pounds in 1945. Certain aspects of this fishery are under investigation but no conclusions as to the cause of the decline have been reached.

The mackerel fishery was the subject of investigation for many years. Success of spawning, which determines abundance, appears to be associated mainly with hydrographic conditions and not with the size of the spawning population. Regulations are of doubtful value. Predictions of future abundance based on knowledge of the spawning success would be of value to the industry. Such predictions will probably depend on surveys with a vessel because to date it has not been possible to consistently predict the abundance by measuring the commercial mackerel catch.

Extensive studies on cod fish migrations and life history were conducted. The cod is probably the largest fish stock in Northwestern Atlantic waters. At present, we believe the cod population is not in great danger of overfishing except in certain small inshore areas.

Numerous other offshore species are taken in lesser quantities. Most important are sea scallops, lobster, whiting, hake, pollock, and the several species of flatfish. Our knowledge of the condition of most of these fisheries is very scant.

Following an extremely prosperous war period the New England fisheries face a strenuous time of readjustment. The fleet has expanded to the greatest tonnage in history. The bottom fish on New England banks are generally scarcer than at any earlier time. It is important to note that the expansion of the rosefish fishery in the past decade brought into production fishing banks which scarcely had been fished. It was in fact an expansion of fishing grounds. No more large banks exist within reach of the New England fleet.

Canada, Newfoundland, and Iceland, which produce tremendous quantities of the same kind of fish as New England, are shipping more and more fish to our markets. Our fishermen are faced with severe competition both among themselves and with foreign fish which will unquestionably bring a sharp decline in prices. The declining fish stocks and the larger fishing fleet make the conservation problem increasingly urgent.

Our recent research on the North Atlantic fisheries, which has been carried on without a vessel, leaves many things to be desired. In studying a fishery, we must know the total number of fish in the population either actually or relatively. This has been obtained by using the experience of the fleet to calculate the abundance of the several species. Such calculations are most reliable only for the species which are the objects of a principal fishery and even with these it is likely that serious errors occur. The principal

difficulty is that the fish populations are not consistently sampled by the fleet and that the population of fish varies tremendously in its degree of concentration or dispersion. There is no method at present of compensating for these difficulties in the calculations.

We have very little knowledge of the abundance and distribution of fish of non-commercial species and sizes. Such knowledge is especially necessary in the case of the young fish of important species, such as haddock and redfish. Knowing the abundance of these young fish would enable us to produce reliable estimates of the fishing to be expected in the immediate future, to determine much more accurately the causes of changes in recruitment, and to more effectively determine if regulations would be desirable.

It has been impossible to test adequately the effect of our proposals for changes in fishing gear and to answer the questions which we must answer if the proposals are to be accepted. For example, use of a larger mesh is subject to many critical questions such as: Will the fish live after going through it? Will the fish gill to such an extent that more small fish are killed and a great deal more labor is required, etc.

The feasibility of a closed area depends on better knowledge of the distribution of young fish than we possess.

Our knowledge of the movements of fish caused by hydrographic conditions such as temperatures, salinity, and the nutrient materials in the water is extremely scant. It has been extremely difficult to handle fish alive such as we must do for tagging fish. In fact it has been impossible to tag haddock successfully from otter trawlers.

The operation of the ALBATROSS III must be directed first at providing us with more accurate and complete vital statistics of the entire fish populations. By vital statistics we mean population size, death rate, and recruitment (birth rate). We must determine any important effects of changes in the environment on the population of fish. Also, we must clearly demonstrate the usefulness of any recommendations for changes in gear or methods of handling fish.

Our total research in the methods of producing the most fish must be directed principally at learning the effect of factors which may be controlled by man. Man, at present, may control only the amount and nature of the catch ~~of the offshore species~~ on the offshore species. Knowledge of the physical factors influencing the catch will probably be of lesser value. Such knowledge will be useful however, if it is possible to vary the catch to take advantage of favorable factors and to nullify the effects of unfavorable factors or to predict the probable catch in the immediate future, or to more clearly demonstrate the effect of man's activities on the stock by removing the confounding effect of such physical factors.

DISCUSSION OF THE PRINCIPAL RESEARCH PROBLEMS

Problem No. 1. Determine the changes and the causes of the changes in the distribution and size of the stocks of fish.

This broad all-inclusive statement is, in fact, the central problem of most fishery research. It is stated broadly rather than being broken down into the many lesser problems because it appears possible to solve this major problem as a whole by operation of the ALBATROSS III.

At present our knowledge of the distribution of fish is limited to the record of the fishing fleet. For species which are the object of a fishery, the fleet probably covers the distribution of that species on the fishable parts of the continental shelf. For species which the fleet captures incidentally while searching for other species, the distribution may in no way resemble the distribution of fishing effort.

Our present knowledge of the size of the stocks is likewise limited to a relative measure obtained by calculating the abundance from the experience of the fishing fleet. Again for species which are the objects of a fishery, the abundance may fairly reflect the size of the stock. We cannot prove it but the data on abundance of haddock, redfish, and flounders seem fairly consistent. The data on the abundance of species caught incidentally unquestionably are less reliable. We do not know how much less, for we have no good measure of reliability. We have no data on the size of the stock of non-commercial sizes and species.

The causes of the changes in the size and distribution of the stock may be many. We are most interested in the effect of fishing. Records of the amount and kind of fishing and the catch are essential. In most cases they are currently available for each stock of fish from shore investigations. Adequate records of the changes in the size and distribution of the stock from investigations at sea will permit evaluation of the effect of changes in fishing upon the stock. Only by making such correlations over a period of years can we be certain of learning the amount and kind of fishing which will produce the most.

The inter- and intraspecific relations between competitors for food and space and between predator and prey may be subject to cyclic changes. Very likely such cycles (perhaps irregular) occur with many species of marine fishes. The early records of the haddock population show evidence of cyclic changes. Knowledge of these relationships will be derived from continued observations of the numbers and distribution of all the animals on the banks.

Changes in hydrographic conditions definitely have been shown to cause changes in fish population. Of course, this occurs annually but also frequently over longer periods. Sette has shown that the spawn of mackerel is vulnerable to changing conditions at the time of spawning. Such vulnerability may cause the phenomenon of dominant year classes. It is important to know the relative importance of changes in hydrographic conditions. If hydrographic conditions cause the major changes in the size of the stock, then it is of small value to regulate the fishing to aid in recruitment. The preponderance of young which a few fish will produce seems to provide adequate recruitment in the case of mackerel and perhaps such fishes as striped bass and bluefish whenever hydrographic conditions are suitable.

It is proposed to attack the problem of measuring the changes in the distribution and the size of the stocks by a periodic sampling using fishing gear from the ALBATROSS III. Such sampling should be conducted to efficiently provide the following data:

1. Estimates of the actual and/or the relative number of fish of each species and size on each segment of the banks.
2. The reliability of each such estimate.

Such estimates obtained regularly and when analyzed in conjunction with data now being gathered ashore and with the hydrographic observations which will be made concomitantly will provide a determination of:

1. The effect of fishing on the various stocks of fish.
2. The relationships between different sizes of the same species and between different species which may compete for the same space or food, or which may eat each other.
3. The effect of changes in hydrographic conditions upon the stocks of fish.
4. The relative importance of each of the above factors.

It is obvious that adequate answers to the problems will demand the most efficient sampling technique. The design of the sampling will entail the following:

1. Design of fishing gear to catch as many sizes of fish as possible and measurement of its selectivity. Selectivity may vary with:

   a. Mesh size

   b. Size of net - width and height

   c. Size of foot rope or rollers

   d. Length of "Legs".

   e. Speed

2. Design of the sampling station layout based on present knowledge of the hydrography, the activities of the fishing fleet, and records of the results of previous experimental fishing. The period between samples, the area to be covered, the number of samples at each station will be determined by a study of the efficiency based on the variance found in available fishing records. The sampling design may be stratified by the following factors:

   a. Location (subareas)

   b. Depth

   c. Type of bottom

   d. Time of day

   e. Time of year

   Data may be adjusted by or analyzed to account for the following factors:

   a. Net selectivity

   b. Kind of tow (if measuring instruments are available)

The areas to be covered in order of importance are:

a. Georges Bank, South Channel, and Nantucket Shoals area.

b. Northern Gulf of Maine

c. Western Nova Scotian Banks

d. Eastern Nova Scotian Bank

3. Provisions for frequent assessment of efficiency of design and redesign as data become available.

4. Procedure to care for missed samples, torn gear, and locations which cannot be sampled.

5. Specification of the kind of measurements to be used on each catch, subsampling techniques.

6. Analytical methods. Use of IBM machines.

Assuming that the ALBATROSS III will be available for sea duty in November 1947, a tentative schedule of operations is:

Design the sampling methods and the gear	March to August 1947
Construct and acquire the fishing gear	August to November 1947
Test gear selectivity	December 1947 to February 1948
Commence regular sampling	March 1948

Problem No. 2. Determine the effect of otter trawling on the quantity and availability of fish foods.

The effect of otter trawling has been a subject of long and confusing controversy. Otter trawling is unquestionably the most efficient form of fishing and unquestionably, too, it probably destroys large numbers of fish below commercial size when used with the present methods. It has been shown that this destruction of undersized fish can be corrected in many cases (Herrington 1936). However, evidence available indicates that, in addition to the destruction of small fish, otter trawling may have a long-time effect on the fisheries by changing the character of the bottom. This effect is thought (Herrington, 1947) to consist of a gradual smoothing out of the bottom by the use of heavy rollers. That such smoothing out has actually occurred is evidenced by the gradual expansion of the otter trawl fleet to grounds which had previously been unfishable because of the rough bottom.

The population of bottom organisms, which are extremely important as food for various groundfishes, is probably proportional to the area of the bottom available. Inasmuch as a decrease in bottom area has been caused by a smoothing out of the irregularities of the bottom by prolonged otter trawling with heavy gear, it is possible that their abundance has been reduced.

That a reduction in the productivity of Georges Bank has possibly occurred is indicated by several lines of investigation. The long steady decline of the fish production on the heavily-fished European banks, and the failure to recover as much as anticipated during the war years may also indicate that perhaps otter trawling is having some long-time effect.

If otter trawling is having a serious detrimental effect on the New England fishery, it is certainly important to show it and correct or modify the harmful practices. It is likewise important, because of the possible expansion of otter trawling to Pacific banks which have heretofore been untouched by otter trawls. Elimination of harmful practices here would greatly aid in the conservation of the fishes.

Study of this problem will depend upon the development of instruments which will provide accurate knowledge of the conformation of the bottom and of the number of the larger bottom animals. It has been proposed to develop a photographic apparatus which would take aerial photographs of the bottom from a fairly close distance. Using these photographs it would be possible to count all of the larger bottom organisms such as starfish, some of the shellfish, and probably to make relative estimates of the burrowing organisms which leave visible holes. An alternative or supplementary method would be to use a large clamshell dredge, which will take an appreciable amount of the bottom such as a square yard or perhaps even more. The photographic method seems much the more practical.

If adequate instruments were available it should be possible to study the effect of otter trawling on a definite area which could be located inshore and could be trawled over, using different kinds of gear in different amounts. A small area such as this, if it were carefully laid out, could be fished as much in a month by one vessel as the fishing grounds on Georges Bank are fished in years by the entire fleet. The photographic instruments could measure what happens to the conformation of the area and to the number of animals on it. Another approach would be to compare the numbers of animals and the conformation of certain

selected areas on Georges Bank. Such areas could be selected in pairs, - one in the immediate vicinity of a wreck or some other object which makes the general location unfishable, and another on the bottom of similar type a few miles away which is fished regularly.

Development of this program will depend very largely upon the development of adequate instruments. A proposal for the photographic instrument has been under consideration for about two years. At present the Navy seems interested, and it may be possible to develop it cooperatively with them. In any event a definite schedule of operations will depend upon the time at which this instrument will be available.

Problem No. 3. Determine whether haddock and cod live after going through the meshes of a net.

The principal objections of the fishermen to using large mesh nets are based on their claim that fish will not go through a net or, if they do, they will not live after struggling through the meshes. It has definitely been shown (Harrington 1936) that most fish of the smaller size will escape through the meshes, and the principal problem remaining is to show if they live after such capture and escape.

The evidence seems to be somewhat contradictory. It has been impossible to get returns from tagged haddock when they were caught in otter trawl nets, even though the fish were landed on deck, handled with care, and released in seemingly good condition. It has been possible to tag them when caught in a line trawl in relatively shoal water. It seems most likely that haddock caught in an otter trawl net die from one of two reasons - the physical and nervous shock of being caught in the net, or the expansion of gases in the body upon being brought rapidly to the surface from considerable

depths. If the second is the principal cause of death it would not affect in any way the small fish going through the meshes immediately after they enter the net.

It would appear possible to test the viability of small fish in two ways: (1) to tag them and release them, and obtain their recapture by the commercial fishing fleet; (2) to hold them in a tank ashore for a long enough period of time to eliminate any reasonable doubt that they would die from the handling while being caught.

It would appear possible to accomplish a solution of this problem by using a standard cod-end, and covering it with a fine mesh which would capture the fish going through, then fishing in shoal water. The catch would be brought to the surface very slowly to eliminate the possibility of "bends". It would be desirable to catch the fish in the colder weather, so that they would not be subject to an extreme change in temperature. It might also be desirable to capture them at night so that they would not be subject to extreme changes in light. After capture, using every precaution against injury, then part of the fish could be tagged and released, and part brought to shore and held in a tank at Woods Hole. It would be most desirable to use haddock for this experiment since haddock is one of the most important species, and since it appears to be one of the less sturdy species, more susceptible to injury.

The urgency of this problem makes it seem desirable to attempt this experiment in December 1947 and January 1948, or immediately after the ALBATROSS III is put in operation. It would be possible to conduct such experiments with only a partial crew within a few hours'sail of Woods Hole. It is proposed to prepare a report on the experiment of holding

the fish in tanks in February 1948 and on the return from the tagged fish about January 1949.

Problem No. 4. Develop methods of handling fish alive and tagging, and extend the tagging experiments already in progress.

It has been possible to successfully tag only flat fish and cod on the more offshore banks. Successful tagging experiments on haddock and redfish would provide invaluable information on their movements and permit a far more satisfactory delineation of the stocks than has been possible to date. Tagging experiments on yellowtail flounder have been considerably curtailed because of lack of a vessel and because it has been impossible to use a commercial vessel at the time and place desired. It is impossible to use commercial fishing vessels to handle the more delicate species of fish because they are not equipped with the special holding tanks, water supply, and other gear which are necessary to handle the fish alive. Neither are commercial fishing vessels able to take the time to haul nets to the surface slowly to prevent "bends" and run the risk of losing part of their catch.

It should be possible to develop the special handling techniques and the tagging methods which will be necessary to tag haddock and redfish. It may be possible to perform this operation in conjunction with the annual census which has been outlined in Problem No. 1. If not, it should be started in the Summer of 1948. Solution of part of this problem may be accomplished in connection with Problem No. 3, and the data used in the solution of both problems.

Problem No. 5. Determine the effect of mesh size on the size and quantity of each species captured, on the durability of gear, on the labor required to handle the gear, and on the efficiency of the gear.

Use of a larger mesh is subject to many practical objections on the part of the fishermen, which pertain to the handling and operation of the gear. Use of the larger mesh would necessitate using larger twine and would result in having the knots farther apart. The knots are the principal bearing surface and receive the most wear, and consequently with fewer knots it is likely that the mesh will wear more rapidly, even though the new strength of the larger mesh were the same as the new strength of the smaller mesh.

Another objection concerns the matter of fish gilling in the mesh and causing the fishermen a great deal more labor in cleaning the net after the catch has been landed on deck. Another problem concerns the capture of different species of fish, some of which must be captured by a fine mesh trawl and others which should be captured by a larger mesh trawl. Thus, there is some conflict between redfish fishing and haddock fishing, which are frequently practised by the same vessel on the same trip. These two species differ greatly in size.

It may be argued that the method of conserving the fish is one problem and the development of gear for effecting this purpose is a problem for the industry after it has been ordered to use different techniques. It would seem to me that these gear problems must be studied by the Fish and Wildlife Service, and the industry informed of the results.

The determination of the effects of mesh size can be made in conjunction with the determination of gear selectivity, as a part of Problem No. 1. The problem of durability of various sized meshes should be solved on testing machines ashore. This has been started and a little experimental data are available, but more adequate experiments are needed. It might also be possible to test the net materials with the ALBATROSS III by using pieces as chafing gear on the nets which will be regularly operated.

Problem No. 6. Determine the economic value of changes in methods of fish handling and conservation.

The operations necessary to produce better quality fish are known to most everyone in the industry. The fish should be handled more cleanly, more rapidly, with less bruising and puncturing than they are at present. Most everyone in the industry knows this. The principal problem is to determine whether the extra expense involved in special handling pays off in greater value of the product. It will be especially important to determine which particular method of special handling may be done with the least extra work and which produces the most extra returns. Solution of these problems is especially urgent at the present time, because of the serious competition in quality which New England fish are receiving from foreign fish, and because of the serious criticisms of the quality of many New England fish when they reach the interior markets.

A solution of this problem depends on a time-and-cost study of the methods and equipment for better handling and a method of evaluating in dollars and cents the increase in quality. This operation should be carried on by the Division of Commercial Fisheries, and could and should be run at the same time as the biological investigations.

Problem No. 7. The distribution and growth rate of small lobsters, redfish, and yellowtail flounders.

It has been impossible to capture the very young of these species in adequate quantities to determine the nursery grounds or to determine the growth rate by length-frequency modes. Both kinds of information are highly desirable. It has been necessary to estimate the growth rate of small lobsters from the growth rate of the adults, and there is room for considerable error in our estimates. The growth rate of redfish and yellowtail flounder has been estimated from the scales, but the scales of both species are subject to considerable interpretation, and proof of the earlier age readings is very desirable. Knowledge of the spawning areas and the source of the young is important before developing any management practices.

These problems can be solved by the collection of adequate samples of the young, and it should be possible to do this for redfish and yellowtail in connection with Problem No. 1. It will be necessary to develop special collecting gear for lobsters and use it as a separate operation. Collection of these data will be started with the beginning of the census in March 1948.

GAMB. B.B.H.
GLOU. FILE
N.B.

NORTH ATLANTIC STAFF April 3, 1947

Aquatic Biologist, Acting in Charge, North Atlantic Fishery Investigations.

Seminar - March 20,1947

Subject: Program for ALBATROSS III

Speaker: William F. Royce

Attendance: Arnold, Baird, Buller, Clarke, Perlmutter, Phillips, Royce, Schaak, Stone, Stringer, Taylor, Higgins

Discussion:

The plans and blueprints of the ALBATROSS III were discussed at length and several suggestions for minor changes were made.

The program of investigation which was forwarded to the investigators beforehand was explained and discussed. Numerous suggestions were made and noted. A revised and expanded program will be prepared in the near future.

The next seminar will start at 11:00 A.M. April 17. The principal topic will be the methods of oceanography. Mr. Stringer will prepare a discussion. In addition Mr. Schaak will discuss the use of punch card systems for analysing data. Problems intended for submission to Dr. Bliss should be prepared in summary form and discussed briefly at this meeting.

WFR/efg WILLIAM F. ROYCE