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United States Research Report for 1987

by

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A. Status of the Fisheries (Subarea 3-6 inclusive)

Brief summaries are provided on the status of fisheries for major species of finfish and shellfish. More detailed information on these and other species is included in a report entitled **"Status of the Fishery Resources off the Northeastern United States"** prepared annually by the Northeast Fisheries Center of the National Marine Fisheries Service (NMFS).

1. Atlantic Cod

USA commercial landings from Subarea 3-6 declined 4% from 27,789 mt in 1986 to 26,808 mt in 1987. Compared to 1986, landings in Subarea 3 decreased 50% (218 mt vs 433 mt), landings in Subarea 4 decreased 68% (29 mt vs 91 mt), landings in Subarea 5 declined 2% (26,399 mt vs 27,055 mt), and Subarea 6 landings declined 23% (162 mt vs 210 mt).

Landings in 1987 from the Georges Bank fishery (Div. 5Z + SA 6) totaled 19,035 mt, 8% higher than in 1986 (17,575 mt), but still the second lowest annual catch since 1977. Fishing effort in 1987 increased 24% from 1986 and was near the record-high levels attained in 1984 and 1985. Commercial CPUE in 1987 was the lowest in the 1964-1987 time series. USA research vessel indices indicate that stock abundance continues to remain depressed: the autumn 1987 Georges Bank survey number-per-tow index was the lowest since 1983; the autumn index of spawning stock size (age 3+) was the second lowest ever. Fishery age composition data indicate that landings in 1987 were dominated by the strong 1985 year class. This year class is expected to again be dominant in the 1988 fishery.

Gulf of Maine (Div. 5Y) landings in 1987 were 7,527 mt, 22% less than in 1986 (9,690 mt), and the lowest annual catch since 1971. Otter trawl effort, which accounted for 58% of the 1987 landings, attained record-high levels while USA commercial CPUE declined to an all-time low. Research vessel indices from both spring and autumn 1987 surveys were among the lowest recorded. The 1987 autumn survey index of spawning stock size (age 3+) was the second lowest in the survey time series.

2. Haddock

USA landings from Subareas 4-5 declined to 3,002 mt, a 39% decrease from 1986. Landings from Georges Bank declined from 3,324 mt in 1986 to 2,154 mt in 1987, a drop of 35%. Poor recruitment since 1979 and high fishing mortality have kept this stock at low levels of abundance. Landings from the Gulf of Maine dropped from 1,590 mt in 1986 to 829 mt in 1987, a 48% decline. This stock has continued to decline since 1979.

3. Redfish

Subarea 3

No landings of redfish were taken by USA vessels from the "Tail of the Bank" (Divisions 3N and 3O) in 1987. In 1986, only 6 mt were landed from Subarea 3.

Subarea 4

USA landings of redfish from Division 4X declined from 62 mt in 1986 to 47 mt in 1987.

Subarea 5

USA landings of redfish from Subarea 5 declined from 2,913 mt in 1986 to 1,860 mt in 1987, marking the eighth consecutive year of decline. Landings in 1987 were the lowest since 1934. Redfish are now taken primarily as by-catch in the Gulf of Maine mixed-species otter trawl fishery. Stock biomass has declined by over 80% since the late 1960's and commercial and research vessel survey indices continue to exhibit downward trends. The 1978 year class is the only significant year class in the fishery. All subsequent year classes have been poor.

4. Pollock

Subarea 4

USA landings in from Subarea 4 declined from 233 mt in 1986 to 102 mt in 1987.

Subarea 5

USA landings from Subarea 5 in 1987 were 20,150 mt, 17% lower than the record-high 1986 landings (24,316 mt). Commercial CPUE has declined since 1985. Commercial fishery age composition data for 1987 indicate that the strong 1982 year class dominated the landings. The 1982 cohort is now fully recruited to the fishery and since subsequent recruitment has been average or below, exploitable stock biomass is expected to decline beginning in 1988.

5. Yellowtail Flounder

Subarea 3

USA 1987 landings from Divisions 3N and 3O were 1,533 mt, a 40% decline from 1986 (2,562 mt).

Subarea 5

USA landings declined from 7,510 mt in 1986 to 5,674 mt in 1987 (-24%). Both commercial CPUE indices and research vessel survey abundance indices in 1987 declined to record-low levels. The fishery remains heavily dependent upon incoming year classes. Recent recruitment in all Subarea 5 yellowtail stocks has been poor.

Subarea 6

Landings in 1987 were 171 mt, 44% lower than in 1986 (306 mt).

6. Other Flounders

USA landings of flounders (other than yellowtail flounder) from Subareas 3 - 6 in 1987 totaled 29,148 mt, 14% less than in 1986. Compared to 1986, landings from Subarea 3 declined by 26% (1,599 mt vs 2,170 mt); landings from Subarea 4 declined by 64% (54 mt vs 152 mt); landings from Subarea 5 declined by 13% (20,640 mt vs 23,744 mt); and landings from Subarea 6 declined by 13% (6,855 mt vs 7,878 mt).

Summer flounder (33% of total), winter flounder (28%), American plaice (17%), witch flounder (13%), and windowpane flounder (8%) accounted for 99% of the "other flounder" landings. Summer flounder landings decreased 14% from 1986 to 1987, winter flounder increased 3%, American plaice declined 17%, witch flounder fell 26%, and windowpane flounder landings declined by 29%. Survey abundance indices for most of the "other flounder" stocks exhibited declines in 1987.

7. Silver Hake

USA commercial landings from Subarea 5 in 1987 were 11,747 mt, a 16% decrease from 1986, and well below levels reported in the 1970's. While recruitment in 1983 and 1984 was only average in comparison to other years, the 1985 year-class appears to be quite strong. Landings from the Gulf of Maine dropped to 4,360 mt from 7,178 mt in 1986, a 39% decline. Landings from Georges Bank increased to 2,432 mt from 1,568 mt in 1986.

In Subarea 6, USA landings were 3,817 mt, a 1% decrease from 1986, but much less than the 1970-1982 average. While recruitment in the last several years has been of only average strength, decreased fishing effort from distant water fleets has helped to steadily increase stock biomass from the very low levels of the mid-1970's.

8. Red Hake

USA 1987 commercial landings from Subarea 5 were 1,563 mt, a 13% decrease from 1986. Recruitment in the past several years has been of only average strength, but decreased fishing effort has resulted in an increase in stock biomass from the low levels observed in the mid-1970's. Landings from the Gulf of Maine dropped to 759 mt from 1,390 mt in 1986. Landings from Georges Bank tripled to 239 mt from 78 mt in 1986. Landings from Subarea 6 increased to 393 mt from 302 mt in 1986.

9. Atlantic herring

USA landings from Subarea 5 were 39,107 mt. Landings in the coastal Maine fixed gear fisheries (stop seines and weirs) were 1,501 mt, a 26% decrease from 1986. Purse seine landings by Maine vessels in 1987 were 19,175 mt, an 8% increase relative to 1986. Landings in the fixed gear fisheries remain at historically low levels. The fixed gear fishery is highly dependent on recruitment; no strong year classes have recruited to the fishery since 1979. Landings from Division 5Z were 193 mt in 1987, primarily from Subdivision 5Zw. There has been no directed herring fishery in Subdivision 5Ze since the collapse of the fishery in 1977. There is recent evidence of recovery of the Georges Bank population based on research vessel survey results. Herring landings in Subarea 6 in 1987 were 267 mt.

10. Atlantic mackerel

USA commercial landings from Subareas 5 and 6 increased about 20% from 10,264 mt in 1986 to 12,310 mt in 1987. Landings in 1987 were the highest since 1962. Total stock biomass (Subareas 2-6) was estimated to be about 1.6 million mt at the beginning of 1988. The 1981 and 1982 year classes were both strong and are still supporting the fishery. The 1984, 1985 and 1986 year classes also appear to be at least reasonably strong.

11. Butterfish

USA landings declined slightly from 4,582 mt in 1986 to 4,508 mt in 1987. About 70% of the 1986 total was from Subarea 5. The decline is attributed to decreased availability of marketable size butterfish on the traditional southern New England fishing

grounds. Recruitment (Age 0 fish) to the butterfish stock declined sharply in 1987, and the autumn survey catch-per-tow index was the lowest observed since 1977.

12. Squid

USA landings of long-finned squid (Loligo pealei) from Subareas 5 and 6 decreased from 13,292 mt in 1986 to 11,337 mt in 1987. Joint venture catches accounted for 994 mt of the USA total. Of the 10,343 mt landed shoreside, 4,762 mt were from Subarea 5 and 5,581 mt from Subarea 6. Catch-per-tow indices from the NEFC 1987 autumn research vessel trawl survey indicate that abundance in 1987 was the lowest in the 1968-87 time series. However, because a large mass of cold water during November 1987 may have affected squid availability to the survey trawl, the 1987 survey index may not reflect the actual abundance of Loligo.

USA landings of short-finned squid (Illex illecebrosus) from Subareas 5 and 6 increased dramatically from 5,176 mt in 1986 to 10,102 mt in 1987. Joint ventures accounted for 3,140 mt of that total. All but 53 mt of the 1987 catch was taken from Subarea 6. Catch-per-tow indices from the 1987 autumn survey were about 10 times the 1986 level and the third highest in the time series.

13. Sea Scallops

USA commercial landings from Subareas 5-6 in 1987 were 13,197 mt (meats), 61% greater than in 1986 (8,209 mt). The 1987 catch was the highest since 1979 and the third highest annual catch ever. Georges Bank (Div. 5Z) landings [4,953 mt] increased 10% from 1985, and Gulf of Maine (Div. 5Y) landings [382 mt] increased by 21%. Mid-Atlantic (Subarea 6) landings in 1987 totaled 7,862 mt, more than double the 1986 catch [3,373 mt].

USA commercial CPUE indices sharply increased in 1987 in all fishery regions: CPUE in the Georges Bank fishery was the highest since 1982; CPUE in the Mid-Atlantic fishery was the highest since 1979; and CPUE in the Gulf of Maine fishery was the highest since 1982. Total USA scallop effort (days fished) in 1987 was a record-high, due to an 81% increase in effort from 1986 in the Mid-Atlantic fishery. In both the Georges Bank and Gulf of Maine fisheries, effort declined in 1987 (-10% on Georges Bank; -30% in the Gulf of Maine).

Catch-per-tow values from the USA 1987 sea scallop research vessel survey indicate that the marked improvement in sea scallop abundance that was initially noted in 1985 has continued. Resource recovery from the record-low 1983/1984 conditions has rapidly occurred due to successive outstanding recruitment from the 1982, 1983 and 1984 year classes on both Georges Bank and in the Mid-Atlantic. Survey abundance indices in 1987 in both regions were among the highest ever recorded.

8. Special Research Studies (Subareas 4-6)

1. Environmental Studies

a) Hydrography. Prepared and distributed a series of four geographical area charts of sea surface temperature for the waters of the continental shelf from the Gulf of Maine to Cape Charles, VA, derived from satellite infrared data. The charts were prepared and distributed in near realtime (within about 24 hours of a satellite pass) and were produced approximately weekly during the April through October period. The charts were prepared for use by fishery scientists, but were also of considerable interest to fishermen.

Compiled reports summarizing environmental conditions in the Northwest Atlantic on the position and variability of the shelf/slope front, movements and paths of Gulf Stream warm core rings, and water column temperature structure across the New York Bight.

Prepared report on water masses receiving wastes from ocean dumping at the 106-Mile Dumpsite off the New York Bight during October, 1986 through September, 1987, based on satellite infrared data and dumping records.

Compiled data and prepared specialized assessments of water temperatures off portions of the coast of the northeastern United States during 1987, and in comparison to prior years, for consideration of possible causes of unusual events in fish and marine mammal populations. One of the products generated was a film-loop of color coded, satellite infrared data covering the five months of May-September and consisting of more than 100 satellite scenes.

Physical oceanographic measurements were made on four surveys of the continental shelf from Cape Hatteras to western Nova Scotia in January/February, May/June, August/September, and November/December.

Two hydrographic surveys were made of the inner New York Bight in May and August as part of a study to document the effects of the cessation of sewage sludge dumping at the 12-mile dumpsite. In May, current meters were deployed near the bottom at seven locations in and around the upper Hudson Shelf Valley, and maintained at six of the locations in 1988.

A manuscript in preparation describes the entrainment of water from the continental shelf by warm core rings using a combination of hydrographic data, current measurements and remotely-sensed surface temperature patterns.

b) Phytoplankton. Monitoring of phytoplankton in Northwest Atlantic shelf water has been improved by the development and deployment of an automated, portable system for measuring surface water chlorophyll continuously at sea. This has been successfully used during three MARMAP (marine monitoring, assessment, and prediction) surveys. The sub-micro-computer based system records in vivo fluorescence of the surface seawater along with location (from LORAN) at one minute intervals to give a resolution of about 300 meters which is about twice that of remote sensing methods.

Retrospective analysis of variance in primary productivity over the northwest Atlantic continental shelf has been studied to determine which variables affecting primary production are amenable to satellite remote sensing. Using MARMAP data obtained from 1977 to 1982, a well-defined seasonal pattern in the ratio of integral productivity to surface layer chlorophyll was found. Surface chlorophyll was highly correlated with mean euphotic chlorophyll concentration (r^2=0.93) and moderately correlated with mean euphotic productivity (r_2=0.62). Published report available.

Major plankton blooms occurred during summer 1987. The chrysophyte Aureococcus anorexefferens, responsible for 'brown tides' in eastern Long Island Sound, reached 1,000,000 cells/ml in mid-July and was likely destructive to scallop spat. A massive bloom of a dinoflagellate, Prorocentrum triestinum, was related to an hypoxic/anoxic event in late July in western Long Island Sound and a kill of marine fauna including fish, crustaceans, and invertebrates. A bloom of Exuviella marina caused localized kills of several thousand blue crab, chiefly in Barnegat Inlet, New Jersey.

In studies of water quality and clams at three sites in Long Island Sound (Greenwich, Milford and Stonington) the presence of Prorocentrum in Greenwich and Milford water samples was associated with reduced clam growth. The persistent bloom of the dinoflagellate Prorocentrum dominated the western Long Island Sound phytoplankton for about 6 weeks in July and August of 1987, and continued to constitute a significant part of the algal assemblage through November at the Greenwich site.

c) Zooplankton. NMFS has completed 26 years of continuous plankton recorder monitoring in the Gulf of Maine for temperature, salinity, and zooplankton. Spring 1986 data show a record high concentration of the dominant copepod Calanus finmarchicus.

Georges Bank zooplankton data for a five-year period (1977-1981) were analyzed using harmonic regression. The resulting model takes seasonal cycles of abundance into account, and provides an improved basis for interannual comparisons. The model was used to compare the 1982 and 1983 plankton abundance to the previous five-year period and showed a marked decrease in total plankton abundance in 1982 and 1983.

d) Ichthyoplankton. Four standard MARMAP cruises (nearly 700 stations) were made in 1987 from Cape Hatteras to the Gulf of Maine, and bongo nets were towed piggyback on groundfish and scallop surveys. Large bongos (.333 mm and .505 mm mesh) and neuston (.505 mm mesh) nets were used at all standard stations; small bongos (.165 and .253 mm) were used at alternate stations along six cross-shelf transects.

Also 380 bongo samples were collected by Polish vessels in Subareas 5 and 6, and 130 samples by a Canadian vessel in the Gulf of St. Lawrence, (Subarea 4T) in a coordinated study of 1987 egg production by the NW Atlantic mackerel stock (see section 2.e) for preliminary results).

e) Benthic Studies. Studies of factors limiting shellfish production included: experiments on effects of metals and sulfide in sediment trays on settlement of larval bivalves and other benthic invertebrates; interviews with lobstermen to assess any changes in catches and pot conditions that might be related to phaseout of sewage sludge disposal; extent of predation on juvenile hard clams, Mercenaria mercenaria, in New Jersey and Long Island bays, and potential means of reducing predation (e.g., spreading Spisula shells); describing seasonal distribution of crabs on the Northeast U.S. continental shelf; and a review of the history of fishing and shellfishing in Raritan Bay (New York/New Jersey).

Manuscripts were completed on: (1) joint efforts with oystermen and the New Jersey Department of Environmental Protection to rehabilitate the Delaware Bay oyster industry; (2) ways of enhancing public shellfish beds; (3) densities, growth and mortalities of juvenile surf clams (Spisula solidissima); (4) benthic faunal production on Georges Bank; (5) benthic carbon budgets for the Continental shelf south of New England.

f) Environmental Quality. Intensive studies of the 12-mile sewage sludge dumpsite off New York continued through 1987 with monthly biological, physical and chemical measurements. Dumping has gradually been phased out and all dumping ceased after December 1987. A preliminary report was completed on activities and findings of the first year (July 1986 through 1987) of sampling, and the site will continue to be monitored to study its recovery. While the dumpsite was still active, there were distinct differences in benthic macrofauna along a gradient from the most sludge-affected station to the least affected station. The most affected station was the only site numerically dominated by the polychaete Capitella capitata, widely used as an indicator of organic pollution. Numbers of species per sample were inversely related to the sludge gradient. However, trawl catches of fish (chiefly little skate, winter flounder and red hake) and rock crabs were higher at two stations closer to the dumpsite than at a station more distant from the site.

A report was completed on major and trace metal concentrations in sediment samples collected at 17 sites in northeast U.S. estuaries during the second year (1985) of the National Status and Trends Benthic Surveillance Project. At sites for which there were two years of observations, no significant changes in sediment metal concentrations were apparent. Boston and Salem harbors and Lower New York Bay remain the most contaminated sites in the northeast region. Analyses were also conducted for hydrocarbons in organs of several target fish species (winter flounder, windowpane flounder and croaker) from Chesapeake Bay to Machias Bay, Maine.

A five-year field study was completed examining anthropogenic and natural factors related to chronic hypoxia in coastal New Jersey waters strongly influenced by sewage wastes from the Hudson-Raritan estuarine plume. In addition reports were completed on a diving study of impacts of acid waste disposal on the water column and benthos of a dumpsite in the NY Bight and a summary of activities and findings of the multi-disciplinary Northeast Monitoring Program (1979-84).

Comparative studies continued on the development, condition, growth and survival of winter flounder and hard clams in various coastal waters representing different degrees of pollution. Within Narragansett Bay, winter flounder juveniles collected at various locations showed differences in size, relative liver weight, biochemical composition (RNA/DNA) and disease incidence. However, with the exception of disease incidence, juvenile flounder condition indices did not correspond to any known environmental gradient in the Bay. Comparisons of recently hatched (within 3 days) winter flounder larvae obtained from eggs stripped from females collected in Long Island Sound and Narragansett Bay showed that Narragansett Bay females produced the smallest larvae with lowest survival rates; correlations were observed between larval survival and weight, protein, RNA and lipid content. Studies of natural spawning of winter flounder at six sites in Long Island Sound indicate some impairment of reproductive success in the more urbanized and industrialized areas. Bioassay studies using hard clam embryos in Long Island Sound indicate that water quality significantly influences egg meiosis, embryo mitoses and larval development and mortality. Studies continued on heavy metal effects on sea scallops and a paper was completed on a biochemical measure of scallop spawning potential.

2. Fish Biology Studies

a) Age and growth. About 35,000 age determinations were completed for 14 species of finfish and shellfish, and a technical manual describing age determination methods for NW Atlantic species was completed. In addition reports were prepared on techniques of age determination for ocean quahogs and hard-shelled clams using acetate peels of sectioned valves. A study of changes in growth and maturation of witch flounder from 1977-1986 was completed, and studies continued on early life history of winter flounder with particular reference to otolith development and growth indicated by daily growth rings.

Age determination continued on the blue shark using vertebrae from 325 sharks, 1,322 tag-recaptures, and 5,200 length frequencies. It is possible and validation for this species may be accomplished using a combination of the above methodology and inclusion of one fluorochrome marked tag-recaptured vertebrae.

Several different techniques for determining the age of krill were compared, including Fluorescent Age Pigment (FAP), length frequency analysis, and computerized image analysis.

Results from all methods suggest an eight-year life span for Antarctic krill.

b) Tagging Studies. In 1987 a total of 5,760 sharks and telosts representing 41 species were tagged. About half the releases were made by volunteer anglers and most of the remainder were made by U.S. Foreign Fishery Observers and commercial fishermen. Tag recaptures in 1987 amounted to 210 tags from 19 species and included returns from 14 countries and island territories; most of the returns were represented by sharks (blue, sandbar, mako and tiger sharks accounted for nearly 70% of the recaptures). Five swordfish were recaptured including one at liberty for 7 years, and one that traveled from the Grand Banks to the Virgin Islands.

A tagging experiment on young-of-the-year blue sharks off the Iberian Peninsula was initiated and joint shark tagging projects were established with Spanish and Portuguese scientists.

c) Striped Bass Stock Discrimination. A rapid technique was developed for ascertaining whether striped bass belong to the southern (Chesapeake/Roanoke) or northern (Hudson) stock by examining scale shape with NMFS's prototype image analyzer. The technique is 75% accurate, and is much faster and less expensive than biochemical methods.

d) Pathobiology. A sarcoma disease in the soft clam (Mya arenaria) is being monitored throughout its range in the northeast United States. Examination of archived tissue collected in the early 1950's revealed low prevalances of the disease (4% to 8%) in New England soft clam populations. Current levels of the disease have been reported as high as 90% in some areas of New England. Historical records of soft clams from Chesapeake Bay indicate that the disease has only appeared since the late 1970's. Studies in Chesapeake Bay now indicate that this disease is spreading geographically and induces mortalities that significantly affect local clam populations.

MSX Haplosporidium nelsoni a pathogenic protozoan parasite of oysters (Crassostrea virginica) is again causing significant mortalities in oyster populations along the mid-Atlantic coast of the United States. Recent studies have extended the range of this disease into all of the Atlantic coastal states. A new rapid diagnostic technique utilizing histocytology has been extensively tested on 3000 oysters collected in cooperation with the Maryland Annual Oyster Disease Survey.

In response to the deaths of several whales in December 1987, the NEFC initiated a screening of whale prey species for toxicity using a mouse bioassay. Paralytic shellfish toxin(s) were found in mackerel livers at levels ranging from <40 micrograms saxitoxin-equivalent per 100 grams liver to 446 ug/100 g with a mean of 185 ug/100 g. All mackerel livers tested were toxic; samples included fish caught as far north as Northumberland Strait in Canada, and as far south as the USA mid-Atlantic region. Mackerel livers from fish caught off Nantucket Island in April 1986 were also found to be toxic. No toxicity has been detected in mackerel muscle tissue or in any visceral organs besides the liver. Also, toxicity was not detected in herring, silver hake, or in monkfish. The screening is continuing into 1988 in order to better understand the nature and extent of the problem.

Light and electron microscope studies on vacuolated cell lesions in diseased livers of winter flounder from Boston Harbor were completed. The cytopathology observed in these lesions was due to apoptotic and necrotic cellular death of hepatocytes presumably due to the action of hepatotoxins.

Studies were conducted on the attachment and tissue affects of parasitic, caligid copepods on yellowtail flounder larvae from Georges Bank.

e) Mackerel Population Estimate. A cooperative project was undertaken in 1987 by the National Marine Fisheries Service (United States), Department of Fisheries and Oceans (Canada) and Morski Instytut Rybacki (Poland) to estimate the egg production and spawning biomass of Atlantic mackerel between Cape Hatteras and the Gulf of St. Lawrence. Six ichthyoplankton surveys were conducted in U.S. waters between April and July and two in the Gulf of St. Lawrence during June and July. Fecundity estimates for the southern and northern populations contingent were derived separately from 1987 collections of mature females from each area.

In U.S. waters spawning began in mid-April, peaked in mid-May and had virtually ceased by mid-July. In Canadian waters spawning peaked in mid-June. Total egg production in U.S. waters was 55.5×10^{12} and in the Gulf of St. Lawrence it was 484.2×10^{12}. Converting these numbers to spawner biomass produced estimates of about 110,000 and 940,000 metric tons for U.S. and Canadian waters respectively.

f) Research Vessel Surveys. In 1987 the NEFC conducted routine spring and autumn bottom trawl surveys from Cape Lookout, North Carolina to Nova Scotia during March-April and September-November, respectively, and a sea scallop dredge survey during July and August. A research fishery for mackerel was again conducted during January-May from Cape Hatteras to Georges Bank in cooperation with Poland using two factory trawlers (ADMIRAL ARCISZEWSKI and KULBIN). Three ichthyoplankton plankton cruises for mackerel eggs and larvae were carried out from May-July on R/V WIECZNO from the Sea Fisheries Institute (MIR) of Poland, and two surveys were conducted in June-July in southeastern Gulf of St. Lawrence by R/V E.E. PRINCE of the Dept. of Fisheries and Oceans, Canada.

g) U.S.-Canadian Gadid Recruitment Studies. In June 1987 the R/V ALBATROSS IV completed a MOCNESS survey of Georges Bank and found cod and haddock larvae and pelagic juveniles to be more abundant and widespread than in previous years. Both species exhibited a wide range in length representing recently hatched to post-metamorphic juveniles suggesting a longer than normal spawning season. In July, a three-vessel experiment was conducted on northeastern Georges Bank comparing observations of 0-group gadids from a Delta submersible with catches of juveniles in a bottom trawl on R/V DELAWARE II and in a pelagic trawl (IYGPT) on R/V ALFRED NEEDLER. Juvenile cod were much more abundant than haddock but both species appeared to have similar feeding behavior and diel movements near the bottom. Principal food of the 0-group gadids consisted predominatly of hyperiid amphipods. Sea ravens and sculpins were important predators on the juvenile gadids.

Reports were completed on comparative vertical distribution of 0-group cod and haddock, and growth based on daily otolith increments through their first six months of life.

h) Food Habits Studies. Gut contents of about 17,000 fish were examined at sea in 1987; about half of the fish were sampled during spring and fall groundfish surveys, with most of the remainder from three summer bottom trawl surveys on Georges Bank. Three major fish predators (spiny dogfish, cod and silver hake) comprised about 30% of the total fish examined. Preliminary appraisal of prey frequency of occurrence indicates that sand lance still dominates the fish component of the diet of these and other major predators.

3. Fishing Power and Gear Selectivity

a) Trawl Door Comparisons. A study to determine the fishing power of the R/V DELAWARE II relative to that of the R/V ALBATROSS IV is continuing. As part of this study, paired tows were made during September 28-October 23 during the autumn bottom trawl survey. The effects of different trawl doors on the performance and catch rates of NEFC standardized survey bottom trawls continued with experiments on R/V DELAWARE II during February 19-27, and on ALBATROSS IV during May 3-5 and November 1-6.

b) Scallop gear. A study of the selectivity of a rigid cage scallop dredge is continuing. Square mesh panels and panels with rings have been placed in one-half of the dredge while the other dredge half is lined with 34 mm square-wire mesh. Another study of scallop gear is investigating the pressure field around a depressor plate to determine if scallops can be hydrodynamically lifted off the bottom. It is hoped this lift can be used to make the gear more selective. The measurements are being done in a tow tank.

4. Miscellaneous Studies.

a) Fisheries Economics. A report was published entitled "Economic Primer on the Appropriate Methods and Measures for Comparative Evaluation of the Value of Recreational and Commercial Fisheries." In addition, work is progressing on a spatial allocation model of effort, landings, processing and consumption related to the New England fisheries.

b) Georges Bank Book Published. A treatise on Georges Bank was published in 1987, representing a comprehensive synthesis of knowledge about the geology, oceanography, and biology of the Bank, as well as economic and political issues involved in utilization of its resources. Of the 57 technical chapters, more than half deal with the biology of Georges Bank including the fisheries; a majority of these were authored by NEFC staff or scientists supported by NEFC or Sea Grant.

c) Evaluation of MARMAP and Trawl Surveys. Technical reports were completed on in-depth analyses of both the MARMAP plankton and bottom trawl survey series by NEFC. Major information products are described including levels of statistical precision, sources of error and variability, and evaluations of sampling designs.