Northwest Atlantic Fisheries Organization

Serial No. N2509 NAFO SCS Doc. 95/8

SCIENTIFIC COUNCIL MEETING - JUNE 1995

Canadian Research Report for 1994

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SECTION I - Newfoundland Region

by

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SUBAREAS 0 AND 1

A. Status of the Fisheries

Nominal landings from 1990 to 1994 for fish stocks are listed in Table 1.

B. Special Research Studies

1. Biological Studies

a) *Atlantic salmon.* No sampling program was conducted in 1994 due to the buyout of the Greenlandic fishery by Atlantic salmon conservationists; only a small local consumption fishery remained.

b) Sampling of commercial shrimp catches by the Canadian Observer Program continued in 1994.

SUBAREA 2

A. Status of the Fisheries

Nominal landings from 1990 to 1994 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Atlantic salmon.* Total landings of salmon (92 t) decreased by 18% from 1993. The recreational harvest totalled 6.9 t.

b) *Arctic charr.* Landings of Arctic charr in northern Labrador totalled 31 t in 1994, a decline of 18% from the previous year. Declines in catches were matched by a reduction in effort which declined to the lowest level recorded since 1974.

c) *Shrimp.* The shrimp fishery had a quota of 11,650 t in 1994 (Jan-Dec) for Div. 2GH and northern Div. 2J; approximately 11,500 t were taken. The Hawke Channel (southern Div. 2J) was included with Div. 3K for assessment and management purposes.

d) *Capelin.* Landings of capelin remained at a low level.

e) *Cod.* Landings were almost nil; the northern cod moratorium has been in effect since July 1992 for cod from Div. 2J3KL; a food (handline) fishery was conducted for a period of 8 days in August-September, with catch restrictions in place..

B. Special Research Studies

1. Environmental Studies

Oceanographic studies. Temperature profiles were taken at each fishing station occupied in the subarea. CTD profiles were collected along the standard NAFO transect line across the Hamilton Bank (Seal Island Line) and several other stations on the Labrador Shelf.

2. Biological Studies

a) *Cod.* Research vessels surveys were carried out in Div. 2J to conduct distribution and abundance studies; detailed biological sampling was performed. A portion of Div. 2J was covered during a cod acoustic research trip in June. Stomachs were collected from the Div. 2J autumn survey.

b) *Arctic charr.* A total of 2,230 samples was obtained for age determination of Arctic charr in commercial landings from 12 northern Labrador fishing areas. Approximately 16,400 fish were sampled for length distribution from the same areas. Information on sex distribution of charr caught in the fishery was obtained, along with stomach samples for evaluation of food and feeding habits. Experimental in-river fisheries were conducted in three Saglek Fiord rivers.

c) *Shrimp.* Sampling of commercial shrimp catches by the Canadian Observer Program continued in 1994.

d) *Flatfish.* Data on distribution and abundance of American plaice, Greenland halibut and witch flounder were collected during groundfish surveys of Div. 2J in 1994.

SUBAREA 3

A. Status of Fisheries

Nominal landings from 1990 to 1994 for fish stocks are listed in Table 1. Additional information on the status of the fisheries is as follows:

a) *Squid.* Total catch of squid in 1994 increased to approximately 2,000 t (provisional data), however it still represented poor fishery performance. The poor fishery, for the twelfth consecutive year, was due to a natural low abundance of squid in commercial fishing areas.

b) *Atlantic salmon.* There was a moratorium on the commercial fishery. The recreational harvest was 34 t.

c) *Shrimp.* The TAC for Div. 3K and southern 2J was 11,050 t (Jan-Dec). The international fishery in Div. 3M which began in 1993 continued in 1994. Canadian vessels caught 1,040 t, approximately 28% of the 1993 catch.

d) *Iceland scallop.* Due to the restrictions to fishing in the new French zone in Div. 3Ps, the nominal catch declined dramatically. Some of the effort displaced from Div. 3Ps shifted eastward to the Grand Bank (Div. 3LNO); commercial vessels (fifty-seven under 65 ft. L.O.A.) harvested about 4,500 t (round) Div. 3LNO.

e) *Clams.* The Grand Bank (Div. 3N, Unit Area 319) fishery for the Arctic (Stimpson's) surf clam on the Grand Bank continued in 1994. The total allowable catch of 20,000 t was taken.

f) *Capelin.* Inshore capelin catches are usually taken during the inshore spawning migration. Female capelin are preferred to satisfy the Japanese roe market. The 1994 inshore TAC was 33,000 t but catches were little more than 1,000 t. The fishery did not open because test fishing indicated that female capelin were too small to meet the size criteria established in the management plan.

g) *Herring.* Landings in 1994 were approximately 5,000 t, 80% of which was taken from White Bay, Notre Dame Bay, Bonavista Bay and Trinity Bay. There was little fishing effort due to the low price of herring.

h) *Cod.* A moratorium on the cod fishery has been in place for Div. 2J3KL since July 1992, for Subdiv. 3Ps since September 1993 and for Div. 3NO beginning in 1995. A limited (8 day) food fishery was conducted in Div. 3L and Subdiv. 3 Ps during August-September 1994.

B. Special Research Studies

1. Environmental Studies

a) *Contaminants.* Contaminant levels were determined in yellowtail flounder from the offshore.

Chronic Toxicity of Oil-Base Drilling Muds. The discharge to the ocean of oil-base mud cuttings during offshore petroleum exploration and development in Canada and the North Sea has been highly controversial. Bodies such as the Paris Commission have recognized the value of sub-lethal effect studies in addressing concerns about the effects of oil-base muds on marine life. Dose-response relationships were studied for a variety of indices in a chronic toxicity study with flounder exposed to sediments contaminated with drill cuttings enriched in aliphatic hydrocarbons. The indices investigated were biologically meaningful and included organ and body condition indices, muscle and liver energy reserves, blood parameters and histopathology. There was no evidence of dose-response relationships and most indices remained unaffected even at the highest exposure level. The study will be of interest for evaluating the scope of environmental risks associated with the use of oil-base drilling muds in the marine environment.

Sediment Quality Criteria. Studies have been carried out on the relationship between levels of polycyclic aromatic hydrocarbons in sediments (from combustion and petroleum sources) and sub-lethal effects in fish. These investigations have now been expanded to include effects on invertebrates. A special focus of these studies is to address the adequacy of monitoring and assessment programs related to oil development in the offshore.

Environmental Assessment. An assessment study is being carried out in Humber Arm, in the Bay of Islands, an estuary receiving pulp mill and sewage effluents. Most of the studies to date have focused on effects on flatfish.

b) *Canada-Newfoundland Offshore Petroleum Board.* In 1994, the Hibernia Management and Development Company conducted a survey to collect baseline information in support of an environmental effects monitoring program for the production phase of the Hibernia project. The survey included seabed sampling with results from sediment chemistry and toxicity analyses expected in mid-1995. As part of the EEM program design, DFO, in collaboration with HMDC, sampled American plaice and Iceland scallops in the vicinity of the platform location and in a control area approximately 50 km to the northwest. Results of taint evaluation and body burden analyses of samples collected will also be available in mid-1995.

c) *Centre for Cold Ocean Resources Engineering (C-CORE), Memorial University of Newfoundland.*

Seabed Crawler. Work has begun in the development of a new remote operated tracked vehicle for use on the seabed. The machine is designed to operate in depths as great as 100 m and outfitted with video cameras. Its application includes cleanup of toxic spills, performance of precision geophysical surveys and harvesting of marine invertebrates. It will rest on the sea floor but will not require propellers or thrusters for movement thereby avoiding the stirring up of bottom sediments.

2. Biological Studies

a) *Cod.* Sampling of the landings from the commercial and food (where commercial closures were in effect) fisheries, both inshore and offshore, were continued in 1994. Using research vessels, surveys were carried out in spring and autumn, in all NAFO Divisions (except 3M) to determine the distribution and abundance of cod. Biological sampling was extensive during these surveys, as well, cod were sampled for gene probe analysis. Stomachs were collected from Div. 3LNO during spring and from Div. 3KL during autumn.

b) *Scallops.* A stratified random survey was completed over two scallop aggregations on the Grand Bank (Div. 3NO).

c) *Squid.* Commercial squid samples were acquired opportunistically from three localities representing Trinity Bay, Conception Bay and White Bay. Biological sampling of squid will include stomach analysis to identify fish species preyed upon by squid.

d) *Atlantic salmon.* Long-term research studies continued to develop a model which could be used to estimate salmon production capacities of streams, optimal egg deposition and stock and recruitment relationships.

e) *Seals.* Sampling of seals to provide data on age structure, reproductive parameters, stomach contents and morphological condition continued.

A series of studies designed to provide information on the role of pinnipeds in the Northwest Atlantic ecosystem continued including research on abundance, diet and distribution of harp and hooded seals. A study of seasonal movements and diving behaviour in free-ranging seals using satellite-telemetry was continued.

f) *Capelin.* Factors governing capelin survival during egg development and larval emergence from beach sediments were continued in 1994. Primary sampling sites were Arnold's Cove, Placentia Bay; Chapel's Cove, Conception Bay; Bellevue Beach, Trinity Bay; Eastport, Bonavista Bay; and Hampden, White Bay.

g) *Herring.* The research gill net index fisherman program was continued for the fifteenth year as an index of herring abundance. An acoustic biomass estimation survey was conducted during November-December in White Bay-Notre Dame Bay.

h) *Flatfish.* Distribution and abundance of flatfish were studied during random stratified surveys in 1994: Div. 3K - fall survey; Div. 3L, 3N and 3O - spring and fall surveys; Div. 3P - spring survey.

Studies into the behavioural ecology of American plaice were continued, largely through laboratory experiments in controlled environments.

A juvenile flatfish survey was conducted in Div. 3LNO in early fall of 1994. This survey is part of a time series directed at establishing a pre-recruit index for yellowtail aged 1-3 years. Information was also collected on the distribution and abundance of juvenile American plaice.

A stratified random survey for Greenland halibut was conducted in Div. 3KLMN in March-April 1995 to investigate stock abundance and biomass and collect data on population dynamics and stock structure.

3. Gear and Selectivity Studies

Industry Development Division, Fisheries and Habitat Management Branch conducted several gear and selectivity studies in 1994:

A redfish selectivity study was conducted between October-December 1994. The M/V *Atlantic Lindsey*, a 44.5 m FPI trawler, fished in depths ranging from 329 to 516 m. The standard model 96 bottom trawl was modified with the addition of a small mesh vertical divider panel to produce a trouser trawl which contained both an experimental and small mesh codend. Objective of the study was to reduce, below 5%, the amount of small redfish (<23 cm) in the catch while maintaining a large percentage of commercial sized fish. Comparative results indicated that codends with lastridge ropes produced sharper and less variable selection characteristics; these codends consistently lost more small fish and retained more commercial sized fish than codends of similar mesh size with no lastridge ropes. Optimal selectivity was obtained using the 90 mm nominal mesh size with lastridge ropes (only 1.3% of fish were small sized and possessed a narrow selection range of 3.3 cm).

In July 1994, two 20 m commercial shrimp trawlers conducted a selectivity experiment off the west coast of Newfoundland to determine if Teflon Nordmore Grates, with narrow bar spacings (8-12 mm) on the bottom of the grate, and a wider bar spacing (25 mm) on the top, would be an effective method to reduce by-catch and also the catch on small (industrial) shrimp. Two different Teflon grates (147x100 cm) were evaluated; one with 12 mm bar spacings from the bottom of the grate up to 60 cm, the other 8 mm up to 60 cm. There were two codends aft of the grate; one to catch shrimp passing through the wide bar spacing, the other to catch shrimp passing through the narrow bar spacing. Results indicated there was little difference in the size of shrimp in either codend placed when the grates were evaluated. There was an indication that this experimental grate resulted in a high loss of shrimp. Additional studies will be conducted.

A study was undertaken to address the problem of high by-catch of cod and American plaice in an experimental skate fishery carried out in April 1994. Tests were conducted using both a 305 mm diamond mesh codend and a 305 mm square mesh codend. While both codends virtually eliminated the by-catch problem, damage and distortion occurred when the square mesh codend was used. Subsequently, a 305 mm diamond codend and lengthening piece was used with a 254 mm diamond mesh for the remainder of the trawl. This modified design produced low by-catch but also reduced catch of smaller skate to 10%.

In the fall 1994, an undersize crab survivability project was carried out in Conception Bay, Newfoundland. The study was designed to subject crab to various procedures that simulated handling techniques commonly used on 13 to 20

m crab vessels to determine the effect of handling practices on crab mortality. Survivability tests included dropping crab from distances of 120 cm and 214 cm, as well as, sliding crab into the hole of the vessel. Crab were tagged, placed into bait holding pots and returned to the sea floor. Holding pots were retrieved, baited and set on a weekly basis. Results indicated that 83-100% of crab died when dropped and 46% of crab died when sled. Both holding times onboard and height from which crab were dropped or sled increased mortality rates.

SUBAREAS 2 AND 3

A. Special Research Studies

1. Environmental Studies

a) *Hydrography.* CHS, Newfoundland Region carried out various inshore sounding surveys. Detailed information for the updating of navigation charts was collected along the northeastern Newfoundland coast and Labrador.

b) *Oceanographic and related studies.* Ships-of-opportunity XBT programs were continued using the surveillance vessel CAPE ROGER. Temperature profiles were taken at each research fishing station occupied during 1994. In addition, over 50 thermographs were deployed by researchers in conjunction with the DFO long-term Temperature Monitoring Program. CTD data were collected using a SeaBird SeaCat Profiler on the groundfish otter trawl.

Three physical oceanographic cruises were conducted to collect CTD, oxygen and plankton profiles along the standard NAFO transects and additional stations, as well as the vertical profiles of the ocean currents along the cruise track.

2. Biological Studies

a) *Assessments.* Assessments of some 25 groundfish stocks presently under catch quota regulations were conducted and refined; advice on TACs for the 1994 fishing season was provided either through DFO or NAFO. Further assessments were conducted of 17 pelagic-shellfish-marine mammal stocks, Atlantic salmon stocks, two Arctic charr stock complexes and other commercial and potentially commercial species.

b) *Cod.* A combined trawl and acoustic survey was undertaken to determine the distribution of cod off the east coast of Newfoundland during the shoreward migration in June, as well as, to determine the depth and temperature of cod concentrations near the coast prior to, and during, the inshore migration of cod. In 1994, this survey was extended to Div. 2J.

c) *Capelin.* An offshore acoustic survey in Div. 2J3KL conducted during September and October resulted in a low biomass estimate. The inshore aerial survey index for 1994 was high.

d) *Redfish.* Several groundfish reeearch surveys conducted throughout Subarea 3, primarily in the spring and fall of 1994, provided information on the abundance, distribution and parasite infestation (Sphyrion lumpi). The collection and subsequent ageing of otoliths from both research and commercial catches, and the application of these to respective length frequencies yielded information about commercial catch-at-age as well as population structure.

e) *Research vessel trips.* Sixty-one offshore and inshore research vessel trips were undertaken in 1994-95 utilizing DFO-owned vessels (Newfoundland-based: WILFRED TEMPLEMAN, MARINUS, SHAMOOK and TELEOST; Scotia-Fundy based: ALFRED NEEDLER, PARIZEAU, MATTHEW; GADUS ATLANTICA and LADY KENDA (charters)).

f) *Commercial sampling.* Sampling of foreign (inside the Canadian zone) and Canadian catches for all commercial fish and invertebrate species by the Canadian Observer Program continued in 1994.

3. Miscellaneous

a) *Northern Cod Science Program.* As part of the Atlantic Fisheries Adjustment Program (AFAP), research initiatives continued for the fifth year, and final year, under the Northern Cod Science Program (NCSP). NCSP initiatives were established to address the science recommendations of the Northern Cod Review Panel which conducted an independent review of the state of the northern cod stock and published a report in February 1990. Resources were assigned to study cod ecosystems dynamics, improve communication, collaboration and education and to take advantage of new technologies in cod research and assessment.

b) *Fisheries Resource Conservation Council.* The Fisheries Resource Conservation Council (FRCC) concentrated on reviewing stock assessments and conducting public hearings primarily on the state of Atlantic groundfish stocks, including stocks within the NAFO divisions. It recommended basic directions with respect to Science priorities, including use of information from fishermen and commercial fisheries in stock assessments, collection of commercial fishery data through test fisheries, involvement of fishermen in scientific research; research initiatives including an ecological approach to develop understanding of complex process, improve quantitative fish counting technology, predator-prey relationships, in particular capelin and groundfish relationship and predators of groundfish (seals).

Table 1. Summary of preliminary catches for stocks within the DFO, Newfoundland Region, 1990-1994.

Subarea	Species	Division	Catch (t) 1994	1993	1992	1991	1990
0+1	Greenland halibut	0	3,723	2,561	8,200	5,945	6,194
	Shrimp	0A	4,727	5,501	7,493	6,788	6,177
		0B	469	106	1,291	1,107	1,609
2	Cod		9	13	-	2,835	46,900
	Redfish		-	-	1	7	192
	Greenland halibut		1,444	1,119	1,800	3,200	3,800
	American plaice		-	-	<10	80	900
	Other groundfish		3	-	100	467	403
	Arctic charr		31	38	74	70	100
	Shrimp		11,456	12,114	12,036	10,655	10,234
3	Cod		2,022	23,573	56,600	159,20	201,600
		3K	368	544	1,756	0	54,400
		3L	932	3,384	22,600	42,800	104,000
		3N	-	328	580	74,500	4,600
		3O	2	3,391	6,600	1,500	7,000
		3Pn	158	2,411		6,500	5,300
		3Ps	562	13,517	24,600	6,500	26,300
	Redfish		10,735	17,481	22,200	16,100	14,900
	Flatfish		2,279	23,755	40,300	45,500	47,200
	American plaice		187	8,015	11,800	27,000	27,500
	Yellowtail		1	6,280	6,800	7,400	5,100
	Greenland halibut		1,619	3,919	15,100	4,000	6,500
	Witch flounder		437	5,420	6,600	5,700	8,900
	Atlantic halibut		35	120		560	790
	Other groundfish						
	Haddock		20	763	1,200	1,600	4,500
	Pollock		189	472	264	1,300	1,800
	White hake		442	-	-	-	-
	Winter flounder		1,404	-	-	-	-
	Wolffish		25	-	-	-	-
	Monkfish		504	-	-	-	-
	Capelin	3L	1,000	23,000	3,000	21,400	48,000
		3K	100	13,000	19,000	20,400	51,900
		3Ps	300	2,000	50	90	1,200
	Herring		5,000	6,100	7,000	18,200	8,500
	Mackerel		-	5,100	1,300	800	1,200
	Squid		2,000	100	923	1,720	4,440
	Shrimp	3K	*10,937	4,363	3,594	3,524	3,669
	Sea scallops (meats)		49	130	67	59	153
	Iceland scallops		4,639	955 (shellstock)	5,530 (shellstock)	70 (meats)	35 (meats)
	Clams	3N	20,000	20,000	11,254	7,200	10,000
2+3	Capelin	2J3KL	-	-	-	450	57,300
	Atlantic salmon	2J3KPs	133	126	213	353	498

* Includes southern Div. 2J (Hawke Channel) in 1994 management plan.

SECTION II - Scotian Fundy Region

by

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Special Research Studies - 4VWX

1. Environmental Studies:

a) Hydrographic studies

Analyses were completed describing the association between cod and haddock catches with depth and near-bottom water temperatures and salinities. A paper was produced on some of the statistical aspects of analyzing fisheries and oceanographic data.

b) Plankton studies

A series of zooplankton stations were sampled using nets and multi-frequency acoustic methods to measure zooplankton concentrations in regions dominated by different water masses in the areas of the Scotian Shelf and Gulf of Maine. This was a continuation of the study dealing with the effects of climate change on zooplankton populations. Continuous Plankton Recorder (CPR) data has shown the zooplankton population is at historically high levels on the Scotian Shelf, but is low on the Grands Banks.

Continued monitoring of phytoplankton species and density in the Bay of Fundy. Completed project on identification of location of major Alexandrium cyst beds in the Bay of Fundy. Horizontal transcripts for chlorophyll a were done on a regular basis in Passamaquoddy Bay to map phytoplankton distribution patterns.

c) Benthic studies

A trawling impact study was initiated in 1993 with the establishment of three paired sets of experimentally trawled and untrawled (control) corridors, each 13 km-long, with a closed area on the Grand Bank. Historically, the study area had supported only a limited fishery and showed no evidence of recent trawling. This study is unique in that it addresses not only the immediate effects of trawling but also the short- and longer-term effects. After trawling the corridors in 1993, epibenthic sled and grab samples were immediately collected to determine initial impacts. Two months later the corridors were again sampled to determine short-term residual impacts. One year after trawling, in July 1994, the corridors were again sampled to determine longer-term residual impacts. After this sampling was completed, the corridors were then retrawled and further sampling undertaken to obtain a second data set on immediate impacts. Further and final sampling and trawling are planned for July 1995. On completion of the experiment, there will be three data sets reflecting the immediate impacts of trawling, one set reflecting the short-term impact (two months), and two sets reflecting the longer-term impacts (one and two years after the trawling). Because of the numbers of samples and operational problems, much of the meiofauna and bacterial samples are still not analyzed. All mega- and macrofaunal materials from the 1993 and 1994 samples have been sorted and identified, and preliminary analyses are under way.

Study was carried out to compare 3 benthic monitoring methods at salmon farm sites and reference sites in the Fundy Isles area.

d) Nil

e) Other environmental studies

Field work at the Cohasset/Panuke oil production field on Sable Island continues

to study the behaviour and fate of particulate drilling wastes. Particular attention is being given to understanding the role of flocculation processes which involve naturally occurring organic matter as well as waste particles.

Development of the habitat sensitivity mapping system continued, with a pilot project being conducted using the Shelburne County data base.

Water movement measurement by gypsum dissolution method was validated at salmon farm and reference sites in the Fundy Isles area; further testing is planned.

2. Biological Studies by Species:

a) Cod

Joint industry/Science surveys were initiated on 4Vn cod. These will supplement the DFO surveys and become a key element in the assessment of the resource. A working group reviewed available data on this resource to determine the degree of interaction with adjacent stocks in the Gulf and on the Shelf. The otolith identification research was important in these discussions. An inshore survey was conducted in September to locate juvenile areas. The results of all this work are new ideas on the stock components in the area and how they inter-relate.

Examination of within management unit variation in cod growth rate. Study was conducted on reproductive success of repeat and virgin spawners.

b) Haddock

On the Eastern Scotian Shelf, dialogue was held with the FSRS on a tagging program to determine the association of haddock caught inshore and offshore. Other species such as white hake will also be studied.

In 4X, the ITQ Committee proposed a joint Science/industry survey to be conducted in July.

c) Flatfish

A cooperative Science/industry tagging study on winter flounder and halibut was planned.

d) Redfish

A biologist was assigned to the Unit 3 resource and the first comprehensive analysis of the available conducted since 1986.

e) Silver Hake

As part of the Harris Panel on Foreign Fishing, analyses were undertaken to better define the spatial and temporal extent of the small mesh gear box. These analyses led to regulatory changes that will significantly reduce the bycatch of species of interest to Canada in the silver hake fishery.

f) Grey Seals

A model of the impacts of seal harvest/contraception was developed to allow analysis of management options. This extended the modelling of the cod/seal interaction developed in 1994.

The cod/grey seal model developed in 1993 was used in the consideration of the harvest advice for 4VsW cod. As well, another model to evaluate the impacts of birth control on the grey seal population was developed and reviewed.

g) Underutilized Species

Associated with a new fishery, a joint industry/science survey of 4VsW skate was initiated. As well, discussions were held with industry on the science requirements of the shark fishery.

Study completed on relating growth and condition of sea urchins to the carrying capacity of the local environment (Fundy Isles region). Continued research on reproductive cycles of the sea cucumber Cucumaria frondosa.

h) Herring

Surveys and port sampling completed successfully.

i) Salmon

Collaborated with Atlantic Salmon Federation in preliminary studies: use of underwater telemetry technology to study salmon behaviour and movements in coastal areas of the Bay of Fundy; determination of the extent and success of reproduction by escaped farmed salmon in rivers of southern New Brunswick.

j) Lobster

A three-year study, aimed at improving understanding of female lobster ecology along Nova Scotia's eastern shore, recently ended. Movement of mature females was fount to be important for the maturation of both ovaries and embryos in these cold waters where temperatures are minimal for the completion of key life history processes. A related study showed the importance of considering size-at-maturity when fishing plans are developed. A small increase in size-at-maturity between two closely related fishing grounds caused a six-fold reduction in egg production. A thorough analysis showed no relationship between long-term lobster production (based on landing records) and various physical parameters such as wind. Assemblages of early benthic phase lobsters in areas of the western Bay of Fundy match those found on more productive coastal Maine (U.S.A.) grounds, suggesting a production bottleneck in a later stage of Bay of Fundy animals. Joint (U.S.A./Canada) submersible studies in offshore Gulf of Maine grounds documented pre-recruit lobsters as small as 40mm CL for the first time, which suggests local recruitment on offshore banks. The pre-recruit index study continued, which is yielding good data on both size- and sex-specific exploitation rates and on seasonal habitat changes of lobster. A study, using the RAPD method, supports previous findings that lobster population structure is conservative and that inter-stock genetic homogeneity can be maintained by movement of only a few animals (<100).

Monitored the Bay of Fundy lobster fishery through field sampling. Air-lift suction sampling was conducted in the Beaver Harbour area to determine settlement strength at benthic recruitment sites.

k) Scallops

Studies on spatial and temporal distributions of scallop spat in relation to physical parameters on southern Cape Breton Island and in the Bay of Fundy, were undertaken to improve catches for scallop farmers. Three artificial substrate types were tested for spat settlement yields: Dupont Blue and Netron yielded similar catch rates; however, traditional mono-filament mesh was superior to both. Density of scallop settlement varied significantly with location as did fouling by mussels; high growth rates co-occurred in areas of maximum densities. The immunofluorescence techniques (developed by Laval University workers) was married to an image analysis system and is now used routinely for rapid identification of scallop larvae. Scallop remote setting studies continued with an industrial partner.

Work on genetic markers to discern wild population structure continues in collaboration with Dalhousie University and NRC/IMB workers. Seven micro-satellite probes have been developed for pedigree analysis. cDNA probes have been applied to animals from seven commercial northern Gulf of Maine, Scotian Shelf and St. Pierre Bank beds. A quantitative assessment using the VPA model was performed for the first time on an inshore (Bay of Fundy) stock. High mortalities of German Bank scallops and the finding of domoic acid in the tissues resulted in domoic acid feeding trials. Scallop digestive glands accumulated the neuro-toxin up to levels of 3000 ppm. Depuration of domoic acid, however, was reasonably rapid.

Continued scallop reproduction (GSI) time series for the Passamaquoddy Bay area. Completed survey of spawning stock in the Fundy Isles area.

l) Clams

Considerable research has resulted in management advice that is now at the consultation stage with the nearshore, softshell fishers. Workers found recruitment rates to vary significantly amongst sites within the Annapolis Basin (Bay of Fundy). Spat settlement was much higher at the Bay's head, than at the mouth, a finding unexpected by industry.

The offshore hardshell clam industry funded a survey of eastern Scotian Shelf beds. RoxAnn bottom discrimination is being used to stratify the banks for abundance; a dredge is being used to verify the RoxAnn results. Age and size-at-maturity data are being developed using imaging analyses techniques.

Completed study on recruitment dynamics of soft-shell clams. Study was done in the Annapolis Basin.

m) Underutilized Species

Fishing pressure on commercially un-developed and underutilized invertebrate and marine plant stocks has increased with the marked decline in groundfish catches. New fisheries are being developed around four crab species, winkles, whelks, marine worms, and kelps. Studies will be undertaken on a number of these species in 1995. The relatively new sea urchin fishery continued to expand, particularly along the Scotian Shelf. Sea urchin ageing studies continued, using micro-probes and Scanning Electron Microscopy. Elemental (Mg/Ca) ratios have shown urchins as small as 50mm test diameter to be 35 years old. Juvenile settlement peaked in August in the Bay of Fundy: densities ranging from 25-50 m-2, three orders of magnitude less than off coastal New Hampshire (U.S.A.).

3. Gear and Selectivity:

Reported under silver hake above.

4. Miscellaneous Studies:

Documentation of bycatch rates for harbour porpoise in the Bay of Fundy groundfish gillnet fishery.

Special Research Studies - Subareas 5&6:

1. Environmental studies

a) Hydrographic studies

Continued involvement with the U.S. GLOBEC modelling team investigating influences of water circulation on the distribution and survival of cod and haddock eggs and larvae.

b) Benthic studies

Work continues on determining the potential sublethal effects of drilling wastes on the growth and reproduction of the sea scallop (see scallop report below).

Substantial progress is being made in the development of a numerical model of sediment transport in the benthic boundary layer. Using data from related projects and input from a regional three-dimensional finite element model, this model will be applied to estimating the spatial and temporal scale of potential impact zones around potential drilling sites on the continental shelf.

c) Other environmental studies

Progress continues to be made on the development of monitoring techniques and

numerical models to assist the development and management of sea cage culture in coastal areas.

2. **Biological Studies by Species**:

a) Cod

Maturity ogives were developed for Georges Bank cod. Tagging investigations were conducted.

b) Haddock

Examination of movement across the international boundary of Georges Bank. Development of assessment methods.

f) Herring

Surveys completed successfully. Continued program of short term excursions aboard commercial seiners.

h) Lobster

Participated in joint US:Canada submersible cruise to study the distributional ecology of offshore lobsters in the Gulf of Maine.

i) Scallops

Long-term growth experiments conducted in the laboratory with adult sea scallops (*Placopecten magellanicus*) indicate that used oil-based drilling muds are more toxic than barite, bentonite, and used water-based drilling muds. Impacts on growth occurred at concentrations of only 0.5 mgL^{-1}, and the zero impact threshold must be lower.