Appendix 7: History of Canadian fisheries research related to resources in NAFO Subarea 5 - 1948 to 1967.

by

F.D. McCracken

F.D. McCracken

1948

Item - There has been close contact maintained with research programs in the north Atlantic by United States Agencies - Federal State and Private (from Directors summary of Atl. Biol. Station activities).

Item - Oysters - a visit was made by the scientist in charge of oyster investigations to the laboratory of Dr. V.L. Loosanoff of the USFWS in Milford, Connecticut to observe operation of the seed-oyster industry in that area.

Note: Although not recorded, closest contacts were probably between the Canadian scientists working on clams and other mollusks and their U.S. counterparts in the Maine Sea and Shore Fisheries Lab at Boothbay Harbour, Me.

Item - Assessment of long-term changes in abundance of stocks of groundfish and the factors affecting such changes was recognized as being of primary importance. Increased emphasis has been placed on collection of such statistics on catch, catch per unit effort, size and age composition for both offshore and inshore areas. This emphasis on bio-statistics was to prove useful when the International Commission for the Northwest Atlantic Fisheries was formed.

Reference - 1948 - Report for 1948 of the Atlantic Biological Station, St. Andrews, N.B. (Fisheries Research Board).

1949

Item - Northwest Atlantic Convention - An international conference in Washington, D.C. in February, 1949, resulted in a Convention between the countries interested in the groundfish fisheries of the northwest Atlantic, which provides for a commission to coordinate research in this field. As the investigations are for the most part to be carried on by the countries themselves, the obligations of the Fisheries Research Board will be affected when the Convention is ratified and comes into force.

Reference - 1949 - Report for 1949 of the Atlantic Biological Station, St. Andrews, N.B. Fisheries Research Board of Canada.

Item - Although not recorded there was an organization called Atlantic Fisheries Biologists which included as members Canadian and U.S. Federal and State Biologists from Newfoundland to New York. Once a year we met to exchange views, find out what programs were being carried out in the various countries, provinces and states. Informal collaboration was the rule.

In 1949 the group met in Woods Hole, Mass. for a two day session. It was attended by 4 or 5 scientists from St. Andrews and most of us remained for several days for informal exchanges with specific groups. I attended and the reference is from personal recollections.

F.D. McCracken

1950

Item - The society of Atlantic Fisheries Biologists again held its annual meeting at the Atlantic Biological Station September 29 to October 1, 1950. This society, with membership consisting entirely of biologists associated with fisheries investigations on the Atlantic coast of Canada and the United States, holds informal meetings intended to encourage frank discussion of their scientific problems. About fifty members attended and group discussions were held, inter alia, on population estimates based on tagging, standardization of scientific and common names and savings gear. Members of the ABS staff contributed activity to the discussions and management.

F.D. McCracken

1951

The following item from the report of Panel 4 in the first meeting of ICNAF seems worth noting since it gives further credence to using research carried out in Subarea 4 where these researches can be associated with the "needs" of Subarea 5 ---- the panel took cognizance of a recommendation expressed by the United States Commissioners on behalf of their advisory committee, ----, that regulatory actions taken in Subarea 5 be coordinated with Subarea 4.

Research Event - Preliminary analysis of research data concerned with mesh size regulation for haddock of Subarea 5 -- in ICNAF Research and Scientific Committee.

Scope - One Canadian research scientist involved during part of a nine day first ICNAF meeting.

Task - To consider whether a minimum codend mesh size for the taking of haddock in Subarea 5 was desirable and to present a recommendation about this to Panel 5 and to the Commission.

Results - (1) Advisors to Panel 5, the R and S committee, the Panel 5 and the Commission agreed that a minimum codend mesh size for taking haddock in Subarea 5 should be established (conditions regarding future data collection were stipluated).

(2) The Committee disagreed on size of mesh to be established and Panel 5 recommended that scientists representing Canada and the United States together consider the haddock mesh size problems and provide the Panel before its next meeting with; a resume of pertinent information available; a recommendation regarding mesh size; a recommended research program to meet requirements stipulated previously.

Significance of Findings - Opened the way to mesh regulation in the ICNAF area, other subsequent regulatory action and set out the idea of collaboration between Canada and the United States in analysis of data from Subarea 5.

Source - 1951. ICNAF Annual Report Vol. 1 with Appendices.

F.D. McCracken

1951-1952

Research Event - Major analysis of all existing (both historic and current) data relevant to the haddock wastage problem in Subarea 5 and the proposal for a minimum codend mesh size there.

Task - To recommend to Panel 5 a minimum codend mesh size for taking haddock in Subarea 5 and to recommend a research program for that subarea.

Scope and Effort - Graham (see reference below) indicates that the scope included; status of the fishery; discreteness of stock; present fishery practices; what size haddock to save; initial effects of a minimum mesh; the necessary mesh size; and measuring the effect of the regulation.

The material analyzed was mainly produced by the U.S. and included historic catch, evidence about sizes landed and discards, growth and total mortality rate, mesh sizes in use and experimental data.

Canadian information about delineation of haddock stocks in the N.W. Atlantic from published papers by Needler, Thompson and Vladykov was used as part of the consideration re discreteness of Georges Bank haddock stock.

Scientific advisors to Panel 5 met three times between the 1951 and 1952 meetings of ICNAF and once at the 1952 ICNAF meeting. These were biologists from the Atlantic Biological Station plus some "outside" experts and biologists from Woods Hole Laboratory of the U.S.F.W.S. Numbers of Canadian scientists at each meeting were ca. 3 or 4 and each meeting was of about 2 or 3 days duration. Preparation for meeting and digestion of meeting results took considerably more time.

Results - (1) A minimum mesh size of 4½" inside knot measure (for the whole net) for the taking of haddock in Subarea 5 was recommended to R and S and to Panel 5 and accepted both there and by the Commission.

(2) The prohibition of using any device to block the meshes in a trawl except for the underside of the codend was included in the regulation.

(3) Recommendations for a research program in Subarea 5 were accepted by Panel 5 and the R and S Committee.

Significance of Findings - (1) The conclusion was reached that for haddock of Subarea 5 an increase in mesh size to at least eliminate discards was beneficial for the stock and fishery. It was also agreed, but with more caution, that a mesh size which released some younger, faster growing haddock currently being landed would also be beneficial to the stock and fishery. These premises underlay much of the mesh size regulation subsequently introduced for species

and subareas for which the available data was much less both in quantity and quality.

(2) A minimum mesh size regulation was adopted and for more than a decade this was the only form of regulation attempted within ICNAF.

(3) Recognition of the need to prevent blocking of meshes in trawls set up a thorny and continuing issue when this and future regulations began to be enforced.

Canadian Effort - Collaboration with U.S. scientists in analyzing and drawing conclusions from material available for Subarea 5 haddock was given very high priority by "groundfish" scientists at St. Andrews.

Since we had no otter-trawl fishery on Georges Bank we could not provide "commercial" fishing data and we had no research vessels capable of working in the area.

References - 1952. ICNAF Annual Report Vol. 2. 1951-52, 1-22.

Graham, H.W. 1952. Mesh Regulation to Increase the Yield of the Georges Bank Haddock Fishery. ICNAF Annu. Rept. Vol. 2. 1951-52, 23-33.

1952. ICNAF. Report of scientific advisors to Panel 5, September 1951. Meeting Doc. 52/4B, Serial No. 36.

1952. ICNAF. Supplementary report of scientific advisors to Panel 5, January 1952. Meeting Doc. 52/4C - Serial No. 37.

1952. ICNAF. Report of meeting of Panel 5, Ottawa, 26-27, February 1952. Meeting Doc. 4, Serial No. 34.

F.D. McCracken

1951-1952

Research Event - Collection, compilation and presentation of statistics of landings of groundfish for the Convention Area (see note at the end of this section).

Task - To present to ICNAF statistics of landings showing amounts landed by subareas for historic and current data.

Scope and Effort - It was recognized early by members of ICNAF that statistics of the fishery in the ICNAF area were badly lacking. European participants were particularly aware of the lack compared with European regions. The Commission recommended immediate attempts to compile what was available for earlier landings and a beginning to annual statistical reporting.

Needler (Canada) prepared a paper on the biologists' needs for fisheries statistics outlining such things as area of capture, methodology, effort, sizes landed, discards, age and growth rate, etc.

While this aspect of research may now be considered "old hat", for much of the fifties and sixties there was emphasis on improving fisheries statistics collection.

For Canada, according to Martin, there was an excellent record of landings for customary groundfish species kept by the Department of Fisheries since 1917 and a less complete record back to 1880. These statistics were recorded by Province, county and shore districts both monthly and annually. For part of this time inshore catches were separated from those taken "offshore" by vessels and otter trawlers. Otter trawlers landings were listed separately but the location of offshore catches by trawlers and vessels were not recorded. According to Martin these catches might have been taken anywhere from Browns Bank off western Nova Scotia to Grand Bank, south of Newfoundland.

In 1951-52 a number of technical staff with research scientist supervision were examining past records, assessing their landing points, form in which the fish were landed, etc. to get some idea of the likely location for capture. They also were converting as landed records to metric, round fresh as requested by ICNAF.

Canada had begun in 1945 to intensify effort to collect statistics of groundfish area of capture, effort, sizes landed, collection and reading of material to establish age, rate of growth, etc. This involved effort of 3 to 4 technicians, a statistical office in Halifax, collection of basic landing statistics by the Department of Fisheries, and supervision of much of these operations by FRB scientists. The requests from ICNAF added impetus to this effort.

Results - For publication in an Appendix to the Report of the Second Annual meeting of ICNAF Canada was able to submit: 1. Landings of cod, haddock, redfish, halibut, flounders and other groundfish by subarea of capture. 2. Historic landings of cod back to 1869 with estimated subarea of capture from 1891; haddock to 1910 with capture subarea from 1933; redfish to earliest landings in 1936; halibut with subarea of capture to 1911; flounder to 1910 with capture subarea from 1933; and other groundfish from 1933 by subarea. 3. No groundfish landings are recorded from Subarea 5 either in 1951 or in the historic review.

Canadian Effort - Effort by Canada was outlined earlier under scope. Naturally Canadian effort was hampered by lack of staff and need to train staff in bio-statistics collection. The task was made very difficult for Canada since Canadian vessels landed at so many small and medium size ports.

Significance of Results - Canadian statistics were mainly for Subarea 3 and 4 but they were allied with those of Subarea 5 in making management decisions. These early decisions were mainly related to preventing discards of small unacceptable fish. Canada's effort in Subarea 4 was closely associated with U.S. effort in Subarea 5 because the U.S. was particularly keen to have identical mesh regulations in both subareas.

The biostatistics series started in the early years of ICNAF (with continued improvement) became the basis of eventual allowable catch and quota systems of managing stocks in Subarea 5 and other ICNAF Subareas.

Note - I have spent considerable ink on setting out the early struggles with biostatistics. Practically every meeting for 10 or 15 years spent a good deal of effort on ways of improving biostatistics. Collaboration between Canada and the U.S. was a common theme. I do not plan to expand on statistics for each year but only mention or discuss new developments, when for example statistics for new species were added and particularly those such as scallops, swordfish where catches by Canada came from Subarea 5.

References - ICNAF Secretariat. 1952. Statistics of Landings of Groundfish from the Convention Area. ICNAF Annu. Rept. Vol. 2 (1951-1952): 35-68.

Needler, A.W.H. 1952. The biologists needs for fisheries statistics. ICNAF Meeting Doc. 52/6B, Serial No. 48.

Martin, W.R. 1952. A summary report of the Maritime groundfish investigations. ICNAF Meeting Doc. 52/5E, Serial No. 45A.

Needler, A.W.H. 1952. Canadian research in Subarea 4: résumé of results and program. ICNAF meeting Doc. 52/12, Serial No. 54.

Report of the Atlantic Biological Station for 1952 (MS).

F.D. McCracken

1952-53

Research Event - Cruises on commercial vessels to measure discards of haddock and cod in the then current fishing practice, and subsequent analysis of data for presentation to ICNAF and to Canadian fishing industry.

Scope - Five Cruises (trips) were made on commercial vessels between November 1951 to September 1952 (Nov., Mar., May, July, Sept.,). A further 8 trips on commercial vessels in 1953 of which four were successful (Feb, May, 2 in Aug.,) and four were unsuccessful because fishing was directed to other species. Two scientists or technicans were usually involved with each trip. Trips were about 8-10 days each. Preparations for the trip and subsequent analysis of the data probably involved 1 person for 2 to 3 weeks.

Task - To estimate numbers of cod and haddock being discarded at sea because they were below commercial size. Commercial vessels were using a mesh size of about 2 7/8". Methodolgy involved measuring catch at sea, then measuring sample of catch ashore and comparing the two. Additional verification included measuring some discards at sea and also making best estimates of quantities discarded at sea.

Results - (1) Trips were mainly to Subarea 4 although some fishing was done in Subarea 3. (2) Few cod were discarded on any of the trips. In the areas fished small cod were not plentiful. Fishing was aimed primarily at the haddock so the results for cod were biased. (3) Discards of haddock from trips in spring-summer and fall ranged from about 15 to 50 percent by number. Few haddock were discarded during the February-March trips since it appears that a large-fish spawning concentration was being fished.

Significance of Findings - Following adoption of a mesh regulation for haddock in Subarea 5 by the Commission it was considering seriously the possible need for a similar measure in Subarea 4. Such action was sought particularly by the U.S. since Subarea 4 abutted Subarea 5 and the U.S. fishery extended into Subarea 4 for haddock. Without mesh regulation in Subarea 4 that in Subarea 5 would be almost impossible to enforce. By demonstrating to our industry the quantity of haddock being discarded, they were able to make some rational conclusions about increasing mesh size.

Combining discards throughout these trips and presenting results to the Commission and Panel 4 gave to both scientists and Commissioners some feel for the extent of the discard problem in Subarea 4 and allowed them to consider the problem relative to Subarea 5.

Canadian Effort - There were various constraints - staff going on sea trips were also expected to carry out regular duties ashore. Finding commercial vessels with adequate room for extra people was not always easy. Sampling on deck

in winter was not really a feasible proposition, but for general purposes the effort appeared to be adequate.

References - ICNAF. 1953. Summaries of Research 1952 publ. in ICNAF Annu. Proc. Vol. 3. 1952-53.

Report of the Atlantic Biological Station for 1952.

Report of the Atlantic Biological Station for 1953.

Research Event - Began mesh experiments for cod and haddock in Subarea 4.

Scope - Three trips were made on chartered commercial vessels to test mesh sizes ranging from 4½" to 5¼" inside knot measure, manila twine. All trips were 8 to 10 days in length and involved 4 persons from Fisheries Research on each trip. On one trip J.R. Clark of USFWS, Woods Hole participated. Previously F.D. McCracken had participated in a trip by the USFWS vessel Albatross III where covered codend mesh experiments were being carried out on Georges Bank. Mesh experiments carried out by Canada included covered codend trials, comparative fishing with large and small mesh nets, and comparison of fish escapement with "chafing gear" in use. Some of the meshes tested were larger than had been tested up to that time in the N.W. Atlantic.

Task - To derive selection data for both cod and haddock for fish of Subarea 4 using the mesh size currently recommended for haddock in Subarea 5 and extend the range of sizes tested. Cod were of particular interest for this part of the experiment. Industry and particularly fishermen were skeptical that large meshes could allow small fish to escape while retaining those of larger size. These experiments were thus in part demonstrative.

Results - (1) Mesh sizes like those and larger than used on Georges Bank gave 50% selection lengths in line with what had been projected from use of smaller mesh sizes both in Subarea 5 and in Europe.

(2) The experiments were able to demonstrate to fishermen that escapement from the larger meshes was specifically related to size of fish.

(3) Use of chafing gear on top of the codend reduced the amount and size of fish escaping.

(4) Large catches dampened the selection effect of the meshes.

Signficance of Findings - Although data were insufficient to determine the optimum age at first capture for haddock and cod a reasonable case could be made that releasing some small haddock now discarded at sea dead would do no harm. On this basis the advisors to Panel 4 and the R and S Committee could begin considering extension of minimum mesh size to Subarea 4. Such action would

reduce markedly one of the objections to mesh size regulation in Subarea 5.

As mentioned under results Canadian fishermen and plant managers were more willing to accept the possibility of using a new larger mesh size.

Canadian Effort - Our effort was constrained by lack of large research vessels. Chartering vessels for single trips had real disadvantages. Carrying out the experiments on commercial vessels had the advantage of making fishermen aware of the possibilities of meshes of different sizes being used to provide controlled escapement of fishes such as haddock and cod. In view of the effort being expended on mesh selection in Subarea 5 and even more so in Europe we probably did most of what was required, although our results lacked the precision of some experiments in which research vessels were used.

References - Martin, W.R. 1954. Summary of Canadian Groundfish Research in the Convention Area during 1953. ICNAF Annu. Rept. Vol. 4: 23-27, (1953-54).

Report of the Atlantic Biological Station for 1953 (MS).

Research Event - Tagging of 1804 cod and 580 haddock off Lockeport, N.S., between May and October 1953. Purpose of tagging was to help identify stocks and possibly arrive at some estimate of mortality. I propose to discuss this under a later year when more tags had been recovered.

Reference - Report of the Atlantic Biological Station for 1953 (MS).

Research Event - Examination of swordfish stomachs from Browns and Georges Bank.

Task - Biological knowledge.

Scope and Effort - In 1952 and 1953, 17 swordfish stomachs were obtained from fish harpooned by commercial fishing vessels. Stomach contents were measured (weight and volume) and contents were identified to species where possible.

Results - Contents were mainly large adult herring, squid, hake, some argentines and lantern fish.

Significance of Findings - Showed that swordfish at surface had been feeding recently and some feeding at least was during forays to considerable depths. Beginning of thoughts about long-lining for swordfish.

Canadian Effort - Effort just beginning. Neither Canada or U.S. had any major research programs for swordfish. Canada was extending swordfish research into Subarea 5.

References - Report of the Atlantic Biological Station for 1952 (MS).

Report of the Atlantic Biological Station for 1953 (MS).

Item - Martin prepared a special paper for the 1953 ICNAF meeting about identification of major stocks of groundfish in Subarea 4. He emphasizes separation of haddock from Browns and Georges Banks based on vertebral counts, tagging, growth rates - and states the Browns Bank population differs sharply from that of Georges Bank. He mentions the mixing of Bay of Fundy haddock with those of Subarea 5 based on tagging results.

For cod Martin indicates that the Northeast Channel may be a barrier but there is less specific reference to separation of Browns and Georges Banks stocks.

For redfish and halibut he is less specific but in a summary section does state "All four of the important groundfish species of Subarea 4 (cod, haddock, redfish and halibut) are, for management purposes, distinct from the stocks of adjacent Subareas".

Reference - Martin, W.R. 1953. Identification of Major Groundfish Stocks in Subarea 4 of the Northwest Atlantic Convention Area. ICNAF Annu. Rept. Vol. 3, 57-61.

Item - Herring - During the summer of 1953 exploratory fishing with trawls for herring was being carried out mainly on banks off Nova Scotia in Subarea 4 but during one cruise 15 tows were made on Georges Bank. The research was being carried out from a chartered commercial trawler. A Dutch type herring trawl was used on Georges Bank. No herring were caught although some bottom species were. These activities show a beginning of interest in the Subarea 5 region for herring.

Reference - Atlantic Biological Station Annual Report for 1953 (MS).

Item - Mid-year Meeting of Panel 5 Advisors - The group (including 5 Canadian scientists) met January 27-28, 1953 in St. Andrews and considered (a) method of measuring meshes for the purpose of regulation of the haddock fishery (b) the arrangements for specific vessels to continue fishing with present small mesh gear (c) measurements of the effects of the experimental mesh regulation (d) other criteria of relative abundance of two-year old haddock (e) research program by United States in Subarea 5, (f) program of redfish research.

Reference - ICNAF Meeting of Scientific advisors to Panel 5. January 1953. Doc. 53/5, Serial No. 81.

F.D. McCracken

1953-54

Research Event - Continued mesh experiments aimed particularly at selectivity for cod by smaller vessels.

Scope - More or less continuous use of the small (ca 45') research vessel Pandalus II during June and July 1954 in the southeastern Gulf of St. Lawrence.

Four trips of about 1 week each on a chartered small commercial dragger (ca 50') were carried out in the same area during August, 1954. Each trip involved one scientist and one technician. Both cotton and manila codends were tested using covered codend methods.

Task - In order to be able to extend mesh regulation from Subarea 5 haddock to Subarea 4 (which was a particular need for the U.S.) it was imperative to obtain selectivity results for cod, other species and smaller vessels. The fishery in Subarea 4 was more "mixed" than in Subarea 5 in parts of the region and more specifically for cod and flatfish in the Gulf of St. Lawrence.

Results - (1) Selectivity by meshes for cod was similar to that for haddock in manila codends used by small vessels (mesh sizes used ranged from 4¼" to 5" inside knot measure). (2) Sizes of cod escaping from a 4½" mesh were below the size being landed commercially. (3) Results for both small and large trawlers were similar. (4) Cotton codends allowed larger fish to escape than manila codends of the same mesh size, and (5) with a 4½" mesh no plaice of commercial value escaped.

Significance of Findings - The mesh regulation for otter trawlers fishing haddock in Subarea 5 had as its basic requirement that about 50% of the haddock entering the trawl were to be released at a length of 39-40 cm (thus a 4½" mesh). Continuing results of experiments in Subarea 4 showed that a 4½" mesh would release practically no fish considered to be of commercial size by the Canadian industry, with the exception of redfish.

Such a conclusion for Subarea 4 was particularly applicable to reducing enforcement problems for Subarea 5. Incidentally, I believe that a point should be made that mesh selection results from anywhere in the northwest or northeast Atlantic were almost equally applicable to Subarea 5 fishes.

Canadian Effort - Our effort in 1954, directed to special Canadian problems in the small trawler cod fishery appears to have been of reasonable magnitude. As noted previously we fitted in to efforts made in Subarea 5, Subarea 3 and in the northeast Atlantic. I don't think the constraints were too great in 1954.

References - Report of the Atlantic Biological Station for 1954 (MS).

Martin, W.R. 1955. Canadian Researches 1954. ICNAF Annu. Rept. for 1954-55. Vol. 5, 22-27.

Research Item - The scientific advisors to Panel 5 met twice during the "ICNAF year", in St. Andrews, December 9-10, 1953, and in Woods Hole, Mass., March 3-5, 1954. They considered and analyzed the effect of the haddock mesh regulation in Subarea 5, the problem of exemptions from the mesh regulation, the status of the haddock fishery in Subarea 5, the quantitative surveys for haddock eggs, larvae and young fish, redfish problems (ageing, stock delineation, growth rates, etc.) and the emphasis necessary for statistics of the fishery. Recommendations were made where applicable. The Subarea 5 data were provided by the U.S. Canada collaborated by providing some of the research and analytical expertise (see comments for previous years).

References - 1954 - ICNAF Research Document 54/15, Serial No. 185 (with two appendices - Report of Scientific Advisors to Panel 5.

Item - Statistics - Annual statistics of the groundfish landings by Canada as collected by the Department of Fisheries and the Fisheries Research Board were submitted by the Atlantic Biological Station for the Maritimes. The Canadian statistics report includes statements on (a) economic factors affecting landings, (b) conversion factors for calculating fresh round weights, (c) numbers of craft by type, (d) landings by Subdivision, (e) landings by months and by market size categories, (f) descriptive list of all otter trawlers and larger line vessels (g) landings by Subdivision, gear and effort, and (h) quantities caught but not landed.

The Atlantic Biological Station has worked closely with the Department of Fisheries and the Bureau of Statistics in the development of a purchase-slip system of collecting landing statistics which is designed to improve the accuracy of statistics for the Maritime Provinces of Canada.

These attempts at improving statistics of landings and catches were to prove a strong incentive for "foreign" countries to provide statistics for all Subareas including Subarea 5 as these vessels began fishing there.

References - Report of the Atlantic Biological Station for 1954 (MS).

F.D. McCracken

1954-55

Research Event - Compilation and analysis of data on cod and haddock for Subarea 4 led to a recommendation to Panel 4 and thus to the Commission that a minimum mesh size of 4½" be introduced for trawls used in fishing cod and haddock in Subarea 4. This occurred at the 1955 Annual Meeting.

Scope - Three meeting documents submitted to ICNAF (advisors to Panel 4) as follows. Factors affecting annual yield - by W.R. Martin, Gear selection in relation to sizes caught and landed by F.D. McCracken and the effect of increased mesh size on yield by J.E. Paloheimo.

These documents brought together much of the results which had been obtained in previous years, including such items as landings, catch-per-unit-effort, area and method of capture, populations, growth, yield per recruit at various sizes of first capture, mesh size versus average size at first capture and relation of size at first capture by various mesh sizes to sizes retained and discarded.

Task - To present sufficient evidence to Panel 4 and its advisors so that they could decide whether or not to proceed with a recommendation for a minimum mesh size in Subarea 4 and if such a decision was made to provide a realistic basis for choosing a mesh size.

Results - (1) Although the data were much less extensive than for Subarea 5 they were sufficient to allow the panel to recommend a 4½" minimum mesh size (manila) for cod and haddock fishing by otter trawls in Subarea 4. (2) The data were such that the problem of mesh equivalents for different materials was introduced. (3) Because the fisheries for cod and haddock were so closely linked in Subarea 4, Panel advisors and Panel 5 were forced to begin considering the situation for cod in Subarea 5.

Significance of Findings - Much the same as results. Reaffirms the close link between Subarea 4 and 5 for regulatory purposes and research leading up to regulation.

Canadian Effort - Canadian biologists, mathematicians and technical staff were in a lead position for Subarea 4 but analysis of results benefited from and final conclusions were reached with collaboration from other members of advisors to Panel 4. Their role was similar to that played by Canadians in the Panel 5 advisors group.

References - ICNAF - Report of Scientific Advisors to Panel 4. Document 55/5, Serial No. 267 - 1955.

Martin, W.R. 1955. Factors affecting annual yield of cod and haddock in Subarea 4. ICNAF Document 55/5A, Serial No. 268.

McCracken, F.D. 1955. Gear selection in relation to sizes of cod and haddock caught and landed in Subarea 4 - ICNAF Document 55/5B, Serial No. 269.

Paloheimo, J.E. 1955. The effect of increased mesh size on yield of cod and haddock in Subarea 4 - ICNAF Doc. 55/8A, Serial No. 274.

ICNAF, 1955. Annu. Proc. for 1945-55, Vol. 5: 9-18

F.D. McCracken

1954-55

Research Event - Cod and haddock tagging results from tagging off Lockeport, N.S. in 1953.

Scope - Tagging of cod and haddock taken by hooks was restricted to relatively shallow inshore water off Lockeport, N.S. to try and ensure good survival of tagged fish. Using 4 kinds of tags 1804 cod and 580 haddock were tagged in the summer of 1953. Rewards were offered for tags returned with information about time and place of recapture.

Task - (1) To compare the efficiency of the different tag types used. (2) To ascertain migratory behaviour (if any) of the tagged fish and presumably that of the stock from which they were caught.

Results - (1) Petersen disks attached through the dorsal musculature by a stainless steel wire gave much the best returns for cod, about 60% and somewhat better returns for haddock, about 20%, than either the hydrostatic or strap tags. (2) Most cod were recaptured on grounds close to the tagging area. Of those recaptured 7 (ca 0.9%) were reported as being recaptured on Georges Bank. (3) Haddock tended to move offshore in winter to LaHave and Browns Bank in Subarea 4. Of 99 reported recaptures 3 (ca 3%) were reported from Georges Bank in Subarea 5.

Significance of Results - These results agree with previous tagging results, studies of meristics, growth differences etc. in showing that cod and haddock in the Lockeport - Browns Bank region are separate from those of Georges Bank in their adult stage of life.

Canadian Effort - This tagging effort lasted from near the end of May to end of October 1953 and occupied the time of one small research vessel, the crew and one technician. Fish for tagging were caught by hook and only those "judged" in good condition were tagged and released. Time and money were not the main constraints, rather the availability of fish and incursions of dogfish hampered the operation. For haddock only a minority of the fish caught were judged to be in satisfactory condition for release.

References - McCracken, F.D. Cod and haddock tagging off Lockeport, N.S. Atl. Prog. Rept. No. 64: 10-15.

Martin, W.R. 1954. Summary of Canadian groundfish research in the Convention Area during 1953. ICNAF Annu. Rept. for 1953-54, Vol. 4: 23-27.

Martin, W.R. 1955. Canadian Researches 1954. ICNAF Annu. Rept. for 1954-55, Vol. 5. 19-27.

Atlantic Biological Station Annual Report for 1954.

Atlantic Biological Station Annual Report for 1955.

Research Event - Herring exploration on Georges Bank in 1955.

Scope - During a summer of exploratory fishing for herring on the Scotian Shelf, two trips were made to Georges Bank in Subarea 5. The first of these on July 20 and 21 used drift nets in an attempt to capture herring. The second trip between August 30 and September 14 used a Dutch type herring trawl for fishing.

Task - To explore for possible commercial concentrations of herring and to examine samples of herring captured.

Results - Large quantities of herring (2000 to 5000 pounds per 90 minute tow) were taken by trawling on August 30 and September 7). These herring were sexually mature fish in the ripe and running stage and presumably spawning at depths of 60 to 90 fathoms.

Significance of Findings - (1) This effort was among the first attempts to take herring by otter trawl from deeper water off Georges Bank. Subsequent large fisheries by East-European nations developed. (2) This is believed to be the first record of spawning herring taken from the shelf region at depths greater than 30 fathoms. (3) It also shows that Canadian research was not restricted from Georges Bank.

Canadian Effort - This was a portion of an exploration on offshore banks in the southern ICNAF area in which one cruise was devoted to Georges Bank. The hope was that the Canadian fishery would follow up on any promising results but this did not occur.

Reference - Report of the Atlantic Biological Station for 1955.

Research Event - Continuation of mesh selection experiments in the small trawler category.

Task - While selectivity of manila codends of various mesh sizes had been relatively well established, nylon codends had recently become of increasing importance to the industry. Thus a need for selectivity results for nylon was

needed. In addition the "chafing gear" problem was still of major interest in setting up regulations.

Scope - During the summer and fall mesh experiments with single strand nylon codends were carried out in the western Gulf of St. Lawrence where catches were mainly cod, and in Passamaquoddy Bay where catches were mainly haddock. Mesh sizes ranged from 4 3/16" to 5" inside knot measure.

Two sets of "chafing gear" experiments were also tried. In both cases manila codends were used and the mesh size of the chafing gear and codend were the same. In one case the chafing gear was applied tightly to the codend, in the other the chafing gear was applied "loosely" to the codend in the manner prescribed by the Subarea 4 and 5 regulations.

Results - (1) Nylon codends allow larger fish to escape than through the same internal mesh for cotton or manila. (2) A 4½" internal diameter mesh size of manila was accepted in regulation to allow 50% of cod or haddock to escape at about 38 cm long. A nylon mesh of the same size in a single twine codend such as used on small draggers would allow 50% of the fish to escape at 43-44 cm. (3) Using a chafing gear attached according to regulation (as described above) did not materially affect the 50% selectivity length. A tightly attached chafing gear even of the same mesh size as the codend reduced the 50% selection length by about 3 to 4 cm and there was a corresponding reduction in numbers of fish released at all sizes.

Significance of Findings - Results of these experiments continued to support the view that if manila 4½" mesh was used as a standard, mesh equivalents for other kinds of material would be needed. These results along with those of other investigators (particularly West Germany) prompted attempts at defining stretch factors for various materials.

The ease with which "chafing gear" could be altered to diminish escapement from the topside of the codend led to continued pressure to get rid of chafing gear altogether or devise some other method of protecting the topside of the codend.

Data obtained during these experiments were equally applicable to U.S. small trawlers fishing Subarea 5.

Canadian Effort - As mentioned earlier these experiments tied up use of a small research vessel all summer and fall plus the time of the crew and one or two investigators. The then current Canadian effort was aimed at plugging specific gaps in knowledge about mesh selection.

References - Report of the Atlantic Biological Station for 1955 (MS).

Martin, W.R. 1955. Canadian Researches, 1954 in ICNAF Annu. Proc. Vol. 5: 22-27.

Martin, W.R. 1956. Canadian Researches, 1955. ICNAF Annu. Proc. Vol. 6: 23-27.

Item - The St. Andrews and Woods Hole laboratories embarked on a new venture in the cooperative study of haddock stocks in Subarea 4. Canadian statistics and sampling data for Division 4X are being shipped quarterly to Woods Hole. United States statistics and sampling data for Division 4W are being shipped quarterly to St. Andrews. It will now be possible for each laboratory to study the complete picture of haddock in one Division, and thereby improve the efficiency of analysis and reporting. The value of this scheme will be assessed at the end of 1956.

Significance of Findings - Haddock landings from Subarea 4 at this time were about equally shared by Canada and the U.S. U.S. research vessel surveys had been extending into the southern part of Division 4X. Our catches were principally by hook and line, U.S. catches by otter trawl. Since the U.S. fishery in Division 4X and Subarea 5 were very much intermixed they were particularly concerned with having access to Canadian data. It was particuarly pertinent to delineating the Georges Bank haddock stock.

Canada was almost equally interested in getting U.S. data from Division 4W since our fishery there tended to be in winter and early spring, the U.S. fishery was mainly summer and fall. The exchange of data seemed a natural and a continuing example of collaboration between the two laboratories.

References - Report of the Atlantic Biological Station for 1955 - Investigations Summaries 1955-56.

Graham, H.W. 1956. United States Research 1955. ICNAF Annu. Proc. 1955-56, Vol. 6: 64-67.

F.D. McCracken

1956-57

Research Event - Comparison of age determination for haddock in Subarea 4 and 5 using scale and otolith methods.

Task - To assess validity of age-determination methodology for haddock in Subarea 4 and 5.

Scope - A cooperative effort between biologists from St. Andrews and from Woods Hole, Mass. to read the scales and otoliths from the same fish (973) taken from various locatities in Subarea 4 and 5. St. Andrews biologists read otoliths, Woods Hole biologists read scales. Otolith reading to determine age of haddock from the Lockeport, N.S. region was validated as a method of ageing through research in 1955-56. The U.S. had used scales throughout their haddock investigations in Subarea 4 and Subarea 5.

Results - (1) Disagreement in age readings per sample has averaged 40% for fish 2 to 13 years of age. Percentage disagreement increases with age of fish. (2) Usually age reading disagreements were randomly spread for fish up to age 8. Above that scale readings were a year or more lower than those for corresponding otoliths. (3) Annuli at the edge of scales are usually more difficult to identify for fish over 8 years old. It is seldom as difficult in otoliths.

Significance - It was concluded that random disagreement of scale and otolith readings for a sample has little effect on growth or mortality rates calculated from either set of data. Apparent dominance of an abundant year-class would be reduced. Lower age readings from scales in the older ages will result in higher growth and mortality rates than if otoliths were used.

Canada and U.S. biologists agreed to use otoliths for haddock ageing in Subarea 4 and to critically review the scale method used for the younger haddock stocks in Subarea 5.

Canadian Effort - Matched that of U.S., involved one scientist and several technicians. Included Canadian effort directly in Subarea 5 operations.

References - Martin, W.R. 1957. Canadian Researches. 1956. ICNAF Annu. Proc. for 1956-57, Vol. 7: 24-27.

Atlantic Biological Station Annual Report, 1956 (MS).

Item - Scallops - Canada reported to advisors to Panel 5, to the Panel and thus to the Commission concerning increased fishing effort by Canada for scallops on Georges Bank. This area has had a record of continuous high production for many years. It seems probable that sustained yields from these stocks could be augmented by appropriate regulation. Some consideration had already been given to this subject, partly in response to demands from the U.S. scallop fishery.

Preliminary discussions of pertinent data collected during the previous year by U.S. investigators were held during the December 1956 meeting of Scientific advisors to Panel 5.

Significance of Findings - Plans were made at the December 1956 meeting for closer cooperation of research efforts and data collection, and for further discussions between St. Andrews and Woods Hole Biologists.

In addition Panel 5 recommended at the 1957 Annual Meeting of ICNAF "that the Commission obtain the opinion of the Depository Government, as to whether sea scallops fall within the terms of jurisdiction of the Commission; and point out that cooperative study of this international fishery is advantageous".

References - Atlantic Biological Station Annual Report, 1956 (MS).

ICNAF 1957. Annu. Rept. 1956-57, Vol. 7: pp 16.

Research Event - Mesh experiments on commercial trawlers for cod, haddock and redfish using various codend materials and arrangements of chafing gears and doubled codends. (At the ICNAF meeting of June 1956 Canada had agreed to test doubled codends since this type of gear was used by various European fleets). *See note at end of this section.

Scope - Three trips were made on chartered commercial trawlers in July, August, and September of 1956. On each trip four scientists and technicians collected data on escapement of small fish. Data were analyzed in time for presentation to Scientific advisors to Panel 4 and 5 and to the ICNAF Research and Statistics Committee at the 1957 Annual Meeting.

Task - The tasks were: (1) Manila netting was being replaced by synthetics and thus mesh sizes equivalents were needed for heavy double strand nylon codends. (2) Does "chafing gear" reduce the escape of small fish? (3) Can a large mesh net produce incidental catches of redfish? (4) To meet a request to test doubled codends.

Results - (1) Field studies with double strand, 80 yard, braided nylon codends showed that a mesh size of 4 3/8" was equivalent to 4½" manila in releasing fish. Selection factors were 3.8 for cod and 3.3 for haddock (i.e. in these tests there was a difference between cod and haddock which had

not shown up in previous tests). (2) Tests showed that a short piece of chafing gear on top of the codend, when applied as specified by ICNAF regulations, does not reduce escapement of cod and haddock through the large meshes. A long piece of chafing gear does reduce escapement. (3) In the Gulf of St. Lawrence a 4½" mesh manila codend released about 50% of the 28 cm redfish caught. Thus a very small proportion of the sizes of redfish then landed in Canada would be released. This mesh size could be used where incidental redfish catches were expected and meshing of redfish seemed less serious than generally predicted. (4) The use of doubled codends greatly reduced the sizes and number of small fish which would escape from a single codend of the same mesh size.

Significance of Findings - (1) Trawl netting materials were proliferating so rapidly (polyamides, polyesters, polypropylenes, etc.) that no one laboratory could expect to test all new materials. Thus the data obtained on double strand nylon in Subarea 4 was applicable to Subarea 5 and along with European data was used to set up mesh equivalents in the northwest Atlantic. (2) Doubled codends were being used in Subarea 4 by various European nations some of which were only a few years away from fishing in Subarea 5. Our results showed that additional strength in the codend should be obtained from increased strength of twine (etc.) rather than from doubled codends if mesh selection is to be effective in releasing small fish. (3) The experiments on "chafing gear" continued to show that only slight variations in how it was attached could cause problems for escapement of small fish.

Canadian effort - As reiterated throughout mesh selection data really knew no boundaries. Experiments in Subarea 4 produced results applicable to Subarea 5 or Subarea 3 and were used by the Commission in recommending regulations. A considerable portion of the Atlantic Biological Stations groundfish effort was devoted to mesh selection experiments in 1956-57.

*Note - At about this time West Germany, which had a laboratory carrying out research on fishing gear, seemed to be the only country willing to spend research time on mesh selection. There seemed to be a decision by Canadians (and I believe by the U.S.A. as well) that further mesh experiments would only tackle specific problems.

References - Martin, W.R. 1957. Canadian Researches, 1956. ICNAF Annu. Proc. for 1956-57, Vol. 7: 21-27.

Atlantic Biological Station Annual Report and Investigators Summaries, 1956.

Research Event - Herring explorations using trawls.

Scope - During the course of several months of efforts (July to early September) in and around the Bay of Fundy, eight hauls were made on Georges Bank.

Task - Determining distribution of adult herring in the Bay of Fundy - Gulf of Maine region.

Results - Substantial quantities of herring were taken from the same areas where they were found in 1955. Their stage of maturity gave evidence of a large spawning population on Georges Bank in August and early September.

Significance of Findings - Relatively new knowledge which suggests the possibility of a trawl fishery for herring on Georges Bank, at least seasonally, indicates a continued Canadian interest in herring stocks of Georges Bank in Subarea 5.

Canadian Effort - A modest effort by Canada but probably greater than by any other country at this time.

Reference - Atlantic Biological Station Annual Report with Investigators Summaries 1956.

Note - The International Passamaquoddy Fisheries Board has been charged with responsibility of determining "the effects which construction, maintenance and operation of the tidal power structure proposed might have upon the fisheries in the area." A Working Committee of Canadian and U.S. biologists was appointed to draw up plans and to carry out a program of research to implement these terms of reference. The research program was approved by the Board at its meeting in Boston, Mass., on March 6, 1957.

This illustrates another area of co-operation between the U.S. and Canada. Graham mentions this joint study in the United States Research report for 1956.

References - Atlantic Biological Station Annual Report and Investigators Summaries, 1956.

Graham, H.W. 1957. United States Research, 1956. ICNAF Annu. Rept. 1956-57. Vol. 7: 63-66.

F.D. McCracken

1957-58

Research Event - Collaboration with USFWS (Woods Hole) in tagging haddock on Browns and Georges Bank and in the Bay of Fundy.

Task - To try and find out more about possible mixing of the two stocks (Browns - Georges) and other stocks in the region.

Scope - About 1100 haddock were tagged in the LaHave - Browns Bank region during March and April. The research vessel J.J. Cowie was used and haddock were caught by otter trawl from depths of 60-80 fathoms.

The U.S. using the R.V. Albatross III tagged 500 or more haddock in Subdivisions 4X, 5Y and 5Z at eight widely separated points.

In November and December the Atlantic Biological Station tagged approximately 1100 haddock on the western side of the Bay of Fundy and about 70 haddock off Digby on the eastern side of the Bay of Fundy. Again haddock were taken by otter trawls.

Haddock tagging in the Bay of Fundy was also a co-operative effort with the USFWS who tagged haddock in the Gulf of Maine as far east as Grand Manan Bank.

Results - It is still too early for meaningful results although the low returns from haddock tagged in March - April on Browns Bank was disappointing, less than 2%. Results will be reported in a later year.

Significance - Too early to attach any significance.

Canadian Effort - One small research vessel for about 4 months in 1957 plus the time of 3 technicians usually two at a cruise. This was the only research vessel available and the J.J. Cowie at 50-55 feet overall length is not exactly at home on the banks and in the period used. We appear to have contributed a reasonable share to this co-operative effort, which was closely associated with efforts in Subarea 5.

References - Atlantic Biological Station Annual Report and Investigators Summaries 1957-58.

Martin, W.R. 1958. Canadian Researches 1957. ICNAF Annu. Proc. for 1957-58. Vol. 8: 23-26.

Graham, H.W. 1958. United States Research, 57. ICNAF Annu. Proc. for 1957-58. Vol. 8: 75-77.

Research Item - At the 1957 joint meeting of ICNAF, ICES and FAO in Lisbon, J.R. Clark, USFWS, Woods Hole and F.D. McCracken, Atlantic Biological Station were named as a committee to review gear and selection problems for the ICNAF area and were asked to report to the 1958 Annual Meeting of ICNAF. We the original committee asked Dr. Templeman of the Newfoundland Biological Station to assist us in preparing the redfish selection review.

The purpose of the review was to evaluate information about selection now available for various species and gears fished in the ICNAF area; to report concisely what is known about gear selection research in the area; and to evaluate needs for further research in terms of present fishing practices, importance of gear and importance of species.

The results of this collaborative effort was published as a major paper in the 1958 ICNAF Annual Report. Species included were haddock, cod, redfish, American plaice, witch, and silver hake. Gears included were otter trawls, hooks, pair trawls, traps and Danish seines. We also tried to set out further research requirements. Various appendices were included. Most data were from the ICNAF area but northeastern Atlantic results were included where necessary.

Significance - This research review and publication was a major collaboration between Canadian and U.S. biologists and adds weight to my previous statements about the application of mesh selection results between subareas.

Reference - Clark, J.R., F.D. McCracken, and W. Templeman. 1958. Summary of Gear Selection Information for the Commission Area. ICNAF Annu. Proc. for the year 1957-58, Vol. 8: 83-99.

Same report in ICNAF 1958 Meeting Doc. 58/33 - Serial 559.

Research Item - Canadian and U.S. Biologists are making an intensive joint study of the measure of the initial strength of the 1952 year-class (haddock) in Subarea 5 as compared with two large pre-regulation year-classes, 1948 and 1950.

Reference - Graham, H.W. 1958. United States research, 1957. ICNAF Annu. Proc. for 1957-58, Vol. 8: 75-77.

Research Item - Haddock statistics and sampling data for Subdivision 4X were sent to Woods Hole, Mass. for analysis. United States statistics and sampling data for Subdivision 4V and 4W were examined at St. Andrews.

Reference - Martin, W.R. 1958. Canadian Researches, 1957. ICNAF Annu. Proc. for 1957-58. Vol. 8: 22-26.

Research - Scallop research program in Subarea 5.

Task - To set up and implement a program to measure scallop stock changes and develop considerations which could be used to manage the scallop fishery and stocks, to define fluctuations versus catch changes.

Scope - The general program set-up in which Canada agreed to participate as outlined by the R.S. Committee of ICNAF was; that investigations of the population dynamics of the exploited scallop stocks, now in progress in the United States and Canada be continued and explanded. In particular that: (1) Catch and improved effort statistics for both fleets be collected for as small time and Subdivisions as practicable; (2) Consideration be given to measuring catch and effort of a selected portion of the fleet and to use a research vessel to improve understanding catch/effort; (3) Tagging experiments for mortality studies; (4) Experimental fishing to measure catching efficiency and estimate fishing mortality; (5) Research on scallop concerning environmental influences on occurrence, behaviour, survival.

Results - It was yet too early to measure any concrete results. Data on effort expended by the Canadian fleet fishing Georges Bank are too scanty to provide accurate information on stock changes. Logbook records for 1958 estimated catch per day the same as the previous year. This indicates no measurable change in abundance. Canadian biologists speculated that though abundance in any one area flutuates, movement of the fleet smooths out general level of landings and masked importance of year to year stock changes. With increased effort fewer alternative fishing areas may be available and abundance fluctuations will show up more markedly in the catch. This possibility has been recognized and discussed by scientific advisors to Panel 5.

Canadian Effort - It is essential as a first step in predicting catch fluctuations, and if possible protecting industry against them, to have accurate information on areas fished and effort expended. Canada proposes to attempt improvement of our logbook coverage of operations and to co-operate as fully as possible with the USFWS in a research program to provide other required basic data.

References - Atlantic Biological Station Annual Report and Investigors Summaries for 1957-58 (MS).

ICNAF 1958 Annu. Proc. for the year 1957-58, Vol. 8: 14 pp.

Research Item - Herring. One cruise (short but duration not given) to Georges Bank in 1957 was made chiefly to obtain samples for population studies but did continue to confirm the presence and abundance of a spawning stock in the area. The largest catch for a single tow was estimated to be 17,000 pounds.

Our efforts on Georges continued to show interest in the area for herring, whereas the U.S. did not at this time seem interested.

Reference - Atlantic Biological Station Annual Report and Investigators summaries for 1957-58 (MS) pp 101-102.

Research Item - Mean lengths and vertebral counts from Georges Bank herring were given preliminary analysis and compared with inshore herring from the Passamaquoddy Bay region, Grand Manan and Machiasport, Me. There were no substantial conclusions from these small samples (Georges and Machiasport) and this was a preliminary analysis.

Research Item - The International Passamaquoddy investigation appears to have involved Canada to some extent in Subarea 5 and certainly involved collaboration with the U.S. Neither ICNAF or the Atlantic Biological Station Annual Report have so far been good source material. I presume reports of this International Investigation will be the best source when I get an opportunity to look these up.

Research Item - The 4½" mesh size became effective for Canada in March 1957. The proportion and sizes of cod discarded at sea in Subdivision 4T were examined on 10 commercial trips. Discards with a 4 3/4" mesh vs. a 3" mesh were reduced from 31% to 12% by numbers and from 10% to 5% by weight on large mesh trips. Even with large mesh nets the proportion of discards was significant. A mesh size of about 5½" would be required to eliminate waste. Comparison of relative efficiencies of small and large mesh vessels give no evidence of decreased landings by the large mesh vessels.

Reference - Martin, W.R. 1958. Canadian researches, 1957. ICNAF Annu. Proc. for 1957-58, Vol. 8: 22-27.

F.D. McCracken

1958-59

Research Event - Beginning of Canadian studies on scallops from Georges Bank.

Task - Various including - status and prospects for the fishery, abundance and mortality studies, selection sizes, possible mesh sizes (ring sizes) for scallop gear, estimates of survival rates among discards, estimates of mortality rates.

Scope Canadian boats were fishing primarily on scallop stocks on eastern Georges, to the southeast of those fished most heavily by the U.S. Canadian studies were directed to the former area. In cooperation with USFWS scientists records of catch and fishing effort are being collected and sea trips are made to provide a basis for abundance and mortality studies.

Results (1) Preliminary results show remarkable differences in density and size distribution of scallops from bed to bed. These differences show up in records of catch/haul during sea trips but not in wharf landings. Apparently the reason is that fishing power of the vessels keeps shucking facilities saturated and higher catches result in higher discards.

(2) In areas of highest catch, mean selection size culled by the crew was about 100 mm shell height, in lower catch areas the selection size dropped to 95 mm. The selection range was narrow in areas where large scallops predominate, but wide in areas where there were large numbers of small scallops. Discards by number varied from 55 to 86%.

(3) These data indicate that mesh size (ring size) could be increased considerably above the 3 inch inside diameter currently used (mean selection size about 72 mm) without seriously affecting present landings.

Signficance - The need for sea trips to measure abundance and a logbook catch record for small unit areas becomes very apparent since abundance estimates from wharf samples are so masked by fishing practices.

Long-term benefit from increasing mesh size would be determined upon whether survival of small scallops released from capture showed improvement. Scanty data on survival of discards indicate that it is relatively high and probably little affected by the handling and exposure they receive. Long-term advantages of increasing mesh size are therefore open to question but are being considered.

Canadian Effort - Canada engaged a biologist to be in charge of scallop investigations in 1959. Both this scientist and several technicians were collecting records of catch and fishing effort from ports of landing and made 2 sea trips in 1958 to provide data as bases for abundance and mortality studies.

References - Martin, W.R. 1958. Canadian research report, 1958. ICNAF Annu. Proc. for 1958-59, Vol. 9: 26-31.

Atlantic Biological Station Rept. with Investigators summaries 1958-59 - pp 35-36.

Research Item - Haddock tagging results from tagging in 1957.

Task - In collaboration with the USFWS to assess the amount of intermixing between Division 4X and Subarea 5 haddock.

Scope - Canadian taggings were 1,123 in March - April on Browns - LaHave Bank, 1,015 in Passamaquoddy Bay in November - December and 70 from Digby Neck - Grand Manan channel in December. All haddock were caught by otter trawl. Recaptures were recorded, location of recapture plotted and the returnees advised about where the fish had been tagged.

Results - (1) Numbers of recaptures from the Browns - LaHave Bank area were disappointing. During the winter 1957-58, of 13 reported captures, 9 came from the region of tagging, 3 from off Lockeport, N.S. and 1 from the southern area of Subarea 5. Only 3 were recaptured in the summer of 1958, none coming from Subarea 5.

(2) Haddock tagged at the mouth of the Bay of Fundy scattered widely during the succeeding winter. Many were recaptured around Jeffreys Ledge and the South Channel region of Subarea 5. A number were retaken on Georges Bank.

Signficance - That Browns Bank and Georges Bank haddock are separate adult stocks has been postulated on the basis of differences in growth, age, size composition and vertebral counts. The results from tagging on Browns Bank (and U.S. tagging on Georges Bank) support this postulation.

Returns of haddock recaptures from tagging in the Bay of Fundy region support the postulation these haddock intermix with those of Subarea 5 including those near South Channel and Georges Bank. These data support postulations of intermixing based on previous taggings, similarities in growth rates, and vertebral counts.

Canadian Effort - While not tagging as many haddock as our counterparts from the USFWS, the number of returns from Canadian tagging has been excellent. Effort included not only the use of a small research vessel for about 4 months but also that expended in processing tag returns, the rewards and letters to the fishermen returning the tag.

References - Atlantic Biological Station Annual Report with Investigators Summaries 1958-59 (MS) pp 59-60.

McCracken, F.D. 1960. Studies of haddock in the Passamaquoddy Bay region. Jour. Fish. Res. Bd. Can. 17(2): 175-180.

Research Item - With the introduction of 4½" mesh in Subarea 4 it was agreed to keep a check on sizes of fish being caught to see whether the increased mesh was influencing discards and possibly whether fish of too large a size were getting away.

Task - See above - the results are pertinent to Subarea 5 since a mesh size increase or decrease recommended for Subarea 4 would affect the fisheries for Subarea 5.

Scope - Ten summer trips on commercial draggers in the Gulf of St. Lawrence provided data on discards of cod. Four trips were on draggers using smaller mesh (3-43/4"). One trip did not provide comparable data by reason of area fished.

Six trips were made on commercial trawlers fishing haddock. All trips were carried out by the St. Andrews Biological Station. Discards at sea vary with sizes of fish available to the gear, selective properties of the gear and sizes of fish acceptable for landing.

Compared with earlier trips for haddock discards results are the most important. The trips for cod compared results with different mesh sizes.

Results - In 1951-52 with codend mesh size of 2 7/8" and large numbers of haddock about 30 cm in length available, about 40 to 60% by weight were discarded. In 1958, although small haddock were numerous, using a 4½" mesh only 3 to 7% of haddock were discarded on "gutted-haddock" trips and about 2 to 4% on trips from which haddock were being landed round.

For cod average discards on "small mesh trips" was about 23% by number and 9% by weight, for large mesh trips they were 12% and 5%.

Significance - It appears that the large mesh nets are releasing virtually all haddock below commercial size and meshes layer than 4½" would release some marketable haddock. The advantage of a larger mesh size would depend on growth and survival of released haddock.

In the cod fishery fishermen cull appears to vary with size of cod available to the fishery. Although it is believed that for both cod and haddock a larger mesh size would be advantageous there are numerous variables which still have to be investigated.

References - Martin, W.R. 1959. Canadian Research Report, 1958. ICNAF Annu. Proc. for 1958-59, Vol. 9: 26-31.

Atlantic Biological Station Annual Report with Investigators Summaries for 1958-59.

Research Item - Top chafing gear studies.

Task - At the 1958 Annual Meeting of ICNAF the prevalent use of top chafing was recognized. This meeting assigned highest priority to studies of chafing gear, with covered net selection trials, of the prescribed ICNAF type.

Scope - During September 3-6, 1958 experiments with topside chafing gear were carried out in Division 4W where haddock of adequate size were taken by the R.V. Harengus using a No. 36 manila trawl. Mesh size measured between 4 7/8 to 5 inches. The topside chafter complied closely with ICNAF specifications. It was eighteen meshes long, attached 4 meshes ahead of the splitting strap attachment, attached along the selvage to a point 3 meshes from the codline mesh. It was about 1½" times the width of the codend.

Results - Covered codend tows (12) without the chafing gear were followed by 8 tows with chafing gear in place.

(1) Selection curves for the two series of tows were similar in shape with 50% retention length and selection factor similar for each series.

(2) Since the effective slack in the topside cover was somewhat less then 1½ times the width of the codend the results suggest that some lesser width of netting might be used.

Signficance - The need to make sure that topside chafing gear does not block the meshes is a necessity. Previous Canadian experiments have shown that top chafing gear 10% wider then the codend reduced escapement. On the other hand netting 1½ times the width of the codend (the width arbitrarily chosen by ICNAF) is awkward and bulky. While it may be impossible to come up with a precise definition of chafing width, limited experiments might allow significant reduction in the width of specified chafing gear.

Canadian Effort - We were apparently the only country to respond in 1958 to the recommendations of ICNAF re experiments of chafing. While the problem wasn't solved our efforts kept this matter, which was applicable to all Subareas, in front of commissioners and scientists.

References - McCracken, F.D. 1959. Top chafing gear studies. ICNAF Annu. Rept. for 1958-59, Vol. 9: 101-103.

Atlantic Biological Station Annual Rept. with Investigators Summaries for 1958-59.

Swordfish Research Item - The swordfish fishery off the Canadian Atlantic coast was becoming increasingly important with Canadian vessels fishing from Georges to the Grand Banks. An investigation was begun in 1958 to determine factors affecting swordfish distribution since the fishery appears to depend on seasonal variations in their occurrence.

There seems to be little reason for concern about the supply of swordfish in the Canadian area with current fishing methodology. Harpooning is a methodology which takes individual fish.

In 1958 particular attention was given to food and feeding habits of swordfish. Swordfish are caught while swimming lazily at the surface. On board a commercial vessel most swordfish had stomachs half filled or full of food. Chief foods were lancetfish, lanternfish and rosefish. Contrary to fishermen's belief that swordfish strike into schools of these smaller fish from below and disable them with their swords, there was no evidence of such injury of prey in the stomachs of the swordfish examined.

This item is a further piece of evidence re Canadian research in Subarea 5.

Reference - Atlantic Biological Station Annual Report with Investigators summaries for 1958-59.

Herring Item - On October 7, 1958 the R.V. Harengus fished with bottom trawls on the northern edge of Georges Bank. Moderate catches resulted in this the fourth year of successful herring trawling on Georges Bank. Herring caught were sampled for biological studies. Again this shows Canadian effort in Subarea 5.

Reference - Atlantic Biological Station Annual Report with Investigators Summaries 1958-59.

Research Item - Assessing effects of the Georges Bank Mesh Regulation.

Task - As recommended by the ICNAF Committee on Research and Statistics, St. Andrews staff have continued to co-operate with USYWS staff in studies aimed at assessment of the Georges Bank haddock mesh regulation. This fishery, with data possibly available to permit establishment of an accurate baseline from which to measure changes in catch and possibly simple enough to allow collection of adequate data for a follow-up, was of special importance since no adequate assessment of a fishery regulation has yet been made.

Scope - St. Andrews biologists were involved with U.S. biologists in working with data from Subarea 5 collected by the U.S. Various meetings throughout the year and exchange of ideas, calculations and estimates led to the following results.

Results - (1) Because data on total catches (i.e. including discards) were not available prior to 1951, the validity of estimates of the mortality and abundance of the 1½ to 2½ year old fish of the 1948 and earlier year-classes depends on the accuracy with which various estimates (not measurements) can be calculated. Two apparently objective methods have been suggested for calculating catches of 2 to 2½ year-olds but possible changes in culling practices cannot be accounted for. (The benefit of the regulation was based on delaying capture from 1½ to age 2½ years.)

(2) Calculations of abundance of year-classes at early ages are complicated by remarkable changes in availability both seasonally and annually. Calculated abundance of fish younger than age 2 may have little resemblance to the actual abundance.

(3) Studies of mortality estimates derived from fisheries statistics show that unidentified variation in the catch data give discouragingly wide confidence limits. Unless some of these sources can be identified and eliminated, errors of estimation will possibly completely mask changes predicted to result from the regulation.

(4) Recent increases in average size and weight of fish landed may be a first positive sign of benefit from the regulation.

Signficance - The problems encountered put aside the notion that demonstrating the effects of the regulation would be easy. The probable need for more refinement of data, is being recognized. Methods of measuring and accounting for errors are being investigated to be able to pursue the concept of comparing yields before and after regulation. Alternative methods of assessment are also being sought.

Canadian Effort - Canada's active role in assessing the effects of mesh regulation, in collaboration with USFWS was being documented. During 1957-58 it occupied almost full time activity of one scientist and one technician plus assistance at meetings by other biologists. Canadian biologists by playing the role of devils advocate were very useful in bringing the problems mentioned above to the fore.

References - Atlantic Biological Station Annual Report with Investigators Summaries for 1958-59 pp 71-73.

ICNAF Annu. Proc. for 1957-58, Vol. 8.

Taylor, C.C. and L.M. Dickie. 1958. A report on the study of the Georges Bank haddock regulation. ICNAF Annu. Meeting Doc. Serial # 541.

Research Item - Role of study boats using small mesh nets in assessing effects of the Georges Bank haddock regulations.

Task - The accepted method for detecting effects of a mesh regulation is to compare a series of pre- and past-regulation catches, corrected for differences in year-class abundance and mortality. This requires a collection of detailed catch and effort statistics over a long period of time. Experience to date indicates that the length of the series of pre-regulation data to obtain the required precision may be inordinately long even for Georges Bank. Alternative methodology is being sought.

Scope - Both Canadian and U.S. biologists are examining possible ways to get around the problem outlined above. Examination of a particularly long series of haddock data from Georges Bank yields very low precision of estimates. Even though such detailed analyses are being carried out, sampling errors in age determination, and incomplete data on catch and effort aside, precision of mortality and abundance estimates from catch statistics varies directly with (1) coefficient of correlation between mortality and effort, (2) number of intervals over which mortality rates are measured, and (3) the amount of variation in effort during the study period. New ideas and analyses for measuring effect of mesh regulation are being actively sought.

Results - A proposal put forward by Canadian scientists was that it appears possible that appropriate use of a study fleet during the change period may be made to measure effects of mesh regulation with a precision at least as great as that afforded by the method described above. This approach involves the introduction of a variable - sized study fleet to fish with the proposed new mesh size (i.e. before regulation) and the use of a small mesh study fleet after the mesh size regulation is introduced.

Calculations and tests in this alternative method are the same type as used in current analysis. Precision comparable with that obtained by present analytic methods could probably be obtained in significantly shorter time.

Significance - Although the proposal was too late for the introduction of the 4½" mesh in Subareas 5 and 4 it was looking ahead to the introduction of larger meshes. Although never put into practice this analysis of attempts to show benefits of increased mesh pointed to the large variations in precision of estimates using study boat techniques. Probably one of the reasons the study boat technique was not extended to Subarea 4 and 3.

Canadian Effort - While USFWS data were being used in the analyses Canadian scientific effort was strong to assist in any way possible the measurement of mesh regulation benefits in Subarea 5.

References - Atlantic Biological Station Annual Rept. and Investigators Summaries, 1958-59, pp 73-75.

Dickie, L.M. 1958. Role of study boat using small mesh nets in assessing effects of the Georges Bank haddock regulation. ICNAF Meeting Documents, 1958, Ser. No. 543.

Research - Effects of mistakes in age determination on mortality estimates.

Task - Studies reported by Gulland (1955) have shown that average mortality and growth rates may not be much in error as a result of errors made in assigning ages of fish from reading annuli on scales and otoliths (with certain stipulations). In Subarea 5 we wished to compare apparent mortalities for different year-classes or to derive mortality estimates from relatively short series of data (mortalities being computed from catch statistics). The question is what is the effect of errors in age reading on such determinations?

Scope - The problem was examined for Georges Bank where it was desired, for assessment of the effect of mesh regulation, to determine abundance of individual year-classes in a regular succession of weak and strong broods. Magnitude of errors was judged from the comparisons of otolith and scale age readings (Kohler and Clark, 1958) for Georges Bank. These comparisons showed that from ages 2 to 8 the disagreements are symmetrical about the mean values. Using errors of the magnitude shown by this study, models were constructed comparing actual and distorted age distributions and mortality rates were then recalculated.

Results - (1) As expected, overall average mortality rates derived from these age distributions were identical. (2) If calculations are made on strong or weak year-classes alone, mortality rates are significantly over - or underestimated respectively.

Significance - Errors of the magnitude used in these models are sufficient to explain the apparent levelling of initially different year-class strengths which has been observed among Georges Bank haddock year-classes between ages 2 and 8, thus making mortality rates and year-class strengths suspect.

A system for correcting such distortions has been suggested and the need for and practicality of introducing corrections should be studied for a greater variety of situations.

Canadian Effort - Again Canadian biologists using USFWS data for Georges Bank in a collaborative effort have made a significant contribution towards understanding the problems of measuring haddock year-classes there, and one of the difficulties in assessing the effects of the mesh regulation.

Reference - Atlantic Biological Station Annual Rept., 1958-59, (MS) pp 74-75.

ICNAF Item - The R. and S. Committee agreed that groups of advisors and scientists from various countries should prepare reports including the best estimates of the immediate and long-term effects of minimum mesh sizes between 4 and 6 inches.

It was also recommended that: a group of 4 to 6 population scientists meet 2 to 3 months before the 1960 Annual meeting to do the final processing of the material at hand, these scientists to be appointed by the Chairman of the Research Committee.

F.D. McCracken

1959-60

Research Item - Scallop research on Georges Bank for abundance and mortality studies and ring size effects.

Task - See above.

Scope - Four sea trips were made to Georges Bank on commercial draggers to view and record their operations. In October-November a preliminary experiment tested the effect of increasing ring size in the scallop drag.

Results - (1) As in previous years the boats are able to saturate the shucking power of the crew and hence it is shucking power rather than abundance which continues to limit catches.

(2) Canadian crews continue to discard over half the catch since these discards are too small to make shucking profitable. The 50% cull point is between 95 and 100 mm shell height.

(3) The tests of a 4 inch ring versus a 3 inch ring indicates that the larger rings are slightly more efficient at catching market size scallops. The major advantage, however, is the big reduction in the amount of trash and small scallops landed on deck.

Significance - Abundance estimates are not possible based on catch per trip records. Sea sampling and special log collections are a necessity for information on abundance and mortality studies.

The use of larger rings in the scallop drags shows some promise for releasing small scallops that would be discarded. Data are insufficient as yet to suggest that this might increase scallop yield, however, coupled with possible increased effectiveness in fishing it may be worth pursuing.

Canadian Effort - Canadian and U.S. biologists are still collaborating in exchanging scallop research data and this collaboration provides much greater effectiveness from the limited sea trip time available. To date Canadian effort has had to take place from commercial operations.

References - Martin, W.R. 1960. Canadian Research Report, 1959. ICNAF Annu. Proc. for 1959-60, Vol. 10: 25-31.

Atlantic Biological Station Annual Report with Investigators Summaries for 1959-60, (MS) pp 57-62.

Research Item - Haddock discard comparisons before and after large mesh regulation in Subarea 4.

Results and Significance - A necessary part of introducing a large mesh was to check whether or not it was working to allow escape of fish that would have been brought on deck and discarded dead. Two comparison periods are available one (1952-53) pre-regulation the other (1958-59) post-regulation. In 1952-53 about 25% by weight and 50% by number of haddock were being discarded. In 1958-59 discards had been reduced to about 14% by weight and 25% by number for vessels landing haddock in the gutted state.

Lower discards in the later period are related to the larger mesh size, lower minimum size of marketable fish and annual changes in numbers of small haddock available to the fishery. The amount of discards indicates there is still a possibility for increasing mesh size.

Cod discards on Nova Scotia banks in the summer period are still low (agreeing with the earlier period) at about 10 to 15% by number and 4 to 5% by weight. Large numbers of other species such as hake, yellowtail and silver hake (Merluccius) were discarded as unmarketable.

References - Martin, W.R. 1960. Canadian Research Report, 1959. ICNAF Annu. Proc. for 1959-60, Vol. 10: 25-31.

Atlantic Biological Station Annual Report with Investigators Summaries for 1959-60 (MS) pp 68-72.

Research Item - Gear selection. Equitable enforcement of mesh regulations requires knowledge of equivalent selectivity of manila meshes and the new synthetic twines which are being introduced to commercial trawlers. Selectivity of the increasingly popular terylene codends was tested during research vessel surveys for haddock, cod and plaice. Terylene was found to be similar to other synthetic twines in releasing larger fish then manila meshes. The following mesh sizes of single-strand terylene are approximately equivalent to 4½ inches manila: for haddock 3 7/8 inches; for cod 3 6/8 inches; for American plaice 3 5/8 inches.

As pointed out previously mesh experiments carried out in Subarea 4 are equally applicable in Subarea 5 and vice-versa. Each experiment adds to the general knowledge particularly about new synthetic materials.

Reference - Martin, W.R. 1960. Canadian Research Report 1959. ICNAF Annu. Proc. for 1959-60, Vol. 10: 25-31.

Research Item - During its 1959 Annual Meeting a request was made by the International Commission for the Northwest Atlantic Fisheries for information on which to assess the long and short-term effects of various increases in otter trawl mesh sizes on the catch and landings of fish in the convention area. As a prime example of collaboration between laboratories in the ICNAF area the following sharing of effort may be noted. Canada had a major share, the St. Andrews laboratory having undertaken the analysis of the fishery in most of Subarea 4, the St. John's laboratory in Subarea 3 and Subdivision 4R, the United States for Subarea 5 and the United Kingdom for Subareas 1 and 2.

It should be noted that in the recent years of ICNAF around this time the push was toward (a) a single mesh size for all areas and species and (b) an increase in this single mesh size.

Reference - Atlantic Biological Station Annual Report with Investigators Summaries for 1959-60 (MS) pp 101-102.

Research - Swordfish investigations.

Task - The rapid development of the swordfish fishery from about 2 to 7 million pounds between 1950 to 1959 requires that we know more about the biology and fishery for this species.

Scope - During 1959 of four trips on commercial vessels one was made to Nantucket shoals region and southern edge of Georges Bank. Data were being collected (but not on all trips) on length and weight of swordfish, food and feeding habits and methods of catch and fishing area. In addition surface water temperatures were recorded on the fishing grounds and observations of swordfish abundance, distribution, sex and parasites were recorded.

Results - (1) Swordfish were reported to be extremely abundant and many vessels had above average catches. (2) While individual swordfish weights varied greatly (from 75 to 533 pounds) average weights were surprisingly uniform, 185 to 199 pounds. (3) Swordfish were found in abundance over a wide range of temperature, from 53 to 66°F on Nantucket shoals. (4) In the Subarea 5 region silver hake occurred in more stomachs and in greater quantities than any other species. Squid were also common but in smaller numbers. Both lancet fish and lantern fish and also herring were commonly found. (5) In contrast to previous findings prey were often damaged apparently by slashing with the swordfish sword.

Significance of Findings - With the marked increase in swordfish landings information about abundance, distribution and sizes available and caught is becoming very pertinent. In addition basic knowledge of their migrations and stock relationships may be obtained from observations on length, age, sex and parasites which are still being examined. Continuation of such studies is expected.

Canadian Effort - Research effort was spread across a large portion of what is believed to the summer range of adult swordfish, with trips extending from Nantucket Shoals to Banquereau. Canadian effort appears to be the main research at this point in time both in Subarea 4 and 5.

Reference - Atlantic Biological Station Annual Report and Investigators Summaries for 1959-60, pp 107-110.

Research Item - Studies of larval herring in the Bay of Fundy and Gulf of Maine, 1959.

Task - To try and outline the origin of the fish supporting the southwestern New Brunswick sardine fishery.

Scope - Larval samples were obtained from 1 cruise Bermuda to Greenland in 1958; 3 cruises in 1959; January in the Bay of Fundy-Gulf of Maine; a February cruise in St. Mary's Bay, N.S.; and a November cruise in the Bay of Fundy, Gulf of Maine.

Results - (1) The cruise in the last two weeks of January achieved fairly complete sampling of Bay of Fundy - Gulf of Maine and found herring larvae sparse (about 130 captured). A few were taken on Browns Bank, in Cape Cod Bay and along the coast of Maine. None were found on Georges Bank. Relatively large numbers were taken throughout the Bay of Fundy. (2) In February only 21 larvae were taken in St. Mary's Bay most near the mouth of the Bay. (3) In the November cruise 341 larvae were taken and in one position on Georges Bank the yolk sac was still attached indicating very recent spawning.

No larvae were found in open waters of the Gulf of Maine or along the coastline. In the Bay of Fundy larval distribution was similar to that of previous years.

Significance - Explorations for larval herring support the conclusion that the most likely source of Charlotte County "sardines" is the spawnings on Lurcher Shoals, Trinity Ledges and other parts of southwest Nova Scotia. Most work will have eventual association with herring stocks and biological knowledge of this species in Subarea 5 as well as Subarea 4.

Canadian Effort - Much effort in 1959-1960 was spent in "cleaning up" the International Passamaquoddy Fisheries Investigation projects. Collection of statistics and samples were continued; a new tag was tried out; plankton collections were studied more thoroughly; larval surveys with 3 cruises were continued and further experimental work was attempted both in the field and laboratory.

Reference - Atlantic Biological Station Annual Report and Investigators summaries, 1959-60 (MS).

F.D. McCracken

1956-59

International Passamaquoddy Fisheries Investigations

Research Project - In a search for power harnessing tidal forces has intrigued man, and the Passamaquoddy Bay, Cobscook Bays in Canada and the U.S. appeared an ideal site. In 1956 the governments of Canada and the United States referred the matter to the International Joint Commission requesting examination "To determine the effects, beneficial or otherwise, which such a power project might have on the local and national economies in the United States and Canada, and, to this end to study specifically the effects which the construction, maintenance, and operation of the tidal power structures might have upon the Fisheries in the area."

The Commission established two boards, the International Passamaquoddy Engineering Board and the International Passamaquoddy Fisheries Board. The latter was charged with the task of forecasting the effects upon the fisheries of the region.

Task - See above.

Scope - The Fisheries Board (INPFB) worked through a Research Commission of government scientists representing the two national sections. In the main the research program was carried out as a co-operative effort of the Fisheries Research Board of Canada and the U.S. Bureau of Commercial Fisheries. Other co-operating agencies undertaking special assignments were: The Woods Hole Oceanographic Institution; the Hydrographic Service of the Canadian Department of Mines and Technical Surveys of Canada; the Maine Department of Sea and Shore Fisheries; the Conservation and Development Service of the Canadian Department of Fisheries and the U.S. Bureau of Commercial Fisheries; the Economics Service of the Canadian Department of Fisheries, and the Department of Economics of Bowdwin College, Me.

The Research Committee studied oceanography, fishery biology, and fishery economics in that order. Preliminary work began in 1956, field work was concentrated in 1957 and 1958 with reporting and some complimentary field work in 1959.

In 1956 preliminary investigations were begun. The following research program drawn up by a Working Group of Canada and U.S. biologists was approved by the Passamaquoddy Fisheries Board at its meeting in March 1957. (1) Studies of catch, fishing effort and capital investment statistics are designed to determine past and present statitics and relative importance of the fisheries in various parts of the region. (2) Biology of the herring is studied to determine the existence of characteristics and amount of mixing of herring stock. (3) Herring migrations are being studied from tagging results. (4) Plankton investigations provide information on availability of food organisms and drift of young herring. (5) Behaviour studies and (6) oceanographic studies (to be summarized and presented by Trites). The program will place major emphasis on herring investigations since this species makes up more than 80% of total landings in the area concerned.

A study of the distribution of herring larvae in the Bay of Fundy - Gulf of Maine was begun in 1956. Cruise lines were drawn throughout the Gulf of Maine including the Bay of Fundy and Georges Bank. Three 10 to 12 day cruises were made by the R.V. Harengus between September 19 to December 1, towing continuous plankton recorders and making special plankton hauls at 83 stations. (The USFWS used the chartered vessel Silver Bay.) These cruises provided data on spawning regions and early development. A laboratory study of tagging was considered sufficiently encouraging to warrant use of the method in 1957 field studies. Statistical studies are being developed both for a longer term (10 years) and as daily catch records on a current basis for the sardine areas in Maine, Quoddy region, New Brunswick and Nova Scotia. These are considered essential. Efforts were begun to collect samples for populations studies from catches of purse seiners in the Quoddy region - these to be analyzed for growth, vertebral counts, mean size and age.

In 1957 major efforts of the herring investigation were concerned with carrying out the program drawn up by the working group of scientists in 1956. Cooperation with U.S. scientists continued, particularly in pooling resources of vessels and technical personnel, but also in analyses and interpretation of data. Major emphasis continued to be on herring research.

Detailed daily records of catches by individual weirs and seines in the Charlotte and Saint John counties of New Brunswick were obtained for the first time. Weir landings began in February, peaked in September and declined to zero in December. (Similar type statistics were apparently being collected in the U.S. portion of the Quoddy Region where fewer weirs were operating. In fact they had been collected for some time previous to these investigations).

Samples for population studies were obtained from commercial fisheries and from special fishing experiments. There were 76 samples from Passamaquoddy Bay area, 2 from Georges Bank, 3 from Grand Manan and 1 from Machiasport Me. Analyses are incomplete but progress within the year included about 13,000 herring measured, 1600 scale samples read and 3300 vertebral counts made.

Field tagging experiments, with assistance from USFWS personnel from Boothbay Harbour, were carried out from June to November (about 37,000 herring were tagged). Of these about 30% were tagged in U.S. waters.

An investigation into the behaviour of herring was begun in September 1957. This included laboratory experiments of behaviour in relation to currents and studies of depth distribution of herring as indicated by sonic sounder recordings.

As background for current studies on herring larval distribution the collection (about 500 tows) at stations Prince 5 (outside Pass. Bay) and Prince 6 (inside Pass. Bay) from 1947 to 1957 were examined. In the 1957 collections of plankton there was a paucity of herring larvae in 294 tows at 14 stations during 21 cruises in the Quoddy region. To supplement these, 3 cruises were carried out in the Bay of Fundy - Gulf of Maine region in September, October and November. Only one herring larvae was taken in September, about 1100 in October along the Nova Scotian side of the Bay of Fundy. In November about 350 larvae were taken with the heaviest concentration on the northeastern part of Georges Bank.

Great variations in annual landings of herring from Passamaquoddy Bay in the last 20 years have not been found to correlate with meterological, hydrographic and biological conditions. In 73 attempts at finding relationships between catches and environmental factors so far, no significant correlations have been discovered.

In 1958 research on herring continued to be concerned chiefly with the program of research and statistics to meet the needs of the International Passamaquoddy Fisheries Board. Besides field work and analyses, efforts of the Research Committee of Canadian and United States Scientists have included four regular meetings of Research Committee; two regular and two informal meetings of the International Passamaquoddy Fisheries Board; four meetings of the Joint Engineering and Fisheries Commission; one joint meeting of the Engineering and Fisheries Board; three meetings of the International Joint Commission; two meetings of the Subcommittee on Anadromous Fishes; two meetings of the Subcommittee on Economics and two meetings of the Subcommittee on Final Reports.

The whole program was reviewed and appraised critically in consultation with Mr. B.B. Parrish of the Scottish Home Department who was employed for this purpose from mid-June to mid-July.

The collection of daily records of herring catches by individual weirs and purse seines in Charlotte and Saint John counties, N.B., was continued and improved during 1958. Catches have been tabulated according to gear, subareas and months. They have also been arranged by regions in relation to the proposed Passamaquoddy Dam sites.

Economics survey of the primary fisheries of Charlotte county for the period 1946-57 was conducted in 1957 and 1958. Special emphasis was placed on the herring weir and purse seine fishery. (Similar statistics were being collected for the Maine region in Subarea 5 by the USFWS.) For the years 1956 and 1957 considerable detail was obtained covering landings, receipts, fixed and operating expenses as well as capital assets such as boats, weirs and other fishing equipment.

Tagging from March to September produced 34 episodes of tagging (USFWS of Boothbay Harbour, Me. assisted in many cases). About 80 thousand herring were tagged about 16% in the United States region of the area under study. Average returns from taggings was about 3.5% and varied from 0 to 24%. During 33 of the tagging experiments drift bottles were released at the same time to try and discover whether there was a relationship between herring migrations and surface drift.

Behaviour studies continued in 1958 to measure maximum swimming speeds and observe behaviour in water currents. The R.V. Harengus was used in 2 cruises May 16 to 28 and September 18 to October 1. During the first cruise the USFWS provided underwater television equipment and a biologist from Woods Hole, Mass. supervised the experiment. During the second cruise a television unit developed by the National Research Council of Canada was used. In the laboratory the upper lethal temperature was determined for 5 groups of unacclimated herring. In the field the ability of herring to withstand sudden changes in depth (from the surface to 150 feet) was tested and herring apparently showed no ill effects of these trials.

Studies on the distribution of herring larvae were continued in 1958 in an attempt to explain where the young herring come from that is the source of the great concentration of these fish in the Passamaquoddy Region. Plankton collections were again made in a co-operative effort with the USFWS. During the year 14 stations were occupied in each of 22 cruises carried out in the Passamaquoddy Bay area. There were three special spring cruises from Grand Manan to St. Mary's Bay, N.S., 3 offshore cruises in the Bay of Fundy and Gulf of Maine, including Georges Bank, 15 exploratory cruises at the entrances to Passamaquoddy and bi-weekly surface tows from early April to the end of December at the Lurcher Lightship.

The biology of plankton populations in Passamaquoddy Bay and its approaches is of special importance to the production and distribution of the young herring concentrated there. Bi-monthly plankton collections over a 2 year period were made. A study of these collections indicates a complex problem with a great many species (mainly neritic group) whose abundance and distribution varied greatly from year to year. During 1958 an attempt was made to relate feeding habits of herring to food available in the Quoddy region. The pattern of feeding activity follows closely the relative abundance of plankton in the region.

Exploratory fishing was carried out in collaboration with USFWS in 1958, as usual. Bottom trawling was carried out on the northern edge of Georges Bank in January. Average catch amounted to only 150 pounds/tow. On October 7, the Canadian R.V. Harengus fished with bottom trawls on the northern edge of Georges Bank. Moderate catches, for the 4th year in a row, were sampled for biological studies. Little is known of the offshore distribution and abundance of herring in Subarea 5.

Continued attempts to relate abundance of annual herring landings to environmental factors have been disappointing. Possibly abundance may be related to environmental factors, but catches (landings) are more controlled by market demand and the fact that weirs operate on the fringes of herring distribution in the area.

Major responsibility for age and growth analyses of herring in the region has been delegated to biologists of the USFWS. Fifty two samples for age, growth and vertebral counts were obtained. Examination of 18 samples showed that 49% of the scales were unreadable. Mr. Parrish (Marine Laboratory, Aberdeen) examined some herring otoliths from the region and concluded from this preliminary study that otoliths would present little difficulty in ageing.

In 1959 the program to assess what effect the proposed Passamaquoddy Tidal Power Project might have on the fisheries of the region was completed. The results were reported to the Int. Pass. Fisheries Board in October. The report of this Int. Pass. Fish. Board to the International Joint Commission included, as appendices, 26 papers describing the work of the Research Committee. Although the research program was carried out co-operatively with the U.S. most reports were prepared on a national basis.

Results (1) Oceanographic studies and results were of prime importance to considerations about the Passamaquoddy Tidal Power Project. (The activites and results will be recorded elsewhere by Dr. R. Trites.)

(2) During the last 20 years Canadian and U.S. landings in the Quoddy region have been mainly of sardine herring. Large year to year fluctuations have averaged out to about 55 million pounds annually. Weirs are the most important method of capture but purse seines and stop seines are accounting for increasing proportions of the herring catch. Landings are seasonal and mainly in summer. Average annual Canadian landings from the "high pool" (1947-48) were 13 million pounds, in the low pool 0.5 million pounds and immediately outside the dams again about 13 million pounds. For the U.S. the average (1947-58) high pool catch was 3.6 million pounds and for the low pool 2.9 million pounds, but fluctuations annually were very wide.

(3) Population studies show that the fishery is sustained by herring which grow to about 4¼ to 5 inches in their first year of life and to between 6½ to 7½ inches in their second year.

Studies of parasites and serological reactions show that adult herring spawning of the Nova Scotia coast are distinguishable from those spawning on Georges Bank. Immature herring from the Gulf of Maine indicate two subgroups "eastern and western" with a zone of mixing in the region of Penobscot Bay, Me. Qualified results suggest that spawning off Nova Scotia coast is principally responsible for eastern sardine stocks, including those of the Quoddy region.

(4) Local migrations were evident from herring taggings particularly into and out of Passamaquoddy Bay. While there is insufficient information to establish a pattern of herring migrations, there is a suggestion of random movement. Results demonstrate that there is no mass movement of herring away from the Quoddy region from April to November. Because the tags only remained on the fish for short periods, no information was obtained on movements into or away from the Region in the winter months.

(5) Temperature at which 50% of herring would die in 48 hours was calculated to lie between 66° and 70°F for 3½ to 12 inch fish. Salinities as low as 5 parts per thousand did not appear to be injurious. Compression and decompression tests on herring indicated that predicted rates of pressure change between turbine intakes and exits are within the limits that herring can withstand. Swimming speeds of herring increased with size of fish and ranged from 2.4 to 4.7 feet/second for herring with mean lengths of 2 3/4 to 10½ inches. Echo-sounder records showed that during the fishing season from May to October median depths of herring shoals varied from about 30 feet during day to about 20 feet at night.

(6) Cruises throughout the Bay of Fundy and Gulf of Maine indicated two main spawning grounds, the northern edge of Georges Bank and the southwest coast of Nova Scotia. Small spawnings were indicated in Penobscot Bay, on Stellwagon Bank, on Nantucket Shoals and south of Grand Manan. The drift of larvae suggested that Nova Scotia spawners are major contributors to commercial herring stocks in inshore areas of southern New Brunswick and eastern Maine. Other spawnings, particularly those of Georges Bank, may also supply some herring to the area.

(7) The importance of different plankters in the diet of the herring varied according to the availability of food in different localities and seasons. There was no apparent relation between plankton abundance and commercial catches of herring.

(8) Exploratory fishing confirmed the presence of a large spawning population on the northern edge of Georges Bank in autumn and located small quantities of post larvae in inshore areas of eastern Maine in the spring.

(9) No consistent correlation between catch and such factors as river discharge, wind speed and direction, air and sea water temperatures, salinities at various depths, plankton and cloud cover was demonstrated.

(10) Other species - groundfish, mollusks, lobsters and anadromous fishes were considered and effects of impoundment by the dams estimated from general knowledge; no particularly large research programs were mounted for these groups. Estimates (predictions) of results were based on the predictions about oceanographic changes.

(11) A major study of the economic effects of impoundment for both the Canadian and U.S. fisheries of the area was carried out and estimates of the effects on various fisheries were made in considerable detail.

Significance - The oceanographic, biological and economic studies related to the fisheries, apparently indicated that effects of the dams and turbines would not be disastrous to the fisheries. Herring were expected to arrive in the area as before without reduction in overall abundance. Local dislocations of fisheries for herring, groundfish, mollusks, and lobsters were suggested. Possible improvement for some anadromous species was indicated.

For other reasons, however, the dams were not built so actual results could never be measured.

This extensive study for herring has proved of great value in subsequent years as vessels of eastern European countries began to fish intensively for herring on Georges Bank and Canadian purse seiners began to exploit herring in open seas of Subarea 5 and Subarea 4.

Canadian Effort - From the preceding it can be seen that Canadians played a major part in this investigation of herring in the Subarea 5-4 region. Staff increased from 1 scientist in 1956 to 4 in 1957 on the biological side. Technical staff also increased sharply. Increased oceanographic staff and involvement of economists were also apparent.

The markedly increased field effort including cruises to Subarea 5 and 4 have already been outlined, year by year.

Canadian efforts in addition to a major share in writing the report to the International Joint Commission on the Passamaquoddy Fisheries Investigations resulted in at least 6 papers on the oceanography of the area, 10 papers on herring and 7 on other species. Two notes about herring were also published in the Journal of the Fisheries Research Board.

References

1959 - Passamaquoddy Fisheries Investigations 1957-58, with Appendices by International Passamaquoddy Fisheries Board, pp 1-40.

Atlantic Biological Station, Annual Report and Investigators Summaries, 1956; 93-99.

Atlantic Biological Station, Annual Report and Investigators Summaries, 1957-58, pp 87-103.

Atlantic Biological Station, Annual Report and Investigators Summaries, 1958-59, pp 81-112.

Atlantic Biological Station, Annual Report and Investigators Summaries, 1959-60, pp 103-104.

F.D. McCracken

1960-61

Research - Georges Bank Scallop Studies - Commercial practices and research vessel operation.

Task - To study current abundance of scallops, fishing practice of commercial vessels, areas fished, cull practices etc.

Scope - Collection of special log books showing details of catch by small unit areas was continued. In addition two sea sampling trips were made to Georges Bank on commercial vessels, one of which used 4" rings rather than 3 inches. Abundance of scallops was recorded, area fished and cull sizes were noted. Also direct mortality rates were observed and estimated.

One sea trip on the U.S. Research Vessel Delaware was made to observe methods of investigation used by the USFWS.

Results - (1) The 1960 fishery depended heavily on a single year-class probably spawned in either 1954 or 1955. The area fished by the fleet changed from "the peak" of Georges and eastern edge to the northeast edge where scallops were more abundant.

(2) Scallops were so abundant that even with extra crew shucking power remained the limiting factor. Where previously boats had dragged almost continuously, in 1960, they fished only in spells of 3 to 4 hours - morning, afternoon and evening. This "deck loading" kept the shucking crews busy.

(3) Canadian crews continue to cull the catch with a 50% shell height of between 95-100 mm. Smaller scallops discarded, larger scallops shucked.

(4) Continuing examination of deck damage to small scallops (discards) showed that where deck loading was practiced 10-20% were killed.

(5) Observations from the R.V. Delaware will be used in developing future research.

Significance - Probably the most significant item is the fact that the fishery is dependent on one year-class and more recent year-classes are less abundant. A fluctuating fishery situation appears to be developing. Probably glut conditions one year and reduced catches following.

It is also significant that so far the Canadian cull size has remained the same even with the abundance of scallops.

The change in fishing area may be significant but it is as yet too early to tell.

Canadian Effort - As Canadian catches increased from Georges Bank, scallop research effort has emphasized this area. Commercial vessel operations have had to suffice since no Canadian research vessels available were fitted for or easily converted to scallop dragging. One scientist and several technicians are now engaged primarily in scallop investigations.

References

Martin, W.R. 1961. Canadian Research Report, 1960. ICNAF Annu. Proc. for 1960-61 - Vol. 11: 31-37.

Atlantic Biological Station Annual Report and Investigators Summaries for 1960-61 (MS) 58-60.

Research Item - Scallop larvae and spat collection.

Task - The biology and life history of scallops needs a much better understanding so that its development in relation to environment can be understood. Scallop spat and larvae have never been completely identified or described even though the larval period may be the most critical stage in the scallops development.

Scope - In the fall of 1960 an attempt was made to collect spat and larvae in Passamaquoddy Bay. Monthly samples of adults placed time of spawning as late August. Plankton tows and various kinds of spat collectors were carried out or sampled regularly. The spat collectors were lost in an October storm.

Laboratory facilities have been set up to try and spawn adult scallops artifically and the raise their larvae.

Results - (1) Field efforts in Passamaquoddy Bay, though quite intensive, failed to collect spat or obtain larvae that could be identified as scallops.

Significance - Finding and learning about the development and settling of scallops larvae and spat would fill in this blank in the life history. As noted above it may be a critical stage. Work carried out in Passamaquoddy Bay should be applicable to scallops in Subarea 5.

Canadian Effort - Beginning and expected to grow. While not in Subarea 5 it is applicable and probably more than is being done in this field elsewhere.

References - Atlantic Biological Station Annual Report and Investigators Summaries for 1960-61 (MS): 60-61.

Martin, W.R. 1961. Canadian Research Report, 1960. ICNAF Annu. Proc. for 1960-61 Vol., 11: 31-37.

Research Event - Measuring mortality rates in scallops.

Task - A knowledge of mortality rate is essential in studying and predicting scallop population trends. Recently the lack of such information has been a stumbling block in assessing possible benefits of using large ring size on offshore (Georges Bank) scallop rakes. During 1960 some aspects of scallop mortality were investigated.

Scope - Canadian scallop boats fishing Georges Bank discard scallops less than 95-100 mm in length. There is no evidence to support or refute the belief that these discards continue to live, grow and be recaught at market sizes. Scallops were exposed in air (simulating deck exposure) for various lengths of time at several temperatures then replaced in running sea water and rates of survival recorded.

We have attempted to refine our estimates of natural mortality of scallops approaching and exceeding commercial size. Estimates are now based on the frequency of empty shells (cluckers) whose valves are still attached by the large ligament. A critical need is to know the length of time the valves stay together after the animal dies. Two tank experiments previously gave quite varying results ranging from about 100 to 300 days. In 1960 two field experiments were carried out in Passamaquoddy Bay. Cluckers for one experiment were obtained by shucking, held for varying lengths of time (56 to 143 days) then towed in scallop drags, dumped on deck and the percentage remaining as cluckers recorded. In the other experiment still going on, scallops were killed (by cutting the adductor muscle) marked, and distributed on a scallop bed. Then dragging the bed would be carried out and ratio of cluckers again recorded.

Results - (1) Scallops in air were hardy, they survived freezing in air if not jarred for periods that they might be left on deck, at temperatures just above freezing (up to 5°C) they survived in air for at least 3 hours. If the animal becomes desiccated it dies.

(2) Results from both field experiments indicate that 100 days (which had been used before) is probably a minimum estimate for the length of time the valves will remain attached. When cluckers 143 days old were towed along the bottom in drags 63% remained attached.

Significance - The results suggest that without the deck loading practice, which is used when scallops are very abundant, up to 80 or 90% of the small scallops are probably alive when returned to the water. This would likely reduce any beneficial effect of releasing scallops through larger rings, although no definitive answer is yet available.

Using the new estimates for length of time that scallop valves stay together will give a lower estimate of natural mortality than previously used. This would affect various estimates of yield per recruit, etc.

Canadian Effort - This continuing effort both in the laboratory and in the field should be applicable to Georges Bank as it is designed to be. These particular experiments are principally constrained by time factors rather than effort expended.

References - Atlantic Biological Station Annual Report with Investigators Summaries for 1960-61 (MS) pp 61-63.

Research Item - Selection of groundfish with large mesh courlene codends.

Task - Measuring escapement of cod, haddock and American plaice through large mesh courlene codends to derive selection curves 50% retention lengths and selection factors. Courlene has become popular as a material in otter trawls.

Scope - While carrying out surveys for groundfish species and some comparative fishing, large mesh courlene codends were used with small mesh covers to provide selection data as an adjunct to the other parts of the field operations. Codend mesh sizes used ranged from about 5 1/8 inches to 4 5/8 inches. All tows were shorter than regular commercial tows or regular mesh selection experiment tows. For cod the selection results are based on 52 hauls during August; for American plaice 48 of the same hauls; for haddock 10 hauls in July.

Average size of the codend of double strand courlene was 4 7/8 inches internal measure.

Results - For cod selection factors were from 3.7 to 3.9, for haddock 3.3, for American plaice 2.0 to 2.1 all slightly higher than for manila.

Significance - On the basis of these results the mesh size equivalent to 4 1/2 inches manila would be 4 1/8 to 4 3/8 inch courlene for roundfish. This is close to the 4 3/8 inch equivalent prescribed by Canadian cod and haddock regulations for double strand, synthetic twines.

Canadian Effort - Except where specific problems arise Canadian efforts concerned with mesh regulations are mainly a by-product of other investigations. They do fill gaps in some of the European data, continue to show that northwest Atlantic and northeast Atlantic results are comparable and are applicable to Subarea 5 even though carried out in Subarea 4.

Reference

Martin, W.R. 1961. Canadian Research Report, 1960. ICNAF, Annu. Proc. for 1960-61, Vol. 11, pp 31-37.

Atlantic Biological Station Annual Report and Investigators Summaries 1960-61, pp 98.

Research Item - Participation in the ICNAF Mesh Assessment Program. In 1959 ICNAF began an assessment of the effects of various mesh sizes on the fisheries of the northwest Atlantic. This was a cooperative effort of a working party of 11 scientists (2 from Canada) backed up by major assistance from personnel of

various laboratories. U.S.A. took prime responsibility for Subarea 5, Canada for Subareas 3 and 4, and U.K. for Subareas 1 and 2. Cross-fertilization of ideas and analytical methods were of course occurring and applied to Subarea 5 as well as to other Subareas. After a preliminary completion of data the working group met at Lowestoft, U.K. in March 1960, Bergen, Norway in June, and presented a report to ICNAF. This gave preliminary assessments of effects of 4 to 6 inch meshes on cod, haddock and redfish fisheries of each ICNAF Division, at present fishing intensities.

Major effort was then directed to a careful re-checking of calculations and results, particularly where additional data became available. A final meeting was held at Lowestoft, U.K. in March 1961 and a final report presented to the 1961 ICNAF Annual Meeting. The R. and S. Committee of ICNAF recommended this final report be published as a supplement to Annual Proceedings, Vol. 11.

Canadian scientists participated in all the meetings connected with this study. ICNAF R. and S. Committee recommended that the assessment group continue in existence and L.M. Dickie (Canada) act as convenor of their next meeting.

Research Item - Herring larval surveys Bay of Fundy, Gulf of Maine.

Task - Larval surveys in the Bay of Fundy - Gulf of Maine are a continuation of the program introduced in 1956, to determine the spawning areas supplying recruits to the southwest New Brunswick "sardine" fishery.

Scope - Five plankton tows were made in August 1960 around the outer part of St. Mary's Bay, N.S. Continuing cruises were made from September 1960 to January 1961, oblique and vertical tows at 235 stations each month.

In October 1960 during a cruise of the CNAV Sackville plankton tows were made at 35 stations from the Bay of Fundy to Georges Bank.

Results - (1) Total larvae taken in the St. Mary's Bay cruises was about 29,000. About 27,500 were taken in September, newly hatched. Those of later cruises were larger and numbers decreased each month to reach a low of 3 in January.

(2) On the CNAV Sackville cruise about 2,500 larvae were taken at 2 stations on the northeast part of Georges Bank. Smaller numbers of larger larvae were caught just off the southern and northern edges of Georges Bank.

Significance - For the areas explored - Bay of Fundy, St. Mary's Bay, and Georges Bank the results suggest two major spawning regions; one on the northern edge of Georges Bank; the other along the coast of southwest Nova Scotia.

The absence of larvae between Nova Scotia and Georges Bank may indicate that Georges is not a source of larvae for the "sardine" fishery of southwest New Brunswick.

The data suggest that the main source of recruits for the New Brunswick "sardine" fishery is off the southwest coast of Nova Scotia.

Canadian Effort - The program of larval herring surveys is stated to be a co-operative effort between Canada and the U.S. Bureau of Commercial Fisheries. Canada obviously contributed heavily to the Bay of Fundy program, but also explored distribution of larvae on Georges Bank during or shortly after the spawning season there.

References - Atlantic Biological Station Annual Report with Investigators Summaries, 1960-61, pp 119-123.

Research Item - Swordfish studies - 1960.

Task - To learn more of the biology, distribution and development of fishing methods.

Scope - Study of the fishery begun in 1958 was continued on a relatively small scale in 1960. Studies were directed to seasonal variation in distribution of catches and effort involved.

From July 28 to August 15, two field trips were made on the R.V. Harengus to offshore Nova Scotia Banks to try and tag swordfish and to test new methods of capture. Length and weight data were obtained from measuring fish from the commercial landings.

Results - (1) Swordfish landings dropped about 40% in 1960 primarily due to lower fishing effort, bad weather during the fishing season and lower efficiency of capture.

(2) Fishing vessel log records show that the fishery began during late May near Block Island, N.Y. continued during the season on Georges Bank, Browns Bank, and Sable Island Bank and ended early in October along the northern edge of Georges Bank. (This was strikingly different from 1959 when most fish were caught farther eastward),

(3) Tagging attempts to strike the swordfish did not prove successful. Tags shot by bow and arrow often missed the fish and those applied by striking the fish with a pike pole seldom remained in the fish.

(4) Fishing by using floating line trawl (supported by canvas bags) and baited hooks proved quite successful and it appears that it could be used by commercial vessels at least at night when harpooning is not possible.

(5) During 1960, 1573 "dressed" swordfish were weighed. Individual weights ranged from 46 to 483 pounds with an average of 211 pounds. There was no indication of size difference for any of the various fishing areas.

Significance - The swordfish is an apparent seasonal visitor to Subarea 4 and Subarea 5. Probably carrying out relatively long migrations. The usual harpooning methods of fishing requires calm weather and good visibility. Using baited, floating lines could increase the efficiency.

Where the young of the swordfish are found in numbers is not documented, but presumably spawning is to the south of Subarea 5. Knowledge of the swordfish life history is a must if the fishery is going to be managed and fished rationally.

Canadian Effort - The scale of Canadian effort was partially related to the size of the fishery and partly to the difficulty of catching fish, (harpoons) and the fact that swordfish are gutted and headed before landing (dressed).

It should be noted that swordfish and their research know no boundaries between Subarea 4, 5 and 6.

Reference - Atlantic Biological Station Annual Report and Investigators Summaries for 1960-61 (MS) pp 127-133.

Research Item - During the summer of 1960 an investigation was begun on the biology of pollock (Pollachius virens (L.)) at the mouth of the Bay of Fundy. Material was collected pertaining to age and growth, distribution according to size and age, and food of both large and small pollock. The pollock in the area studied are on the borderline between Subarea 4 and Subarea 5 so tagging was carried out during 1960 to see whether pollock from Subarea 4 migrated for any distance.

One thousand medium and large pollock were tagged. Four hundred and ninety-eight were released between Deer Island and Campobello Island and 493 off northern Grand Manan, all taken by handline.

Reference

Atlantic Biological Station Annual Report and Investigators Summaries for 1960-61 (MS), pp 103-106.

Atlantic Biological Station Annual Report and Investigators Summaries for 1961-62 (MS) pp 82-86.

F.D. McCracken

1960-62

Research Item - Studies on estimation of mortality rates of fish populations.

Task - Natural and fishing mortalities estimates are very important population parameters in analysing fisheries. The Beverton-Holt method currently used in theoretical cases gave fairly wide variance estimates. The task was to develop a method, (hopefully simpler) which would reduce the variance estimates.

Scope - A linear formula for estimating mortalities was developed and tested in a set of thirty hypothetical examples against the Beverton-Holt method using a computer in the analyses.

Subsequently the U.S. Fish and Wildlife Service made available to us seasonal catch per effort figures for Georges Bank. This type of information is collected by many fisheries research organizations studying commercial fisheries. The expectation in that these data may be used to follow population fluctuations, to estimate the total mortality rate and to separate the total mortality rate into its component natural and fishing mortality rates.

Few fisheries have such a long (1931-59) detailed account as the Georges Bank fishery. These data allowed us to estimate the course of the average total mortality rate through the haddocks' life span in the fishery.

Results - (1) In the cases comparing the new linear formula method with the Beverton-Holt method, the numbers of calculations were reduced considerably, it increased accuracy of the estimation of mortality rates by about 50% (in terms of the variance of the estimates). Neither method gives necessarily unbiased estimates.

(2) The linear method applied to the Georges Bank quarterly data shows that the total (instantaneous) mortality rate variability between seasons is rather large (hence must be taken into account in analysis) and that either the mortality increases or the catchability decreases with age. For example the total apparent mortality rate at age 3 is 0.45 but at age 6 is 0.73.

(3) This detailed analysis did not result in any significant improvements in the estimates. Indeed no correlation between estimated total mortality rate and effort was evident.

Significance - The results have a great deal of significance in trying to use commercial data for mortality estimates. The lack of correlation may partly reflect error inherent in gross fisheries' statistics. There may be more basic underlying factors. The expectations of correlations between simple measures of apparent change in abundance and effort arises from the commonly made assumption that the theory of random search is an appropriate way to describe activity of fishing vessels and their prey. The regular short term variations exhibited

by fisheries data found for haddock supports the conclusion that changes in catch are at least as sensitive to secular changes in the distribution of the fleet and the fish as they are to overall changes in abundance.

Canadian Effort - The important Canadian effort was mainly mental plus having the facility of a computer to work with. It adds a new dimension to the catch-per-unit effort problem and will require analyses of research vessel catches, species association and more detailed records of log books for vessels exploiting these stocks.

References - Fisheries Research Board Canada. Biological Station St. Andrews, Annual Reports and Investigators summaries 1960-61 and 1961-62.

Paloheimo, J.E. Studies on estimation of mortalities. Comparison of a method described by Beverton and Holt and a new linear formula. J. Fish. Res. Bd. Canada (18)2: 645-662.

F.D. McCracken

1961-62

Research Event - Studies of the Canadian Georges Bank Scallop Fishery continued with collection of log records, two trips on commercial draggers and continued recording of commercial practices. Canadian landings from Georges increased 35% in weight from 1960 to 1961, because more vessels fished and carried more crew. The super-abundant year-class upon which the 1960 landings mainly depended was markedly depleted and boats had to drag continuously (seldom deck-loading) and redistribute themselves, fishing on the northeast "peak" as well as the northeast edge of Georges.

The 50% commercial cull length remained at 95-100 mm shell height but discard had increased to about 50% of the catch from 20% in 1960 (by number).

Sea samples indicate that the year-class entering the fishery is not exceptionally strong and it is anticipated that catch/boat will decline in 1962.

References - Atlantic Biological Station Annual Report and Investigators Summaries for 1961-62 (MS) pp 48-49.

Martin, W.R. 1962. Canadian Research Report 1961, ICNAF Redbook 1962 (II): 21-27.

Research Item - Georges Bank Sea Scallop Studies.

Task - To assess variation in place to place scallop density and also compare catches with large rings versus small rings (4" vs 3").

Scope - At the 1961 Annual meeting in June, Commissioners requested Canadian and U.S. scientists to prepare a better founded statement on possible benefits of larger rings. To this end Canada chartered a successful commercial dragger for one trip (August 30 to September 9) timed to take place between two United States research cruises.

Canadian studies were carried out where the Canadian fishing effort is concentrated (northeast peak and northeast edge of Georges). Many 10 minute experimental hauls were made, the distances of bottom covered measured with an odometer and the scallops caught were measured and counted. This provided an estimate of population density. Areas explored included those which had experienced heavy, medium and light fishing.

Catches of scallops made with 4" rings and 3" rings were compared as previously done in 1959. In 1961, however, an attempt was made to be more precise, there was an effort to study the effect of "multiple linkage" as well as ring size on catches of trash as well as scallops.

Results - (1) Incompleted analyses already show great variations of scallop density in the types of areas fished. This variation can lead to marked sampling errors, to inaccurate calculations of fishing mortality, and to substantial errors in predicting increases in yield from introducing larger ring sizes to the fishery.

(2) The difference in performance of 4-inch and 3-inch ring size was not as pronounced as might have been judged from experiments in mesh selection for fin fishes. The 50% selection points for the two rings were closer together than expected. Although the 4-inch ring caught fewer small scallops than the small ring and also significantly less "trash" it did not catch significantly more large scallops. Presumably scallops do not struggle to escape (as fin fish appear to do) and the mechanical sorting of the dredge must be seriously reduced by the great amounts of trash (sometimes up to 3/4 of the catch).

Significance of Results - The data available from both Canada and the U.S. were not sufficient to allow Commissioners and advisors to move toward a regulated increase in ring size. Although the opinion still was that increasing the size of scallops taken could prove valuable, more research is needed. Possibly a new approach such as a size regulation might be necessary.

Canadian Effort - Canadian effort was correlated with that of the U.S. None of the Canadian Research Vessels were rigged for scalloping thus a charter vessel was necessary. With the good catches being made that was difficult and expensive. There were some decided plus factors, as Captain Langille of the chartered vessel, knew the grounds better than a research vessel captain would.

Four staff members of the Atlantic Biological Station were aboard during the cruise, plus preparation and analysis time of a number of staff members.

References - Atlantic Biological Station Annual Report and Investigators Summaries, 1961-62 (MS) pp 49-50

Martin, W.R. 1962. Canadian Research Report, 1961. Part B. Subareas 4 and 5, biology, ICNAF Redbook 1962 (II): 21-27.

Research Event - A laboratory program, investigating aspects of the biology of the sea-scallop, was continued in 1961. Major emphasis was devoted to a study of the larval stages which have not previously been described. Scallops were spawned in the laboratory and the larvae reared by feeding them on cultured phytoplankton. Larvae were raised for 42 days (until all had died) but they did not settle in this time. A record of stages was made. Continuation of the work is planned for 1962.

It was believed that understanding development and behaviour in the larval stages will help explain the population fluctuations observed in regularly fished stocks such as on Georges Bank in Subarea 5.

References - Atlantic Biological Station Annual Report and Investigators Summaries, 1961-62 (MS) pp 46-47.

Martin, W.R. 1962. Canadian Research Report, 1961, Part B. Subareas 4 and 5, biology. ICNAF Redbook, 1962 (II): 21-27.

Research Event - Pollock population studies in the Bay of Fundy Region (includes stocks of both Subarea 4 and 5).

Task - Pollock has become increasingly important to both otter trawl and line fisheries in Canada, particularly in the southwestern Nova Scotia, Bay of Fundy regions. A knowledge of the biology of this species is necessary if the stock is to be fished rationally.

Scope - In 1960 data were collected on age and growth, distribution according to size and age, food, reproduction and definition of stocks. Tagging was carried out from hook caught fish in the summer of 1960. In 1960 observations were mainly from commercial vessel catches (trips at sea and shore sampling). In 1961 a commercial dragger was chartered for a week in June and a week in August in order to sample represenative catches from the various fishing grounds in the Bay of Fundy. The R.V. Harengus was used for dragging on the same grounds in July.

Results - (1) Returns from 991 medium and large pollock (60-85 cm) tagged off Grand Manan and Campobello Islands, N.B., near the boundary of Divisions 4X and 5Y, in summer 1960 reached 13% by December 1961. The returns show a southern migration in autumn to a winter spawning area of the southern Gulf of Maine (5Y) particularly at the mouth of Massachusetts Bay. In summer 1961 a few returns were taken in the "Western Hole" fishery between Browns and LaHave Banks, N.S. (4X), but most returns came from the tagging area.

(2) The distribution of pollock in the summer of the two years was very similar. The young so-called "harbour" pollock (0, 1, 2 year olds) live in the shallow, sub-littoral zone and are not found offshore. Large fish (65 to 85 cm) were caught in the Wolves Bank - River area on the north side of the Bay of Fundy. Medium fish (60-75 cm) were caught south of Grand Manan Island, on Yankee Bank on the south side of the Bay of Fundy, and in the "Western Hole" area south of western Nova Scotia. Smaller fish (40-65 cm) were caught on grounds to the west of Nova Scotia. Large pollock occasionally invade the sub-littoral zone apparently following prey.

(3) Since otter trawl and hand-line catches from the same ground had similar size distributions, it is concluded that gear selection has little influence on the observed schooling pattern of pollock distribution.

(4) Most pollock caught by otter trawls were above the sizes released by 4½-inch manila meshes.

Significance - Pollock being fished in Subareas 4 and 5 belong to the same general population, components of which move from one subarea to the other apparently freely.

The pattern of tag returns explain the absence of pollock from the tagging area in winter months by demonstrating a southern migration in autumn months and a return northern migration in spring months.

The schooling behaviour of pollock, i.e. distribution by size, will be an important factor to consider in future analysis of year-class strength and growth.

Canadian Effort - With increased interest by Canadian fishermen in pollock as a species for otter trawling the basic biology of pollock is being pursued to the extent that its importance would appear to warrant at the present. Effort in 1961 is outlined under scope of the investigation.

References - Atlantic Biological Station Annual Report and Investigators Summaries 1961-62 (MS) pp 82-86.

Atlantic Biological Station Annual Report and Investigators Summaries 1960-61 (MS) pp 103-106

Martin, W.R. 1962. Canadian research report 1961, Subareas 4 and 5 Biology. ICNAF Redbook Part II: 21-27.

Item - Panel 5 members recommended that investigation on herring in Subarea 5 be conducted with the same co-operation under the Commission as the investigations on other species.

Reference - ICNAF 1962 Annual Proc. for 1961-62, Vol. 12: p. 15.

Research Event - Studies on the origin and recruitment of Charlotte County, N.B. "Sardines".

Task - To try and add further support to current "conclusions" about the origin of the Charlotte County "sardines" by a comparison of their otoliths with those of the two most likely sources of recruitment; southwest Nova Scotia and Georges Bank.

Scope - "Sardine" otolith samples (3,250) were collected from April to December 1961 inclusive from weir and purse seine landings at Blacks Harbour, N.B. Otolith samples (300) from southwest Nova Scotia adults were taken from gillnet and purse seine catches there in August and September. Otolith samples (150) from Georges Bank were taken during the course of two cruises of the R.V. A.T. Cameron in October (aimed primarily at pelagic species). Hatching season was determined for all fish by examining the otolith nuclei under a binocular

microscope. Based on age and growth parameters the southwest Nova Scotia and Georges Bank stocks of herring are undistinguishable.

Results - (1) Three types of otolith nuclei were distinguished, indicating autumn, winter and spring hatching. The first growth zones of the otoliths were measured with a micrometer eye-piece. From these parameters the Charlotte County sardines have a somewhat greater affinity with Nova Scotia adults than either have with Georges Bank adults.

(2) The differences are not striking and much additional information about this method is needed. Coupled with results of larval, hydrographic, serological and parasitological studies it has added to knowledge of the origin and recruitment of "sardine" herring.

Significance - With advent of fishing for herring on Georges Bank and development of the Canadian fishery in Division 4X it will become most important to know where recruitment of "sardines" comes from. Fishing of the offshore herring could have a marked effect on the "sardine" fishery and an argument could be made that the opposite relationship could be detrimental to the offshore herring fishery.

Canadian Efforts - Canadian efforts in the Bay of Fundy region and waters adjoining Subarea 5 have continued at a relatively high level following the cessation of the International Passamaquoddy Fisheries Investigation. Scientific staff has increased and a new research vessel is being designed and built to aid in herring investigations.

Reference - Atlantic Biological Station Annual Report and Investigators Summaries 1961-62 (MS) pp 103-105.

Research Item - In two cruises carried out in the Gulf of Maine in October (primarily designed for exploratory fishing) with the R.V. A.T. Cameron some plankton collections were made and some herring larvae caught. Twenty-two plankton tows during the first half of October yielded only 4 larvae all on the northeast edge of Georges Bank. During the last half of October an equal number of tows yielded larvae off Grand Manan, N.B., 16 between Yarmouth, N.S. and Browns Bank and 49 along the northern edge of Georges Bank.

Reference - Atlantic Biological Station Annual Report and Investigators Summaries 1961-62 (MS), pp 111-112.

Research Item - Explorations for pelagic fish in 1961 in Subareas 4 and 5.

Task - To carry out exploratory fishing operations in offshore waters of the southwest Canadian Atlantic area in an attempt to discover concentrations of pelagic fish (herring, mackerel, tuna, swordfish, sharks, etc.) that might be available for commercial exploitation.

Scope - Areas of operation included Georges Bank, Browns Bank, Bay of Fundy, Gulf of Maine and the western edge of the Gulf stream. The R.V. Harengus was used for 1 cruise during the latter half of August. The R.V. A.T. Cameron was used for two cruises for the month of October. Fishing was done with mid-water trawls, bottom trawls, Japanese tuna gear, handlines and drift gillnets. Temperatures and salinities were taken at all fishing stations.

Results - (1) During the August cruise the Swedish type mid-water trawl was used 4 times on the northern edge of Georges Bank. In October it was used twice on Georges Bank, once off Grand Manan and once at the edge of the Gulf stream. The only significant catch was 140 pounds of large sexually mature herring taken in one August tow on Georges Bank.

(2) Dutch herring trawls used from the R.V. Harengus and a 41-5 bottom trawl (small mesh) used from the R.V. A.T. Cameron yielded mostly groundfish species. The R.V. Harengus made 8 tows on Browns Bank and 9 tows on Georges Bank. A few herring were taken in 8 out of 11 tows on Georges Bank by the A.T. Cameron.

(3) Japanese long-lines fishing on Georges and Browns Bank was relatively successful on all 3 cruises. Night sets were mainly used. Thirteen sets caught 130 sharks and 2 bluefin tuna.

Significance - Probably the most significant result of all three cruises was the availability of mackerel sharks for which there is a good market demand.

Reference - Atlantic Biological Station Annual Report and Investigators summaries 1961-62 (MS) pp. 119-121.

Research Item - Swordfish research in 1961 was confined to collection of landing records, catch records from vessel log books, compilation of these data, measurements of fish as landed and an attempt to continue studies of food and feeding habits by having preserved stomachs brought ashore.

Landings in 1961 declined 18% from 1960, probably because of poor weather and diversion of some vessels to scallop fishing. The swordfish fishery began in late May southwest of Cape Cod, Mass. Most important fishery grounds were Georges and Browns Banks.

Weights of individual swordfish ranged from 60 to 520 pounds with a mean weight of 196 pounds (dressed).

All the material obtained from stomachs brought ashore was in such an advanced state of digestion that it was impossible to identify it.

Canadian effort related to large pelagics, in 1961, was directed to exploratory fishing for other species which might be commercially profitable. A background review of swordfish biology and the Canadian fishery was completed and published.

Reference - Atlantic Biological Station Annual Report with Investigators summaries 1961-62 (MS) pp 121-125.

Tibbo, S.N., L.R. Day, and W.F. Doucet. The swordfish (Xiphias gladius L.), its life-history and economic importance in the northwest Atlantic. Bull. Fish. Res. Bd., No. 130, 47 pp.

F.D. McCracken

1962-63

Research Item - Continued study of elements of the Georges Bank Scallop fishery by Canadian vessels.

Task - To recognize and attempt to assess possible changes taking place in the Georges Bank fishery.

Scope - Statistics of the fishery were still collected ashore including landings and catch records from vessel log book records. Two trips were made to Georges Bank on commercial vessel to sample catches, measure discards and make biological observations. No further trials with large ring sizes were carried out in 1962.

Results - (1) Scallop landings from Georges Bank increased again in 1962. The increased landings by the offshore fleet resulted from increased effort (39 boats Cfd. 28 in 1961). Crew sizes remained about the same as in 1961.

(2) Trips to sea on commercial scallopers showed that in 1962 the vessels fished continuously in order to keep crews busy. Deck loading which had been common in 1960 and early 1961, was uncommon because catch per unit effort decreased. Boats also fished over a greater area of the bank than in former years.

(3) Minimum size for shucking dropped slightly in 1962, the 50% retention length being at a shell height of 90 to 99 mm. Five of six vessels which had used the 4-inch ring drag reverted to 3-inch.

(4) Catch per unit effort (measured by observers on commercial vessels) declined markedly over the past 3 years. Expressed as catch of market size scallops in bushels per drag, per tow, per minute, it declined from 1.93 in 1960 to 0.4 in 1962.

Significance - As predicted earlier the super-abundant year-class that was the mainstay of the fishery in 1960 contributed little to the fishery in 1962. Fluctuation in year-classes and the increased fishing effort add emphasis to the need for biological information about the sea-scallop and the effect of the fishery upon it. Sea sampling suggests that recruitment to the fishery in 1963 will be poor, forcing the fleet to fish harder, over a wider area and over rougher bottom.

Canadian Effort - Has remained at about the same level as the previous 2 years. It is both compatable and a co-operative venture with the USFWS biologists.

References - Atlantic Biological Station Annual Report and Investigators Summaries, 1962-63 (MS) pp B29-B31.

Martin, W.R. 1963. Canadian Research Report, 1962, Subareas 4 and 5, Biology. ICNAF Redbook, Part II. pp 14-21.

Research Event - The program on scallops carried out in the laboratory was continued in 1962. This program investigating aspects of basic biology of the scallop devoted major emphasis to a study of "unknown" larval stages. Larvae were obtained from six spawnings and reared under different temperatures and fed various foods. Larvae from one spawning were kept alive for 58 days and measured 275 x 288 microns. They developed a foot and appeared ready to settle but did not.

In 1962 further attempts in the field to collect larvae by plankton tows and setting out spat collectors in Passamaquoddy Bay failed.

References - Atlantic Biological Station Annual Report and Investigators Summaries, 1962-1963 (MS) pp B28-29.

Martin, W.R. 1963. Canadian Research Report 1962, Subareas 4 and 5, Biology, ICNAF Redbook, Part II. pp 14-21.

Research Item - Scallop gear research.

Task - To make underwater observations of scallop drags to see what towing characteristics and selectivity of towing gear is and whether it could be made more efficient and more selective.

Scope - In September the R.V. Harengus was used in the southern Gulf of St. Lawrence to tow an 8 foot offshore style drag on a scallop bed (this region was chosen since scallop beds are in shallow enough water that divers using scuba gear could make observations). Two trained scuba divers of the ABS staff attempted to observe the drags action on bottom.

Towing speeds during commercial fishing are so fast (about 4 knots) that the divers were unable to ride the drag and observe its towing action. Instead the bottom where the drag was towed was examined before and after. Also the divers followed the drag path and picked up scallops left by the drag.

Results - Preliminary results indicate that the present style drag is very efficient at catching market size scallops when they are sparsely distributed over the bottom.

Significance - A beginning has been made at understanding the effectiveness of the present style drag. These preliminary results, however, are not really applicable to Georges Bank yet, since boats there have started dragging rougher

bottom as catch per boat declined.

Canadian Effort - This was a totally Canadian effort but one which should be applicable to other regions if and when more material results have been obtained.

References - Atlantic Biological Station Annual Report and Investigators summaries, 1962-63 (MS) pp B31-B32.

Martin, W.R. 1963. Canadian Research Report, 1962, Subareas 4 and 5, Biology. ICNAF Redbook, Part II, pp 14-21.

Research Item - The pollock research which was begun in 1960 was completed. Field work, except for collection of tag recaptures was completed in 1961 and in 1962 the analysis of data was completed. A paper giving details of the investigation was submitted for publication and accepted by the Journal of the Fisheries Research Board. A final brief summary of results was also presented in the Canadian Research Report to ICNAF.

None of the final analyses changed the results and conclusions already reported in these documents for 1960-61 and 1961-62. Chief among these was the migratory behaviour of pollock between Subareas 4 and 5, the distribution of pollock by size groups in the Bay of Fundy-Gulf of Maine region and that plankton, particularly a euphausiid, was the principle food of pollock in the Bay of Fundy.

References - Steele, D.H. The pollock (Pollachius virens (L.)) in the Bay of Fundy. J. Fish Res. Bd. Can.

Martin, W.R. 1963. Canadian Research Report, 1962, Subareas 4 and 5, Biology, ICNAF Redbook, Part II, pp 14-21.

Atlantic Biological Station Annual Report and Investigators Summaries 1962-63 (MS) pp C33-34.

Research Item - Swordfish statistics of landings and fishing vessel log records for 1962 were analyzed. Landings increased by about 8% over 1961. There was no increase in fleet size.

In 1962 the fishery began in early June somewhat later then usual and was centered then in the southeast part of Georges Bank. In July most swordfish were caught on Browns Bank, Emerald Bank and Sable Island Bank. The fishery in August was located almost exclusively in the Banquereau area. In September some swordfish were caught on Sable Island Bank and Georges Bank, but most of the effort and catches from late August to early November were along the southwest edge of the Grand Banks. The season was exceptionally long and very unusual in that successful fishing on the Grand Banks continued into late autumn about 6 weeks later then usual. By comparison with 1961, when most of the swordfish landings were made from Georges and Browns Bank, the catch in 1962

was more evenly distributed along the edge of the continental shelf from Georges to Grand Banks.

The year 1962 marks the introduction of longlining for swordfish in the Canadian swordfish fishery along with harpoons.

Reference - Atlantic Biological Station Annual Report and Investigators Summaries in 1962-63, (MS) pp D10-D13.

Research Item - Explorations for pelagic fish in Subareas 4 and 5.

Task - To attempt to find concentrations of pelagic fish (herring, mackerel, tuna, swordfish and sharks) which might be available for commercial exploitation by Canadian fishermen.

Scope - Four cruises of 8 to 10 days each were made from late July to late September, 2 on the R.V. Harengus and 2 on the R.V. A.T. Cameron using gillnets, longlines (floating), bottom trawls. Some plankton tows were included. Areas fished included the Lurcher-Seal Island area off southwest Nova Scotia, Browns Bank and around the northern part of Georges Banks.

Longlines were set 42 times (19 on Georges, 14 on Browns and 9 in the Lurcher-Seal Island region), bottom trawls were towed 52 times (32 on Georges, 13 on Browns and 7 in the Lurcher-Seal Island region). The gillnets were set only once and caught nothing.

Results - (1) Sharks dominated catches on the floating longline gear with a total of about 200, 179 of which were blue sharks and 17 were porbeagles. They appeared to be more numerous on Georges Bank than elsewhere.

(2) Bottom trawls caught groundfish species and herring mainly, although herring were only abundant on the northwest part of Georges Bank during the first September cruise of the R.V. A.T. Cameron. Herring were scarce on Browns Bank. None of the herring taken up to mid-September were as yet ripe and running and it appears that spawning of herring in that area was considerably later then in the past several years.

Significance - The continued exploration for pelagic fish in Subareas 4 and 5 with gears not commonly used probably helped lead to the use of longlines for swordfish fishing. The continued availability of large mature herring on Georges Bank did not attract Canadian or U.S. fishermen to the area, but Canadian results may have played a part in the exploratory fishing and subsequent heavy commercial fishing there by the USSR.

Canadian Effort - Four research vessel cruises to this area related to surveys of possible commercial pelagic fish concentrations seems quite adequate in view of both development and marketing problems.

Reference - Atlantic Biological Station Report and Investigators Summaries 1962-63 (MS) pp D25-27.

Research Item - No herring larvae were taken in 2 cruises with the R.V. Harengus or 2 with the R.V. A.T. Cameron in August and September on Georges Bank and offshore areas of the Gulf of Maine. This result is probably to be expected since spawning of herring on Georges Bank appears to have been later than usual. Examination of maturity stages of adults showed that none were ripe and running before mid September on Georges Bank.

Reference - Atlantic Biological Station Annual Report and Investigators Summaries, 1962-63 (MS) pp D-29.

F.D. McCracken

1963

Research Item - Scallop distribution and abundance studies on Georges Bank.

Task - To assess abundance and distribution of Georges Bank scallops in relation to sampling techniques being used in surveys.

Scope - Two years of data have been used for this analysis, 1961 and 1963. To facilitate scallop studies U.S. and Canadian biologists have divided Georges Bank into unit areas with coordinates at 10 minutes of latitude and 10 minutes of longitude (about 75 square nautical miles). For purposes of these sampling surveys each unit area was divided into 100 quadrats (about 0.75 square nautical miles). Using a chartered vessel in 1961 and the R.V. A.T. Cameron in 1963 surveys were done in 3 unit areas in 1961 and in 1 unit area in 1963. Various combinations of tows were used, parallel, repeat, duplicate. Cruises were in the August-September period.

Results - (1) The results show great variance in abundance between unit areas. For scallops over 100 mm in 1961 average number per 1000 square yards ranged from about 140 $\pm$ 65 to 530 $\pm$ 290. For scallops under 100 mm the range was even wider. Abundance of small scallops in a unit area did not seem to be related to abundance of large scallops there.

(2) According to these results distribution estimates obtained from samples also varied widely. Small scallop catches were more heterogenous than large scallops. Variation between "duplicate" tows was as great as between quadrats, in 1961, and about half as great in 1963.

(3) Various other specific variables were noted suggesting distribution in pockets or schools.

Significance - Probably the most significant thing is the care that must be taken in using research vessel or single cruise data to estimate either distribution or abundance of scallops. In one unit area (#7) there appears to be a chance of detecting annual mortality of 25% or greater. For the other unit areas sampled the sampling would have had to have been about 4 times greater than it was for comparable accuracy of mortality estimates.

Canadian Effort - Co-ordinated with USFWS. Somewhat constrained by vessel time and personnel who were occupied elsewhere in other scalloping areas.

Reference - Bourne, N., E. Cadima and J.E. Paloheimo. 1964. ICNAF Document 64/65, Serial No. 1361, pp 4.

Item - Current data for selectivity in the ICNAF area show large differentials between manila and some synthetics (polyamides and polyesters) but not for others (polyethylenes).

National interpretation of equivalents for the ICNAF minimum mesh size regulation by Canada and the USA has led to grouping of all synthetics under one mesh size. International agreement on "equivalents" seems desirable.

Mesh measuring comparisons carried out in 1963 and a study of net manufacturers specifications suggest that ICNAF regulations might well be written in two forms (1) for countries using spring-loaded ICNAF gauges, and (2) those using simple gauges, the latter being about 4 mm less than for #1. (Canada cannot use a spring-loaded gauge in cases of prosecution).

Reference - McCracken, F.D. 1964. Minimum mesh sizes and equivalents for different materials to meet ICNAF regulations. ICNAF Doc. 64/72, Serial No. 1368.

Item - There was no Canadian herring fishing reported from Subarea 5 in 1963. Studies carried out there involved fourteen samples of herring obtained from bottom trawl catches by the R.V. A.T. Cameron on Georges Bank in August. These fish ranged from 18 to 40 cm (total length) with a mean of about 26 cm. Age and maturity data were included in the sampling but are not yet analyzed.

Research Event - Studies of swordfish and the swordfish fishery.

Task - To follow and interpret changes in the fishery and in the distribution of swordfish particularly in relation to the introduction of longlining and its use in 1963.

Scope - Landing statistics and fishing vessel log book records were collected and compiled for distribution and effort. Studies of size and weight composition were included in the program. Two trips on a commercial vessel allowed direct observation of fishing techniques and biological studies of the catch.

Results - (1) Longlining for swordfish introduced near the end of 1962 was continued and expanded in 1963. Forty-eight vessels fished with both harpoons and longlines, 70 vessels used only longlines. A remarkable change in a fishery that has been virtually unchanged since its beginning about 60 years ago.

(2) Catches increased about 3½ times in 1963 from the level of 1962. Number of fish caught per trip increased about 3 times.

(3) Average size of fish landed was about 165 pounds compared to an average of about 190 pounds in 1962. Size composition, however, varies with area fished and with the season. For example there were quite different size compositions of swordfish caught on Nova Scotia Banks in October than on Georges Bank in November.

Significance - The major change in methods of fishing adds considerably to the complexity of the fishery. They do provide a better opportunity of learning more about swordfish biology than harpooning which apparently took only large female fish at the surface. It is as yet too early to understand changes in the sizes of fish landed.

Canadian Effort - Swordfish are fished along the edge of the continental shelf from Cape Hatteras to the Grand Banks. Canada is the major exploiter of this species. Research was carried out without limitation by Subarea boundaries, but in cooperation with the USFWS.

References - Tibbo, S.N. 1964. Review of Canadian Fishery and Research on Large Pelagic Fish in the ICNAF area in 1963. ICNAF Doc. 64/74, Serial No. 1370 pp 1-3.

Item - Two New Brunswick purse seiners fished for tuna during the last half of 1963. They caught about 290 metric tons of bluefin tuna and 45 metric tons of skipjack. Fishing was carried out in the Cape Cod region of Massachusetts (Subarea 5) and south to Long Island, New York. Detailed log records of these operations were obtained. Length composition of 161 bluefin calculated from fish landed in Sept-October had a predominant length of 110-115 cm.

Reference - Tibbo, S.N. 1964. Review of Canadian Fishery and Research on Large Pelagic fish in the ICNAF area in 1963. ICNAF Doc. 64/74, Serial No. 1370, pp 1-3.

Item - Canadian effort for haddock increased on Georges Bank during 1963 particularly in Div. 5Z. Statistics of effort and landings and results of sampling of length and scales are still to be compiled. They will be analyzed by biologists from USFWS with whom we are collaborating on Subarea 5 haddock research efforts.

F.D. McCracken

1964

Research - Scallop research efforts on Georges Bank in 1964.

Task - Assessment of scallop stocks and future fishing on Georges Bank.

Scope - Investigators at St. Andrews continued to collect and compile catch and effort statistics for the Canadian fleet. These data were reported to U.S. investigators and to ICNAF.

Two trips were made to Georges Bank one on a commercial vessel to sample and observe commercial catches. The second trip on the R.V. A.T. Cameron to continue intensive sampling of unit areas begun in 1963. Also comparisons were made of two types of odometers used to measure the distance scallop drags travel over the bottom.

Results - Off the northeast peak of Georges Bank, where the commercial vessel fished, scallops were small and belonged almost entirely to one year-class. The cull point was about the same as in 1963 and all scallops over 90 mm shell height were shucked.

The research vessel studies to determine sampling error and measure mortality rate were continued.

Comparison of the two types of odometers (wheel type and roller type) showed that both gave a reasonable estimate of the distance travelled by scallop drags over the bottom.

Significance - Preliminary analyses of the data from Subarea 5 indicate that the incoming year-class on Georges Bank is no stronger than the one that entered the fishery in 1964. Total landings in 1965 from the offshore fleet may decrease further in 1965.

The year 1964 marks the first time since offshore scalloping began that landings have decreased from the previous year. Log book coverage of 70% of the fleet showed that catch per boat decreased slightly again in 1964.

Canadian Effort - Collaboration with the biologists of USFWS continued as noted above. One Canadian scientist and three technicians were engaged full time in scallop research.

Again in 1964 rearing of larval scallops continued. This is of general interest since knowledge of the larval stages of scallops is so poorly known in all ICNAF subareas.

References - Fisheries Research Board of Canada, Biological Station, St. Andrews - Investigators Annual Summary Repts, 1964, Original Manuscript # 1007 pp 1-10.

Hart, J.L. 1965. Canadian Research Report, 1964, Subareas 4 and 5. ICNAF Redbook Part II, pp 20-35.

Research Item - Studies to assess scallop populations by using an underwater camera were continued.

Reference - Fisheries Research Board of Canada, Biological Station, St. Andrews, Investigators Annual Summaries for 1964. Original Manuscript #1007, pp 2.

Research Item - Studies on development of sea scallop larvae were continued in the laboratory but again the methodology failed to rear larvae to the settling stage. The limited knowledge about stages of development and the lack of information about settlement of spat has been pointed out for previous years in this series along with the significance of finding out such information.

References - Fisheries Research Board of Canada, Biological Station, St. Andrews - Investigators Annual Summary Reports, 1964. Original Manuscript #1007, pp 1-10.

Hart, J.L. 1965. Canadian Research Report, 1964, Subareas 4 and 5, ICNAF Redbook Part II, pp 20-35.

Research Item - The lobster biologists at St. Andrews were encouraged by the greatly expanded lobster research program of the U.S. Bureau of Commercial Fisheries initiated in the fall of 1964. Emphasis will be on establishing the relationship, if any, among inshore and offshore populations and to determine optimum levels of fishing. Work by an augmented staff at Boothbay Harbour, Me., will probably be supplemented through contracts with Massachusetts, Maine and Rhode Island.

Biologists from the Laboratory at Boothbay Harbour and from the Mass. Division of Marine Fisheries visited St. Andrews to discuss plans for the new research program and to consider where co-operative work will be possible. Further meetings in Maine are planned for shortly.

Significance - An active federal lobster research program in the United States will stimulate lobster research generally and interaction between Canada and the U.S. will provide much needed constructive criticism of the two countries programs.

Reference - Fisheries Res. Bd. Can. Biol. Sta., St. Andrews, N.B. - Investigators Annual Summaries for 1964. Original Manuscript, 1003, pp1-30.

Research Item - Silver hake otolith exchange between Canada, U.S. and USSR.

Task - To attempt to validate the age reading results and make them comparable between the 3 countries named above.

Scope - Otoliths taken in the U.S. fishery and research vessel surveys, from the Soviet samples of silver hake, and Canadian research vessel surveys were interchanged between the three countries for comparative age reading.

Results - Not yet available.

Significance - Since the fishery is prosecuted in both Subareas 4 and 5 by the USSR and in Subarea 5 by the USA, and because the stocks may intermingle it is important that correct ages be assigned when considering recruitment, distribution, effect of the fishery, etc. So far Canadians have not landed silver hake commercially, but have carried out research on this species in Subarea 4.

Canadian Effort - Ties in with current research work and our participation in the otolith exchange and reading for ages is in line with our need for knowledge of the stocks.

Reference - Fish. Res. Bd. Can., Biol. Sta., St. Andrews, N.B. - Investigators Annual Summaries for 1964. Orig. Manus. No. 1008, pp 1-48.

Graham, H.W. 1964. United States Research Report 1964, ICNAF Redbook Part II, pp 123-141.

Research Item - Canadian haddock landings have increased from the Browns Bank region of Subarea 4 and the Georges Bank region of Subarea 5. Discards were estimated by an observer on three commercial trips which fished the Browns Bank - Georges Bank region. Discards of haddock averaged about 15% by number and about 7% by weight. Mean length of discards was about 36 cm. Discard estimates for haddock from the Captians log averaged about 4% by weight.

Reference - Fish. Res. Bd. Can., Biol. Sta., St. Andrews, N.B. - Investigators Annual Summaries for 1964. Orig. Manusc. No. 1008, pp 1-48.

Research Event - Swordfish research on the fish and fishery.

Task - With a major change in swordfishing methods taking place in 1963 and 1964 reexamination of the fishery seemed necessary, plus a more comprehensive look at the biology of the species.

Scope - Continued analysis of the seasons and areas fished, now that longlining has become the principle method of fishing swordfish, was carried out from fishing vessel records and examination of fish, etc. at sea. Five sea cruises were made during 1964, two on commercial vessels, two on a chartered vessel and one on the R.V. A.T. Cameron. Fish stomachs (314) were examined and where possible contents identified. Twenty-eight swordfish were tagged. Swordfish were examined for sex and maturity.

Sea trips were mainly to the southeast part of Georges Bank, but one was to the Cape Hatteras region and one to the Browns Bank region. Beside the biological observations noted above, the sea trips experimented with bait, hook size, temperatures and fishing depths.

Shore sampling for length-weight studies was continued in 1964 (about 8000 fish measured and weighed). Detailed measurements of swordfish for a morphometric description were continued.

Results - (1) In 1964, for the first time Canadian vessels fished swordfish year round. The winter-early spring fishery was off Cape Hatteras; subsequently it spread along the coast from Georges Bank to the Grand Banks. Log records for the period 1962 through 1964 show that in 1963 and 1964 the number of fish caught per days fishing was much higher (about 4 times) than during the harpoon type fishery in 1962.

(2) Weights of fish landed in 1964 varied from 7 to 485 pounds, averaging about 142 pounds. These contrast with an average weight of about 200 pounds when harpoons only were used.

(3) Males occur in swordfish taken with longlines. Apparently the harpoon fishery took only females but with longlines the ratio of females to males is about 3:1. Gonads of both males and females appeared to be quiescent, although not yet microscopically examined.

(4) Results attempting to relate catch to various items such as hook size, bait, temperature, etc. are inconclusive.

(5) Twenty-eight species (or families) of fishes have been identified from swordfish stomachs. Swordfish from Georges and Nova Scotian Banks fed chiefly on silver hake, redfish, barracudinas and lanternfishes. Samples taken southward to Cape Hatteras contained a greater variety of species (probably more prey species available). In 30 stomachs examined from a collection in August the fish-squid ratio was about 3 to 1.

Significance - For most items studied it is yet too early to set out significance of results in a meaningful way. The change in the fishery needs a watching brief. The increase in numbers of fish caught and the decrease in size seem of particular importance in assessing the health of the fishery.

Canadian Effort - While it would probably be better to have a research vessel available, the results obtained from commercial and chartered vessels seem quite useful. Possibly crews accustomed to swordfish fishing may be better than more generalist crews on research vessels. For the size of the fishery the effort expended in Subarea 5 by up to three scientists with supporting technical staff seemed adequate.

References - Fish. Res. Bd. Can., Biol. Sta., St. Andrews, N.B. 1964 - Investigators Annual Summaries, Orig. Manuscript No. 1010, pp 1-10.

Hart, J.L. 1965. Canadian Research Report, 1964, Subareas 4 and 5. ICNAF Redbook Part II: 20-35.

Research Item - Tagging of large pelagics continued during 1964 from catches on five research and commercial vessel cruises. Mainly large sharks were tagged although 28 swordfish were tagged. Tuna were tagged south of Cape Cod from the catch of one purse seiner. These taggings will be discussed later, if tag returns warrant it.

Reference - Fish. Res. Bd. Can., Biol. Stat., St. Andrews, N.B. 1964 - Investigators Annual Summaries Orig. Manuscript No. 1010, pp 1-60.

Research Item - A purse seine fishery by two New Brunswick vessels for tuna south of Subarea 5 was started in 1963 and continued in 1964. It presented opportunities for research on tuna some of which were undertaken. This fishery only lasted through 1965 and it would seem preferable to consider research over the 1963-65 period as a single item.

Research Item - Studies of Georges Bank herring samples 1962-64.

Task - To examine changes in age and size frequency of Georges Bank herring.

Scope - Herring stocks sampled by otter trawl on Georges Bank in September 1962, August 1963, and August 1964, were examined for length frequency, age-class and year-class composition. Age determinations were made from a sub-sample of the total fish measured.

Results - (1) In the 1962 samples the 1956 year-class, age-class VI, was very strong (40%), but was virtually non-existent in the 1963 sample. This result was similar to that reported by the USSR who attributed the loss of the 1956 and 1957 year-class to natural mortality. In 1964, however, both these year-classes were well represented in Canadian samples (were dominant year-classes).

(2) The 1960 year-class showed up strongly in the 1963 samples (75%).

(3) Size composition of the catches from which the sub-samples were taken agree with the changes in year-class strengths as shown by age-determination.

Significance - It appears that the bulk of the 1956 and 1957 year-classes were not available to the 1963 fishery. Possibly there was a migration which removed them from the fishing range. These fluctuations illustrate the difficulties encountered in obtaining a true mortality rate for species such as herring.

The 1960 year-class in the 1964 sample suggests that they will be abundant recruits to the Georges Bank fishery.

Canadian Effort - Canadian fishermen are not fishing offshore herring stocks on Georges Bank. They are being exploited extensively by the USSR. Canada maintains a watching brief.

Reference - Fish. Res. Bd. Can., Biol. Stat. St. Andrews, N.B. 1964 - Investigators Summaries, Orig. Manus. No. 1010, pp 1-60.

F.D. McCracken

1965

Research Item - Offshore otter trawling for lobsters 1965 and 1966.

Task - In recent years, U.S. trawlers operating along the continental slope south of Georges Bank have landed over 2 million pounds of lobsters annually. Our task was to learn more about the abundance and distribution of lobsters offshore, particularly in areas more accessible to Canadian fishermen.

Scope - In 1965 a chartered stern trawler made 192 three quarter to one hour tows with a #41 Yankee trawl from July 17 to August 27. This fishery was done at 50 to 200 fathoms (depths similar to the U.S. fishery) from south of Georges (Subarea 5) to Sable Island (Subarea 4).

In 1966 from June 21 to July 30, a chartered side trawler made 115 half-hour or hour tows with a #41 Yankee otter trawl. Sixty-five of these tows were made along the slope of the shelf from Emerald Bank (Subarea 4) to the eastern end of Georges (Subarea 5) mainly at depths of 100 to 300 fathoms. The remaining fifty tows were made in the Sable Island-Banquereau area (Subarea 4) at depths of 50 to 150 fathoms. A scientist with technical assistance was involved in the operations.

Lobsters were tagged and released close to the point of capture using a yellow spaghetti type tag. One hundred and eighty-two were tagged in 1965 and 21 in 1966.

Some plankton towing was carried out during the course of the operations and in 1966 a series of bottom photographs were taken near where lobsters had been caught in depths of 100 fathoms.

Results - (1) In 1965, a total of 196 lobsters were taken by trawling, with 90% from off eastern Georges Bank. In 1966 only 24 lobsters were taken. Lobsters taken in 1965 ranged from ¼ to 22 pounds averaging about 5 3/4 pounds.

(2) Of the 182 lobsters tagged and released in 1965, 15 were returned within 1 to 13 months. Average distance between release and recapture point was 23 miles. There was no obvious pattern to the movement.

(3) During cruises in 1965 two Stage II larvae were caught on eastern Georges Bank and two Stage IV larvae were caught between Browns and LaHave Banks.

Significance - In two seasons of surveys along the slope of the shelf from the eastern end of Georges Bank to Banquereau we failed to find new concentrations of lobsters. In addition, few lobsters have been taken in this area by research or commercial vessels trawling for groundfish. It seems unlikely that sufficient quantities of lobsters occur along the slope east of Georges to support a commercial fishery. Our only real successes were off Georges in Subarea 5.

Canadian effort - No further trawl surveys in the slope area east of Georges Bank are planned. The effort expended seems worthwhile in outlining the limited distribution of lobsters in the deep slope area.

References - Fish. Res. Bd. Can., Biol. Stat. Ann. Rept. and Investigators Summ., 1965, pp A3-4.

Fish. Res. Bd. Can., Atl. Biol. Stat. Ann. Rept. and Investigators Summ., 1966, pp A6-7.

Item - There was a hiatus in the scallop investigation in 1965 as the scientist in charge and a senior technician both accepted other positions. We were only able to follow the fishing on Georges Bank through collection of log records.

It may be noted that in 1965 Canadian vessels began fishing grounds off the coast of Virginia where Canadians had not fished before.

Research Item - Exploratory fishing for argentine and silver hake in 1965 and 1966 from Georges Bank to Banquereau.

Task - To explore for and make biological observations about these species, currently unfished by Canadians but exploited by the USSR.

Scope - Exploratory fishing for these species were carried out in conjunction with the work on lobster (and herring as well) using the same chartered commercial vessels and the same cruises. Four cruises were carried out in July and August 1965 between the southeast part of Georges Bank to Sable Island. Three cruises were carried out in June-July 1966 between eastern Georges Bank and Banquereau. A #41 otter trawl lined with small mesh in the codend and lengthening piece and a Dutch type herring trawl were used in various areas.

Biological data on size, age, distribution and probable seasonal occurrence was collected for both argentines and silver hake. To-date in 1966 the material on silver hake has not been analyzed. That for argentines taken in 1965 has been analyzed and published. The 1966 argentine data on food, fecundity and gonad development is being made available to a Post-Graduate Fellow who is studying this part of the biology of argentines.

Results - (1) Argentines were found in many locations along the edge of the shelf from Georges Bank to Sable Island. Best catches in Subarea 5 were from depths of about 100 fathoms and temperatures of 8° to 9°C. Five tows at this depth averaged about 1 ton with individual catches up to 2 tons near Corsair Canyon region of Georges Bank.

(2) Most argentines caught in the Georges Bank region were between 32 and 38 cm somewhat larger than off the Scotian Shelf (20-25 cm long). Ages for the Georges Bank argentines were not analysed but off the Scotian Shelf they appeared to be slow growing and were mainly from 2 to 7 years of age. About 70% of the catch off Georges had gonads in the early ripening stage.

(3) Small numbers of silver hake were caught at most stations fished in Subarea 5 in depths of 50 to 180 fathoms. Most fish caught were between 28 and 32 cm. Examination of the gonads suggest that spawning was taking place in August. Other biological data have not yet been analyzed.

Signficance - In general the argentines and silver hake taken in these explorations seem too small to be of interest to Canadian fishermen unless much larger quantities could be taken with some other more specialized fishing gear.

Observations of the activities of the Soviet fleet suggest that the fishery for silver hake would be seasonal and that probably argentines are an incidental catch.

Argentines appear to be slow growing and late maturing and it is possible that intensive fishing could rapidly reduce stocks.

Canadian Effort - Since there is no fishing by Canadians for these species and in view of the results a fishery is unlikely to develop rapidly, Canadian research effort will likely be modest. Results of Soviet research and their fishery will be followed closely.

References - Fish. Res. Bd. Canada, Biol. Stat., St. Andrews, Annual Report and Investigators Summ., 1965, pp CA 26-27.

Fish. Res. Bd. Canada, Biol. Stat., St. Andrews, Annual Report and Investigators Summ. 1966 pp CA 22-23.

Hart, J.L. 1966. Canadian Res. Rept. 1965. Subareas 4 and 5, ICNAF Redbook Part II, pp 13-24.

Research Item - Swordfish research off the coast of North America.

Task - To continue observations on changes in the fishery, to continue examination of swordfish food and feeding, and to explore for larvae and post larvae.

Scope - Analyses of log records were related to changes in distribution of the fishery and changes in catch per effort. Changes in sizes caught and landed were explored both at sea and ashore. Food habits were examined during five cruises. A special attempt to examine larvae and their origins was made on a research vessel cruise south of Subarea 5 in February. Swordfish research, like the fishery, extended from Subarea 3 to south of the ICNAF area. Swordfish tagging was continued.

Results - (1) Catch per trip for swordfish declined in 1965. Swordfish utilization has increased about threefold in recent years and there are already signs of decrease in mean size, catch per effort and total catch. Average weight of swordfish landed in 1965 was about 143 pounds. Size composition

of swordfish has been decreasing about 9% annually since introduction of longlining in 1962.

(2) The 413 swordfish stomachs examined in most instances showed that food types reflected the area of capture. In catches over the continental shelf bottom species predominated, in other areas bathypelagic species were dominant.

(3) Studies of the distribution of post-larval swordfish resulted in the capture of 47 specimens ranging in length from 1.8 to 11.1 cm. These were taken in three general regions of the northwest Atlantic, off Cape Hatteras, in Florida Straits and in the northeast part of the Caribbean Sea.

(4) Evidence from distribution differences in sizes of swordfish taken in different areas from Cape Hatteras to the Grand Banks did not yield conclusive results.

Significance - During the time when harpooning was the only method of fishing swordfish used the changes in the fishery were considered to be almost completely from environmental factors. Recent changes, however, indicate that the fishing may be having a considerable effect on the stocks. Such changes need to be followed closely if the stocks are to be managed effectively.

While the number of post-larvae caught were few, their location and size during February 1965 suggests that there are two or more spawning areas for swordfish in the western Atlantic, although precise locations still have to be established.

Canadian Effort - While the swordfish fishery is not large in tonnage compared to some others it has been lucrative for a number of Canadian fishermen. Since Canada is the largest exploiter over a wide range Canada also probably spends more effort on swordfish then other countries.

References - Fish. Res. Bd. Can., Atl. Biol. Stat. St. Andrews, N.B., Annual Rept. and Investigators Summaries, 1965, pp CB 1-11.

Hart, J.L. 1966. Canadian Research Report, 1965. Subareas 4 and 5, ICNAF Redbook, Part II, pp 13-24.

1966. Report of the Subcommittee on Herring and other pelagic fish. ICNAF Redbook, Part I., App. V, pp 73-82.

Research Item - Investigations on the small purse seine fishery for tuna conducted by Canadians in the Cape Hatteras-Cape Cod area.

Task - To examine commercial catches made by two Canadian purse seiners, which began fishing tuna in 1963 continued into 1965 and withdrew from the fishery at the end of 1965.

Scope - Research on commercial catches of tuna increased in 1964 and 1965. Species composition of catches along with size composition were obtained in both years. Records of area fished and dates were kept. Depths fished were recorded. In 1964 and 1965 some tuna taken by purse seiners were tagged. During 1964, 82 skipjack, 4 bonito and 8 small bluefin were tagged. In 1965 tagging was most concerned with bluefins.

Results - (1) In 1963 the vessels started late and only fished north of Cape Cod so variety of fish was limited.

(2) In 1964 the first successful sets were off Cape May in June when bluefin tuna of about 75-175 cms were caught. These were followed by 75-85 cm bluefins (age-class III) with age-classes VI-VII (130-158 cm) predominating in July. By July skipjack appeared in the catches. Larger skipjack predominated at first (about 48-60 cm) but by September the size range was about 45-55 cm.

(3) In 1965 for bluefin tuna much the same pattern of size distribution occurrence was observed, but fish tended to be later in arriving. Fishing didn't start until mid-July. Skipjack were much less abundant in 1965 than in 1964.

(4) Results of tagging for large pelagics will be discussed later.

Significance - The distribution and movements of bluefin tuna as seen in the Canadian fishery fits the pattern of migrations proposed by Woods Hole biologists.

Canadian Effort - This rather short-lived Canadian commercial purse seine fishery warranted some attention. It was probably always marginal whether small purse-seiners of the type being used here would be profitable. In addition to the interest Canadians had in this specific fishery it was useful in considering the probable migrations of the very large bluefin tuna being taken seasonally in Subarea 4.

References - Fish. Res. Bd. Can., Biol. Stat. St. Andrews, N.B., Annu. Rept. 1964, Orig. Manusc. No. 1010, pp 1-60.

Fish. Res. Bd. Can., Biol. Stat. St. Andrews, N.B., Annu. Rept and Investigators Summaries, 1965, pp CB 1-17.

Hart, J.L. 1966. Canadian Research Rept. 1965, Subareas 4 and 5, ICNAF Redbook Part II, pp 13-24.

Item - Herring samples (about 1300 fish) were obtained from Georges Bank during September and October using a Dutch type herring trawl on the northern edge of Georges Bank. Total lengths ranged from 19.5 to 35.5 cm. Of 453 sets of otoliths used for age determination 3% appeared to be spring-spawned fish. Of the autumn spawned fish 66% were of the 1961 year-class and 23% of the 1962 year-class. (Other countries carrying out research there had no evidence of spring-spawners from this area.)

Reference - Fish. Res. Bd. Can., Biol. Sta. St. Andrews, N.B., Annual Rept. and Investigators Summaries, 1965, pp CB 1-CB 17.

Report of Subcommittee on Herring and other pelagic fishes. ICNAF Redbook, 1966. App. V. pp 73-82.

F.D. McCracken

1966

Research Item - Scallop research in Subarea 5 and research on scallop larval biology. (Scallop research resumed after a hiatus in 1965).

Task - To follow changes in the fishery as a result of scallop distribution changes. To study abundance and age composition from research vessel surveys. Exploration for and study of scallop larvae to further knowledge of this important life history stage.

Scope - Scallop dragger log records of the commercial fishery were compiled as usual and data exchanged with the Woods Hole Laboratory of U.S. Fish and Wildlife Service.

One cruise to Georges Bank was made in 1966 on which detailed records of most tows were kept. In March 1966, a scalloping trip was made to Penobscot Bay, Maine to look for early post-larval stages of sea scallops (described from there in early studies by Baird). The trip was made possible with the co-operation of the Boothbay Harbour Laboratory of the USFWS.

Results - (1) Analyses of log records and landings showed that there were reduced landings from off Virginia; that catch per day rose slightly on Georges Bank and that scallop vessels fished over a smaller area there; and that more scallop vessels changed from one type of fishery to another in 1966 than in previous years.

(2) Data from the cruise to Georges Bank are still in the process of analysis.

(3) Juvenile scallops were found in abundance in Penobscot Bay epifaunal on Gemellaria loricata a colonial bryozoan itself living on the shells of adult scallops. Subsequent explorations on grounds fished by Canadians for scallops (Passamaquoddy Bay, Bay of Fundy, Georges Bank) failed to discover similar stages, and Gemellaria occurs sparsely in these regions.

(4) Examination of behaviour of these juveniles showed that they detached readily from the bryozoan and reattached to stones and other debris. Experiments in the laboratory showed that reattachment was rapid. Experiments of a preliminary nature were carried out to estimate numbers of scallops attaching by a byssus thread according to size.

Significance - Reduced effort off the Virginia coast may have been due to reduced abundance there. Settlement of scallops in that region may be more sporadic than on Georges Bank. The capture of juvenile scallops in Penobscot Bay allowed experimentation without the necessity of trying to culture them from laboratory spawning. It is still believed that a greater knowledge of the early life history of the scallop will provide a better basis for prediction and management on Georges Bank.

References - Fish. Res. Bd. Canada, Biol. Sta. St. Andrews, N.B., 1966, Annual Report and Investigators Summaries, pp CC1-CC8.

Hart, J.L. 1967. Canadian Research Report, 1966, Subareas 4 and 5. ICNAF Redbook Pt. II., pp 12-25.

Item - Landings of haddock from Subarea 5 in 1963 and 1964 were about 11,000 to 12,000 tons annually. In 1965 and 1966 they increased to about 15,000 and 19,000 tons annually.

Sampling of landings from Subarea 5 was continued. The scales obtained along with records of length composition were forwarded to the Woods Hole laboratory of the USFWS for compilation and analysis.

Sampling at sea on a Canadian stern trawler in October 1966 showed haddock discards to be negligible.

References - Hart, J.L. 1967. Canadian research report, 1966. Subareas 4 and 5. ICNAF Redbook Pt. II, pp 12-25.

McCracken, F.D. 1968. Canadian research report, 1967, Subareas 4 and 5, ICNAF Redbook Pt. II., pp 12-22.

Research Item - Offshore exploration for herring 1965 and 1966.

Task - An attempt was being made to try and encourage exploitation of offshore herring stocks by Canadians and in addition to learn more of the herring stocks being exploited offshore in recent years by the USSR.

Scope - This investigation was combined with those for lobsters, argentines and silver hake being carried out along the edge of the continental shelf from Georges Bank to Sable Island. Four cruises were carried out in July-August 1965 and three cruises in June-July 1966. Herring were measured and in 1966 sampled for year-class, sex, and season spawned.

Results - (1) Best catches in both years were made in the Corsair Canyon region of Georges Bank. Overall results were not encouraging in either year.

(2) In 1965 about 90% of the catch was taken between 30 and 80 fathoms. Average length was about 30 cm. Specimens taken east of Georges Bank along the Scotian Shelf were smaller.

(3) In 1966, the numbers caught were too few to establish a depth pattern. The 1961 year-class made-up 69% of the samples, the 1960 year-class next at 20%. Spring-spawned fish made up about 7% of the sample and and the sex ratio was 50% male/female in the 439 herring examined.

Signficance - Although the Soviet Union has been exploiting herring extensively on a seasonal basis on Georges Bank (and extending the season) Canadian fishermen have not participated. The Soviet catch is used for food, Canadian landings from Georges Bank at this stage would probably be used for reduction. If so, levels of abundance we encountered using otter trawls of a size compatible with our herring vessels would not be sufficient attraction for a Canadian fleet, at least while there are more productive areas using purse seines off western Nova Scotia and in the Bay of Fundy.

The biological data obtained by Canadians adds to the information provided by the Soviet fishery and U.S. research vessels.

References - Fish. Res. Bd. Canada, Biol. Stat. St. Andrews, N.B., 1965. Annu. Rept. and Investigators Summ. (MS) pp CB 1-17.

Fisheries Res. Bd. Canada, Biol. Stat. St. Andrews, N.B., 1966, Annu. Rept. and Investigators Summ. (MS) pp CB 1-32.

Hart, J.L. 1967. Canadian Research Report 1966, Subareas 4 and 5, ICNAF Redbook, Pt. II., pp 12-25.

1967. Report of the Subcommittee on herring and other pelagic fishes. ICNAF Redbook Part I, App. V., pp 71-75.

1966. Report of the Subcommittee on herring and other pelagic fishes. ICNAF Redbook, Part I, App. V., pp 73-79.

Research Item - Swordfish research and fishery, 1966.

Task - To continue monitoring the changed fishery (longline) and to examine the biology of this species on a continuing basis.

Scope - Log records of swordfish vessels were collected, compiled and analyzed to provide a pattern of swordfish size and distribution in the northwest Atlantic. It is of particular importance to follow changes which relate to varying methods of fishing (hook and line, harpoon). Fish were measured and weighed and the results related to area of capture. Overall distribution of the fishery was made available from these analyses and by observations from commercial vessels at sea.

Swordfish sex and maturity studies were continued in 1966 including microscopic examination of both male and female gonads.

Results - (1) Swordfish landings after a major increase in 1963 (the first full season in which longlining was used in the fishery) declined sharply in 1965 but stabilized at about the same level in 1966. Catch per unit effort and the mean size of fish caught have both declined since introduction of longlining in 1963. Overall average weight was about 136 pounds, about 5% less than in 1965. Average weights for the different regions were quite similar in 1965 and 1966, and the 5% decline may be attributed to the different areas fished.

(2) Harpoon fishing is still used extensively during the summer and mean size of fish taken by this method tends to be about 50 pounds larger than from longlines at the same time and place.

(3) In 1966 the swordfish fishery expanded the regions fished farther offshore to the warmer waters near the Gulf stream. Hooking rates in the new areas were high and similar to levels in other areas at the beginning of longlining.

(4) During 1966, results of sex and maturity studies showed a higher proportion of males (35% of 231 fish examined) than for any previous year. This result may be an artifact.

Significance - That the fishery seems to have stabilized in the areas fished with longlines since 1963 is important. Continued rapid declines in catch per effort, size caught and total landings would have led to more concern about intensity of fishing.

Expansion of the fishery into warmer waters near the Gulf stream is important since it increases the known area throughout which swordfish can be caught.

Canadian Effort - Since Canadians currently share this fishery only with the USA, and land a larger share than the US from all subareas our effort has to be greater than the poundage and value of the fishery might appear to warrant.

References - Fish. Res. Bd. Canada, Biol. Stat. St. Andrews, N.B., 1966, Annu. Rept. and Investigators Summ. (MS) pp CB 1-32.

Hart, J.L. 1967. Canadian Research Report, Subareas 4 and 5, ICNAF Redbook, Pt. II, pp 12-25.

1967. ICNAF Redbook, Pt. 1, App. 5., pp 71-77.

Item - Racial studies on mackerel were continued in 1966 by counting of fin rays from the southern and northern contingents. A co-operative effort by the US provided x-ray plates of 50 fish sampled at Provincetown, Mass. to compare with x-ray plates of fish taken off Halifax, N.S. (vertebral counts). In co-operation with the Halifax Station of the Fisheries Research Board and the USFWS heart and muscle samples of 500 fish from both the Gulf of St. Lawrence and Cape Cod Bay are being examined electrophoretically. This effort is not complete but preliminary results show no differences.

Reference - Fish. Res. Bd. Canada, Biological Sta. St. Andrews, 1966, Annu. Rept. and Investigators Summ. (MS) pp CB 1-32.

F.D. McCracken

1967

Research Item - Lobster explorations offshore Subarea 5.

Task - To seek promising lobster trapping grounds on Georges Bank.

Scope - The lobster trap survey programmed for Georges Bank was seriously hampered by hurricanes. A 93 foot vessel was chartered and 11 stations on Georges Bank were occupied in late August early September. About 60 traps were set and hauled at each station, and on Georges Bank 620 trap hauls were made. Stations were chosen on the basis of USFWS published results about bottom fauna on Georges Bank. Fishing was carried out on the northeast section of Georges Bank in depths of 15 to 50 fathoms. Twenty half hour surface tows with a neuston net were made on Georges Bank.

Results - (1) The catch was poor. On Georges Bank only 23 lobsters were caught, averaging 2 pounds. Some of these lobsters were tagged and released but up to December 1967 no tags had been returned.

(2) All the lobsters caught were taken at 5 of the stations, on gravel or sandy gravel bottom (would be considered a typical lobster bottom inshore).

(3) No larvae were caught.

Significance - Our lobster surveys offshore have not been productive. Neither the otter trawl (reported elsewhere) or the trap surveys have yielded commercial quantities. Undoubledly with more knowledge of the offshore area and by concentrating efforts where lobsters seemed most plentiful, the offshore catch could be improved. Possibly a different design of trap would be more successful.

Canadian Effort - Research is of an exploratory nature. So far results have been unsatisfactory so far as suggesting the possibility for a viable fishery offshore. Possibly a pilot project would yield better results.

Reference - A.J. Wilson and D.G. Wilder, 1967. Lobster trap fishing on Georges Bank and Seal Island grounds August 14 to September 20, 1967. Fish. Res. Bd. Canada, MS Series #948, pp 1-5 + tables and figures.

Research Item - Scallop research for Georges Bank.

Task - Studies of changes in distribution and fishing effort to follow the increased activity in scallop fishing.

Scope - Scallop catch statistics continued to be collected from offshore fleet log records and catches assigned to 10-minute squares. Data exchange with the U.S. Bureau of Commercial Fisheries continued.

During 1967 Canadian effort was analyzed by unit areas for the years 1957, 1960, 1963, and 1966, covering the main period of growth of the fishery. (Unit areas are defined by a grid of horizontal and vertical lines at 10-minute intervals of latitude and longitude. This divides Georges Bank into 175 units, 80 square miles in area, with some part of each area lying within the 50-fathom contour.) Bearings obtained from scallop vessel log records are transposed into this system to give a record of production for each area on an annual basis.

Results - (1) A progressive expansion of area of operation from 1960 to 1963, coincides with the period of decreasing scallop abundance and increasing fleet and crew size.

(2) Landings and operating area by Canadians have remained more or less constant since 1963, although covering a smaller percentage of the bank than the US fleet. The reduced effort by the the US fleet in recent years is quite evident when the number of unit areas fished by them in 1963 and 1966 are compared.

(3) Landings by the combined fleets during the last 10 years have been reported from 147 unit areas, but 40 of these have produced 80% of the total catch. Most consistently productive areas in the last 10 years have been the Great South Channel, the northern edge and the northeastern peak of Georges Bank.

Significance - For this fishery, which has expanded so rapidly, good data on distribution and abundance of scallops are a necessity. Since scallops tend to be found in "beds", without the motility of fin fish, it is most important to follow changing activities of the fleet if management of the fishery is attempted. Continued studies will be necessary to see whether the Georges Bank scallop populations may be cyclic, as has been indicated for scallops supporting the long established fishery in the Bay of Fundy.

Canadian Effort - Scallops are of such importance to sections of the Nova Scotia fleet that research effort must be continued at a relatively high level. Because of the nature and behaviour of the species research must also be innovative.

Reference - Caddy, J.F. and E.I. Lord. 1968. Recent developments in Georges Bank Scallop fishery. ICNAF Redbook, 1968 (III): 89-93.

Item - The following observations on scallops and the efficiency of drags, while carried out in Northumberland Strait, Gulf of St. Lawrence is of interest for Georges Bank as well even though depths were much shallower. This work was carried out between August 7-19.

The efficiency of an 8 foot scallop drag was estimated from population density estimates by scuba divers. Density measurements had to be made with an enclosed quadrat because of scallop swimming activity. Scallops responded to approaching objects by facing away from them and swimming. A steep rise usually preceded level swimming at a mean height of about 0.5 m. Point to point swimming distances of up to 4 meters were recorded with ground speeds in excess of 67 cm/sec. Few scallops over 100 mm could be induced to swim. Direct observation of drag function showed that swimming activity rather than selection by the drag was responsible for the low drag efficiency for capturing scallops smaller than 100 mm.

Reference - Caddy, J.F. 1968. Underwater observations on scallop (Placopecten magellanicies) behaviour and drag efficiency. J. Fish. Res. Bd. Canada, 25(10): 2123-2141.

Research Item - Examination of the results of the fishery on swordfish stocks.

Task - To assess changes in the swordfish abundance and size composition based on results of the fishery.

Scope - Swordfish were measured both ashore and at sea. Log records of effort expended by the fleet showing area of capture, method of fishing, season, etc., were compiled and analyzed.

Results - (1) Average number and total weight of fish caught per trip were substantially higher as longlining increased and the fishery was prosecuted in several new regions.

(2) Mean size of fish caught and landed decreased about 7% from 1966 to 125 pound (57 kg).

(3) The distribution of catches indicates a gradual expansion of the fishery offshore within the boundaries of the Gulf stream.

(4) Studies of food and feeding habits which have been reported on before were completed and results presented for publication.

Significance - In 1967 analyses focused on changes in size of swordfish being caught and landed. Increased intensity of fishing may be one of the reasons, in which case the problem of overfishing could be seen on the horizon. There are many other causes, however. That longlines take smaller fish has been discussed in previous years. In 1967 size of fish landed was considerably influenced by area fished. Increased fishing took place off Cape Hatteras where swordfish caught have always tended to be smaller. In 1967 there was substantial increase in landings from south of the Grand Banks where the fishery tends to be newer. Both are believed to be the major factor behind the decline in fish size in 1967.

Canadian Effort - Extensive sampling ashore and at sea has continued because Canada is the major fishery operator for this species. Research has not been related to ICNAF boundaries.

References - McCracken, F.D., 1968. Canadian Research Report, 1967, Subareas 4 and 6, ICNAF Redbook 1968, (II): 7-23.

Beckett, J.S. and S.N. Tibbo, 1968. Recent changes in the size composition of Canadian swordfish catches. ICNAF Res. Doc. 68/69, Serial No. 2056 - pp 1-7.

Item - Two samples of herring (200 fish) were obtained from the northern edge of Georges Bank in October, one from a purse seine the other from a mid-water trawl catch. Length range of the former was 29-36 cm (mean 31.6 cm) of the latter 23 to 35 cm (mean 31.4 cm). Herring from these samples were not aged.

Reference - McCracken, F.D. 1968. Canadian Research Report, 1967, Subareas 4 and 5. ICNAF Redbook, 1968, (II): 7-23.

Item - The new research vessel C.G.S. E.E. Prince (130 feet) completed her first year of operations successfully. She operated in areas from Cape Hatteras to the Gulf of St. Lawrence carrying out research on pelagic fish, groundfish, scallops and hydrography.

F.D. McCracken

1961-69

Research Event - Swordfish, shark and tuna tagging, 1961-69.

Task - To provide information on distribution and behaviour of large pelagic fishes.

Scope - Tagging of large pelagics was begun in 1961 and continued each year since. About 2440 fish of some 20 species were tagged. Specimens for tagging were caught by tuna purse-seining, pelagic longlining, fish traps and angling. Five types of tags were used although all were essentially dart type.

Offshore tagging was carried out between 36°-41°N in the western Atlantic. Inshore tagging was mainly from St. Margarets Bay, N.S. (trap caught large bluefin tuna) and from purse seine fishing off Delaware and New Jersey (smaller bluefin).

Swordfish were caught and released offshore (124 in all) caught by longline or harpoon. This species was of most interest in this tagging program but proved most difficult to obtain specimens in good condition.

Blue sharks made up the major portion of the offshore releases (1176 being tagged). Smaller numbers of other shark species were also tagged.

Tagging of large pelagics fishes proved to be difficult and various methods of handling the fish were tried. Condition of fish tagged may be reflected in number of recaptures reported.

Results - Swordfish - Five recaptures were reported after being free for two to thirty-seven months. All were recaptured near the release point, from 7 to 128 miles away.

Bluefin tuna - Thirteen recaptures were recorded from the large bluefin tagged in St. Margarets Bay. Nine recaptures were made in the year of release and 4 a year or more after tagging. Of the latter, 1 was recaptured close to the release point and 3 about 300 miles southwest off the coast of Massachusetts. Of the nine recaptures shortly after release none had moved far (maximum 120 miles).

No recaptures of bluefin were made from fish tagged offshore. Forty-two small bluefin were recovered all released off the mid Atlantic Coast between 37° and 41°N. Eighteen recaptures were made during the year of release, 17 after one winter at liberty, the remainder from 2 to 4 winters. All recaptures were in the same season of release (July-October) and all but one within 5 to 200 miles of the release point. The exception travelled at least 3000 miles, being recaptured in the Bay of Biscay in European waters.

Skipjack - Only 3 recaptures were made from fish tagged off the U.S. coast, all shortly after tagging and didn't show any pattern of movement.

Blue shark - Of 1176 tagged eleven tags were returned. Those recaptured show fairly extensive movement and possibly a regular pattern. During spring the "southern group" may be concentrated along the edge of the Gulf stream and move onshore into shallower water later in the season (off the U.S. coast). Of those tagged off the Grand Banks in summer recaptures came from shallower water and a number had moved to the shelf off Nova Scotia.

One blue shark tagged in the Gulf stream off the mid-Atlantic region moved at least 600 miles to the southern Grand Banks area in the year of release.

Mako shark - Several recaptures of mako sharks show movements towards the south and west, but numbers (2 at liberty for several months) are too few to provide any real pattern.

Significance - By themselves the data from tagging hardly presents a signficant pattern. Coupled with other data from the fishery and tagging elsewhere they help provide clues to distribution and movements of bluefin tuna, swordfish, and possibly blue shark. For example the small bluefin tuna that went transatlantic joins others that were tagged by the Woods Hole Oceanographic Institute.

That the swordfish were retaken near the point of release at least agrees with size composition of swordfish in various areas in suggesting that there may be separate stocks or possibly that swordfish are not as migratory as has been conjectured.

The three bluefin tuna recaptured off Massachusettes from releases in St. Margarets Bay, N.S. is the first direct connection between the bluefins of the two areas. It does, however, agree with similarities in morphometrics and timing of seasonal occurrence of this species in the two areas.

Canadian Effort - Canadian have put a lot of effort into the difficult task of tagging large pelagic species. Much of the tagging effort has been frustrating. How to handle large species without harming them is a major problem particularly for swordfish. Canadian effort has involved commercial trips, chartered vessels, co-operation from trap operators and voluntary tagging by sportsmen.

References - Beckett, J.S. 1970. Swordfish, shark and tuna tagging, 1961-69, Fish. Res. Bd. Canada, Tech. Rept. No. 193, 1-13 plus tables and figures.

Fisheries Res. Bd. Canada, Biol., Sta. St. Andrews, N.B., Annual Report and Investigators Summ. 1961 to 1969.

Mather, F.J. III, M.R. Bartlett and J.S. Beckett, 1967. Transatlantic migrations of young bluefin tuna. J. Fish. Res. Bd. Can. 24: 1991-1997.

Appendix 8. History of Canadian fisheries research related to resources in NAFO Subarea 5-1968 to 1980.

by

R.G. Halliday

Halliday

1968

Item: Scallops

After the work of Bourne in the early 1960's there was a hiatus in research on Georges Bank scallops. However, a detailed monitoring of the Canadian commercial fishery was maintained and Caddy and Lord (1968) described the development of the fishery through 1966, the diversion to Virginia grounds in 1965 and 1966, and the detailed year by year distribution of fishing on Georges Bank by 10' squares of lat. and long.

Item: Large Pelagics

Field research continued with an observer taking a June trip (JR-3) on a swordfish longliner which fished in 5Z and two swordfish tagging operations run in July-August which included work on Georges, one by the Harengus (H-96) and one by a chartered vessel, the Promise (PR-01). A cruise on the Harengus in July, H-105, did some further swordfish tagging but also initiated a programme of sampling large pelagic fish for mercury contamination, a problem which was soon to cause closure of the Canadian swordfish fishery. Recent changes in the Canadian swordfish fishery were reported on at ICNAF (Beckett and Tibbo, 1968) but with ICCAT coming into existence about this time, ICNAF showed no further interest in large pelagics. Work on the food and feeding habits of swordfish was brought to publication (Scott and Tibbo, 1968) and new records of barnacle distribution (Beckett, 1968a) and development of tagging equipment and longline lures (Beckett, 1968 b & c) were spin-off from swordfish research. Another winter cruise was undertaken to the Caribbean aboard the Hudson.

Item: Herring abundance survey in Div. 5Y

Beginning in 1967 a substantial fishery for adult herring developed in the western portion of the Gulf of Maine concentrating on Jeffreys Ledge, Stellwagen Bank and adjacent areas. This development was pioneered by Canadian purse seine fishermen from the Bay of Fundy who continued to take significant catches from Div. 5Y until 1976. Canada conducted a research cruise by the E.E. Prince (P-37) in November 1968 to survey the abundance of herring in the area from Campobello to Cape Cod Bay using echo sounder, sonar and midwater trawl. The distribution and abundance of herring were described from sounder and sonar records but the midwater trawling was unsuccessful. The results were not published.

Item: Herring larval surveys

After the major co-operative USA-Canada research effort on herring larval surveys in conjuction with the tidal power research of 1956-59, Canada conducted occasional multi-purpose cruises to Georges Bank and the Gulf of Maine which included herring larval sampling (e.g. ATC-59 in Sept. 1962, ATC-107 in Sept.-Oct 1965, ATC-121 in August 1966). However, the aquisition of the E.E. Prince in late 1966 allowed for another major initiative to be undertaken in the

form of a three year series of seasonal surveys the intent of which was "To study the temperature and salinity distribution of the water masses, the non-tidal drift at surface and bottom, the distribution of fish eggs and larvae...". A primary intent was to gain knowledge of herring larval distribution in particular. The standard station grid covered "Entrance to Bay of Fundy, the eastern half of Gulf of Maine, eastern Georges Bank, Browns, LaHave and Roseway Bank areas". Cruises in this series were as follows:

February 1967	-	ATC-128
Apr-May 1967	-	P-04*
July-Aug 1967	-	P-10
November 1967	-	P-15
January 1968	-	KAP-05
April 1968	-	P-24
July 1968	-	P-31
November 1968	-	P-38
January 1969	-	CH-01
Apr-May 1969	-	P-44
July 1969	-	P-50
October 1969	-	P-56, CH-03
November 1969	-	P-58*
April 1970	-	P-69
August 1970	-	CH-04

*These cruises omitted coverage of 5Z due to weather.

The original objective of 4 seasonal cruises per year for 3 years was met and two additional cruises were run in 1970. The oceanographic data collected entered the data banks for use in a variety of projects. Data on the distribution of herring spawning, larval drift, and larval growth and mortality were reported on in the literature (Das, 1968, 1972; Tibbo and Lauzier, 1970a; Messieh et al., 1971).

Item: The ICNAF Georges Bank - Gulf of Maine Environmental Survey. Sponsored by the Subcommittee on Environmental Studies of STACRES (ICNAF).

This matter arose at the 1965 Annual Meeting of STACRES (see ICNAF Redbook 1968, Part 1, pp. 79-80). In relation to further work at sea arising from the results of the NORWESTLANT Surveys, Dr. Graham (USA) proposed that an environmental survey be carried out in the Georges Bank area to study the effects of the environment on the recruitment of haddock. The USSR expressed interest and a joint USA-USSR proposal was presented to the 1966 Annual Meeting. A working group with representation from USA, USSR, UK and Canada was set up to further develop the proposal, and a number of recommendations were made for preparatory work. Dr. Graham presented a revised plan to the 1967 Annual Meeting and the USA reported on plankton gear efficiency tests. Further gear development and tests were carried out by the USA and a joint USA-USSR at-sea experiment was conducted on the design, conduct and analysis of a zooplankton sampling programme in 1967 and reported on at the 1968 Annual Meeting. Large differences in estimates of zooplankton abundance between ships, areas and times occurred in the latter exercise and another joint exercise between USA, USSR and

Canada was planned for 1968. This took place on Nantucket Shoals (Div. 5Z) in September 1968, the Canadian charter vessel "Theta" participating (Posgay, J.A., MS 1969. International co-operative work on methods of sampling zooplankton in 1968. ICNAF Res. Doc. 69/35, Ser. No. 2169, 2 pp.). The USA and USSR did further work on sampling design in 1969 and the USA alone did a series of surveys to delineate haddock egg production curves in 1967 and 1968. However, the main project never got underway and the USA diverted its efforts to the MARMAP programme in the early 1970's. ICNAF Redbook reports refer to the progress in analyses of the 1967-69 data until 1972, after which there is no further mention of the project. The results of the experiment involving Canada were not published.

Item: Groundfish

A cruise of the E.E. Prince (P-30) worked in both 4X and 5Z on the general distribution, abundance and biological parameters of groundfish in the two areas. A study of the distribution of cod and haddock catches on Georges Bank (and the Scotian Shelf) by Canadian commercial trawlers in 1965 was published in 1968 (McCracken, 1968). A similar study for the year 1967 was published in 1969 (Kohler, 1969).

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Beckett, J.S. 1968c. Longline lures for swordfish. Fish. Can. 21 (5): 26-27.

Beckett, J.S. and S.N. Tibbo. 1968. Recent changes in the size composition of Canadian swordfish catches. ICNAF Res. Doc. 68/69, Ser. No. 2056. (Also published in ICNAF Redbook 1968 (III): 62-66.)

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Cruises

Herring & Hydrography

KAP-05, P-24
P-31, P-38

Herring acoustic survey

P-37

Groundfish

P-30

Large Pelagics

H-96, H-105, PR-01, (+ one observer trip)
(Hudson-Caribbean)

Squid

ATC-150

Halliday

1969

Item: Large Pelagics

Field research effort on large pelagics moved south with two cruises of the Sackville being run, one in January-February from Bermuda to the eastern part of the Caribbean Sea and the other in April-May in the Gulf Stream between 60° and 70° west and south to Bermuda. A further observer trip was run on the commercial vessel Judith R. (JR-04) when it longlined for swordfish off Cape May in November-December. The purpose of the Sackville cruises was to study the distribution of large pelagic fish (swordfish, tuna and sharks) at the egg, larval and adult stages, collect general biological data and to describe the oceanographic conditions under which these fish live. Collections were made by longline (for adults) and plankton nets (for eggs and larvae). Results of an earlier cruise to southern waters (Hudson in 1965) concerning the successful collection of larval swordfish were reported on in detail in a Technical Report (Tibbo and Lauzier, 1969) and subsequently in summary form in the primary literature (Tibbo and Lauzier, 1970b).

Item: Squid

A series of three cruises on the A.T. Cameron were run to investigate the distribution, abundance and biology of the squid, Illex illecebrosus, which at this time was supporting a significant fishery only in inshore waters around Newfoundland. The first of these (ATC-130) took place in March-April 1967 covering the continental slope between LaHave Bank (4X) and Cape Hatteras (SA6). The second (ATC-150) was in August-September 1968 and concentrated in the Mid-Atlantic Bight. The results of these cruises were published in 1969 (Mercer, 1969 a and b). The third cruise (ATC-157) was run in February 1969 and covered the continental slope from Delaware Bay (SA6) to off Fort Pierce in Florida. The results of this cruise were published in 1970 (Mercer 1970a). In this year Mercer also published two other papers which related to squids in this area and in the Northwest Atlantic in general (Mercer, 1970b and c). Substantial fisheries for Illex developed throughout Subareas 3-6 in the 1970's and substantial research was conducted by Canada in Subareas 3 and 4 which related to resource management problems and resource ecology relevant throughout the area. In May and November-December 1975, Canadians participated directly in expeditions by the French R.V. Cryos to Subarea 5 to conduct squid surveys (Mesnil et al., 1976).

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Cruises

Herring and Hydrography

CH-01, P-44
P-50, P-56, CH-03, P-58

Groundfish

-

Large Pelagics

Sackville (BIO-69-023) (+ one observer trip)
(Sackville BIO-69-003- Bermuda to Caribbean)

Squid

ATC-157

Halliday

1970

Item: Scallops

Recruitment to the Georges Bank scallop stock was poor subsequent to the good recruitment of 1959-60 which precipitated the major expansion of the Canadian fishery in 1960 to 1962. Catch rates fell by 80% over the period 1961 to 1969 and landings in the late 1960's were maintained only as a result of increasing effective fishing effort. However, late in 1969, commercial vessels reported appreciable numbers of young scallops on the Bank. As a result a scallop survey was conducted by the E.E. Prince (P-72) in June of 1970. In addition, research was conducted on gear selection and efficiency and on shell length/meat weight ratios. The survey located a bed of recruit scallops on the Northern Edge occupying approximately 80 sq. mi. and estimated the standing stock (Caddy, 1971a). The results implied that the new recruitment was not very extensive and that the concentration in the recruitment area by some Canadian vessels was detrimental to future yield prospects.

Item: Large Pelagics

The commercial vessel Promise was chartered in July to conduct more swordfish tagging mainly on Georges Bank. Meanwhile, the results of large pelagic fish tagging in 1961-69 was prepared for publication as a Technical Report (Beckett, 1970) - see separate report for results. A further southern cruise was conducted in February and March by the Sackville covering the western Sargasso and Caribbean seas and the Gulf Stream to 35°N. The purpose was again to collect larvae of swordfish and tuna and longline for adults.

Item: Adult herring investigations on Georges Bank

Investigations sponsored by the International Passamaquoddy Fisheries Board of 1956-59 established the occurrence, and large size, of the herring spawning stock on Georges Bank. Canadian cruise plans included the objective of monitoring the size and age composition of this stock from as early as 1959 (ATC-03) and continued usually in conjunction with research on large pelagic fishes in 1961 (ATC-46 and 47), 1962 (ATC-59 and 60), 1964 (ATC-90), 1965 (ATC-107), 1966 (ATC-121) and 1967 (ATC-128). With initiation of the new series of oceanographic and herring larval surveys in 1967, sampling Georges Bank adult herring was continued as a secondary cruise objective in cruises P-10, 15, 24, 31, 38, 44, 50, 56 and 69 between July 1967 and April 1970. Cruise P-58 in November 1969 had collection of adult herring from Georges Bank as a prime objective but failed to reach the area due to adverse weather, and indeed the intention to sample Georges adult herring in this cruise series from 1967 on was frequently frustrated. The early data in the late 1950's and early 1960's during the time of development of the Georges Bank fishery was of some importance in determining events in this new situation. However, later data was

too scant in relation to other data sources to be of importance. This project was terminated with the April 1970 cruise (P-69).

Item: Georges Bank herring spawning bed survey

USSR scientists had carried out quantitative surveys on the extent and intensity of herring spawning on Georges Bank since 1964 using bottom grabs and dredges to sample deposited spawn. These surveys had shown a progressive contraction in the area of the spawning grounds and in the estimates of total number of eggs laid, from which a corresponding reduction in adult stock size was being inferred. However, there were a variety of possible sources of bias in these estimates and the desirability of calibrating the surveys by direct observation was recognized. In September-October 1970 a co-operative field programme was mounted with the USSR contributing the research vessel Alferas, Canada contributing the submersible Pisces I and the USA contributing the Albatross IV. The Alferas was to locate the main spawning grounds and carry out the grab and dredge survey as in previous years, while the Pisces, using the Albatross IV as a mother ship, observed the located spawning beds in detail. Three spawning beds were detected by the Alferas and USSR scientists concluded these were the main ones. A bed marked by Alferas with a radar buoy was subsequently successfully located by the Pisces. This utilization of the Pisces was very much a developmental operation and new survey and sampling techniques had to be developed. Observations were made on sediment preferences of spawning herring, the ontogeny of a spawning bed, the associated fauna, predation on herring spawn, and herring larval behaviour (Caddy and Iles, 1973) and on sedimentology of the area (Drapeau, 1973). It was not possible, however, to mount a sufficiently extensive operation to actually calibrate the USSR surveys.

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- Cape Hatteras to Caribbean.

Cruises

Herring and Hydrography

P-69, CH-04

Scallops

P-72

Swordfish

Promise
(Sackville BI-70-004 to Gulf Stream and Caribbean.)

Halliday

1971

Item: Large Pelagics

Field work in 1971 emphasized collection of samples for study of mercury contamination although general biological data was also collected. The Harengus (H-104) collected on Georges Bank for a week in July and in October the charter vessel Dorothy & Gail (DG-3) sampled from Georges south to Cape Hatteras. It was in this year that the Canadian swordfish fishery was effectively (although indirectly) closed due to high levels of mercury in the flesh. Recent events in the Canadian longline fishery were analyzed and described for ICCAT (Beckett, 1971) and Iles (1971) published the results of research on swordfish parasites.

Item: Scallops

The results of the 1970 E.E. Prince survey were analyzed and published (Caddy, 1971a) and the preliminary results of the gear selectivity and efficiency work also reported on (Caddy, 1971b). Analysis of commercial fishery statistics showed substantial (80%) decline in catch per effective effort (Caddy and Lord, 1971) and analysis of meat sizes landed by the Canadian offshore fleet in 1970 indicated a reduction in cull size to around 70 mm from the previous 90-95 mm (Caddy and Sreedharan, 1971). This substantial analytical activity was accompanied by further field work. The E.E. Prince (P-86) conducted further gear selectivity work and resurveyed the area of high recruitment on the Northeast Edge in June 1971. In August 1971 the PC-8 submersible was chartered to make direct underwater observations on the tracks of scallop drags. It was noted that offshore dredges cause heavy mortalities and that they kill as many scallops as they capture (13-17%). This study was done in Chaleur Bay but should be applicable to Georges Bank.

Item: Herring larval and young fish surveys

At the 1970 Assessments Subcommittee of ICNAF studies of the disperal of larval and early 0-group herring from the main centres of spawning, especially on Georges Bank and in the Bay of Fundy, were identified as research priorities (ICNAF Redbook 1970, Part 1, pp 54-55). At the 1971 Assessments Subcommittee meeting arrangements were made for a coordinated larval survey of the Gulf of Maine - Georges Bank involving 4 cruises in Sept.-Nov. 1971 and vessels from France, USA, USSR and possibly FRG. It was considered necessary to have similar coverage of the Bay of Fundy area and it was hoped that Canada would provide this coverage (ICNAF Redbook 1971, Part 1, p. 51).

Note: This was the year the ICNAF Herring Working Group of the Assessments Subcommittee was established under the Chairmanship of a Canadian.

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Cruises

Large Pelagics

H-104, DG-3

Scallops

P-86

Halliday

1972

Item: Large Pelagics

The commercial vessel Francis Geraldine was chartered to conduct sampling of swordfish for further work on mercury contamination and, as a secondary objective, to survey for commercial quantities of tuna. The work was conducted offshore with the first cruise (FG-6) in May starting off Cape Charles and working east in the Gulf Stream to 55°W. The second cruise (FG-7) in June worked in Gulf Stream and adjacent waters west of 68°W. The last of the winter southern cruises was run on the Dawson in February-March 1972. The objectives were similar to previous cruises but, in addition, included fish sampling for heavy metal contamination and environmental sampling for oil pollution.

Item: Scallops

The 1970 and 1971 field and analytical work provided a basis for a detailed analysis of the impact of recent events on the stock (Caddy, 1972a). It was clear that concentration of fishing on beds of new recruits was most detrimental to future yield prospects both from lost yield-per-recruit and high incidental mortality. Recommendations for conservation actions were put forward (Caddy, 1972b). These resulted in a Canadian proposal being made, which was accepted by the ICNAF Fisheries Commission, to limit the size of scallops taken on Georges Bank (ICNAF Proceedings for 1972, No. 7). Further field work on scallop dredge selectivity was conducted in June of 1972 with the E.E. Prince (P-101), and in June of 1973 another survey was conducted again by the E.E. Prince (P-118). On this latter cruise it was intended to conduct trials with an experimental "box" dredge but the gear did not function properly. The size limit regulation met stiff opposition from Canadian fishermen and Canada had to lodge an objection against the ICNAF regulation based on its own proposal. Subsequently, the USA Government followed suit and the ICNAF regulation came into effect for all Contracting Governments, except Canada and the USA, on 29 March 1973. Although this regulation remained on the books further conservation actions were on a bilateral or unilateral basis. Canada phased in a size limit through introduction of progressively lower meat counts until a count of 40 per pound (the original ICNAF proposal) was reached.

Item: Herring larval and young fish surveys

The plans of the Assessment Subcommittee in 1971 were carried out and, indeed, 5 cruises (2 by USA) were carried out offshore in Subarea 5, and 4 cruises in 5Y by USA. Canada conducted a survey in the Bay of Fundy in October (E.E. Prince-92). The Subcommittee considered the results promising and recommended what had now come to be called the "international herring larval survey program" in the Gulf of Maine, Georges Bank and Nova Scotia areas be continued and intensified in 1972. Canada was encouraged to participate in the offshore surveys (but could not due to lack of a suitable vessel at the appropriate time).

Juvenile surveys were off to a slower start with only the USA and USSR participating.

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Cruises

Large Pelagics

FG-6, FG-7
(Dawson 72-004-Gulf Stream and Caribbean.)

Scallops

P-101

Halliday

1973

Item: Large Pelagics

Canada had dominated the northwest Atlantic swordfish fishery and large pelagic research was heavily oriented to that species. Closure of the swordfish fishery in 1971 required revision of research priorities. No field research for swordfish was mounted in either 1973 or 1974. In 1975 two vessels were chartered, the Dorothy & Gail and the Scotian Maid, to collect swordfish for further mercury contamination studies and these vessels worked in both 4X and 5Z. The opportunity was taken to also collect data on biology and abundance. Following this, it was not until the swordfish fishery was reopened in 1979 (with relaxation of mercury content regulation in Canada) that further field work was undertaken. In that year, observers were placed on two swordfish longliners which happened to fish in Subarea 4. In 1980, the commercial swordfish longliner Jane R. was chartered from August to October to conduct a swordfish survey and general biological studies from Cape Hatteras north over Georges Bank and across the Scotian Shelf. Two cruises occupied stations in 5Z. The International Billfish Symposium in Hawaii in 1972 provided impetus to analyse and report on previously collected data on swordfish biology (Beckett, 1974b; Scott and Tibbo, 1974), mercury contamination (Beckett and Freeman, 1974), the fishery (Tibbo and Sreedharan, 1972 (paper presented, abstract only published in 1974 NOAA Tech. Rept. NMFS-675)), and larval distribution (Markle, 1974). Analytical reviews of factors related to elucidation of the population dynamics of swordfish and approaches to its management (Caddy, 1976; 1977a) illustrate a continuing interest in this resource. With re-opening of the fishery and reinitiation of field research, reports on stock status and the fishery have again begun to be produced (Hurley and Iles, 1980).

Bluefin tuna had received some attention in the large pelagic fish research programme including some tagging in the 1961-69 period reported by Beckett (1970). A further field operation was mounted in 1973 with the E.E. Prince (P-102) making a trip to the coastal waters of New Jersey to tag bluefin in conjunction with the Canadian commercial tuna purse seine fleet, a total of 156 fish being tagged. Much of the bluefin tagging work was conducted in cooperation with USA scientists and some results of cooperative work on tag shedding were published (Lenarz et al., 1973). However, some were purely Canadian ventures and were published separately (Beckett, 1974a). Subsequent work on large pelagics concentrated very largely on Canadian bluefin fisheries in Canadian coastal waters but the work was relevant to a substantial extent to management of the bluefin resource as a whole which was assessed on an Atlantic-wide basis. Canada played an important role in conduct of the first stock assessments of Atlantic bluefin in ICCAT (Caddy, 1975b; Caddy et al., 1975). Canadian participation in the bluefin tuna fishery off New Jersey begun again in the early 1970's when several large tuna purse seiners began operating out of St. Andrews, N.B. to supply the new canning plant opened there. From about 1977, these vessels confined there operations to Pacific waters and the New Jersey fishery has been prosecuted in several, but not all, years since by vessels from the Bay of Fundy herring purse seine fleet. This fishery was

monitored by biological observers on many of the trips of vessels engaged in this fishery.

Item: Herring larval and young fish surveys

Conduct of the larval programme in 1972 was similar to that in 1971. Canada surveyed the Bay of Fundy and northern 5Y which was included in the standard station grid adopted for the Nov. 1972 survey (P-109). Each year since this grid has been occupied (to the extent permitted by weather) at least twice a year in spring and fall (maximum 5 times in 1974). Canada participated in data summary and interpretation of Subarea 5 cruise data (Schnack and Stobo, 1973).

The juvenile surveys were bolstered in 1973 by research vessels from FRG and Poland. Canada played a small role in analysis of the data (Dornheim, Iles and Grosslein, 1973) and Canadian personnel occasionally participated in the cruises of foreign vessels involved in the programme, but no Canadian vessels ever participated.

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Cruises

Large Pelagics

P-120

Scallops

P-118

Halliday

1974

Item: Herring tagging

ICNAF had discussed co-operative herring tagging experiments for the Georges-Gulf of Maine-Bay of Fundy stock complex from 1971 but was unable to get any programme off the ground. At the 1974 meetings Canada reported that a tagging experiment had been conducted in November and December 1973 resulting in over 11,000 juvenile herring being tagged with external tags in the area around Grand Manan Island.

Note: The ICNAF Herring Working Group last met at the May-June Annual Meeting of 1974. In 1975, the assessment work was conducted by an ad hoc working group of the Assessments Subcommittee.

Item: Fishing Effort Regulation in Subareas 5+6

At the January 1973 Special Meeting of the ICNAF Commission its Standing Committee on Regulatory Measures (STACREM) considered a USA proposal for effort regulation in Subarea 5+6. It accepted a USA offer to host a special meeting of experts to answer questions raised by STACREM regarding the USA proposal (ICNAF Proceedings No. 4, January 1973). The "Meeting of Experts on Effort Limitation" met in Woods Hole in March 1973 with Canadian participation. A second meeting was held in May-June 1973 in Copenhagen (ICNAF Proceedings No. 5, June 1973). At the third meeting of what had become the "Working Group of Experts on the Practicability of Effort Limitation" in January 1974 in Rome, Canada provided detailed descriptions of Canadian fisheries in Subarea 5+6 in terms of vessels, gear, and operational characteristics as a contribution to the work of the group (Halliday, 1974a; Carrothers, 1974; ICNAF Proceedings No. 4, January 1974). The report of the third meeting was received by STACREM at the June 1974 meeting, the Working Group was disbanded and further technical considerations referred to STACRES (ICNAF Proceedings No. 5, June 1974). However, about this time the direct effort limitation approach in Subareas 5+6 was essentially abandoned. STACRES did, however, run an "Ad Hoc Working Group on Fishing Effort Studies" at its 1975 Annual Meeting (ICNAF Redbook 1975, pp. 83-85). This group met for a final time at the 1976 Annual Meeting (ICNAF Redbook 1976, pp 133-134).

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Cruises

Nil

Halliday

1975

Item: Mackerel

The rapid expansion of the mackerel fishery in Subareas 5+6 in the early 1970's was partly responsible for increased Canadian research activities in Subarea 4 in relation to sampling of catches and tagging. Stock assessment of mackerel became a highly controversial matter and the ICNAF Assessments Subcommittee set up an ad hoc Mackerel Working Group in May 1973 to deal with it. This W.G. assessed mackerel in Subareas 5+6 but the first tag returns of Parsons and Moores (1973, 1974) were already available to indicate migration from Subarea 3 to Statistical Area 6 and hence the likelihood of a mixing problem between northern and southern stock contingents. Further tagging results in 1974 (Beckett et al., 1974) from Subarea 4 taggings confirmed substantial movement to, and exploitation of the northern spawning stock in the winter fishery in, Subareas 5+6 and a TAC for Subarea 3+4 was recommended (ICNAF Redbook 1974, P. 93). In 1975, the ICNAF Assessments Subcommittee did a combined assessment of mackerel in Subareas 3-6 and Canadian scientists presented one of three assessments used as the basis of ICNAF considerations (Lett et al., 1975). More extensive data on the migrations of Newfoundland mackerel were published in 1975 (Moores et al., 1975), and of Subarea 4 mackerel in 1976 (Stobo, 1976). Canada mounted a survey of overwintering distribution of mackerel in Subareas 4-5 from mid-November to mid-December 1976 aboard the research charter vessel Cape Argos (Kulka, 1977; Kulka and Stobo, 1981. Can. Tech. Rept. Fish. Aquat. Sci. No. 1038). It was found that some proportion of the age 0 and age 1 population could well be overwintering on the Scotian Shelf but no conclusive evidence was obtained which challenges the hypothesis that the bulk of the northern contingent overwinters in Subareas 5+6 and contributed significantly to the international fishery there. With extensions of jurisdiction, third party fishing for mackerel was terminated. Canadian and USA scientists assessed the stocks independently although both continued to treat Subareas 3-6 mackerel as a unit (Lett and Marshall, 1978; Winters, 1978; Maguire, 1979, 1980).

Item: Herring larval surveys

As a result of a USA proposal at the 1974 Annual Meeting of STACRES for a significantly expanded ICNAF programme of coordinated environmental research, an "Environmental Working Group" of the Environmental Subcommittee was established "to suggest a proposal aimed at determining the factors involved in the production of good and poor year-classes in some of the main fisheries in the ICNAF Area". After two meetings in 1974-75 this Group (chaired by a Canadian - E.J. Sandeman) selected herring in the Georges Bank-Gulf of Maine area as one set of stocks for detailed investigation. This required the monitoring of larval production which had been ongoing under the "international herring larval survey programme" to be continued "at least for the next two years" and that new projects on oceanographic processes and larval patch dynamics be built around these (ICNAF Redbook 1975, p. 19).

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Cruises

Large Pelagics

Dorothy & Gail, Scotian Maid

Halliday

1976

Item: Herring tagging

At it's April 1976 mid-term meeting, the Assessments Subcommittee addressed the possibility of undertaking a major international herring tagging programme to address the problem of herring stock intermixture. The report points out that "Herring tagging has been demonstrated to be technically feasible by Canadian biologists" (Stobo, Scott and Hunt, 1975; Stobo, 1976a) and that results of Canadian work in the Bay of Fundy area had demonstrated inter-relationships between herring from southwest Nova Scotia and the Gulf of Maine and Georges Bank. The Subcommittee strongly recommended a major international tagging programme be initiated. STACRES set up an ad hoc working group which proposed a three year programme and planned in detail the field operations for 1976 and 1977. These plans called for application of close to 500,000 tags in herring from Div. 4R south to 6A but mainly in the Div. 4X - Subarea 5 region by Canada, USA and USSR. A Canadian was appointed project coordinator (ICNAF Redbook 1976, pp. 153-155).

A progress report was made to the December 1976 Special Meeting which indicated that 29,000 herring were tagged on Georges Bank in October through the cooperation of Canadian, USA and USSR scientists and utilizing the USSR purse seiner Ubileiniy and the USSR R.V. Belogorsk as a support vessel. Tagging had also been carried out on Jeffey's Ledge and in the inshore areas of the Gulf of Maine and Bay of Fundy more or less as planned. Plans were in hand for the 1977 taggings and completion of the original plan was encouraged.

Note: With USA and Canadian extension of jurisdiction imminent, STACRES expressed concern for the future of its cooperative herring larval and juvenile survey, and herring tagging, programmes.

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Cruises

Mackerel

Cape Argos

Halliday

1977

Item: Scallops

No field work was conducted on Georges Bank scallops in 1974 to 1976 although some theoretical development work on population dynamics modelling was motivated by the particular problems of dealing with the Georges Bank stock and the results were applied to this fishery (Caddy, 1975a). Canadian domestic regulations imposed a meat count of 60/lb in June 1973 and progressively reduced this to the target of 40/lb by May 1976. Fleet size had also been frozen and, in March 1977, limits were introduced on maximum catch per trip and maximum allowable catch per 4-month period. It would appear that the management actions precipitated by the good recruitment observed in the 1971-72 period paid off as, despite restrictions on Canadian fishing effort, landings increased from a low of about 5,000 mt (meats) in 1972 and 1973 to about 11,000 mt in 1976. However, with indications of possible reversal of the long-term trend of decreasing USA fishing effort and first estimates of the 1977 landings suggesting an all-time high of over 16,000 mt, the state of the stock was again analysed (Caddy and Jamieson, 1977). Field work had been reinitiated in July 1977 with the E.E. Prince (P-185) conducting a survey and tagging experiments and the survey results were used in the assessment. However, with extensions of fisheries jurisdictions in 1977 precipitating the Georges Bank boundary dispute, scallop management became a central and intractable issue. Canada maintained regulatory control of her fishery but the USA fishery remained unregulated and her fishing effort increased greatly. Landings in 1977 were actually about 18,000 mt, rather than 16,000 mt, and 1978 landings were about the same. However, total landings decreased in both 1979 and 1980, Canadian landings decreasing after 1977. USA landings were kept increasing through 1979 by continually increasing fishing effort but dropped in 1980 despite this. Most recently, the Canadian fleet has reverted to fishing small recruit scallops creating a situation similar to that of the early 1970's and the fishery is in crisis. Canada has continued field research, conducting another population survey in 1978, tagging scallops and examining survey methodology (P-199, P-201). The survey was repeated in 1979 (P-220) and in 1980 (P-237). Further tagging was performed on P-220 in 1979 and in 1980 a special cruise (P-241) was run to test the usefulness of BRUTIV (Bottom Referencing Underwater Towed Instrumented Vehicle) for photographic surveys of scallops. Work on the methodology of population assessment was continued (Jamieson and Chandler, 1980). Thus, Canada has maintained a substantial research interest and the ability to assess the status of the stock and advise on management should rational management again become possible.

Item: Groundfish

Subsequent to the groundfish survey of 1968 (P-30) and the fishery distributional analysis of McCracken (1968) and Kohler (1969) most of the Canadian contribution to groundfish research in Subarea 5 was in the nature of critical comment and review in the ICNAF forum. However, contributions to

fishing effort regulation studies, although they related to fisheries in general concerned primarily groundfish in the Canadian context (q.v.). In addition there was publication of studies by Scott (1972) on sand launce morphological variation, by Templeman (1972) on cod and haddock year-class success, and Halliday (1974b) covered 5Z argentines in his review of their biology. Then in 1976 a joint USA-Canada stock assessment of the combined pollock resources in 4VWX+5 was produced (Clark et al., 1976). Subsequent pollock assessments have included both 4VWX and Subarea 5, that for 1977 being produced jointly by scientists of the two countries (Clark et al., 1977) but subsequent ones separately, the Canadian assessments being by Cleary (1978, 1980). Swan and Clay (1979) conducted some comparative studies on the feeding of silver hake in Subarea 5 versus 4VWX.

Canada initiated some winter cruise coverage of northern Georges in 1977 (ATC-259) in an investigation of haddock distribution in relation to the closed areas on Browns and Georges. Coverage was missed in 1978 but repeated in March 1979 (ATC-288) and in March 1980 (H-34). Canada also extended the area of sampling of haddock to follow the development of infestation by the protozoan parasite Eimeria gadi from Western Bank (4W) into haddock in 4X and Subarea 5 in a winter cruise (April) in 1978 by the E.E. Prince (P-194).

Canada has been actively addressing the stock structure question for pollock which is currently viewed as a shared resource between Canada and the USA. Tagging experiments conducted in a wide variety of locations along the coast of Nova Scotia and around the Bay of Fundy have resulted in over 30,000 juvenile fish being released in 1978-81. A previously unknown relationship between Scotian Shelf pollock and those on the Northeast Peak of Georges Bank has been demonstrated but the previous relationship between Bay of Fundy and Gulf of Maine fish (Steele, 1963) has not yet been observed.

Item: Herring Tagging

The original plan was followed in 1977 to a large extent although at-sea operations were less successful with the USA-USSR offshore efforts in Subareas 5+6 in May 1977 tagging only 23,000 fish in relation to their objective of 60,000. Canadian efforts in Div. 4W in January 1977 were also largely unsuccessful, 1,000 fish being tagged. STACRES was pleased with progress at its 1977 Annual Meeting and asked for progress reports in 1978. However, these reports were not forthcoming and the subject was not discussed further in ICNAF.

Note: The matter was raised again in the NAFO Scientific Council in relation to the analysis of the Georges Bank herring larval surveys and at the Annual Meeting of September 1980 it was recommended that USA and Canadian scientists "review the results of the ICNAF International Herring Tagging Program---". This is currently happening (January 1982).

Item: Herring Larval Surveys

Four countries participated in the 1976 Georges Bank monitoring of herring larval production, and at the 1977 meeting of the Environmental Subcommittee of ICNAF, plans were made for continued monitoring in 1977 and 1978 by FRG, GDR, Poland, USSR and USA. In addition, plans were made for a larval patch study in 1978 the purpose of which was "to gain a basic understanding of short-term physical and biological mechanisms controlling growth, mortality and dispersal of recently - hatched larvae ---". Canada committed two vessels to this study. Canada participated in a smaller scale operation run in November 1977 in preparation for the 1978 experiment, the Canadian research vessel E.E. Prince spending 10 days in the Georges Bank area (P-191).

References

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Cruises

Scallops

P-185

Herring

P-191

Groundfish

ATC-259

Halliday

1978

Item: Deep-sea red crab

Canadian interest in development of a deep-sea red crab fishery was shown by the exploratory trawl fishing for red crab conducted on the P.J. Lawrence survey in 1966 (McKenzie, 1966a). In 1969-71 further exploratory work on the Scotian Shelf was conducted by the Nova Scotia Provincial Department of Fisheries. In 1978 the Federal Department mounted an offshore trap survey for red crab between Sable Island and Georges Banks on the charter vessel Judy and Linda IV. However this exploratory work has not resulted in any commercial fishery development to date.

Item: Herring Larval Surveys

As planned, a major international multi-disciplinary, multi-ship larval herring patch experiment was conducted from mid-October to early November 1978 in the Georges Bank-Nantucket Shoals area. Three Canadian vessels participated. One was the oceanographic research ship Dawson and the work of that ship and on oceanography is described in the history of oceanographic research section of this report. The other two were the Canadian fisheries research vessels Lady Hammond, which did micro-scale larval distribution studies, and the Canso Condor which did broader-scale studies on larval distributions and on potential predators. Five other vessels were involved from USA (2 vessels), FRG, Poland and USSR.

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Winters, G.H. 1978. Estimation of natural and total mortality rates of northwest Atlantic mackerel. CAFSAC Res. Doc. 78/35.

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Cruises

Groundfish

P-194

Scallops

P-199, P-201

Herring

H-08, CC-03

Scotian Shelf Icthyoplankton Programme

H-(05, 06, 07)

Halliday

1979

Item: Herring larval surveys

At its 1979 meeting the ICNAF Environmental Subcommittee decided that, with 10 years data, this project should move into a more analytical phase and proposed that the Task Force on the Larval Herring Program be reconsituted to undertake the analysis and to consider the matter of continuing field work. The Task Force was adopted by the NAFO Scientific Council and has played a largely coordinating role in the analysis of historical data in 1980 and 1981.

References

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Cruises

Scallops

P-220

Groundfish

ATC-288

Scotian Shelf Ichthyoplankton Programme

H-15, H-28

Halliday

1980

Item: Lobsters

The USA offshore lobster fishery begun in 1950, developed gradually in the 1950's but expanded rapidly in the 1960's. Canada conducted exploratory fishing for offshore lobsters in the mid-1960's on both Georges Bank and the Scotian Shelf (McKenzie, 1966 a and c; Wilson and Wilder, 1967) and tagged a small number of lobsters (about 200) on Georges and Browns banks. However, there are no records of returns from this tagging. In 1972-73 a further 642 lobsters were tagged on NE Georges and SE Browns banks of which 110 were recovered, all from the offshore fishery (Stasko, 1980a). One lobster moved from Browns to Georges. The higher returns likely reflect the use of better tags but also the increased intensity of fishing in the area. The Canadian offshore lobster fishery began in 1971 and the USA fishery reached peak landings in 1972. The tagging experiments reflect interest in movements and hence stock inter-relationships. Another approach to this question was through plankton sampling for larvae. The exploratory fishing cruises of 1965 with the Louise P. (McKenzie, 1966c) conducted plankton tows in July (9 tows, no larvae) and in August (47 tows, 2 larvae) on Georges Bank. The 1966 exploratory fishing by the P.J. Lawrence (McKenzie, 1966a) did a further 14 tows in July without success. A further 22 unsuccessful tows were made during an exploratory trapping survey for lobsters on Georges Bank in August-September 1967 (Wilson and Wilder, 1967), but 6 tows caught 6 larvae in July 1972 during a further trap survey on Georges in that year (Wilder and Graham, 1973). Thus, in total these early efforts were not successful, catching 8 larvae in 98 tows. However, this was generally true with a further 279 tows on the Scotian Shelf during these same exploratory operations yielding only 4 larvae. The first successful offshore sampling of lobster larvae by Canadians occurred incidentally to marine fish egg and larval sampling by the E.E. Prince (P-170) in August 1976 when 142 larvae were taken in the Browns-LaHave banks area, mainly by surface neuston net (Stasko, 1977). Lobster larval sampling was conducted on Georges Bank during the E.E. Prince (P-185) scallop survey in July 1977 and 191 larvae were taken. A further cruise to the northeast of Georges Bank in 1978 also sampled for lobster larvae (Stasko, 1980b). A comprehensive review of these data and data on lobsters in general was conducted by USA and Canadian scientists at a workshop held in St. Andrews, N.B., in October, 1978 (Anthony and Caddy, 1980) and Stasko (1978) reviewed the inshore-offshore stock question. Subsequently, available Canadian data on biological sampling of lobsters from the offshore commercial fishery and the trends in that fishery were analyzed and reported (Stasko, and Pye, 1980 a and b).

Item: Scotian Shelf Ichthyoplankton Programme

This Canadian programme was initiated in 1976 and was developed in the 1976-78 period as a broad scale survey conducted several times a year to delineate the spatial and temporal distribution of fish eggs and larvae. This standardized survey has been conducted from 1978 to the present. The

standardized station grid adopted for 1978 and subsequent surveys included the eastern part of the Gulf of Maine (eastern Div. 5Y) and a large proportion of Georges Bank (at least half of Subdiv. 5Ze). However, the logistics of occupying the original 245 station grid proved impractical and in 1979 it was reduced to 150 stations of which about 5 were located on the northeastern part of Georges Bank. About 15 stations of the 1978 station grid were occupied once in 1978, and the revised grid of 5-7 stations were occupied twice in 1979 and thrice in 1980.

References

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- includes Subarea 5 data.

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Stasko, A.B. 1980(b). Lobster larval surveys in Canada. In: Anthony, V.C. and J.F. Caddy (ed.). Proceedings of the Canada-US workshop on status of assessment science for N.W. Atlantic lobster (Homarus americanus) stocks. St. Andrews, N.B., Oct. 24-26, 1978. Can. Tech. Rept. Fish. Aquat. Sci., No. 932: 157-165.

Stasko, A.B. and R.W. Pye. 1980(a). Geographical size frequency differences in offshore lobsters. CAFSAC Res. Doc. 80/57.

- includes SA5-6.

Stasko, A.B. and R.W. Pye. 1980(b). Canadian offshore lobster fishery trends. CAFSAC Res. Doc. 80/56.

- includes SA5.

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Cruises

Scotian Shelf Ichthyoplankton Programme

H-32, H-35, H-36

Groundfish

H-34

Scallops

P-237, P-241

Swordfish

JR-01, JR-04

Appendix 9. Update for 1981.

A History of Canadian Fisheries Research

in the Georges Bank Area of the Northwestern Atlantic -

UPDATE FOR 1981

The record of Canadian observer trips on domestic vessels fishing in Subarea 5 in 1981 is contained in Table 1. There have been no research vessel trips to the south of Subarea 5 since 1980. The following cruises have conducted work in Subarea 5:

19 Jan-20 Feb 1981	Lady Hammond (H-47)	Scotian Shelf Ichthyoplankton Programme	4VWX, 5Z (9 stns. in 5Z)
2-12 Jun 1981	E.E. Prince (P-)	Lobster survey	4X, 5Z
27-31 Jul 1981	E.E. Prince (P-257)	Scallop survey	5Z
12-20 Aug 1981	E.E. Prince (P-259)	Scallop survey	5Z

In addition, Lady Hammond (H-61) and E.E. Prince (P-250) cruises surveyed for larval herring in the Bay of Fundy, continuing historical coverage including coverage of the northern corner of Div. 5Y.

The following papers of relevance to Subarea 5 matters have been produced in 1981:

Dawe, E.G., P.C. Beck, H.J. Drew and G.H. Winters. 1981. Long-distance migration of a short-finned squid (Illex illecebrosus). NAFO SCR Doc. 81/VI/24, Ser. No. N303.

Dawe, E.G. and H.J. Drew. 1981. Historical records of mature female short-finned squid (Illex illecebrosus) from the northwest Atlantic and the first record of a mature female captured inshore at Newfoundland. NAFO SCR Doc. 81/VI/26, Ser. No. N305.

- includes records from Subarea 6.

Hurley, P.C.F. and T.D. Iles. 1981. Status and assessment of northwest Atlantic swordfish stocks. CAFSAC Res. Doc. 81/15.

Jamieson, G.S., M.J. Lundy, G.L. Kerr and N.B. Witherspoon. 1981. Fishery characteristics and stock status of Georges Bank scallops. CAFSAC Res. Doc. 81/70.

Kulka, D.W. and W.T. Stobo. 1981. Winter distribution and feeding of mackerel on the Scotian Shelf and outer Georges Bank with reference to the winter distribution of other finfish species. Can. Tech. Rept. Fish. Aquat. Sci., No. 1038, 38 pp.

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TABLE 1. RECORD OF CANADIAN OBSERVERS ABOARD DOMESTIC COMMERCIAL FISHING VESSELS FOR THE PURPOSE OF COLLECTING BIOLOGICAL DATA - NAFO SUBAREAS 5 and 6

Dates	Vessel	Area	Fishing For:	Gear	Scientific data
22 Feb-3 Mar 1981	Cape Howe	4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
14-24 Feb 1981	Cape Pictou	4W, 4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
25 Feb-7 Mar 1981	Cape Bauld	5Z, 4X	Groundfish	Bottom trawl	Biological samples of catch
17-25 Nov 1981	Cape Hunter	4X, 5Z, 4W	Groundfish	Bottom trawl	
10-17 Feb 1981	Cape Blomidon	5Z, 4W	Groundfish	Bottom trawl	
26 Feb-9 Mar 1981	Cape Wrath II	5Z, 4X, 4W	Groundfish	Bottom trawl	Biological samples of catch
9-18 Nov 1981	Cape Fame	4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
16-24 Nov 1981	Cape Lance	4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
3-11 Dec 1981	Cape LaHave	4W, 4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
14-22 Feb 1981	Gulf Georgetown	4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
20-29 Aug 1981	Cape Brier	4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch

Dates	Vessel	Area	Fishing For:	Gear	Scientific data
5-14 Nov 1981	A.W. Henriksen	4W, 4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
5-15 Jun 1981	Cape Fortune	4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
23 Feb-4 Mar 1981	Cape Hunter	4W, 4X, 5Z	Groundfish	Bottom trawl	Biological samples of catch
3-11 Sept 1981	Cape Hunter	5Z, 4X	Groundfish	Bottom trawl	Biological samples of catch
6-16 Nov 1981	Cape Beaver	5Z, 4X	Groundfish	Bottom trawl	Biological samples of catch