of fishing. Present work shows that, at least in many species, this intensity affects the abundance level of fish stocks. We know, as a biological truism, that in general as a stock of fish increases in numbers natural mortality increases until the number of fish is brought into uneasy equilibrium with the environment. The actual level may vary from year to year but to the best of our knowledge it maintains some long-time over-all average (if we can ignore the climatic cycles stretching over hundreds or thousands of years.) Such a balance is developed through increasing intra-specific competition for food and space, increased cannibalism and predation, or other factors related to increasing density of population. We know also that as a population is reduced in abundance a level eventually must be reached where the production of eggs and young is insufficient to make full use of the environment. At some level or levels between these extremes, the optimum conditions must exist with respect to adequacy of spawning and minimum mortality rates. It may be that the level required for adequate spawning is so low as to enable us to disregard it as a practical matter. It may also be that significantly increased mortality rates develop at abundance levels sufficiently high that we may disregard them in a reasonably intensive fishery. However, results of some investigations such as those on haddock, indicate that these factors can be of considerable importance, at least at some of the abundance levels actually observed. Where this is so, an understanding and evaluation of these factors would provide some of the most promising tools for the fishery investigator and administrator.

DISCUSSION

BIOLOGICAL SESSION

Discussion Leader: PAUL GALTSOFF

Discussion Panel: J. L. MCHUGH, THOMAS H. LANGLOIS, HARDEN TAYLOR

Galtsoff: You have heard the papers given this morning by Dr. Hile, Dr. Graham, Mr. Herrington and Dr. Schaefer. A certain emphasis has been placed on the use of mathematical analysis to reveal the mysteries of the population fluctuations in the sea. I would like the audience to inject their ideas in relation to these annual fluctuations and the social, political and economic disturbances caused by changes in the ecological situation in the fisheries. The first paper we will have in our discussion on will be Dr. Hile's paper and the problems of the fisheries in the Great Lakes.

Langlois: I am in substantial agreement with Dr. Hile's paper. I do think that several points should be carried further to take in the fluctuations in the fisheries. The variability found here is a function of environment and is apart from fishing activity.

Lake Erie is a pool in the Great Lakes system, besides being considered a separate entity. All of the lakes except Lake Erie are below sea level. Lake Erie

is also shallower, generally warmer, and quite different from the rest.—
(Charts were shown and the physical characteristics of the lake pointed out).

Regardless of the fishing effort in Lake Erie the fish populations fluctuate. The abundance of the Coregonids in particular is dependent upon conditions being favorable to the food cycle.

Certain conditions favor survival. When these conditions are good the number of pounds of fish landed is high. In 1945 the cisco catch was high and as the success of this year class dropped off and conditions became poor in 1947 the stock disappeared.

The western end of Lake Erie is the key area. If there is a good fish survival year the productivity is high and fish can be landed cheaply. An economic problem is involved then.

The various environments are of the most importance in the welfare of the stock. Some economic gain may be realized by a change in the fishing effort but this would not make conditions better for the fish.

H. Taylor

I, too, am in agreement with Dr. Hile. All of the papers give us reason to be proud of fishery biology as a science. My retrospective view of them, however, is that all of the papers leave out the economics of the fisheries. I think of economics as everything being related. This can be likened to the fish net with its many knots. Cutting out or displacing any of the knots has an effect upon every other part of the net.

With each fishery at its maximum yield we would have a bad condition, for prices would be low. In the Maine lobster fishery the catch today is only 40 per cent of the catch in 1890, but the price is six times greater and the purchasing power of the fisherman has been increased three times.

Nature seems to follow the Sherman Anti-Trust Laws in limiting production. In the early years the main inland areas did not have any fish except the salt cod. As the population grew and we had better icing and shipping facilities Cape Cod fish were shipped west to St. Louis and Kansas City. At first they were getting 100 per cent Cape Cod whiting. Later on many other species which resembled the fresh water panfish, to which these people were accustomed, were shipped inland. This new trend affected the economics of the fisheries. There was a change in prices, demand and supply. The fisherman was also called upon to put forth a more intensive effort in fishing for new species.

These changes in economic conditions have affected

prices and production and can result in the fisherman getting more money for less fish.

McHugh: The fisheries of the Great Lakes are complex, with the gear taking more than one species. We have the same situation in Chesapeake Bay. There are three or four major types of gear, pound nets, haul seines, gill nets and trawls, which all catch the same types of fish. If we were in a position to know the biological condition of a fishery the management of the fishery would still be difficult. How could we tell the fisherman what the limits were? We have pound netters and off-shore trawlers operating on the same species.

Q. Allee: I would like to know about the smelt and lamprey problem in the lakes.

A. Hile: The smelt problem is unsolved. We do not know if it is a blessing or a curse but right now the fishermen are benefitting. With a rise in smelts the other species decrease. Mortality of smelts is followed by a rise in other species.

The lamprey is the cause of the collapse of the lake fishery at Lake Michigan, especially the lake trout. The main food of the lake trout was the chub and bloater. The subsequent relief of pressure by the lake trout on the chub and bloaters has resulted in the increase in these latter species which now fill the lake and make fishing difficult.

Galtsoff: We can proceed to a discussion of the papers of Dr. Graham and Mr. Herrington. Since these are similar I think we might discuss them together.

Q. H. Taylor: I noticed references to Goode's paper in Mr. Herrington's discussion. I have found that Goode got himself all tangled up and there are many mistakes in his calculations and estimates. I mean no discredit to Goode who, if he were alive today would probably have corrected these mistakes.

Since 1908 the jurisdiction of the government has been extended and treaties have been entered into with several foreign countries. Even though the production of Costa Rica is very low it is the subject of a treaty. In a bulletin put out by the State Department in 1949 they state that it is the policy of the U. S. to provide for the possibility of each fishery in the world in order to obtain a maximum yield. This is hard to understand. The fishery biologists leave too much out. What would the effects be if the croakers in North Carolina were more plentiful. The maximum sustained yield theory does not go along with the theory in that increased catch reduces price and the fishermen do not benefit.

The population centers change and conditions change. From 1900 to 1940 there has been a reduction

in the number of fishermen but the amount of production is the same.

I question the use of the word "profit" as it is used in this paper. The North Sea is our heaviest fished area. In England when the markets were glutted with herring the fishery remained the same. When the fish were depleted, the costs rose and other fish were competing with the herring. This competition sent the fishermen to Iceland where new fishing grounds were discovered. The operation of the economic laws brought this discovery about. The fisherman has found out that the fish are not where the people are and that he must go out to get them.

A. Pritchard: I can assure you that we, in Canada, do consider the social and economic problems of the fishery as well as the biological. Our deputy minister is also an economist. Under our constitution the federal government has jurisdiction over the fisheries. By agreement, the provinces, under the federal act, take over these duties. I do believe, however, that the dollar will control fish populations.

Q. F. G. W. Smith: The area of the Caribbean needs protein food. In the future we look for an increase in poulation in this area and therefore an increase in the need of fish as a source of protein. Certainly biology is worth while in many instances. One might cite the transplantation of the striped bass and the shad or the establishment of the French oyster as classical examples of instances where biology has been beneficial. A further analysis of the economics might reduce their value. Yet, I challenge the fishery biologists to show where population dynamics and control have been beneficial.

A. McHugh: One definite accomplishment we have made is to knock the hatcheries idea on the head. This will save much money in the future.

A. Pritchard: The salmon hatcheries in British Columbia were stressing the wrong phase of the life history, and did not accomplish much.

Q. Schmidt: I would like to ask Dr. Taylor one question. If he is so opposed to biologists why is he one of the prime movers in the development of fishery biology at Morehead City?

A. H. Taylor: The Institute at Morehead City is not interested purely in fishery biology. We are also interested in economics and marketing.

Q. F. G. W. Smith: I am hopeful that by looking over the accomplishments of the past years the fishery biologist can approach his problem with a new attitude. In many instances the fishery biologist has operated by necessity rather than by intention. His work is only one of the means of solving the overall problem of extending the fish bank,

but it is an essential one. In almost every case the public is not interested in why certain things happen. We need people who can direct the activities of subordinate groups in an overall way, taking into account the economic as well as the biological factors to extend and increase our supplies. Dudley Wiles did just this thing in Barbados, where there was a small fishery for flying fish, valued at $780,000 a year. They were using sailing vessels and scoop nets, which Wiles persuaded them to abandon in favor of small gill nets. The result was an increase in the value to $1,000,000 per year. This increase then brought about a problem of glut and a marketing problem. Further problems of freezing, transportation and economics were also confronted, but are being solved.

I think the fishery biologist should work on his problems with all these aspects in mind with the ultimate object being that he should benefit society.

A. Schaefer: (Schaefer explains his graphs further)
The biologists produce the work necessary to make these graphs and the picture they represent. There are four points of possible maxima in various terms of fish, or money. Dr. Taylor can choose his own maximum. It is not the job of fishery biologist to decide what to do after he has presented his information. It is also not the job of the fishery biologist to place restrictions on the fishery in all cases.

Q. H. Taylor: What do you want people to do?

A. Schaefer: That is not our problem.

Q. Pritchard: I am on Schaefer's side as far as regulations are concerned. Nine hundred and ninety-nine out of one thousand of our regulations are no good. However, don't blame them on the biologists. We like to lift a regulation as well as put one where necessary. It is the decision of the people which prevails after the evidence has been presented.

A. Idyll: It is a dangerous generalization to say that the work of the fishery biologist is always to restrict the fishery. In Florida we have suggested lifting regulations where our investigations have shown such restrictions are not warranted. We have suggested the lifting of the closed season on mullet; secondly we have lifted the ban on night fishing for shrimp. Our philosophy is to regulate the fisheries for the fishermen, not the fish.

A. Carlander: In the early days regulations were not proposed by the biologists. In fact the first research by the biologist Thomas Huxley was to abandon regulations. Our aims are a maximum sustained yield and a profit to the fisherman. In agriculture we have research and production problems which are kept apart with the research being paid for by a lower cost production.

There may be times when we need the fishery biologist's knowledge, but this is apart from production. In any event we need a greater amount of protein production.

Q. Springer: I would like to take this opportunity to pat the fishery biologist on the back. It was through the biologist that we first found out that snappers could be found in deeper waters of the Gulf. This led to the development of electric reels and an increased production. Even today the snapper fishery has a chance for expansion with a need for better marketing facilities.

Another instance of the value of the fishery biologist's work is where they point out possible new areas to be exploited. Several years ago we were told by Luis Rivas that there were quantities of sardines in the Gulf which could be commercially exploited. On a recent cruise on the Oregon we sighted several of such schools which indicated the sardines were there in large enough quantities to be commercially exploited.

I have two questions to ask Dr. Schaefer. Does he take into consideration such an innovation to a fishery as the use of the depth finder or any new gear in his evaluation of his unit of effort? Also, when three boats fish together and get a higher unit of effort than when the fish single, does he weigh these factors?

A. Schaefer: Yes, we do weigh these factors. There are different devices employed such as the size categories for boats and the use of link relatives in weighing the catch per boat. With cooperative fishing the problem is more complicated. Evaluation becomes more difficult but not impossible.

Q. Schmidt: The work of the fishery biologist was found necessary as a result of the politician's need for data necessary to legislation. This data was needed when state pressure was put on to find out if the existing laws were any good. Our aims are to increase the income of the fisherman and make more protein food available to the people. As far as the economic laws of supply and demand are concerned it is the job of the commercial fish companies to educate the people and create a demand for seafood. I have a question for Dr. Taylor. How do you justify fishery investigations at Morehead City?

A. H. Taylor: (No comment.)

A. Galtsoff: The fishery biologist has his roots in the past and yet he must look to the future: he must recognize the activities of the past which will help in guiding his future actions. It was the necessity for an understanding of the fishery problems which was the forerunner of a desire for knowledge of the fisheries and the sciences of oceanography and marine biology. We

must give the fisheries credit for stimulating this oceanic research.

In one instance biologists were working on the pearl oyster problem at Ceylon years ago. There was no accomplishment but a wealth of information was learned about the biology of the sea. These volumes of academic and general knowledge were put into the records and can be used for 200 years. If you ask me if I think this work was wasted, I believe not. I think it was worth while.

Q. McHugh: We have been considering using such methods as Dr. Schaefer in working on our oysters. In oysters the essential data such as growth rate, recruitment and natural mortality are easier to measure and work with than in another fishery. I believe our data show that the fisherman would be better off if he took up the oysters after 18 months rather than 3 years.

A. Schaefer: The problem of harvesting of oysters is less trouble than in a more dynamic fishery such as the tuna. You can multiply your survival rate by your growth rate at any time to get your maximum yield.

The causes of fluctuations are important. There is always the relationship of fishing mortality and natural mortality. Some ecologists say that the natural fluctuations are so large that fishing mortality is negligible.

Our attempts have been to predict the situation in order to get the greatest yield. Even if we know only 50 per cent of the required information I think we should use the 50 per cent that we do know until we learn the rest.

Galtsoff: The tool of statistical nowledge is a valuable one, but it is not a substitute for a knowledge of the biology, physiology and behavior of the species. In our next meeting I hope we hear more of the behavior of the species and am looking forward to advances being made in this area.