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# Meeting 2
# October 3, 1996
# Regional Advisory Process (RAP)
# Habitat Subcommittee:

# Middle Shoal Channel Improvement Program

J.D. Pringle (Chairperson and Rapporteur)

Marine Environmental Sciences Division
Science Branch
Maritimes Region
Fisheries and Oceans Canada
Bedford Institute of Oceanography
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November 1996

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## TABLE OF CONTENTS

## 1. OBJECTIVE OF THE MEETING

The Middle Shoal Channel Improvement Project is a channelization project being carried out by the Little Narrows Gypsum Co. Ltd. in the southern Sydney Bight area of Cape Breton Island, N.S. (see Appendix 3). The primary purpose of the Subcommittee meeting was to review the scientific data available on the project's attempt to improve lobster habitat by constructing a reef, approximately 400 m x 400 m, at Site A Revised (see Appendix 4 for approximate location.), using clean dredging spoils from the channelization site. (David Scarratt, private consultant present at the Subcommittee meeting and the Canadian Atlantic's biological expert on artificial reefs, was the scientific advisor to this phase of the project.) (See Appendices 1 and 2 respectively for the list of meeting attendees and the agenda.) Specifically, the Subcommittee was requested by Habitat Management Division to advise them on whether or not **"...the site should be continued as per the conditions issued in the Authorization, and will there be a significant adverse impact on the overall well-being of the cod stock which seasonally occupies the area?"** (provided to John Pringle by Habitat Management Division's Reg Sweeney on October 3, 1996).

Secondary objectives, as per Mr. Sweeney's request, included:

- **The definition of preferred cod habitat.**
- **What evidence is there that Site A Revised specifically contained that habitat?**
- **How does the placement of pebble to cobble material destroy that habitat?**
- **If it is destroyed, would it have a significant negative impact on the productive capacity of the stock?**
- **What evidence is there that cod are being destroyed?**
- **If all cod are presumed killed at Site A Revised, what impact will this have on the stock?**

## 2. BACKGROUND

Mr. Sweeney and Brian Thompson provided information on the project to date. They provided the sizes of the barges being used as: 191 $m^3$, 306 $m^3$, and 765 $m^3$; the time for the material to reach the bottom was ~10 sec; the approximate bottom covered by the discharge from each of the three barge types is ~60 $m^2$, ~81 $m^2$, and ~225 $m^2$; there are ~35 trips per day; and total daily discharge time is ~5.8 min.

## 3. ARTIFICIAL REEFS

Dr. Scarratt noted his experience with reef construction, dating back to 1965 in Northumberland Strait (Kouchibouquac Bay), and with the Belledune Harbour reef (see Appendices 5 and 6), which was about 1 km x 800 m in size. The former reef was deemed successful in not only attracting mature lobsters to it, but in enhancing lobster habitat in the area as well, when large numbers of early-stage juvenile lobster were found in the reef over a period of years. Similarly, the Belledune Reef has been judged a huge success by area fishers. In fact, fishers of the

immediate area have requested DFO to limit reef use to them, as the reef had attracted numerous fishers who did not have a history of fishing the reef area and surrounding grounds.

In relation to the Middle Shoal project, Dr. Scarratt noted the reef construction material dumped at Site A Revised (hereafter referred to as the "Reef Site") consisted of rock somewhat smaller in size than that ideal for mature lobster. Though it was assessed to be appropriate for immature lobster, he recommended more coarse material be added to the reef to make it more suitable for mature lobster. In an attempt to attain a greater "edge effect," the material has been discharged into numerous individual squares that have the potential to hold 3,824 $m^3$ of material.
Dr. Scarratt is confident the artificial reef will be as suitable a habitat for lobsters as the site from whence the material came, and noted that in effect the fishers will be getting two sites from one. He is confident the dredged channel will again support lobsters once ecological succession occurs. Furthermore, he suggested the reef should enhance the productivity of all species that normally inhabit the area.

## 4. LOBSTER AND JUVENILE COD DISTRIBUTION

Tim Lambert provided background information on his inshore research survey, run bi-annually since 1991 (see Appendix 7 for station locations), and designed to monitor juvenile cod abundance. The stations are monitored in about June and again in about mid- to late September, using a flounder trawl towed over flat bottom from the R/V *Navicula*. The tow lengths are ~1 nm (1,853 m). Mr. Lambert suggests the net provides a conservative estimate (see Appendix 8) of young-of-the-year and 1-yr-old juveniles (<11 cm in length), as there is "...ample opportunity for..." these age groups "...to pass through the much larger meshes of the wings and main part of the trawl."

***Lobster:*** Mr. Lambert consistently captured lobsters only in the fall (see Appendix 9) at one of his stations, which by coincidence goes through the Reef Site. Considerable discussion ensued regarding these data. It was noted that little is known about mature lobster distribution during the fall/winter, once they move from the nearshore summer grounds in early to mid-fall.

Lobsters are currently being monitored daily at the Reef Site, via traps set by local fishers under contract to a consultant. (It was previously agreed that if catch/trap was >0.3 lobster, then dumping would stop.) Mitigation is now in effect. (Norval Collins, consultants, noted that on September 27, 1996, lobster number/trap ranged between 1 and 3; three traps set on top of the artificial reef contained a total of 14 lobsters; but by October 3, 1996, 45 were captured in these three traps. Hence, reef construction activities were halted at this site.) To meet obligations as per lobster reef design (see Dr. Scarratt's comments above), the contractor recently requested permission to "top up" the reef with material, now available from the channelization site, of the size that is more appropriate for mature lobsters. A rough calculation suggested about one lobster per 20 $m^2$; thus there will be some mortalities, but it was felt by most that the impact will be negligible. Steve Campana noted that the impact will likely be negligible, but what impact will the reef have on altering a possible migration route? Little is known about the seasonal migration

patterns of mature lobster, but it was deemed unlikely the reef would impact adversely on this type of trek.

***Recommendation:*** ***That Habitat Management Division personnel, along with other appropriate members of DFO Science, meet with representatives of the lobster fishers to explain the rationale and the risks for adding more material to the reef at Site A Revised, despite the presence of lobsters.***

*Cod:* Mr. Lambert noted the "...centre of distribution of very young cod to be around the Bird Islands...," with older juveniles occurring northward in the Gutter (see Appendices 7 and 10). He went on to suggest recruitment has been low for 10 yr; but in the current year, his sixth year of surveying, the catches were the highest yet observed. He could give no solid reason why the young cod concentrate in these waters, but suggested it may be because of the presence of mysid shrimp. Others suggested it unusual to find such young cod on sandy, flat bottom, though Dr. Campana did find juvenile cod on both sand and rock bottom throughout southwestern Nova Scotia. Mark Hanson noted the literature from Newfoundland, Nova Scotia, and the Gulf of Maine report both survival and growth of young cod to be much higher on rocky to cobble bottom than on sand (see Tupper and Boutilier 1995; Fraser et al. 1996; Lough et al. 1989). In addition, other studies show juvenile cod tend to be in shallow, nearshore waters from <1 m to <35 m (Methven and Bajdik 1994; Riley and Parnell 1984; Godo et al. 1989; Olsen and Soldal 1989; Keats et al. 1987; Pihl 1982; Hawkins et al. 1985), with some researchers using beach seines to sample some concentrations. Of particular interest is the work of Hanson (1996) in nearby southern Gulf of St. Lawrence waters. Mr. Hanson analyzed cumulative catch data to clearly show 1- and 2-yr old cod are exclusively found in waters <35 m deep. These analyses were based on juvenile cod surveys performed over a range of bottom types during 1991 through 1994.

There was concern that though there was indeed juvenile cod in the study area, this was still not the most appropriate habitat and that sampling in certain adjacent habitat may have yielded much higher catches: that the actual peak in young cod densities may be closer to shore, over rocky, macrophyte-covered substrates; that Mr. Lambert was only on the edge of the true concentrations (see Appendix 10, first figure [16]). The sampling gear limited Mr. Lambert's sampling to the more rugged bottoms south and north of his study area. It is here that many felt was the most likely habitat for cod <15 cm long. It should be noted that in 1996, these sized juveniles were found over a large area (see Appendix 8 - his fifth and twelfth figures). As well, Mr. Lambert noted that the Reef Site was the flattest, sandiest bottom of all his stations. Northward of the Reef Site, but within Mr. Lambert's survey area, the bottom is more rugged and more typical of juvenile cod habitat. Mr. Lambert noted that the delineation of the study site was somewhat "...by trial and error...," though the study area was largely based on the fact fishers found young cod in the area.

The number of both young-of-the-year and 1-yr-old cod captured by Mr. Lambert was questioned; his densities were deemed low for "nursery ground" delineation, even in 1996, the year in the series with the highest abundances. Mr. Lambert suggested his gear severely undersampled these age classes. The rationale used to declare the Bird Islands the "centre of the

nursery grounds" was that in the years when juvenile recruitment was low, they were only found at these Stations (see Appendix 8, first figure). Of interest, though, was that in 1996 there were no more cod <11 cm in length here than at many other stations surveyed (see Appendix 8, his sixth figure); and in fact the station with the greatest densities was some distance north of the Bird Islands. The same trend was noted for 1-year olds (see Appendix 8, twelfth figure).

## 5. CONCLUSIONS

Concensus was that until gear such as the rock hopper, used for sampling juvenile cod over rocky bottoms off southwestern Nova Scotia, was used in southwestern Sydney Bight, it would be most difficult to both define the areal limits of this nursery ground, and the centre of its distribution. It was felt the centres of concentration for cod <11 cm in length were likely to the south and north of the Reef Site, where the benthic substrates were more typical of cod nursery grounds as described elsewhere. There was thus little support for the concept the Bird Islands were the centre of juvenile cod distribution. In fact, the overall distribution ranged throughout the study area, and likely both the southern and northern limits of distribution have yet to be described.

It was further concluded that given the broad distribution of cod <11 cm, the impact on juvenile cod habitat of reef building at the Reef Site (only 400 m x 400 m in size), even were it prime juvenile cod habitat, would be insignificant and unmeasureable. However, given that it likely is poor juvenile habitat, based on substrate type, it was felt the artificial reef might even have a chance of improving cod habitat over time. Our best guess for the coefficient of impact, with the data at hand, was either zero or slightly positive. The construction of the reef has "altered the habitat," rather than "destroyed habitat." The alterations were thought to be at least one of "...no net loss..." to both cod and lobster over the long term, but with a good chance that over time, the changes could indeed enhance lobster production.

## 6. HABITAT MANAGEMENT DIVISION'S QUESTIONS

A detailed response to each of the questions is provided in Appendix 11.

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## APPENDIX 1

List of attendees at the RAP Habitat Subcommittee meeting - October 3, 1996

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|---|---|---|---|
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## APPENDIX 2

Agenda of the RAP Habitat Subcommittee meeting - October 3, 1996

**RAP HABITAT SUBCOMMITTEE**

**MEETING #2**

**MIDDLE SHOAL CHANNEL DREDGING**

**AGENDA**

1. **Introduction** (J.D. Pringle)
2. **Background** (R. Sweeney)
3. **Artificial Reefs** (D.J. Scarratt)
4. **Juvenile Cod Distribution and Abundance in Relation to "Site A Revised"** (T. Lambert)
5. **Discussion and Recommendations**

## APPENDIX 3

Rationale, as provided by the consultant of the Little Narrows Gypsum Company, for requesting permission to initiate the Middle Shoal Channel Improvement Program.

*December, 1995*

# *Environmental Review and Approvals Submission for... Middle Shoal Channel Improvement Program*

***Presented to:***
Department of Fisheries and Ocean,
Canadian Coast Guard,
Environment Canada,
c/o DFO
P.O. Box 550,
Halifax, Nova Scotia B3J 2S7

***On behalf of:***
Little Narrows Gypsum Company
RR#1
Little Narrows, NS B0E 1T0

***By:***
John A. Amirault, P.Eng.
c/o William Alexander & Associates
5171 George St., Suite 300
Halifax, NS B3J 1M6

## *1.2 Need for Improvements*

Ocean shipping is the most cost effective and socially acceptable mode of long distance transportation of heavy bulk materials such as timber and minerals. The present navigational limitations at the Middle Shoal, off the seaward approaches to Great Bras d'Or are growing obstacles to the viability of trade in bulk resources from central Cape Breton Island. To maintain a competitive presence in international trade, transportation costs must be controlled by the efficient use of suitable cargo vessels. The navigational and draft limitations of the Middle Shoal Channnel cause vessels to be loaded to less than 80% of their full cargo capacity, with a proportional penalty on the unit cost of transportation (ref. Fig. 1.2). In addition, the pool of charter cargo vessels is restricted now, and is diminishing, leading towards less competitive transportation costs and increasing difficulty in chartering good vessels with good crews.

The transportation cost of low value commodities such as timber and gypsum is a large proportion of the total delivered cost of product. The inefficient shipping is contributing to a decline in the marketability of the region's resources. The projected impacts of this trend are loss of employment and skills, loss of capital investment and the adverse social consequences of a declining and narrow based local economy.

The current declining trend is both real and serious. There is a course of action available that can not only halt the decline, but may reverse it and offer opportunities for renewed strength and growth in the local economy. That course of action is to dredge and create an improved navigational channel into the Great Bras d'Or. The contrast between the two options, do nothing or make the improvements, is very stark. The section of this submission that deals with the socio-economic impacts of the project provides that comparison. The improvement option involves implementation of a realistic project that is not based on speculative or experimental solutions, but on relatively straight-forward dredging work similar to that carried out in waterways and coastlines every year.

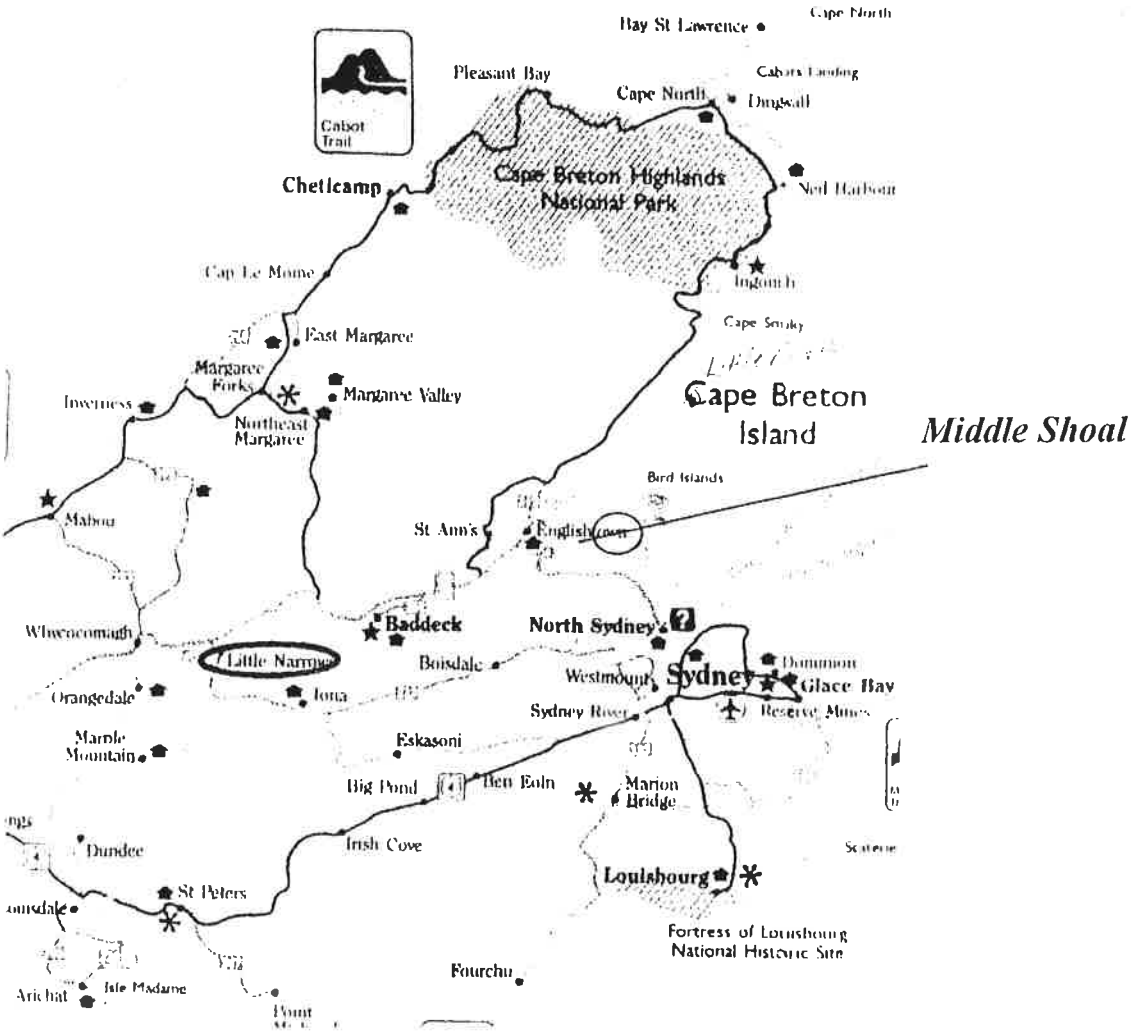
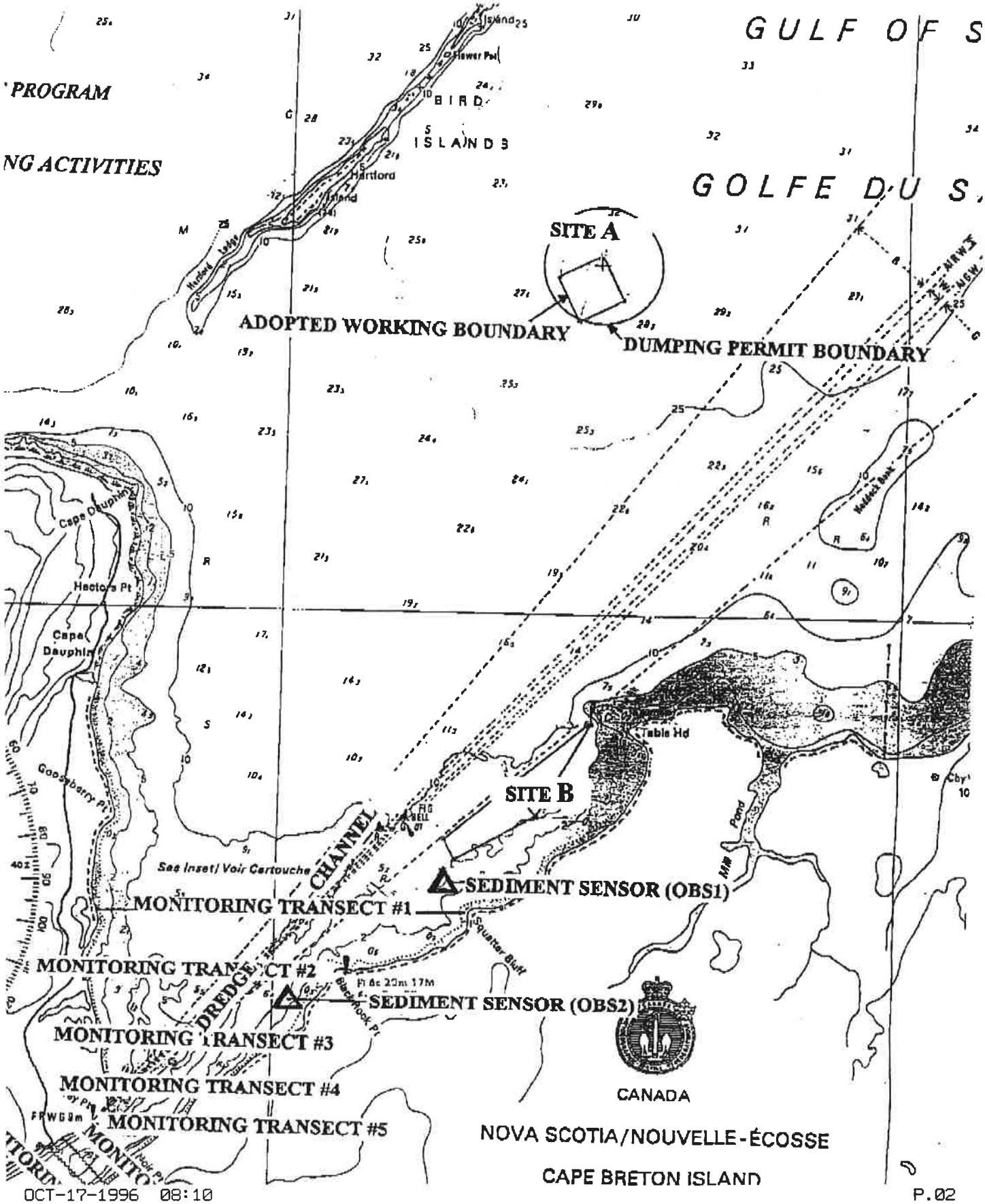

Bay St Lawrence
Cape North
Pleasant Bay
Cape North
Dingwall
Cabot Trail
Chéticamp
Cape Breton Highlands National Park
Neil Harbour
Cap Le Moine
Ingonish
East Margaree
Margaree Forks
Margaree Valley
Inverness
Northeast Margaree
Cape Breton Island
Middle Shoal
Bird Islands
Mabou
St Ann's
Englishtown
Baddeck
North Sydney
Wreckhouse
Little Narrows
Boisdale
Sydney
Dominion
Glace Bay
Orangedale
Iona
Westmount
Reserve Mines
Sydney River
Marble Mountain
Eskasoni
Big Pond
Ben Eoin
Marion Bridge
Dundee
Irish Cove
Louisbourg
St Peters
Fortress of Louisbourg National Historic Site
Arichat
Isle Madame
Fourchu

*Fig. 1.1*

## APPENDIX 4

Location of Site A, the location of Site A Revised (Reef Site) where the artificial reef (400 m x 400 m in size) was constructed. Note the location of Bird Islands.


PROGRAM
NG ACTIVITIES
GULF OF S
GOLFE D U S
BIRD
ISLANDS
Hartford
Island
SITE A
ADOPTED WORKING BOUNDARY
DUMPING PERMIT BOUNDARY
Cape Dauphin
Hector's Pt
Cape Dauphin
Table Hd
SITE B
CHANNEL
See Inset/ Voir Cartouche
SEDIMENT SENSOR (OBS1)
MONITORING TRANSECT #1
MONITORING TRANSECT #2
SEDIMENT SENSOR (OBS2)
DREDGE
MONITORING TRANSECT #3
MONITORING TRANSECT #4
MONITORING TRANSECT #5
CANADA
NOVA SCOTIA/NOUVELLE-ÉCOSSE
CAPE BRETON ISLAND

## APPENDICES 5 AND 6

Submitted to the Habitat Subcommittee meeting by one of the project's consultants, D.J. Scarratt (specialist on the biological aspects of artificial reef construction in the marine environment).

# APPENDIX 5

Report of meeting held February 7 1996, between:

Fishermen from Bras d'Or and Dr. David J. Scarratt

to discuss the Middle Ground Dredging Proposal
submitted by Little Narrows Gypsum Company

Joe MacLean, chairman.

Seven fishermen were in attendance, two others came later. Joan Reid, DFO Habitat Branch was also in attendance.

David Scarratt began with a general description of artificial reefs built for lobsters in eastern Canada, and drew on some other examples of reefs from Europe and elsewhere. In general, on the basis of observations elsewhere and an understanding of the type of material which will be dredged, it is not expected that dredging the channel will create any permanent disturbance to lobster populations although the 'scar' will take 2 - 4 years to re-establish a bottom fauna. The material is a coarse glacial till with only 3% fines, and should recolonize readily once dumped

To create an artificial substrate for lobsters, spoil should be dumped in a discontinuous random series of 'reeflets' rather than in one large pile. This will occupy a greater area but will maximize the 'edge effect' noted in existing artificial reefs and increase the number of lobsters accommodated. Given that the material is gravel and poorly sorted till with relatively few large boulders, the effectiveness of the reef could be improved by depositing any larger material gained from dredging ledge bedrock after the smaller material has been placed. If funds were available purpose-quarried material could be used to increase the size range of lobster burrows. Experience shows that while initial colonization will be by larger lobsters, small lobsters will settle on the reef once the natural biota begins to be established and real productivity will be increased permanently after a period of 5 - 7 years. The extent of the gain will be a function of the material used to build the reef.

There was much discussion on the numbers of lobsters likely to be killed during the dredging, (very few, since they will mostly avoid the grab) and the number which may be smothered during the dumping (possibly somewhat higher, depending on the nature of the bottom and the time of year). There was discussion on the best location for the site selected for the reef. If a 'dispersed' design is adopted, the area required will be about 1 km X 1 km. There was some suggestion that shallower water than that found off the Bird Islands would be preferable due to an increased likelihood of establishing kelp beds, and an area immediately North of the dredge site (between Table Head and Cape Dauphin) was suggested. This would reduce the distance the spoil would need to be transported. The area suggested is not regarded as prime lobster bottom, although there are a few scallops. Other areas discussed and dismissed were between Black Rock and Table Head (too shallow, too exposed) and Table Head to Point Aconi inside Haddock Bank. Any savings in transporting the spoil might be used for adding quarried rock to the reef design.

There was discussion on the value of an experimental dredge/dump program which should be conducted as soon as possible. This would allow some estimate to be made of the amount of fine sediment likely to be disturbed and lost during dredging and dumping. This would in turn allow evaluation of the likelihood that adverse concentrations of suspended sediment, or reductions in dissolved oxygen, might inhibit the passage of migratory fish such as salmon, mackerel, herring, smelt, through the narrows at Carey Pt. and into the lake. The idea was discussed of requesting that an operational monitoring program be established to ensure that dredging cease if excessive levels of silt were detected sufficient to inhibit the passage of migratory fish. There was a suggestion that some baseline monitoring be done of natural

sediment concentrations under extreme storm conditions in order to make comparison with dredge-induced conditions.

An experimental dredge program would also allow evaluation of the surface configuration of newly dredged bottom and of dumped spoil, and hence their future suitability as natural habitat and as an artificial reef respectively. The need for augmenting the reef surface with additional rock would become apparent. There was some discussion that the suggested site for a reef (off Cape Dauphin) is close to an old stone ballast dumping ground where lobster fishing is good. This is regarded as evidence that an artificial reef built of rocks will support lobster populations.

There was discussion on the likely effect of deepening the channel on current velocity. Not all present accepted that currents would not change in any significant or measurable fashion. Not all present accepted that there would be no detectable changes in salinity regimes due to the dredging, even though no reason exists for anticipating any changes in salinity. There was discussion on the likely need for blasting and its possible effects. The Company's position is that any rock encountered will be taken out by digging and no blasting will be done under any circumstances. Blasting would require a separate permitting procedure and could not be done as a spur of the moment decision.

Joan Reid, DFO, outlined the permitting route the Company would be obliged to take to have the project approved. It will require the approval of DFO, including Coast Guard, and DOE. While changes to fish habitat are, in general, not allowed, the minister may authorize changes if, on balance, there is no significant deterioration of fish habitat, or if potentially damaged habitat is compensated for by construction of new habitat which will improve fisheries production. All proposals will be evaluated by experts capable of deciding whether the net balance between loss and improvement is favourable.

Other fisheries that may be considered vulnerable are:

1. Scallops. There is concern that sediment from the dredging will bury scallop beds, however this is unlikely due to the small amounts of fines in the spoil, and the strong currents in the area. Spoil dumping may bury a few scallops (and lobsters) directly, but a dispersed reef will allow dragging for scallops between and over the piles, or scallops may be harvested by recreational diving in the undisturbed areas between the individual piles of spoil material.

2. Sea Urchins. This experimental fishery is not yet fully established. A reef shallow enough to allow the growth of seaweeds will in time support an urchin population. No long term-disruption will be anticipated if the reef site is selected with care. There may be a long-term benefit to this fishery if the amount of bottom where seaweeds may grow is increased.

3. Crabs. Some fishermen set traps for rock crabs. Some crabs may be smothered during reef construction, but overall populations will be enhanced by an artificial reef, due to improved conditions for larval settlement, and the shelter provided.

4. Flatfish. Seining for flounder and other inshore ground fish is not common, but any future initiatives in the area of an artificial reef would be adversely affected due to the changes in bottom topography. Long lining or hand lining for groundfish, or the setting of bottom or surface gill nets, if allowed, would be unaffected.

Other issues addressed were:

1. Ballast water. There is a concern for the discharge of living foreign organisms in ballast water. It is recognized that this is an existing issue which is not directly changed by alterations in the channel configuration. Nevertheless, the risk of introducing foreign species may be

increased if vessels from European ports, encouraged by deeper channel depth and reduced unit costs for shipping, begin to use the channel. This requires resolution through enforcement of existing shipping regulations and operational protocols.

2. Deck washing and tunnel washing. Vessels departing the gypsum wharf have been observed washing decks of accumulated rock dust, and washing conveyer machinery and spaces of dust while exiting the Bras d'Or. This issue is also unaffected by the channel proposal, but is nonetheless a bone of contention and should be addressed by direct negotiation with the Company.

General Discussion.

In general the fishermen are opposed to the proposal and wish that they could get about their work without any hindrance. They believe that they alone will be subject to disruption of their normal working lives and, depending on location, will be subjected to losses attributable to the project for a period of up to 7 years, or however long it takes to re-establish natural living communities in the dredged and dump areas. They may also be displaced from some of their traditional fishing areas while the work is in progress and while the grounds are being re-established, with consequent increased fishing pressure on neighbouring grounds, and annoyance to neighbours who may not otherwise be directly affected by the project.

There is already an inconvenience and expense in having to deal with the project, attend meetings, and defend and protect their own interests and livelihoods. In the future they may have to establish personal monitoring and accounting systems which will help them identify and quantify any losses they may incur. The fishermen recognize they may be disadvantaged in not having adequate historical data to support claims and appeals. They also acknowledge that the proposal to create improved lobster habitat may result in improved conditions after 5 - 7 years, but submit that such results can be neither guaranteed nor quantified in advance, and they will be subject to loss and disruption while the reef is maturing and its success is being determined.

If the project is approved in spite of their opposition, they recognize that they will not all suffer equal disruption or loss, and while general principles may apply, each fisherman's case will need to be assessed individually. They are concerned that proper procedures for evaluating the short and long term environmental effects be put in place, and that adequate monitoring and claim procedures be established so that appropriate compensation for inconvenience, direct and indirect losses, and increased costs attributable to the project can be negotiated. This may include, but is not necessarily limited to compensation for keeping lobster traps or other gear ashore rather than crowding them on to neighbouring grounds, for the losses in revenue caused by reduced fishing opportunity, or for poor fishing success due to changed bottom type.

Whether or not the proposed reef is successful in increasing lobster productivity, this should be quantified through an appropriate long-term monitoring program, so that some scientific understanding of the process will be gained. Similarly the recovery of the biota in the dredged channel should be monitored.

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# APPENDIX 6

# Artificial reefs for lobsters in Atlantic Canada

## A Working document for the Middle Ground Dredging project

A proposal to dredge the Middle Ground Channel in the entrance to the Great Bras d'Or (Amirault, 1995) includes the suggestion that the spoil may be used to augment lobster habitat. Following is a discussion of the known occasions on which artificial habitat for lobsters has been created in Atlantic Canada, which may be used as a basis for evaluating the reef construction concept.

a) The Kouchibouguac Bay, N.B. lobster reef:

The first artificial reef known to have been constructed in Atlantic Canada was built in the summer of 1965 of quarried rock, about 5 km offshore in Kouchibouguac Bay, Northumberland Strait (Scarratt, 1968; 1973). The site was selected on the basis of a comprehensive sedimentological survey of the area, and pre-surveyed by divers. The bottom was of a poorly sorted glacial till, predominantly sandy at one end and with a coarse gravel/sand mixture at the other. Depth is 18m at low tide. About 1500 $m^3$ of rock, 5-100cm diameter and up to 15 cm thick were dumped in an irregular pattern roughly 100m x 50m, and covering about 2740 $m^2$ (=0.274 ha or about 0.677 acres). The nearest natural outcrops on which lobsters were found was about 400m distant, and the nearest major concentrations of lobsters are 2 - 2.5 km shoreward.

Colonization of the reef by lobsters was initially by vagrant animals which occupied the crevices among the rocks, and were likely transitory. Lobsters were believed to have overwintered on the reef in 1966-7 since obviously hibernating individuals were recovered from deep among the rocks in May 1967 when the water was still extremely cold.

Productivity on the Kouchibouguac reef (Scarratt 1968, 1973).

The lobster population increased progressively from nothing in 1965 to an estimated 425 lobsters in 1971, and an observed 402 in 1973. At the same time there was a systematic decline in the mean size of the lobsters until it was not different from that on inshore grounds (40-42 mm carapace length). The total biomass of lobsters increased to an estimated 41.5 kg in 1971; equivalent to 15.1 $g.m^{-2}$, higher than the mean of 12.6 $g.m^{-2}$ on good natural lobster grounds reported in 1968. The smallest lobster seen measured 7.2 mm c.l., and had clearly settled on the reef. It may safely be assumed that the artificial reef is supporting a natural population of lobsters which settle there as well as larger vagrant lobsters which occupy the reef temporarily.

After 5 years maturation, lobster biomass on the reef was estimated at 41.5 kg, of which 11.5 kg (27.8%) was estimated to be of legal size (>63.5 mm c.l.). At that time, a legal-sized population of 11.5 kg on the reef measuring 0.274 ha, was equivalent to 41.97 kg/ha, which, at an exploitation rate of 75%, was equivalent to a legal harvest approaching 30.15 kg/ha. It should be noted that Maritimes-wide lobster landings in 1971-73 (when the survey was conducted), were about 15,000 tonnes, almost the lowest since records have been kept. By contrast, overall landings in 1988, at 40,000 tonnes, were approaching the highest ever recorded. Thus it may safely be assumed that the reef population would have also reflected this increased biomass, perhaps approaching 110 kg, with an annual commercial harvest of about 23.4 kg, equivalent to a commercial productivity rate of about 86 kg/ha.

Observation of the Kouchibouguac reef suggested that there was a considerable "edge effect". That is, the edges of the reef offered better lobster habitat (or at least supported more lobsters) than

the centre. Unpublished conclusions, supported by a variety of other sources, suggest that the same volume of rock, scattered in discrete piles over an area of 1 - 1.5 ha, would have maximized the production potential of the reef material. Some settlement and inundation of the reef material by sand was reported in 1973. The reef has not been visited since then and a thorough re-examination would be valuable.

b ) The Belledune Reef.

A second artificial reef for lobsters was constructed of rock excavated from the approaches to the harbour at Belledune, N.B. in 1990 and 1991. Approval for this dredging project was conditional upon the design of an appropriate plan for disposal of the excavated rock in a manner which would compensate for the lobster habitat destroyed by the excavation (SEnPAq, 1992). The reef constructed covered an area of 0.8 $km^2$, and comprised individual piles of rock distributed more or less randomly within the designated area approximately 1.5 km east of Belledune Harbour. The bottom was of sandy mud and considered to have low productivity for lobsters. The design was based in part on the findings of (inter alia) Scarratt, (1968); Cobb, (1971); Himmelman and Steele, (1971); (Mann and Breen, 1972); Cooper and Uzman, (1983); and D'Itri, (1986):

Lobster biomass on the artificial reef constructed east of Belledune, N.B.

Lobster biomass on the newly constructed Belledune reef can be estimated from a preliminary survey conducted in summer of 1992 (SEnPAq, 1992) when the reef was 1-2 years old. The survey report purports to have examined 2.7% of the reef area, however there are several inconsistencies in the SEnPAq document. If the track of the dive survey was 9 m wide as claimed then the area examined was 21,600 m2, (not 20,500 as stated), and some assumptions need to be made as to the continuity of the individual 50 m transects which encompassed rock piles and natural sea bed. Eighty six lobsters were collected and measured.

From Cobb and Phillips, (1980: Vol 1, p 122) it is possible to estimate the weight of lobsters of a given size. These conversions have been applied to the data of SEnPAq, (1992) yielding an estimated lobster biomass of 19.802 kg on the surveyed area. This equivalent to 0.967 $g/m^2$. From this it is possible to estimate that 11.89 kg of lobsters, equivalent to 60% of the total biomass, exceed the local legal size limit of 62.5 mm carapace length. Total reef population could thus be estimated at 3,185 lobsters weighing 733 kg, of which 1911 individuals (440kg) would be of legal size

Note that the Belledune reef is by no means mature. Scarratt, 1973 showed that, for the first few years of the Kouchibouguac Bay reef's existence it served mainly to attract vagrant lobsters, and did not become colonized by small lobsters until the fourth or fifth year. The Belledune reef, after 1-2 years is behaving in exactly the manner predicted from Scarratt's observations.

The overall topography of the Kouchibouguac and Belledune areas are similar, low rocky foreshores, with areas of reef, glacial till and soft sandy or muddy bottoms. It is therefore a reasonable assumption that reefs constructed at Belledune and off Kouchibouguac will have similar productivity.

c ) Observations on artificial reefs constructed in the Gaspé:

In November 1992, after a careful scrutiny of the sea bed out to the 20m contour, in an area extending some 10 km on either side of Cap d'Espoir (approx 15 km south of Percé) two types

of reef were deployed specifically to explore the possibilities of augmenting lobster productivity in the area (Anon, 1994; 1995). A series of 7 locations, either on sand or on bare bedrock were covered with loads of quarried rocks ranging from 5 - 50 cm diameter. These artificial reefs were designed to be attractive to settling lobsters, and were similar in most respects to the Kouchibouguac reef.

A second type of modular reef unit comprising scrap auto tires bedded in concrete was designed to attract adult lobsters. Twelve units were constructed, each measuring 1.2 x 2.5 m, and deployed at a single location on hard bedrock. The reefs were examined in the summer and fall of 1993 and 1994, and lobsters seen were recorded. In some cases lengths and weight were measured, in others just estimated.

The quarry rock reefs attracted lobsters ranging from 20-80 mm carapace length in much the same way as the reefs of Belledune and Kouchibouguac, except that overall biomass was somewhat higher, and small lobsters (<50mm c.l.) were found at an earlier date in the reefs' maturation. Numbers and biomass ranged between 10 - 46 /100 $m^2$, and 1.2 - 5.8 kg/100$m^2$ respectively. While no young-of-the-year were found on the Gaspé reefs they clearly were attractive to small lobsters, and the rate of colonization clearly indicated a large local population for them to draw from. By way of contrast, the Kouchibouguac reef after 5 years had a lobster biomass equivalent to 1.51 kg/100$m^2$ (151 kg/ha), at a time when lobster populations generally were barely 40% of those in the early 1990's.

Ten lobsters only were observed in the tire reef units and all were large (ca. 80mm c.l.).

The reefs developed a typical fauna of fouling organisms in the time observed, however the tire units were subject to some displacement either as a result of ice or storms.

## Application to the Bras d'Or situation

According to Amirault (1995) the bulk of the material to be dredged from the Middle Ground is a poorly sorted gravel and glacial till with occasional larger cobbles and boulders up to 30 cm diameter. This is unlikely to produce a substrate with a great number of interstices of a wide range of sizes. Most of the intertices will be small, and thus support a relatively small size of lobster. Larger irreular shaped boulders will be more likely to create opportunity for larger lobsters to excavate burrows. There is a small possibility that some bedrock may need to be excavated. If possible this should be placed on top of other dumped material to increase the likelihood of creating suitable topography for lobsters.

If the spoil is dumped on a firm substrate it will likely remain on the surface rather than sink out of sight. If lobsters do colonise the area, their biomass will be increased by a adopting a discontinuous structure for the reef, i.e a series of discrete piles of rock, rather than having all the spoil dumped in one continuous pile. This will mean that the total area occupied by the spoil will be larger than indicated by the design engineers. A shallower site may be more appropriate.

## Bibliography


Amirault, J. 1995. Environmental Review and Approvals Submission for Middle Shoal Channel Improvement Program. Submitted to DFO, CCG, and Environment Canada on behalf of Little Narrows Gyspsum Co. Dec 1995.

> This applications reviews the need for dredging through the Middle Channel, namely that existing gypsum vessels using the waterway are limited to loading to less than full capacity by clarances in the channel. Discussions with local fishermen and others have identified that the basic concern is the deposition of the spoil, which is gravel with some larger cobbles and a very small proportions of fines. The proposal suggests that this material may be used to create an artificial reef for augmentinmg lobster populations

Anon, 1994. Essai d'augmentation de la biomasse du homard "Récifs artificiels". Programme d'essai et d'expérimentation halieutique at aquicoles, Rapp. d'étape 95. produit par Mariculture de Percé Inc. pour Ministère des Pêches et des Oceans du Canada. 52 p.

Anon, 1995. Essai d'augmentation de la biomasse du homard "Récifs artificiels". Programme d'essai et d'expérimentation halieutique at aquicoles, Rapp. d'étape 95. produit par Mariculture de Percé Inc. pour Ministère des Pêches et des Oceans du Canada. 68 p.

Cobb, J.S., 1971. The shelter-related behaviour of the lobster *Homarus americanus*. Ecology, 52(1): 108-115.

> American lobsters prefer low profile to high profile shelters and prefer habitata with back doors. Shelter is used during daylight.

Cobb, J.S., Phillips, B.F. 1980. The Biology and Management of Lobsters. Vol 2. Academic Press, New York. 390p.

Collins, K.J., A.C. Jensen, and A.P.M. Lockwood, 1990. Fishery enhancement reef building exercise. Chemistry and Ecology, 4: 179-187.

> Describes observations in Poole Harbour, England, where a reef has been designed to include areas of artificial substrate interspersed with unaltered bottom. While lobsters have been observed on the Poole Harbour reef, the population dynamics of European lobsters are sufficiently different to disallow direct comparison with Canadian stocks, but the initial colonization by larger lobsters parallels all observations made on lobster reefs to date.

Cooper, R.A., and J.R. Uzman, 1980. Ecology of juvenile and adult Homarus. In: Cobb, S.J. and B.F. Phillips, The biology and management of lobsters, Vol II, Ecology and Management, Academic Press, New York, 390pp.

Dow, R.L., 1969. Lobster Culture. Maine Department of Sea and Shore Fisheries, Augusta. Fisheries Circular 23:16.

> Trapping experiments and observations have shown that lobsters can be recruited into an area if the proper habitat is available. Shelter materials and designs are proposed.

Hruby, T., 1979. Experimental lobster ranching in Massachusetts. IN: Avault, J.W., ed. Proceedings of the tenth annual meeting World Mariculture Society, Honolulu, Hawaii.

Concrete-filled tires on sandy bottoms were used a shelter by lobsters but the populations were 'unstable' since the lobsters were continually moving.

Scarratt, D.J., 1968. An artificial reef for lobsters (Homarus americanus). J.Fish Res. Bd. Canada, 25: 2683-2960.

Scarratt, D.J., 1973. Lobster populations of a man-made rocky reef. ICES, C.M. 1973/K: 47, 3p.

SEnPAq, 1992. Récif artificiel de Belledune, Évaluation biologique. Tracadie, N.B. 21 p.

Sheehy, D.J., 1976. Utilization of artificial shelters by the American lobster (Homarus americanus). J.Fish Res. Bd. Canada, 33: 1615-1622.

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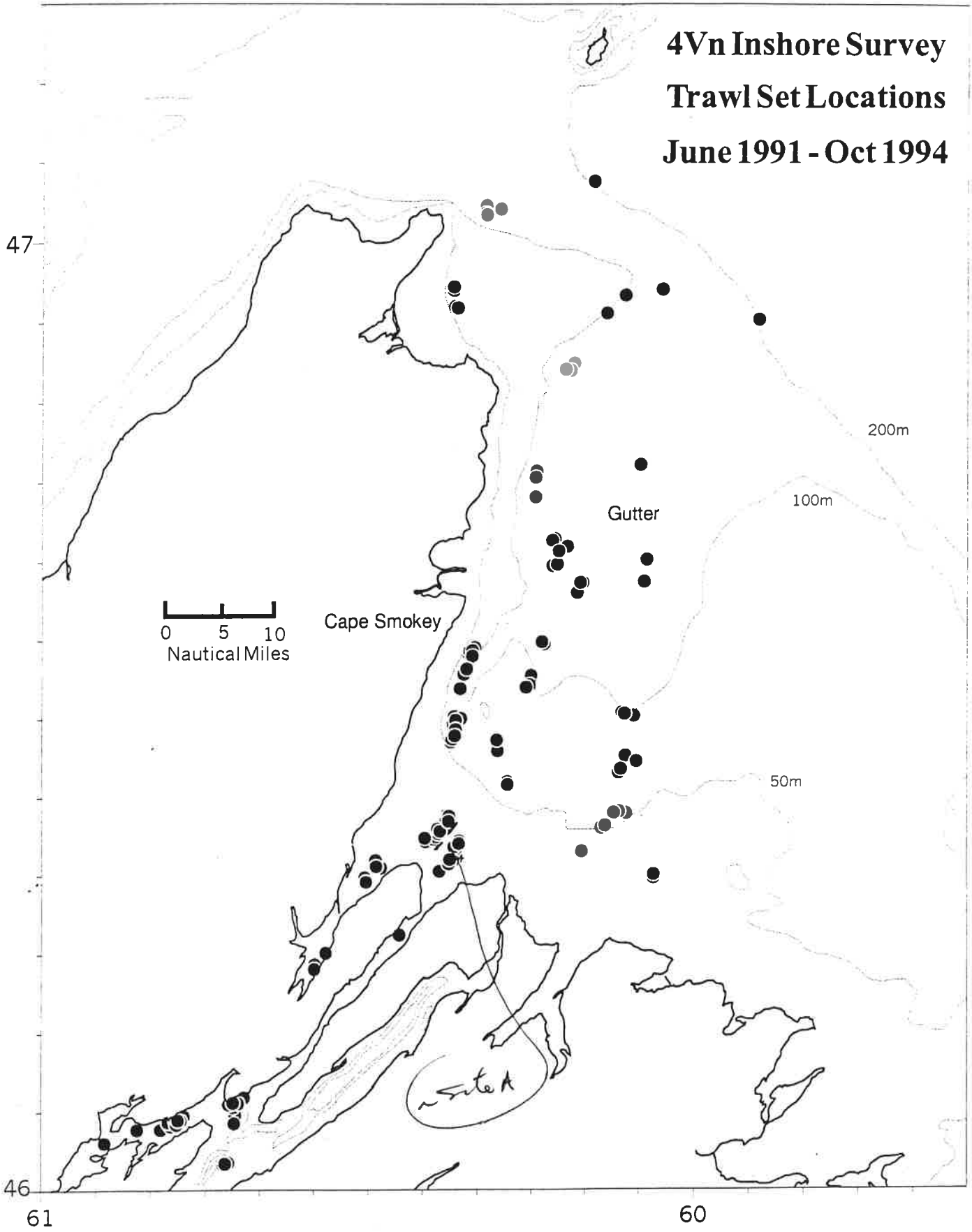
February 1996

## APPENDIX 7

Location of T. Lambert's juvenile code survey stations, sampled bi-annually from 1991 through 1996.


4Vn Inshore Survey
Trawl Set Locations
June 1991 - Oct 1994
47
46
61
60
200m
100m
50m
Gutter
Cape Smokey
0 5 10
Nautical Miles

## APPENDIX 8

Figure showing the numbers of juvenile cod captured in surveys carried out by T. Lambert from 1991 through 1996 in the southern Sydney Bight.

## Cod Nursery Area in Sydney Bight.

*Background*

The area to the west of Sydney Bight from the so-called "Gutter" (east of Cape Smokey), south to the Bird Islands - St. Annes Bay area is well known to inshore fishermen as a cod spawning area and an area where small cod were common. Our inshore survey begun in 1991 showed that the origin of this juvenile cod distribution seemed to be the Bird Island area. The information regarding the presence of juvenile cod in the Bird Island area has been freely discussed with the inshore groundfish fishing industry often at public meetings. At such a meeting in Sydney in late 1991, the sensitivity of the area was recognised and there was general agreement between fixed and mobile gear sectors that there should be a closure to fishing in the SW Sydney Bight area to protect both spawning and juvenile cod. A suggested area as a candidate for such closure was subsequently forwarded to Fisheries Management.

The abundance of juvenile cod in the Bird Island area has been routinely monitored since 1991 in the hopes of developing a reliable recruitment index for 4Vn cod. This information has been presented at annual Resource Assessment Meetings and published in annual DFO Research Documents ( see below). Today there is mounting pressure to reopen fisheries where moratoria on fishing have been imposed; 4Vn is no exception. There has been little or no recruitment to both 4Vn and 4VsW cod stocks since the late 80's and science's response to the clamour for reopening is that there can be no thought of this until substantial recruitment is realised. Thus it is not surprising that cod fishermen are upset when they here of dumping of dredge spoils in an area where the much needed recruitment probably originates.

The inshore survey this autumn (1996) has revealed the highest numbers of juvenile cod in the six-year time series. The area of distribution of juveniles is greatly expanded and now extends as far north as Cape Smokey from the Bird Islands where it was previously localised. However, although juveniles are found over a much larger area, the smallest cod (6-8 cm) are still found only in the Bird Island area. The evidence of six years would indicate that the Bird Island area is the origin or centre of the distribution of young fish and hence perhaps the area of bottom most critical to the success of year-classes.

*Publications*

The following publications include information on the inshore survey conducted in 4Vn where reference is made to the cod nursery in the Bird Island area.

Lambert, T.C. 1992. Subdivision 4Vn cod (May-December): Update of stock status for 1991. CAFSAC Res. Doc. 92/81, 34p.

Lambert, T.C., and S.Wilson. 1994. Update on the status of 4Vn cod: 1992-1993. DFO Atlantic Res. Doc. 94/46, 23p.

Campana, S. (editor), P. Fanning, M. Fowler, K. Frank, R. Halliday, T. Lambert, R. Mohn, S. Wilson, W. Stobo, M. Hanson and A. Sinclair. 1995. Report of the 4Vn cod

working group on the scientific value of a 4Vn cod (May-Oct) stock assessment. DFO Atlantic Res. Doc. 95/16, 110p.

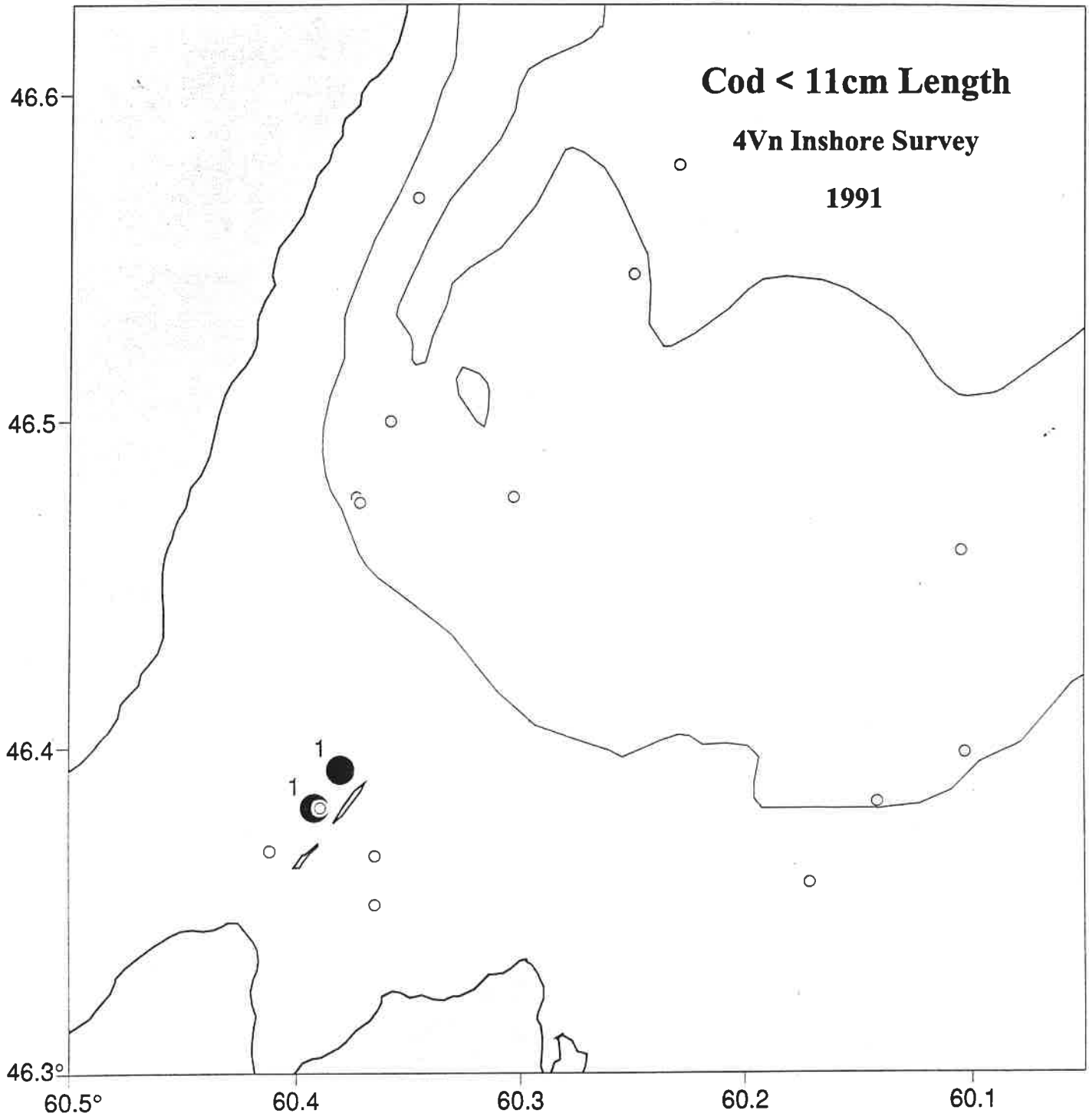
Lambert, T.C., and S.Wilson. 1995. Update on the status of 4Vn cod: 1994. DFO Atlantic Res. Doc. 95/27, 10p.

Lambert, T.C., and S.Wilson. 1996. Update on the status of 4Vn cod: 1995. DFO Atlantic Res. Doc. 96/66, 12p.

*Data Summary (1991-1996)*

Catches of young cod are expressed as numbers per one mile tow. It is difficult to say what absolute abundance this represents. The small flounder trawl that is used for the survey is equipped with a small mesh liner to retain small fish; however it is only located in the bottom part of the cod end of the net and there is ample opportunity for small young-of-the-year and one year-old cod to pass through the much larger meshes of the wings and main part of the trawl. Also, kelp and other large algae often occurs where the small cod are found; large amounts of this seaweed would almost certainly hamper the action of the net causing it to ride off the bottom. Thus while the densities of young cod are probably underestimated, it is also probable that the numbers taken by the net are a reasonably good relative estimate of abundance.

Two length groups of cod are plotted: <11 cm and 11 to 15 cm. The former range represents young-of-the-year and the latter, one year-old fish.

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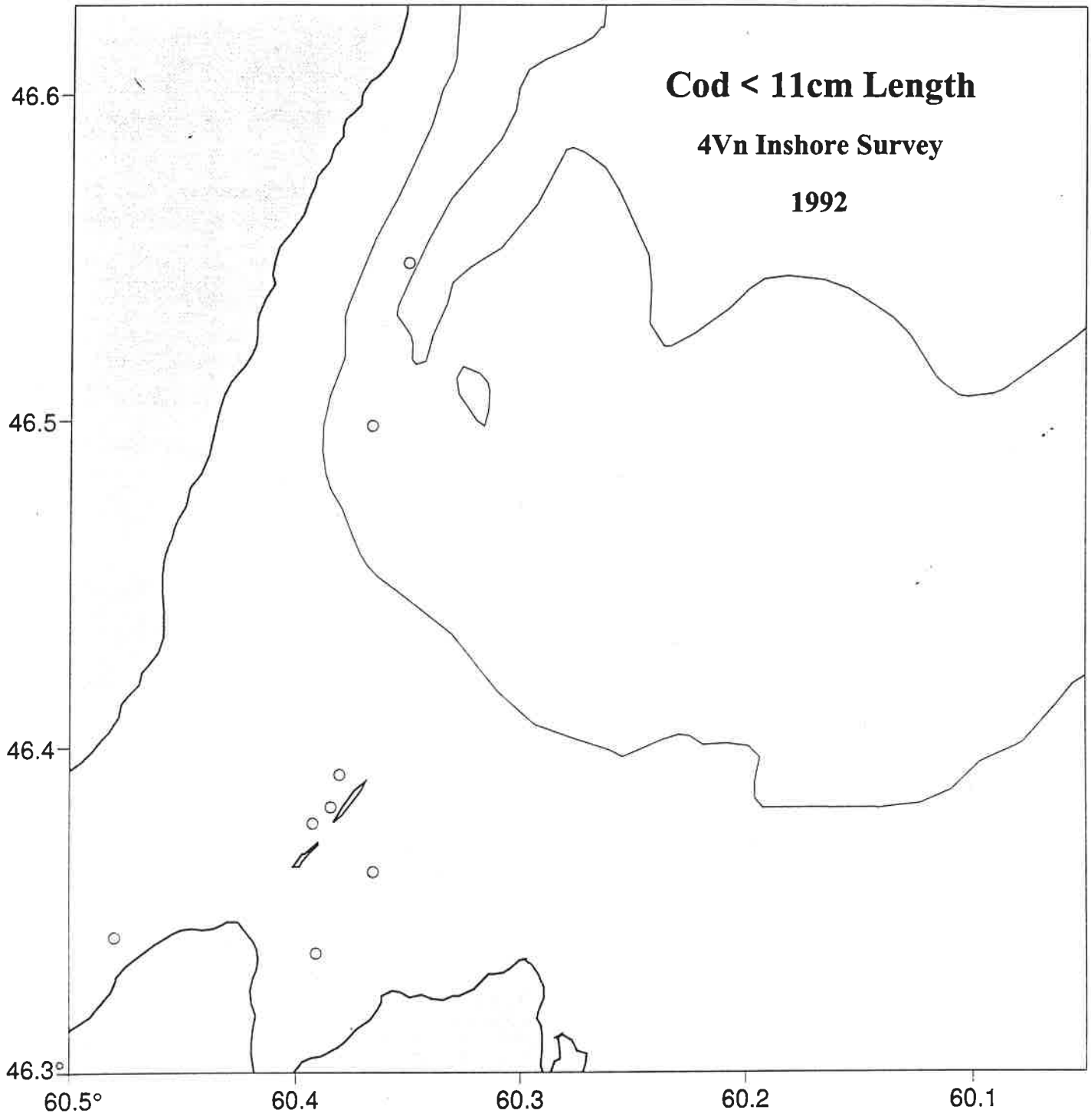


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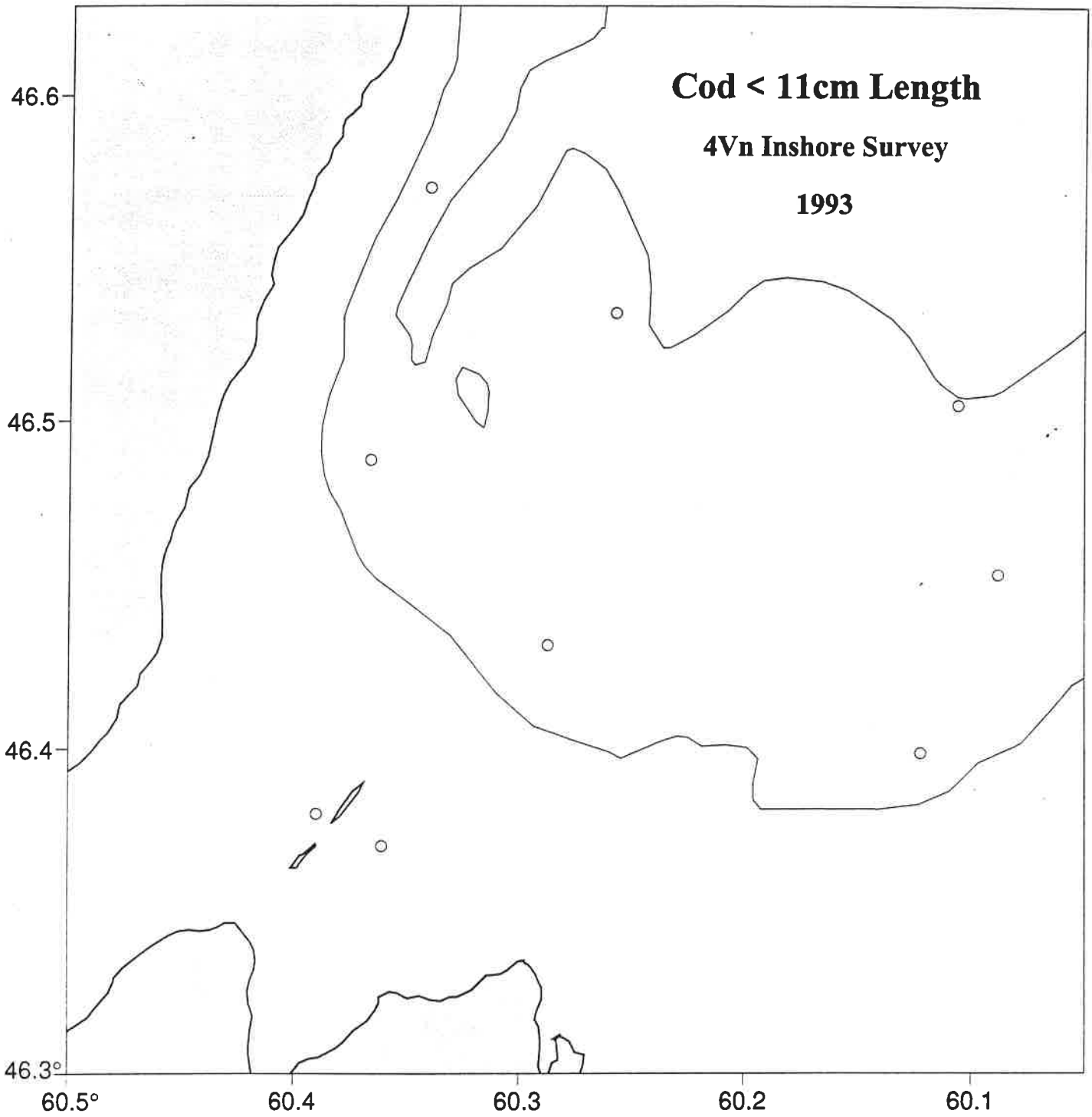


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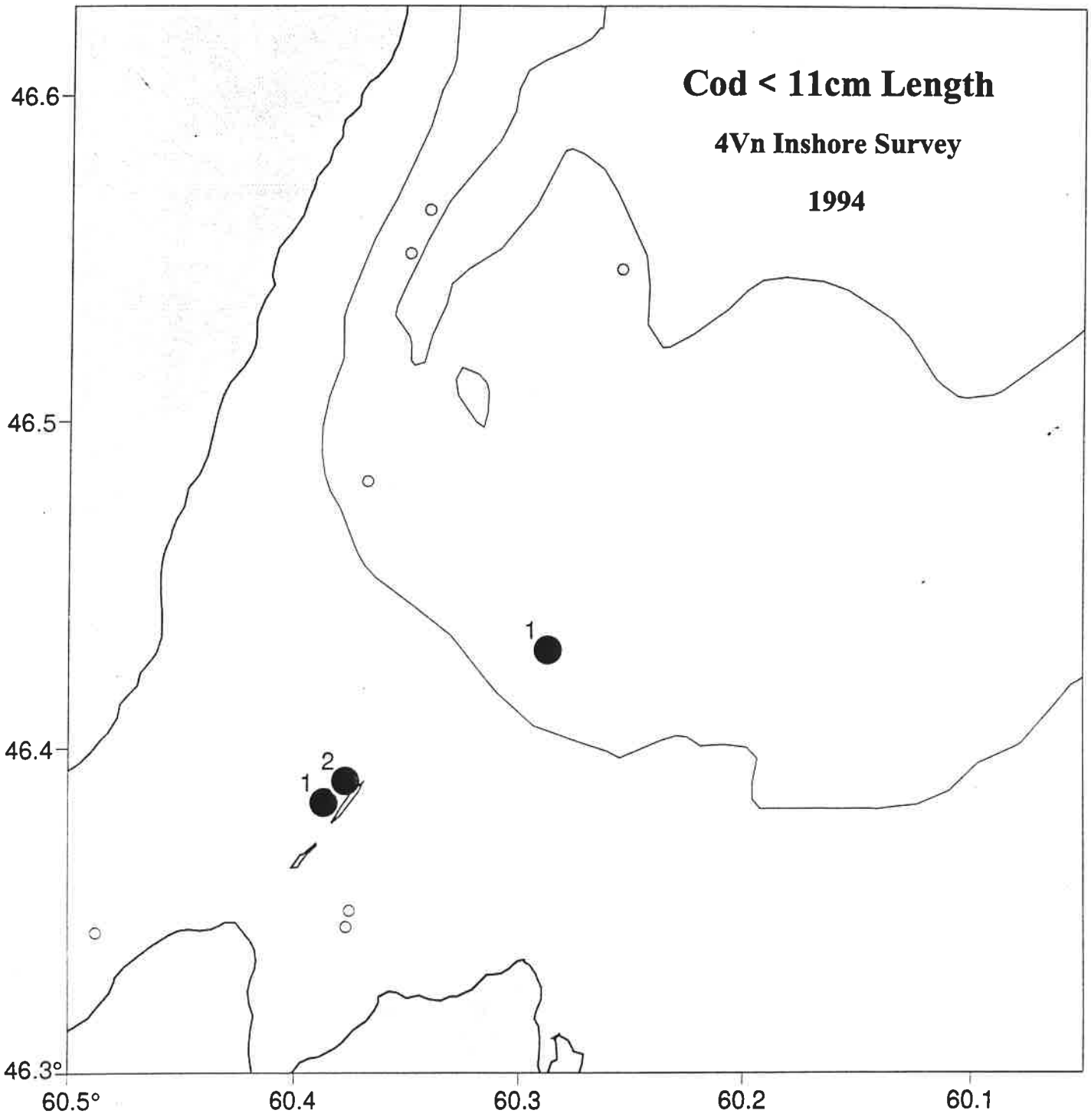


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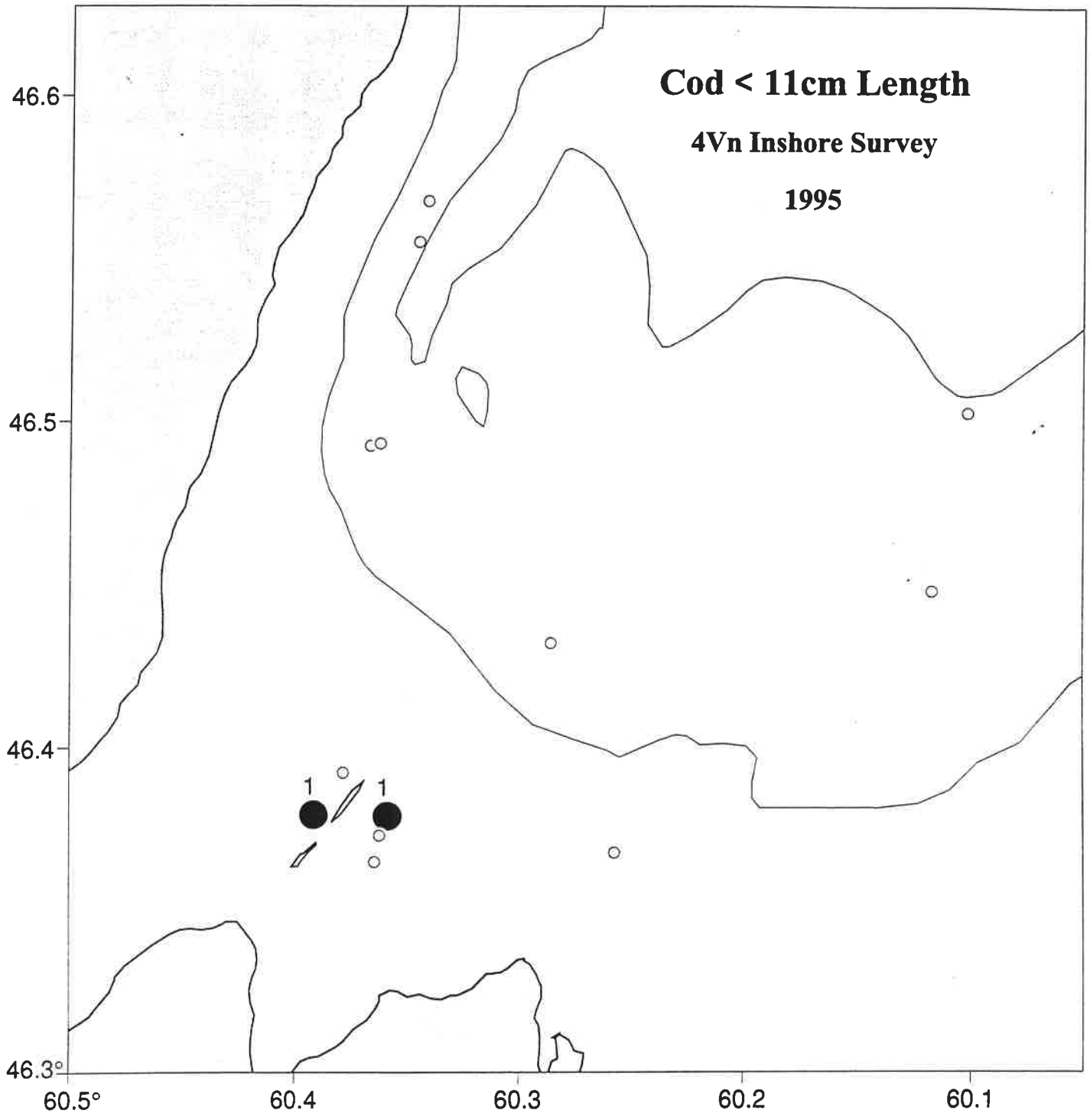


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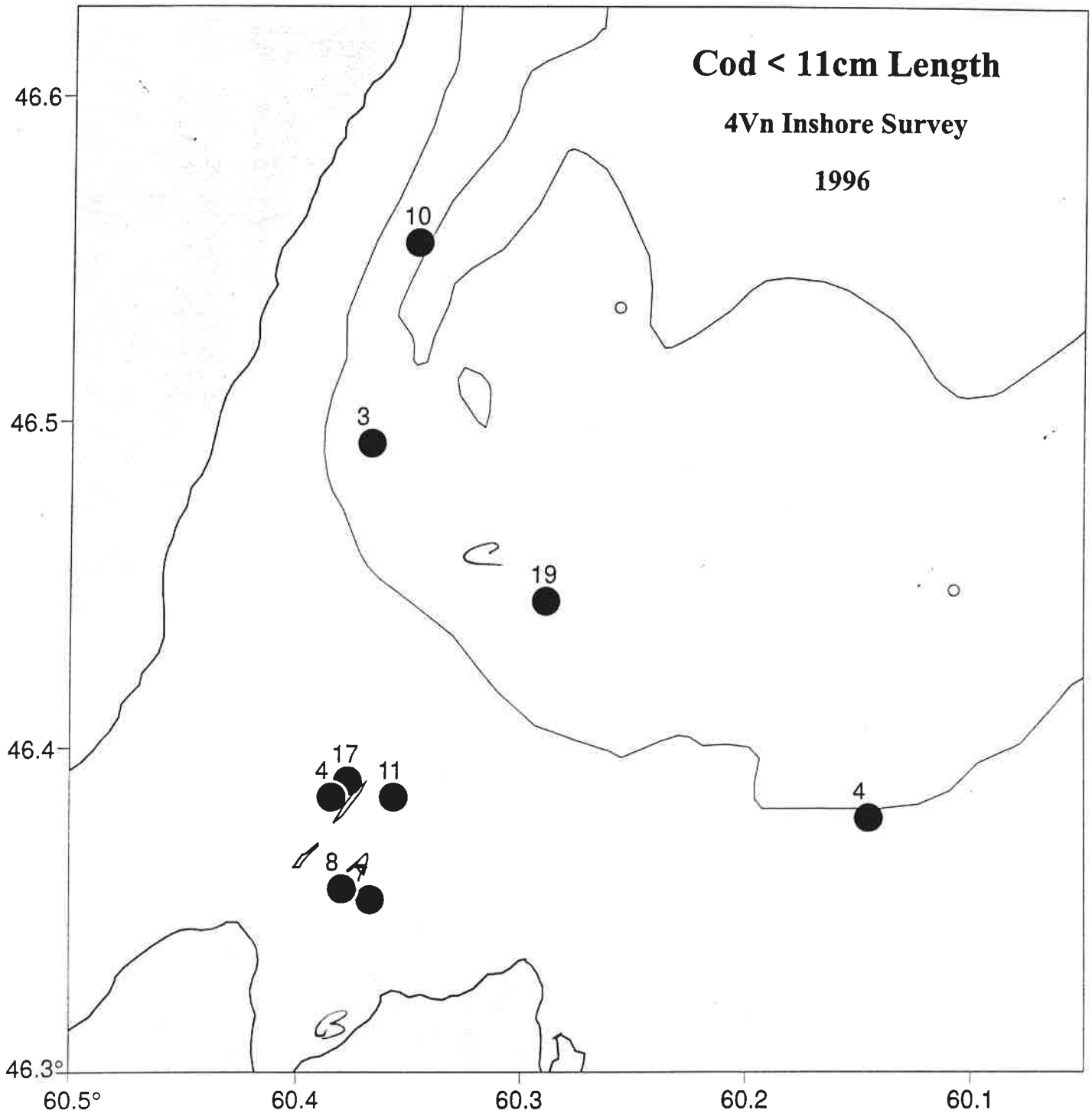


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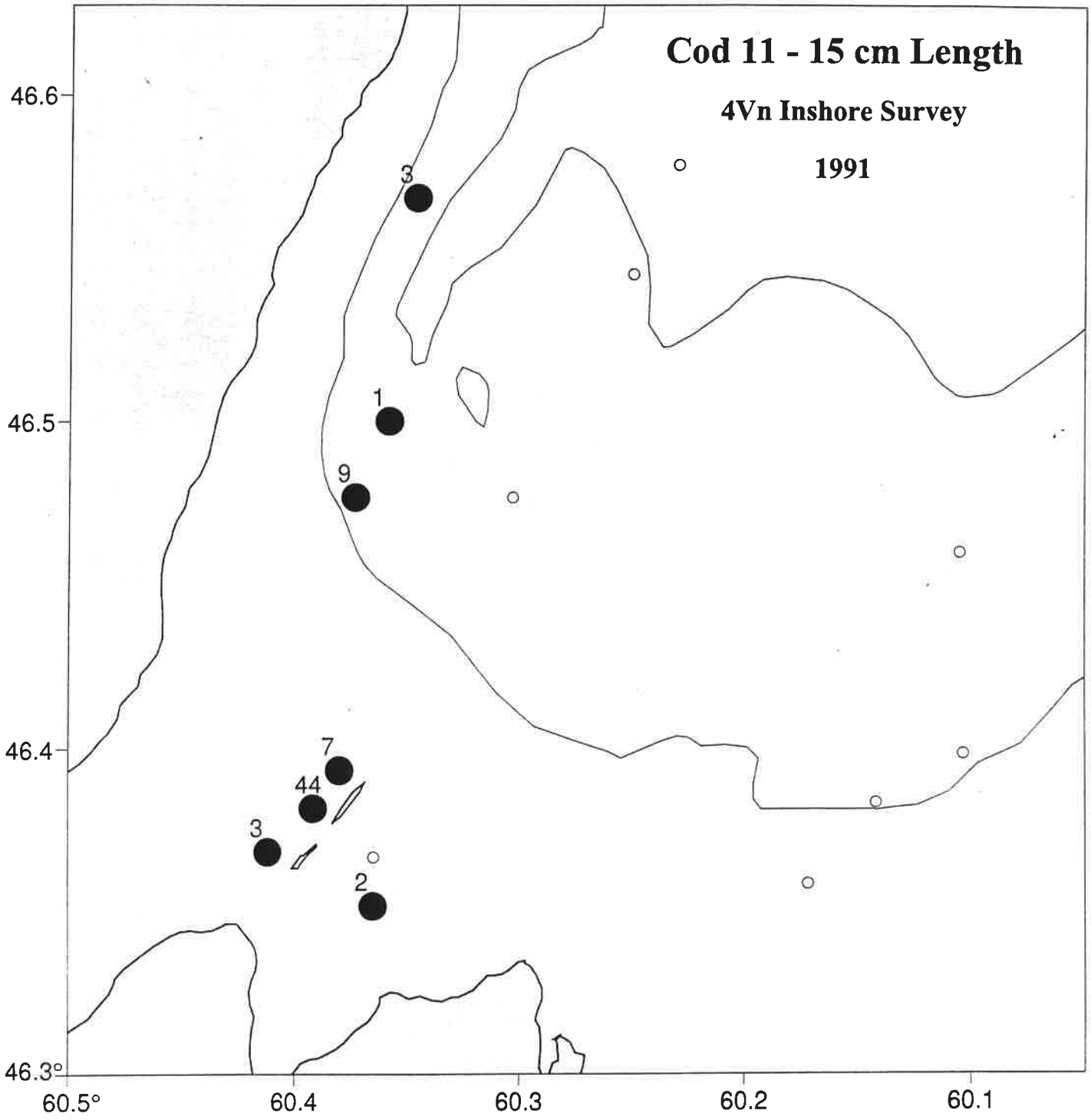


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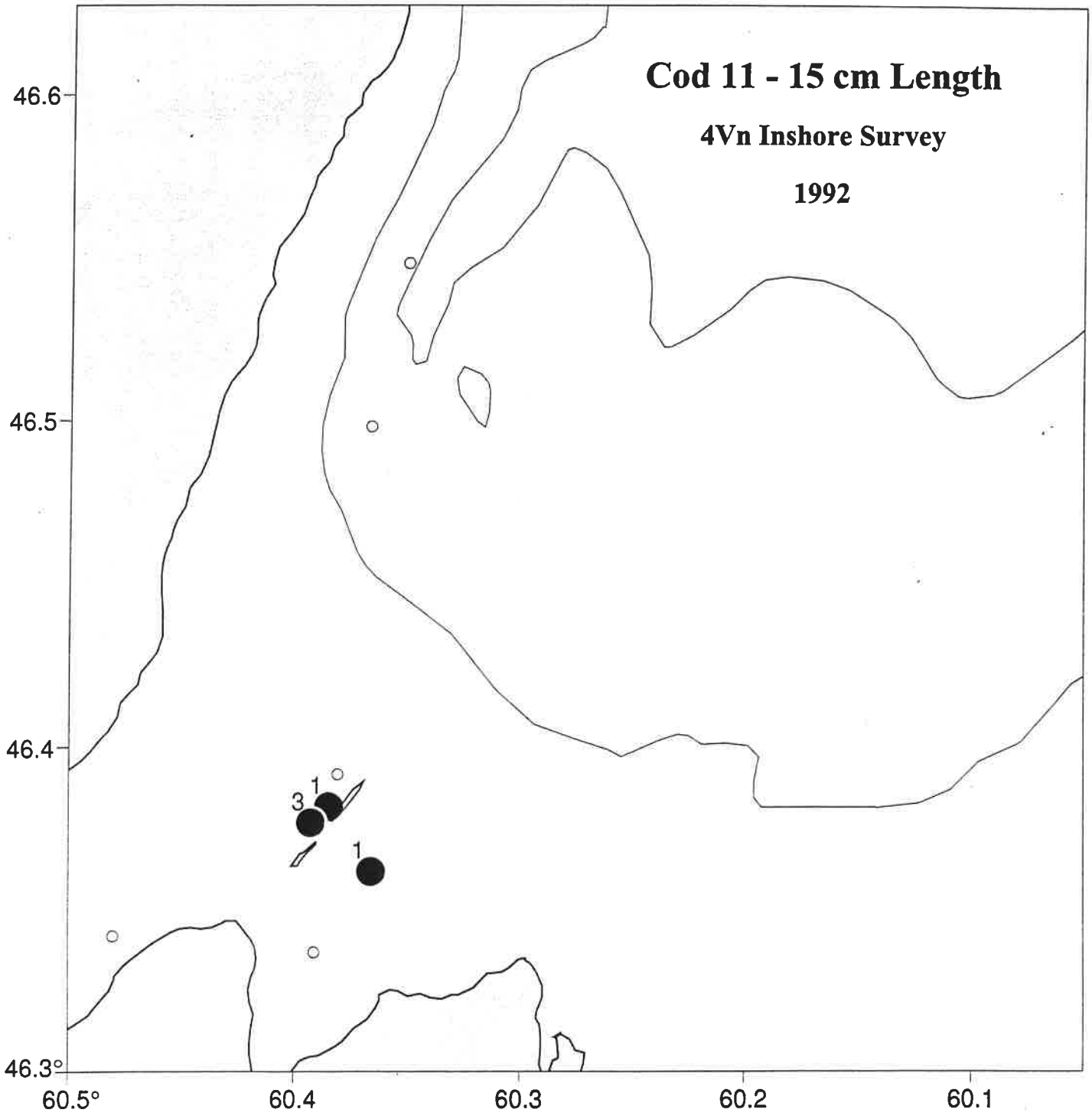


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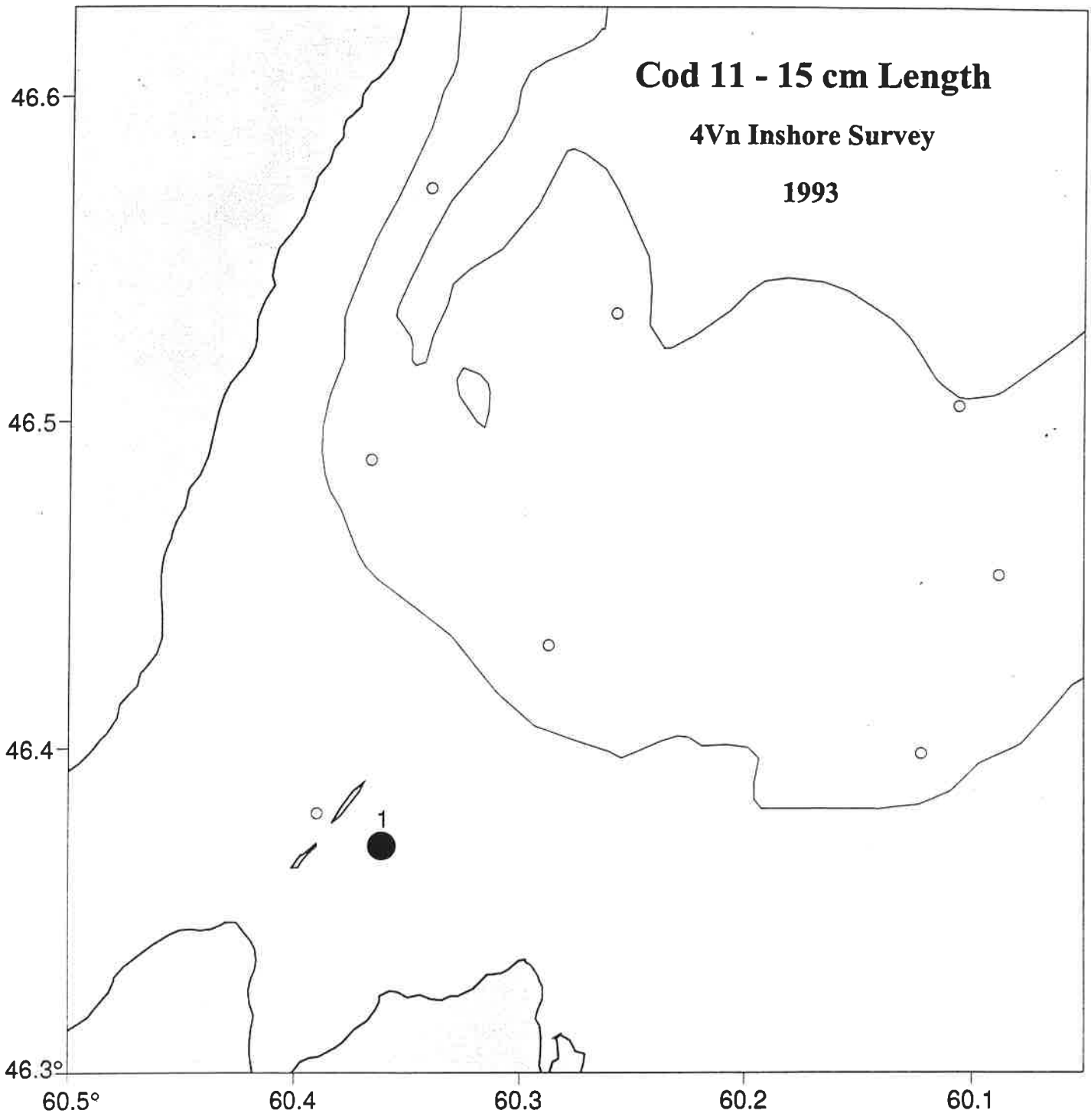


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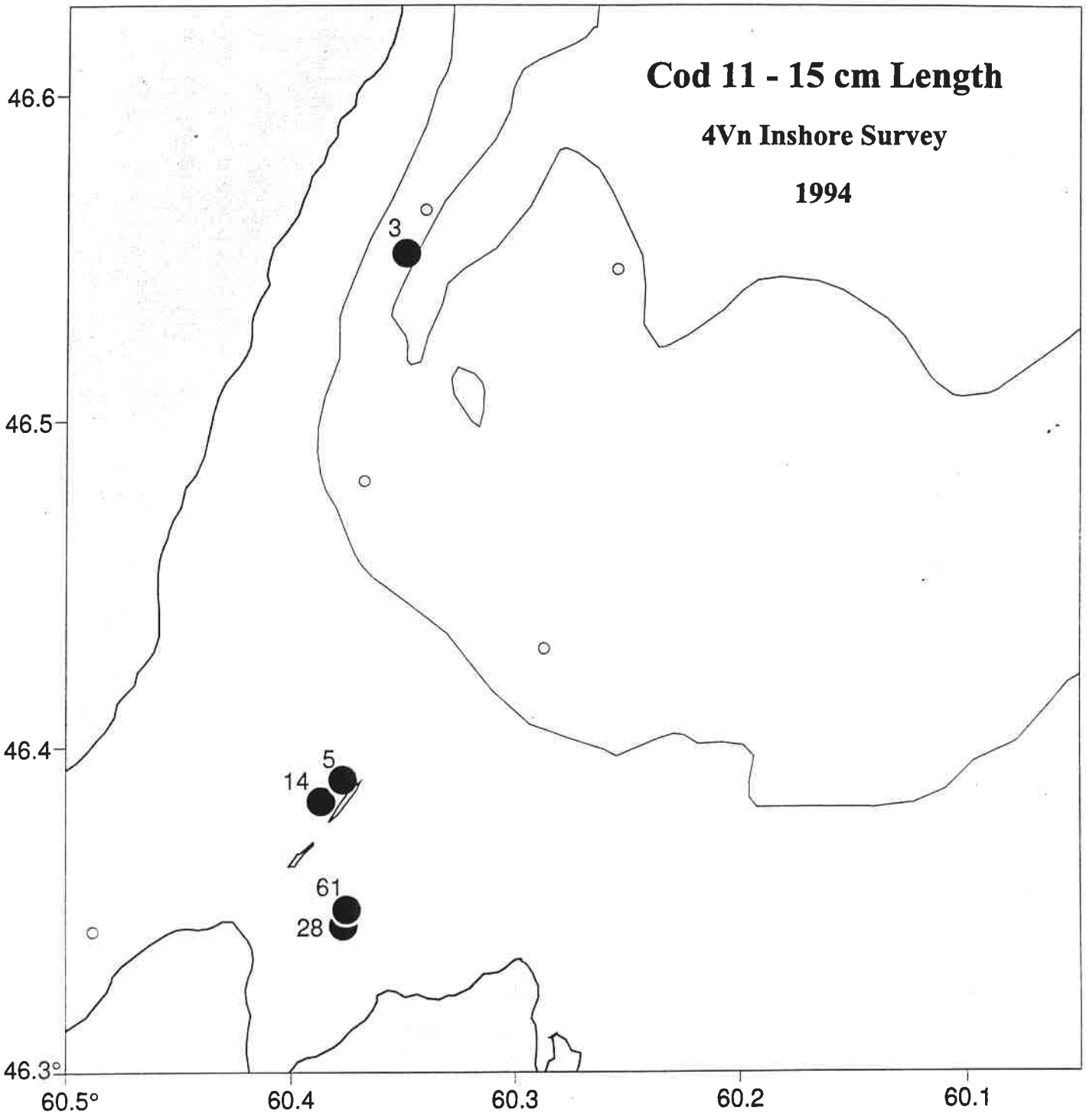


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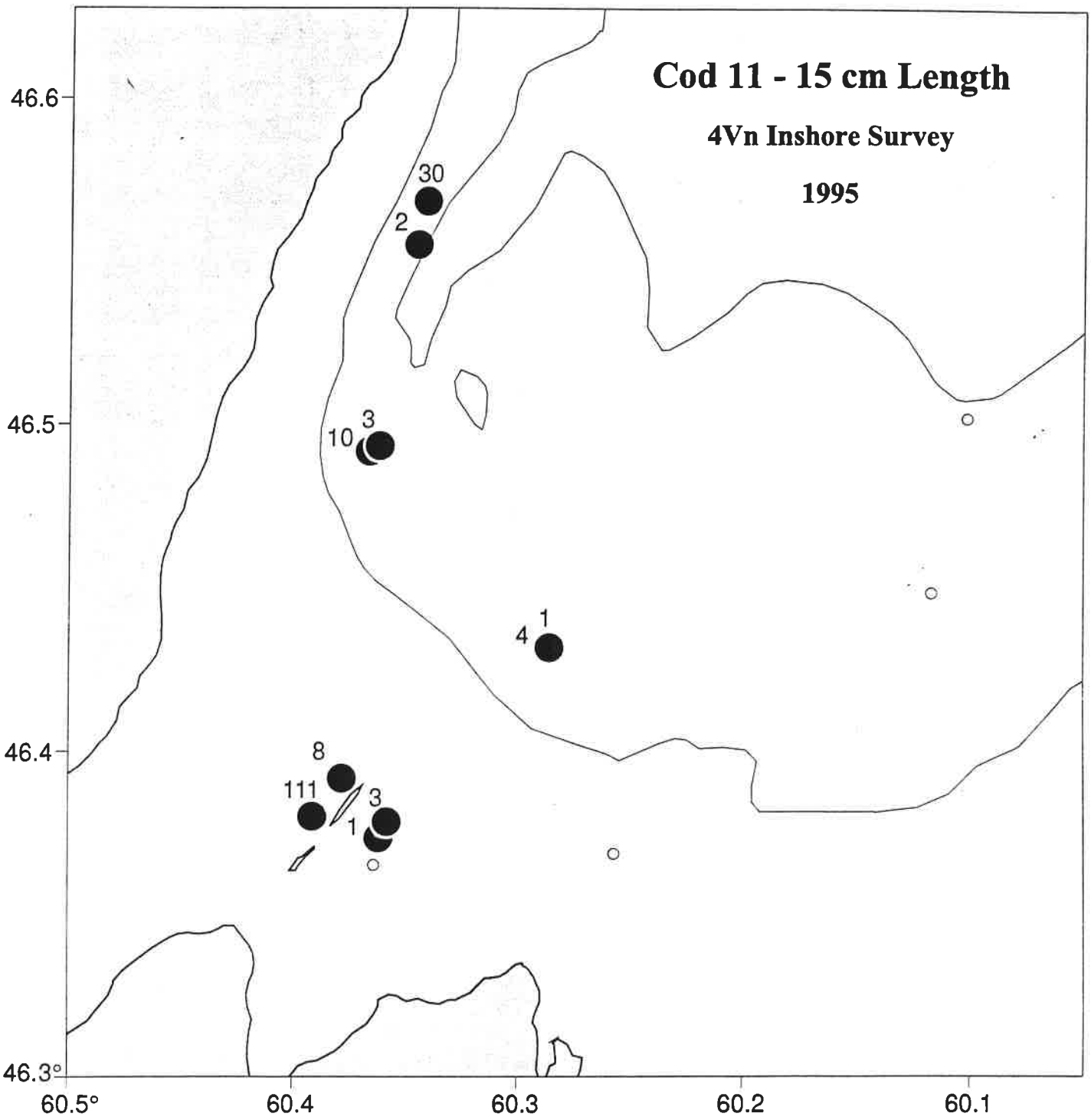


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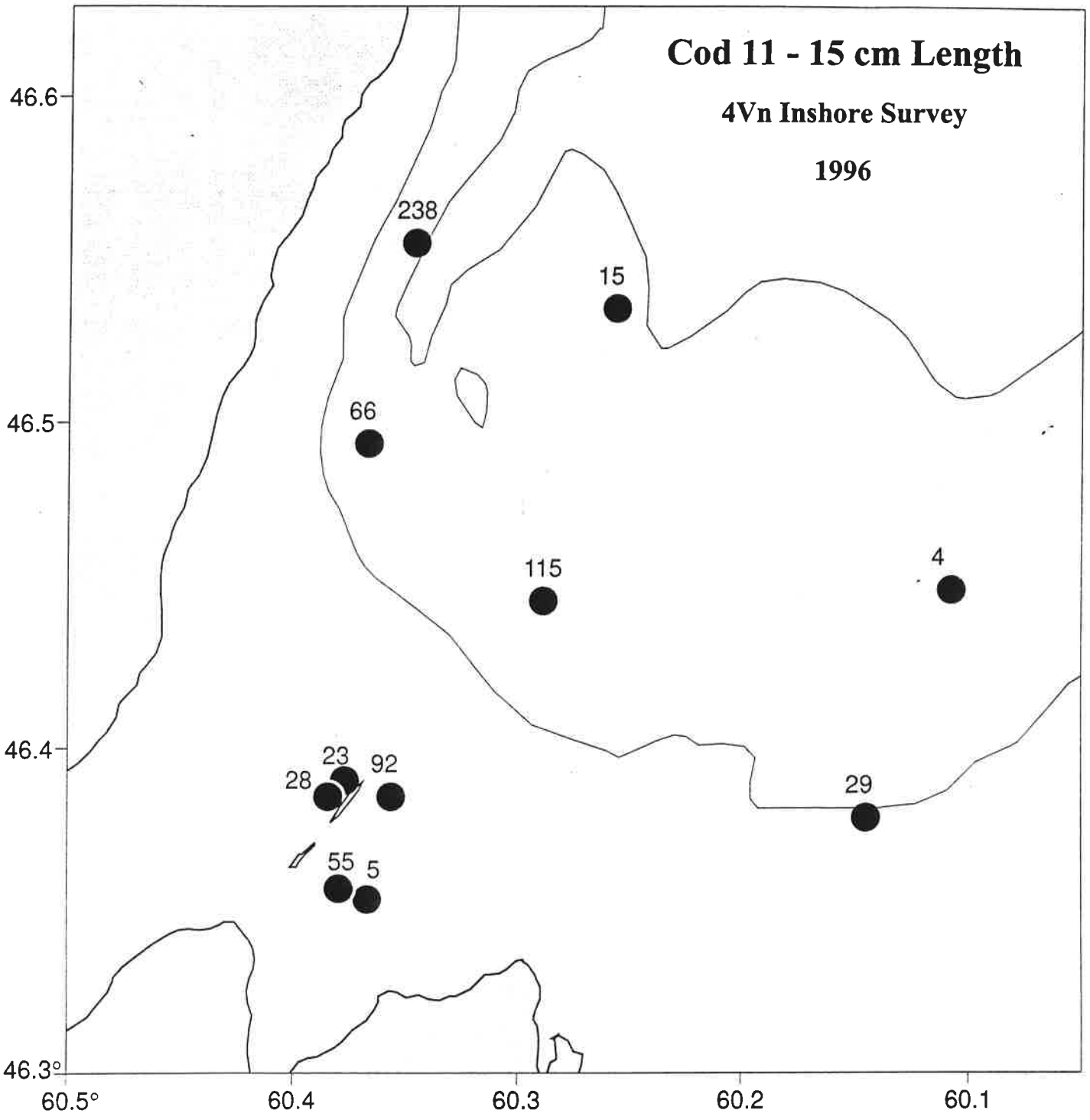


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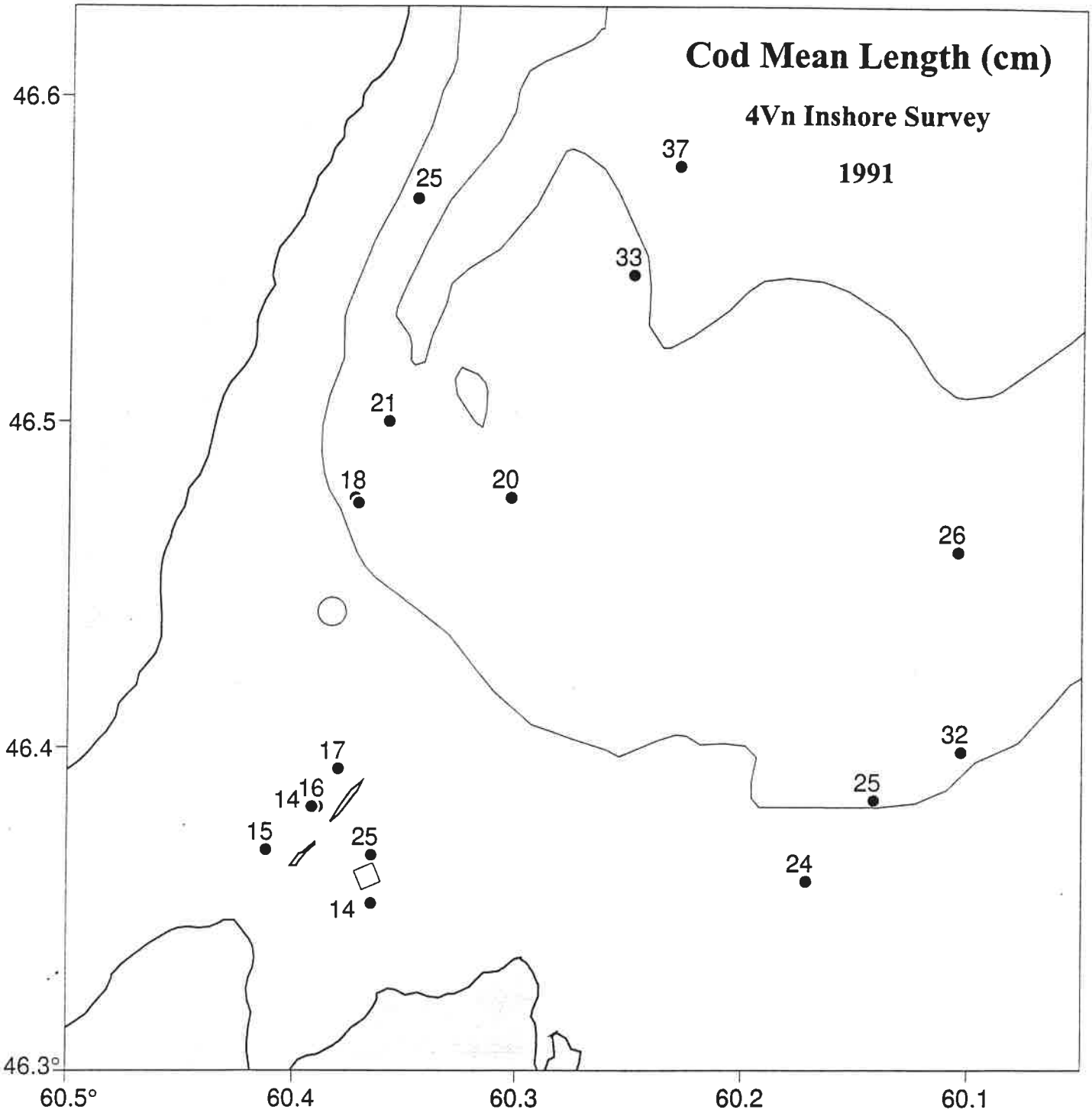


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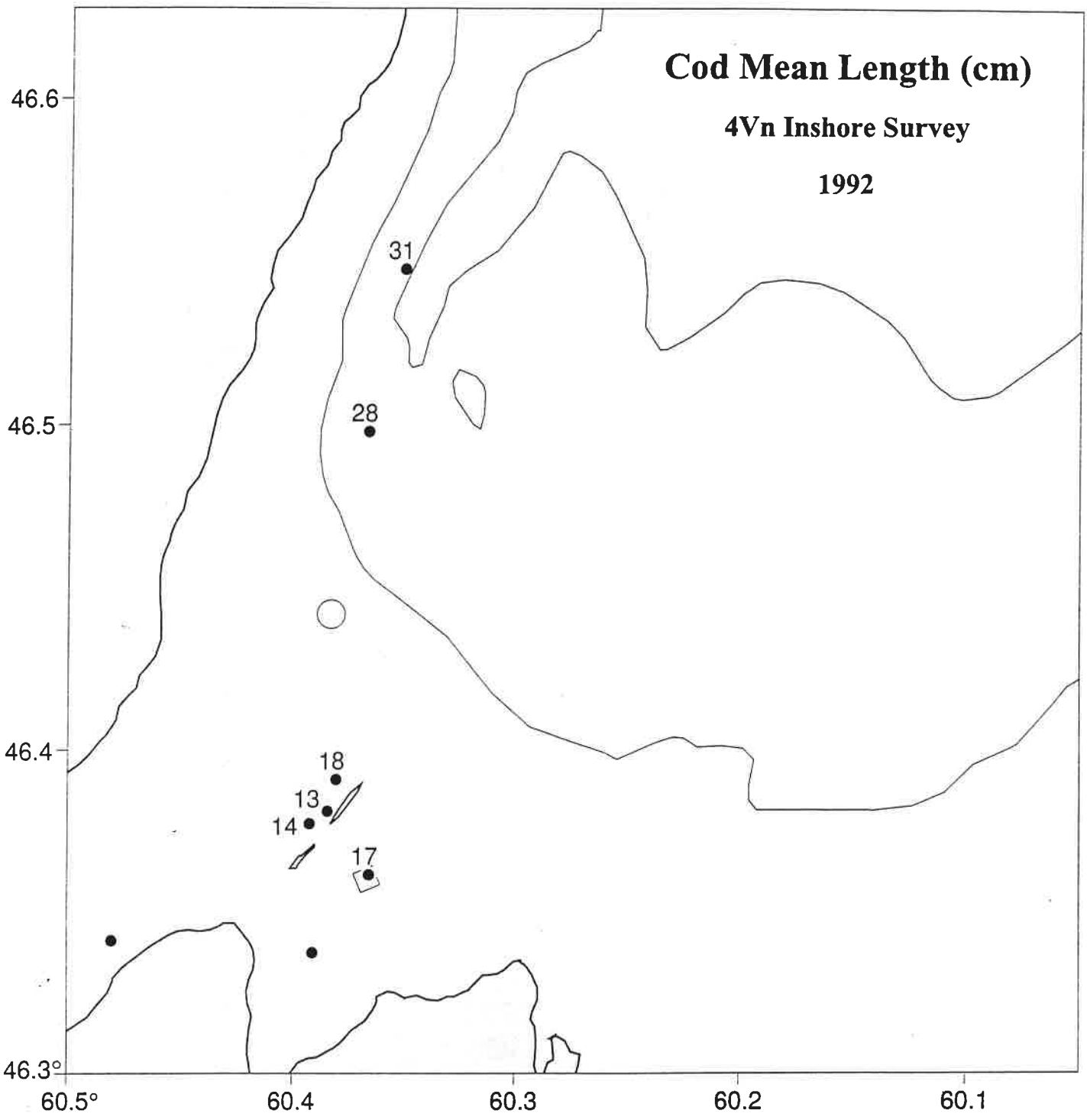


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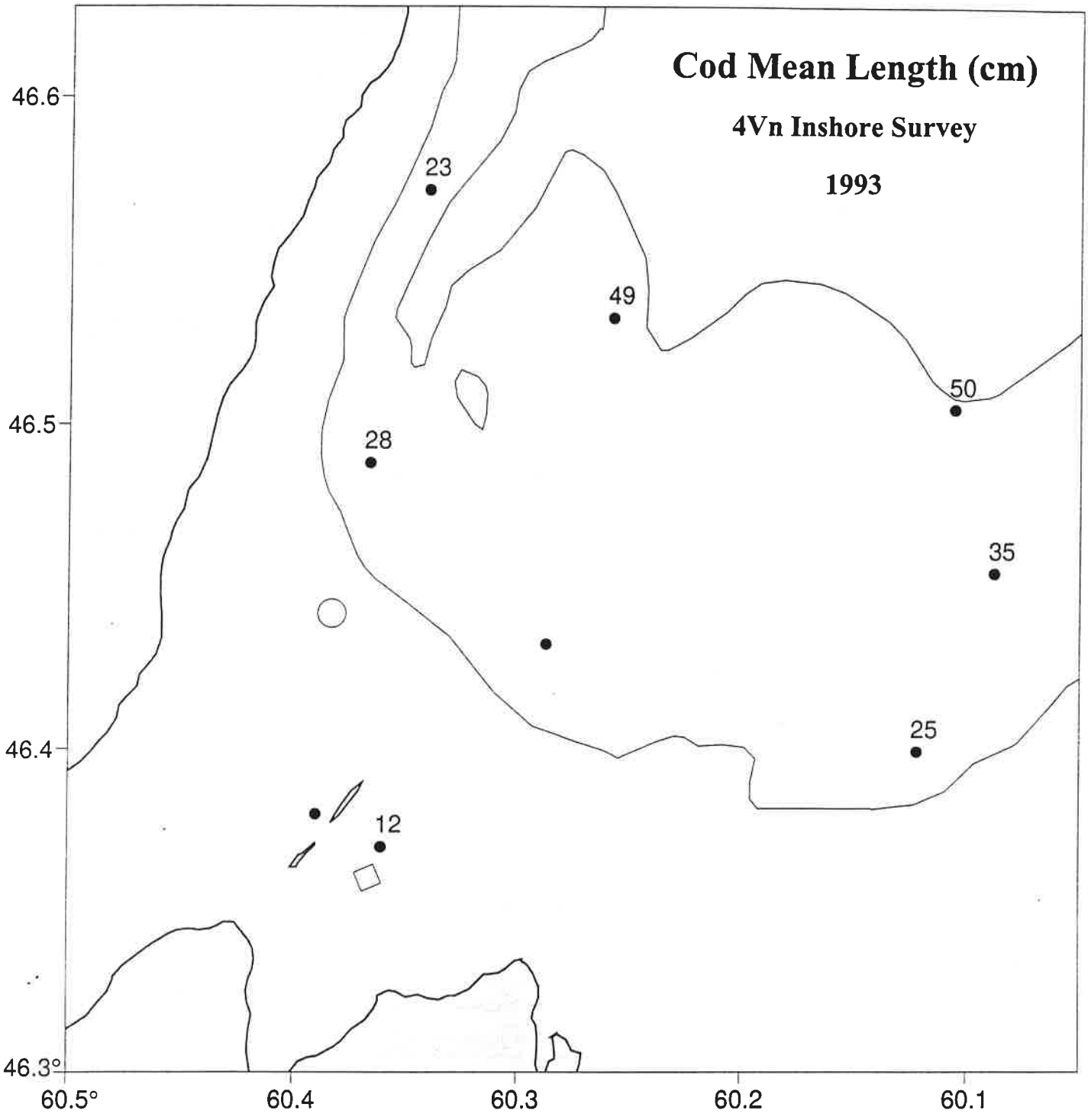


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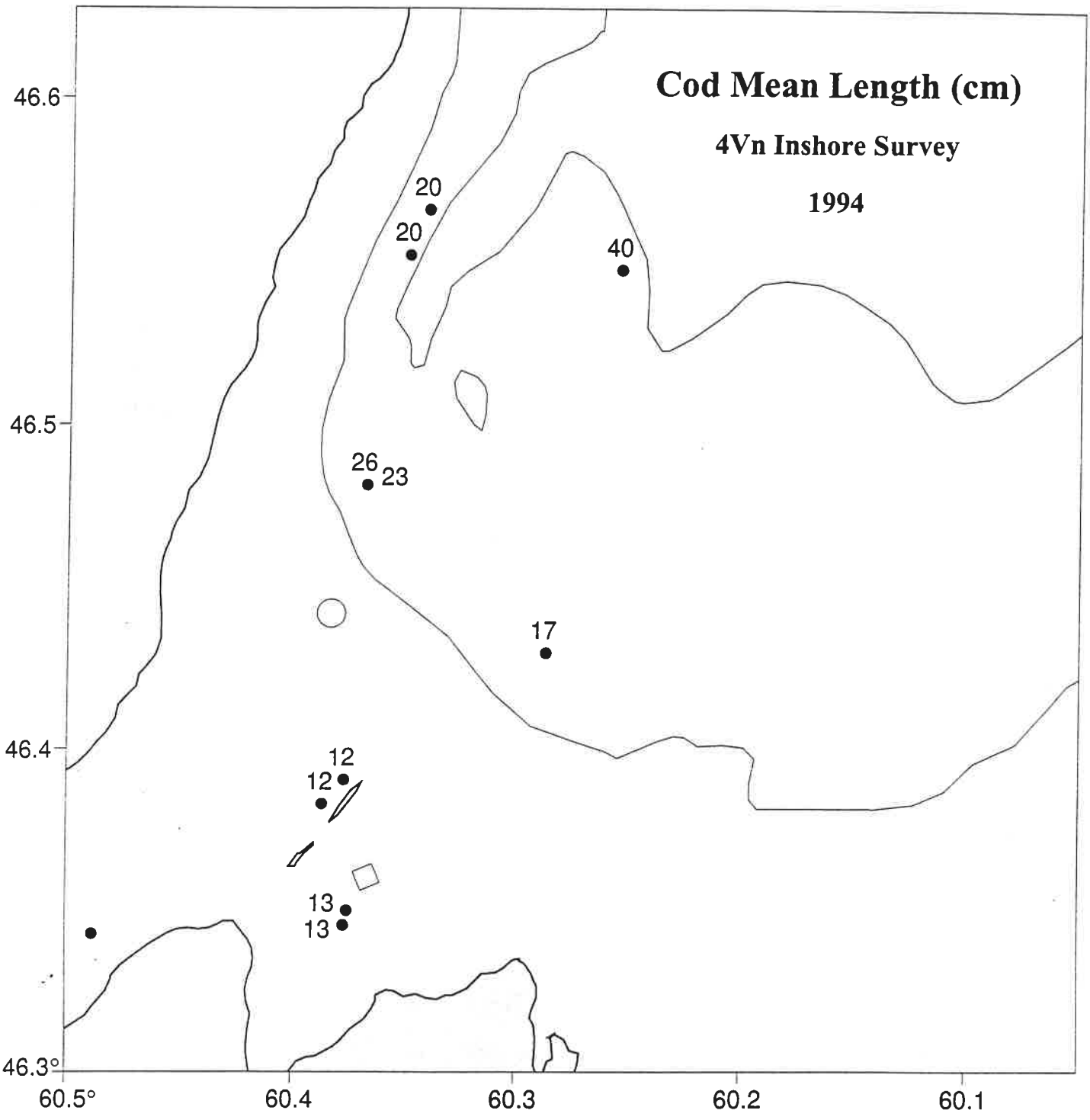


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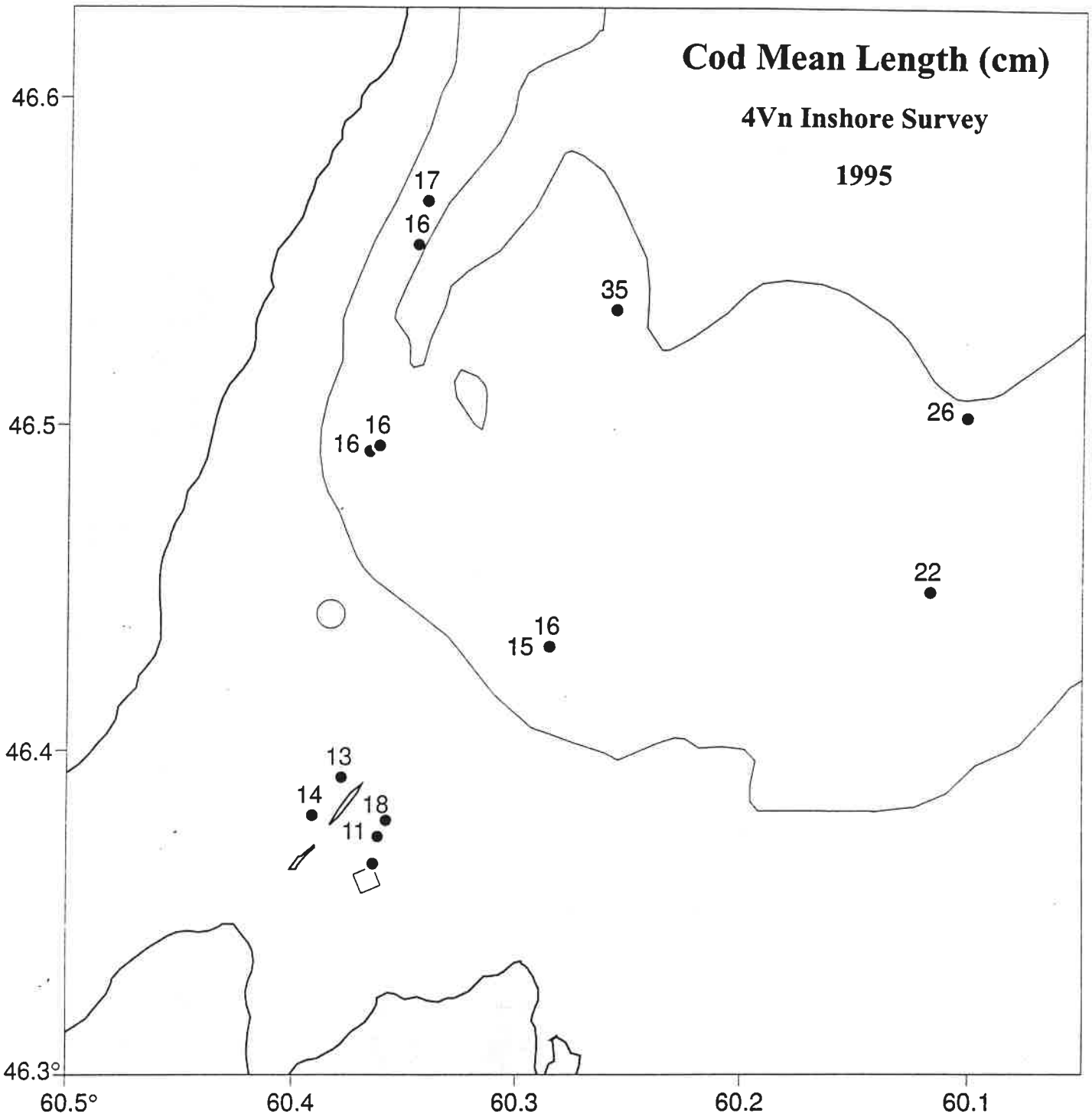


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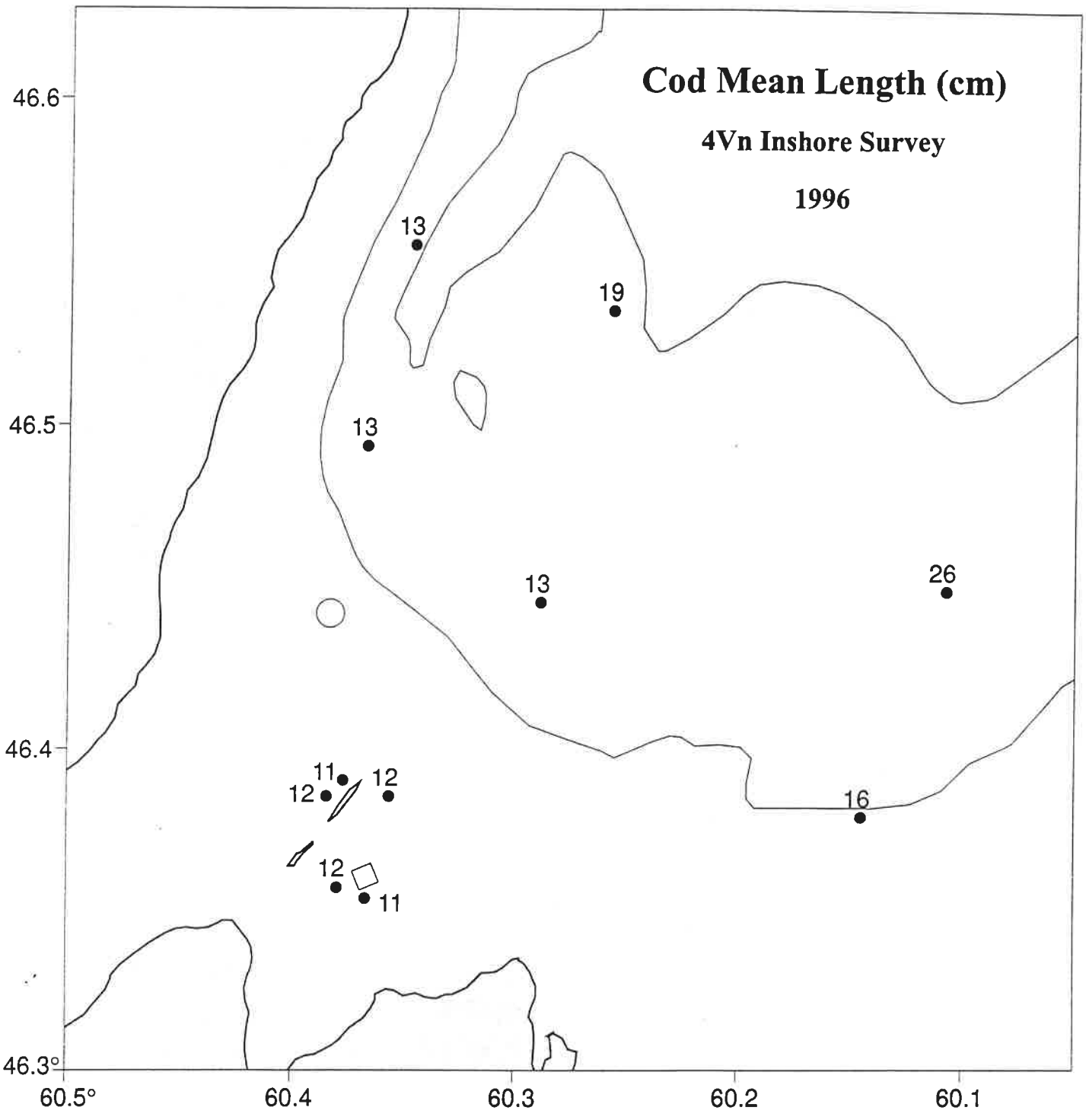


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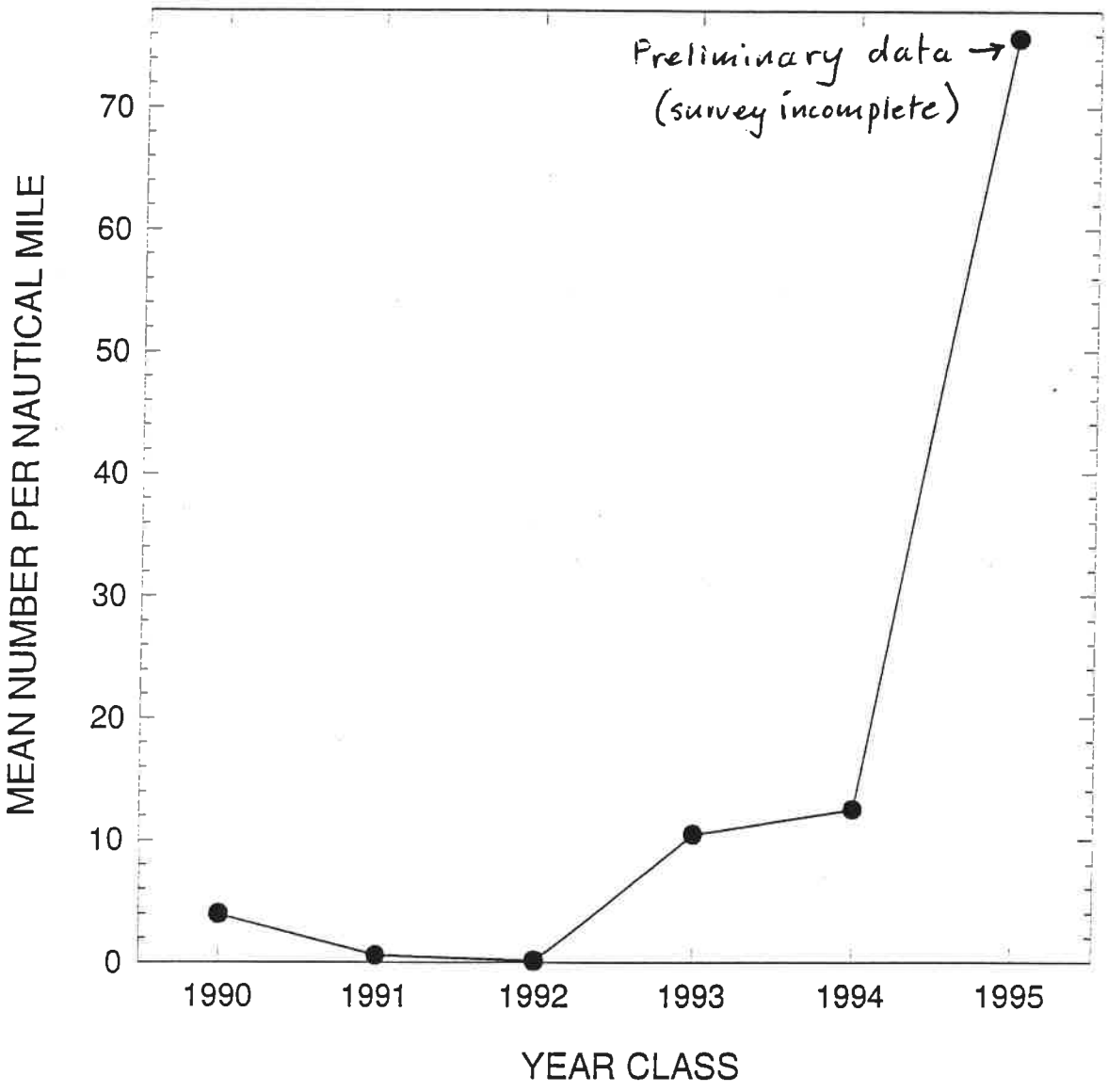
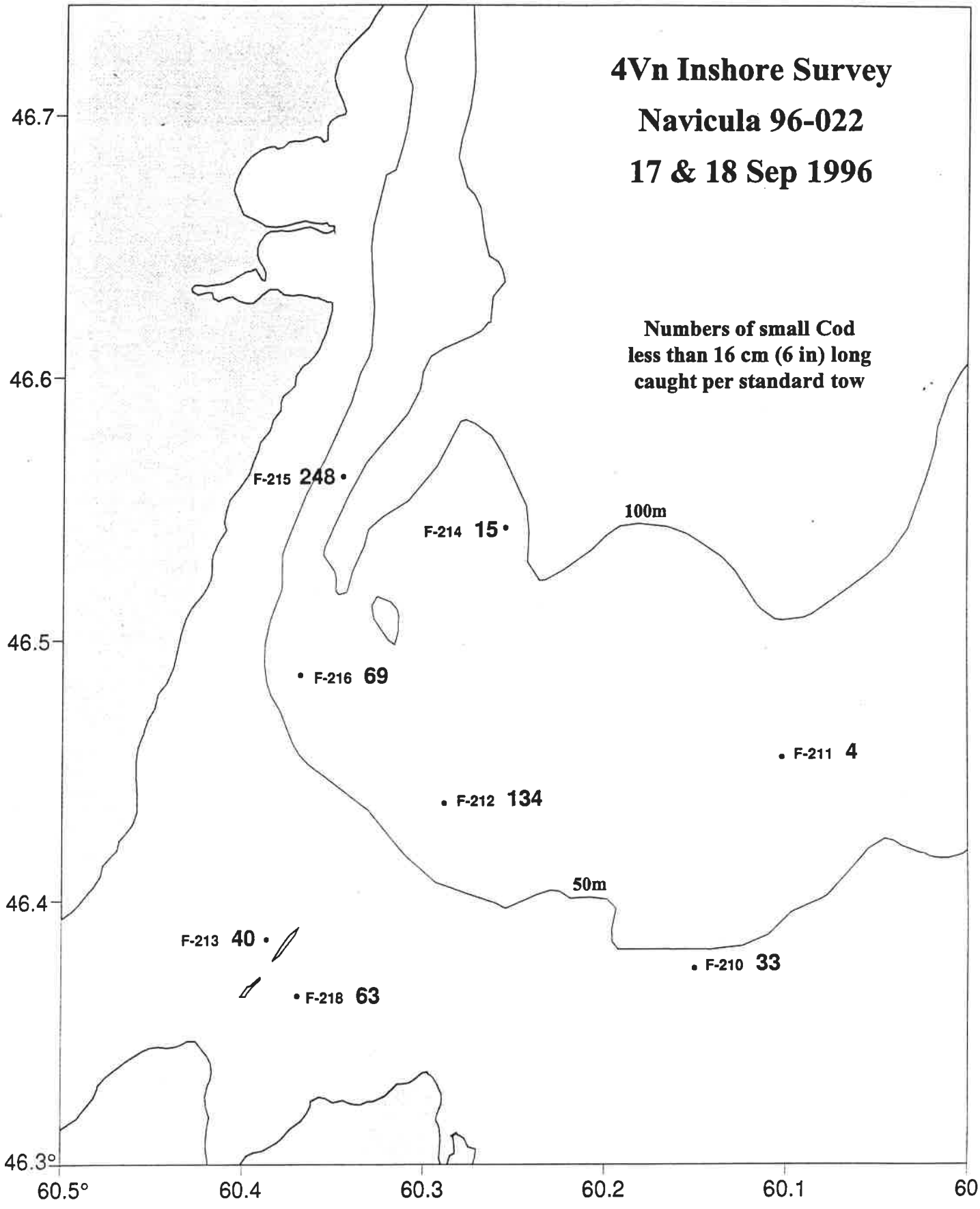
# 4Vn COD


Preliminary data →
(survey incomplete)
MEAN NUMBER PER NAUTICAL MILE
0
10
20
30
40
50
60
70
1990
1991
1992
1993
1994
1995
YEAR CLASS


4Vn Inshore Survey
Navicula 96-022
17 & 18 Sep 1996
Numbers of small Cod
less than 16 cm (6 in) long
caught per standard tow
F-215 248
F-214 15
100m
F-216 69
F-211 4
F-212 134
50m
F-213 40
F-210 33
F-218 63
46.7
46.6
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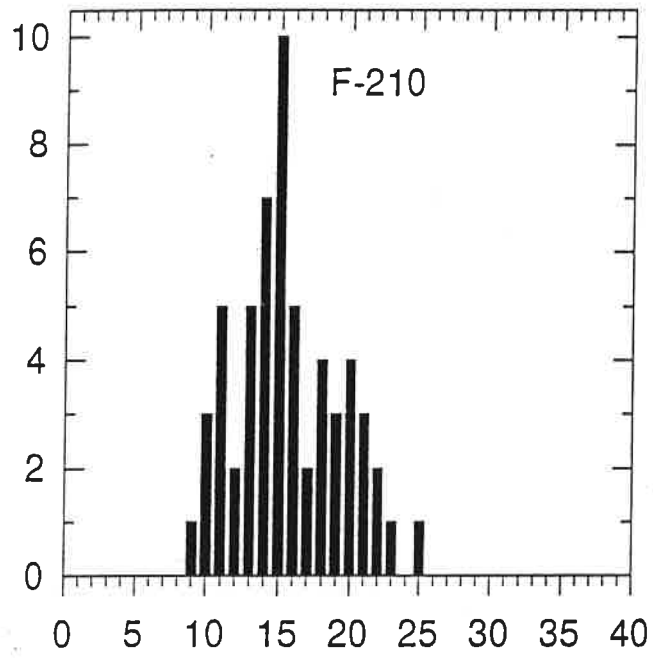
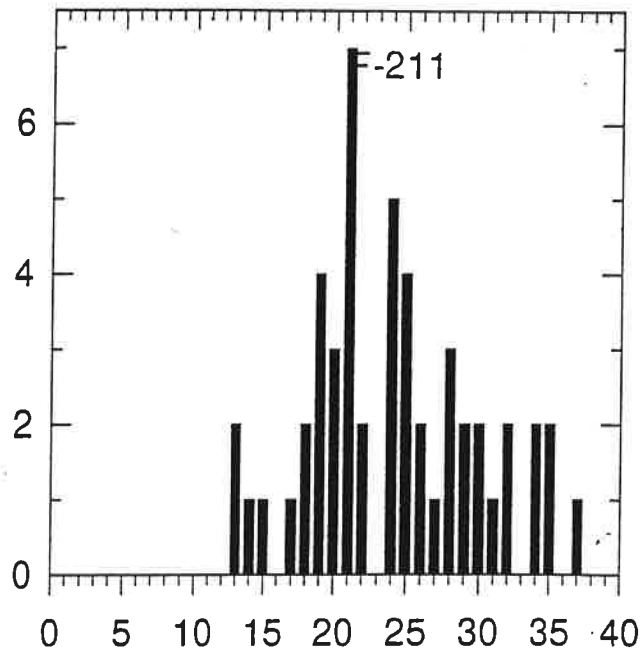
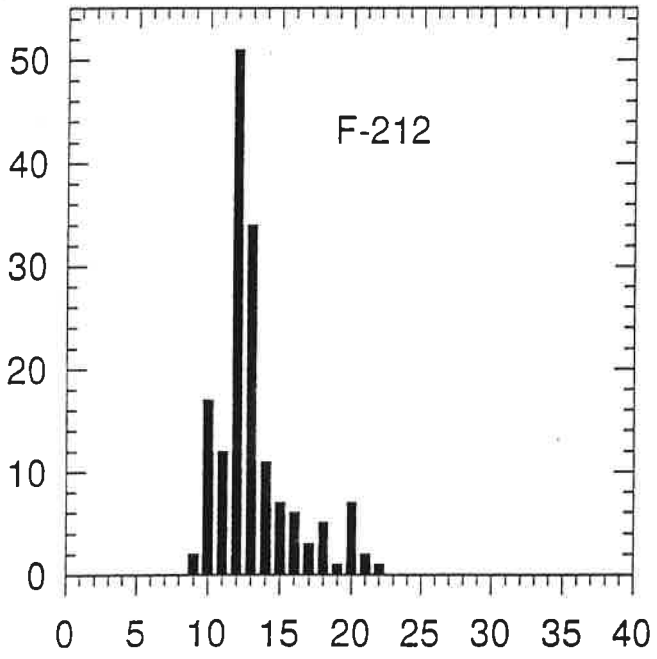
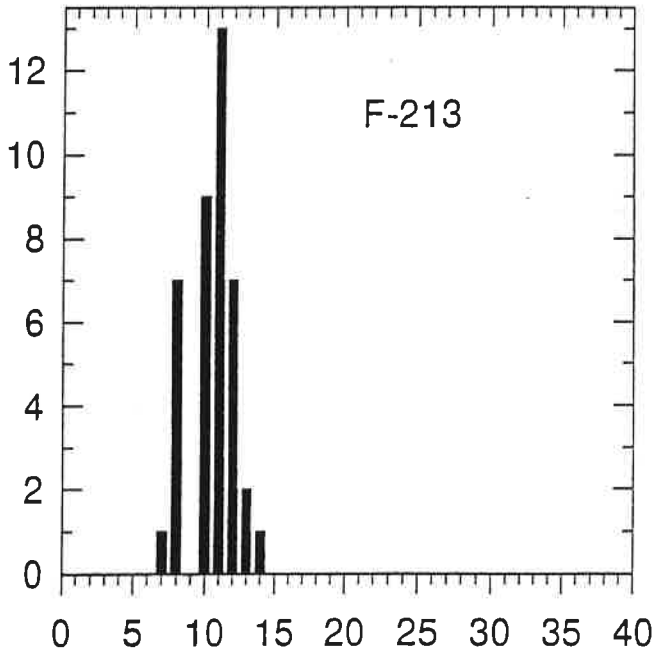
60.3
60.2
60.1
60
9622SmallCodNumbers



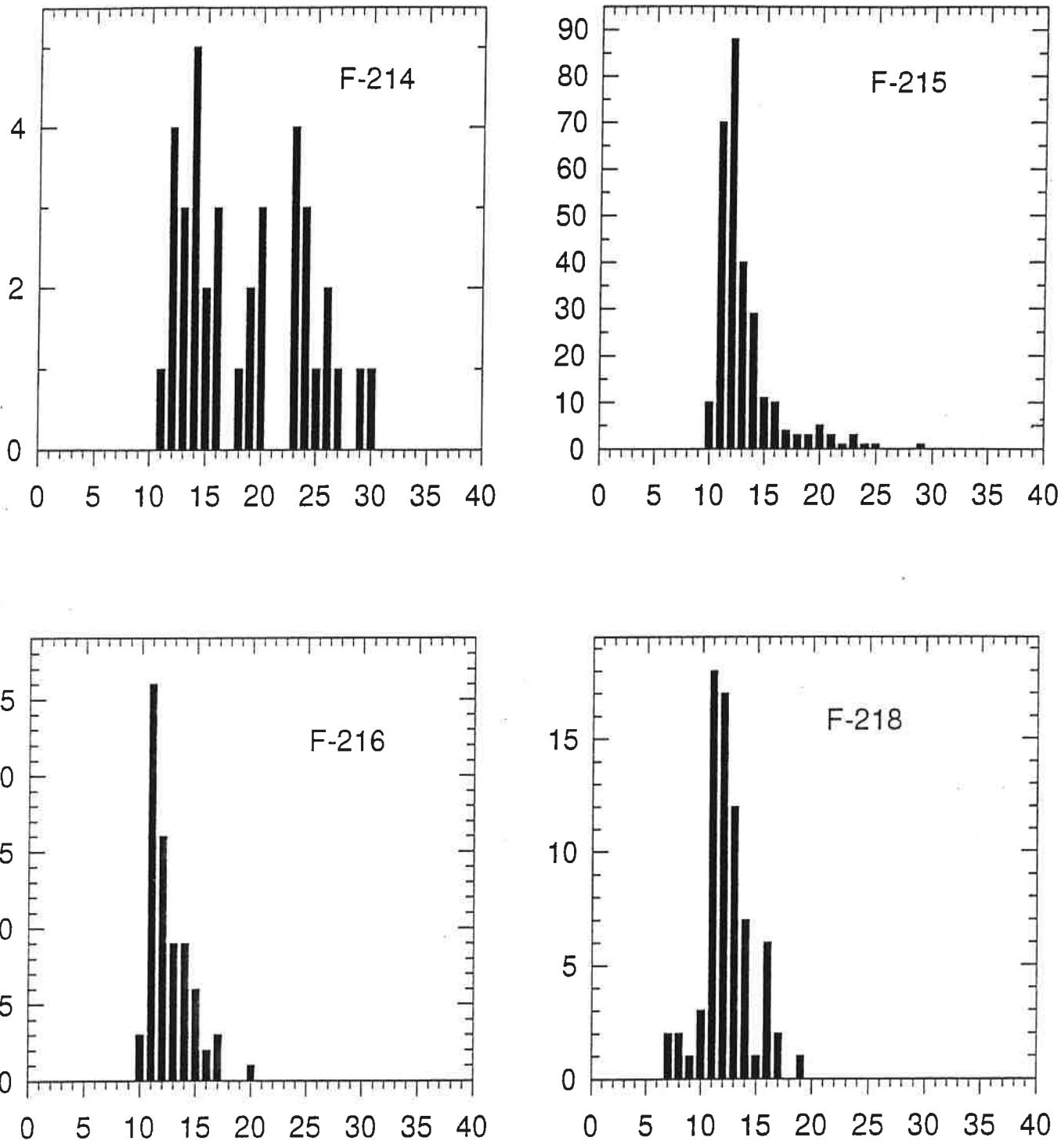




Length (cm)

Length (cm)

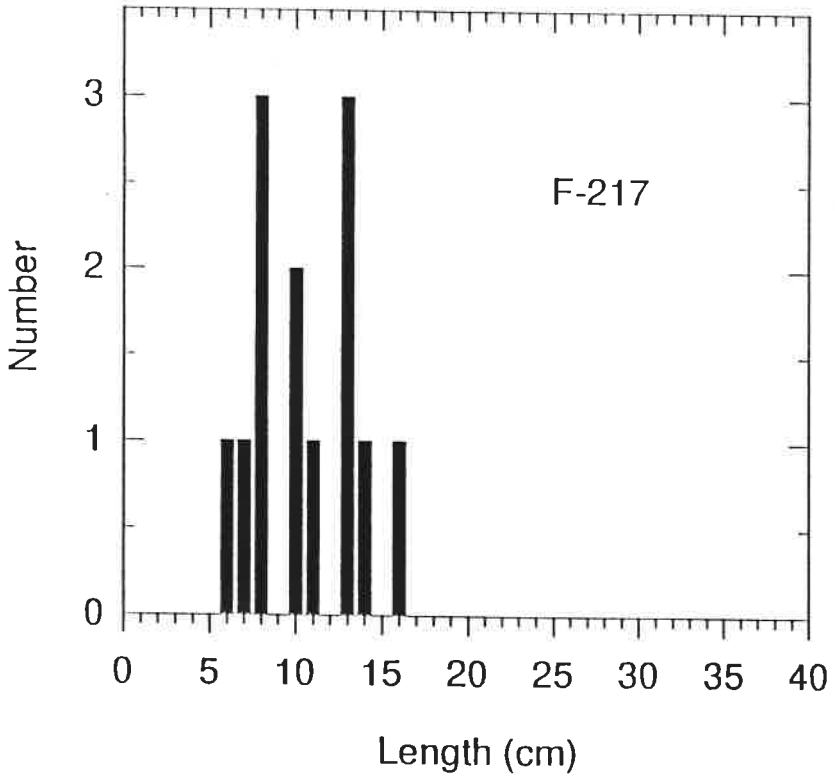
# Inshore Juvenile Cod Survey

September 17, 1996

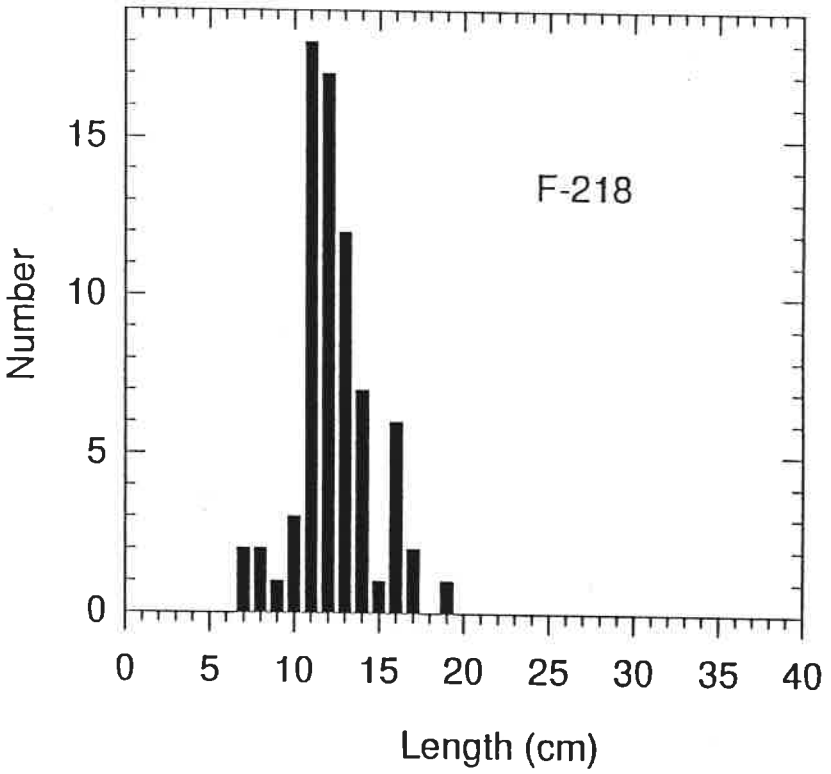



# Inshore Juvenile Cod Survey

September 18, 1996



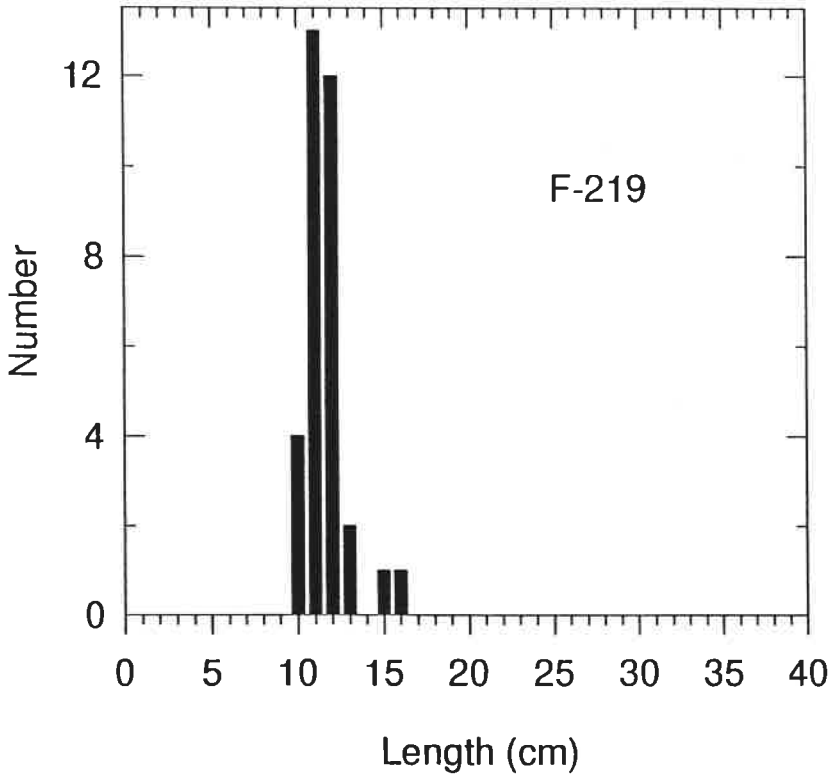

Special short tow (0.25 nm)
along SE border of dumpsite A.



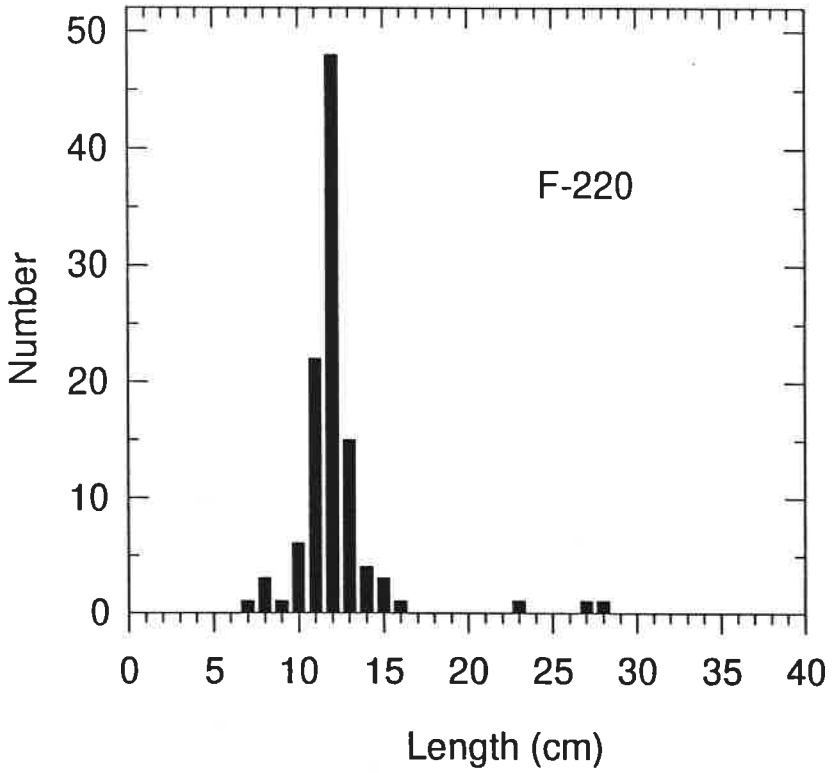

Normal 1.0 nm survey tow
along NW border of dumpsite A.

# Inshore Juvenile Cod Survey

September 18, 1996




Normal 1.0 nm survey tow
just to west of the Bird Islands.




Normal 1.0 nm survey tow
up to NE border of dumpsite A.

# Inshore Juvenile Cod Survey

October 1, 1996

## APPENDIX 9

Numbers of lobster captured, per 1 nm (1.82 km) tow, through the Reef Site (Site A Revised), in the southern Sydney Bight during the spring and fall (1992 through 1996).

## Lobster Occurrence at Dumpsite A

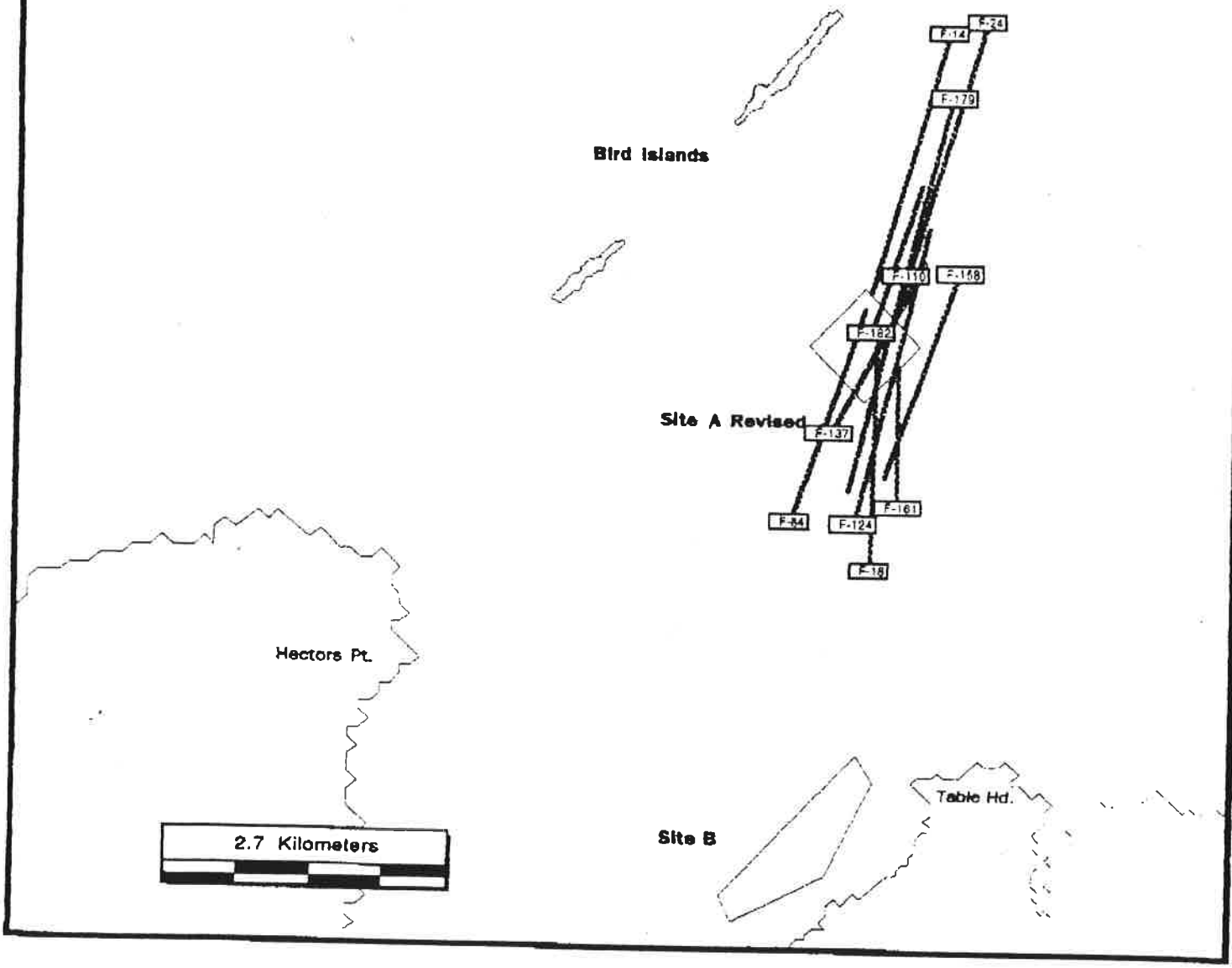
We rarely encounter lobsters during our inshore surveys and the numbers taken during the autumn in the vicinity of the proposed dumpsite are quite unusual (Normally, over about 10 sets we might pick up one or two lobsters at the most). It is clear there is a seasonal pattern to the catch. Lobsters appear to be in the area only in the autumn. The fact they are not present in the spring and summer no doubt accounts for the fact that most local lobster fishermen believe there are no lobsters in this particular area (lobster fishing season normally ends on July 15).

**Numbers of lobsters taken in one mile tow by research trawl at proposed Bird Island dumpsite.**

| Early Summer | | Autumn | |
|---|---|---|---|
| June 17,1992 | 0 | October 2, 1992 | 35 |
| June 17,1992 | 0 | Sept 23, 1993 | 306 |
| May 13, 1993 | 0 | September 13, 1994 | 43 |
| July12, 1993 | 2 | September 13, 1994 | 101 |
| June 10, 1995 | 0 | September 21, 1995 | 3 |
| June 10, 1995 | 0 | September 21, 1995 | 0 |
| June 20, 1995 | 0 | October 5, 1995 | 19 |
| May 6, 1996 | 0 | September 18, 1996 | 0 |
| | | October 1, 1996 | 16 |

# Location of Inshore Trawls

## 1992 to 1995



## APPENDIX 10

Quantitative data (presented at the RAP Habitat Subcommittee meeting [October 3, 1996]) on juvenile cod (number/tow, length frequencies, etc.) captured in T. Lambert's study in the southern Sydney Bight from 1991 through 1996.

trend is the same (Fig 12). Note the drastic change in mean length between 1984 and 1985; this marks another of the apparent population changes described above.

Total mortality estimates were made using the survey mean numbers at age for the past ten years. As Fig 13 shows, these data are highly variable and obviously cannot be used to determine any reliable estimate of fishing mortality. Nevertheless, there does appear to be an increasing trend.

## NEW FIELD RESEARCH

A field research programme has been initiated in Sydney Bight to address the problem of stock mixing. The primary goal is to estimate the size of the diminished local stock and determine its distribution within Sydney Bight. Six cruises, each of about 10 days duration, were carried out at roughly monthly intervals between April and November in 1991. These cruises were planned using information on probable spawning areas and bottom topography provided by local fishermen.

Ichthyoplankton sampling (132 stations) and bottom trawling (27 sets) were carried out and hydrographic information (112 CTD casts) was also routinely collected. Sampling revealed spring spawning of cod in Bras d'Or Lake and in the western Bight (Fig 14). Analysis of plankton samples taken during the first cruise in early May indicates quite low levels of spawning. However, water temperatures were exceptionally low at this time and could be responsible for the sparse spawning activity. It is not yet possible to say how well spawning was monitored or to give any indication of the number of spawning cod until analysis of plankton samples is completed. Plankton tows in later cruises were successful in sampling the larval cod population.

Preliminary analysis of cod taken in bottom trawl sets in the Smokey Bank area indicate a high degree of segregation by size. Cod were more plentiful closer to shore (Fig 15) and the near shore to offshore gradient in fish size with depth noted in previous years (Smith & Sinclair 1985) within the larger scale July groundfish survey was evident on a smaller scale in these nearshore surveys (Fig 16). Aggregations of juvenile cod were located and found consistently at one of the stations in the vicinity of Bird Islands (Fig 17).

## TAGGING

An analysis was begun of accumulated recaptures of cod tagged in the Gulf of St. Lawrence and on the Scotian Shelf between roughly 1950 and 1980. Apart from a brief review of those findings which have a direct bearing on the 4Vn fishery, the bulk of the results will be reported elsewhere (Stobo and Lambert, in preparation). It must be stressed that percentage returns presented in this section should not be considered reliable since numbers have not been weighted in any way to account for the greater likelihood of tags being returned from areas experiencing greater fishing effort.

Tags returns showed evidence of at least two stocks of cod in the southern Gulf of St. Lawrence; one occurred mostly in the western Gulf in the Bay de Chaleur - Gaspe region and the other frequented the southern and southeastern Gulf. These correspond to stocks identified by McKenzie and Smith (1955) and supported by Templeman (1962). These authors provided evidence in the form of vertebral counts and tag returns for four possible stocks of cod; 1) Gaspe, 2) Chaleur Bay, 3) Prince Edward Island and 4) Western Cape Breton. Confirmation for at least two of these stocks appears to be provided by the identification of two major cod spawning areas by ichthyoplankton studies carried out by the Fisheries Research Board during the 1960's (see Figure 4 in Lett 1980). These accumulations of cod eggs occurred between New Brunswick and the western end of Prince Edward Island (The Shediac Valley), and off the west coast of Cape Breton Island, Nova Scotia. The present analysis showed that cod tagged in the western Gulf of St. Lawrence during summer and early autumn began to move into 4Vn in November. By December about 40% of tag returns for that

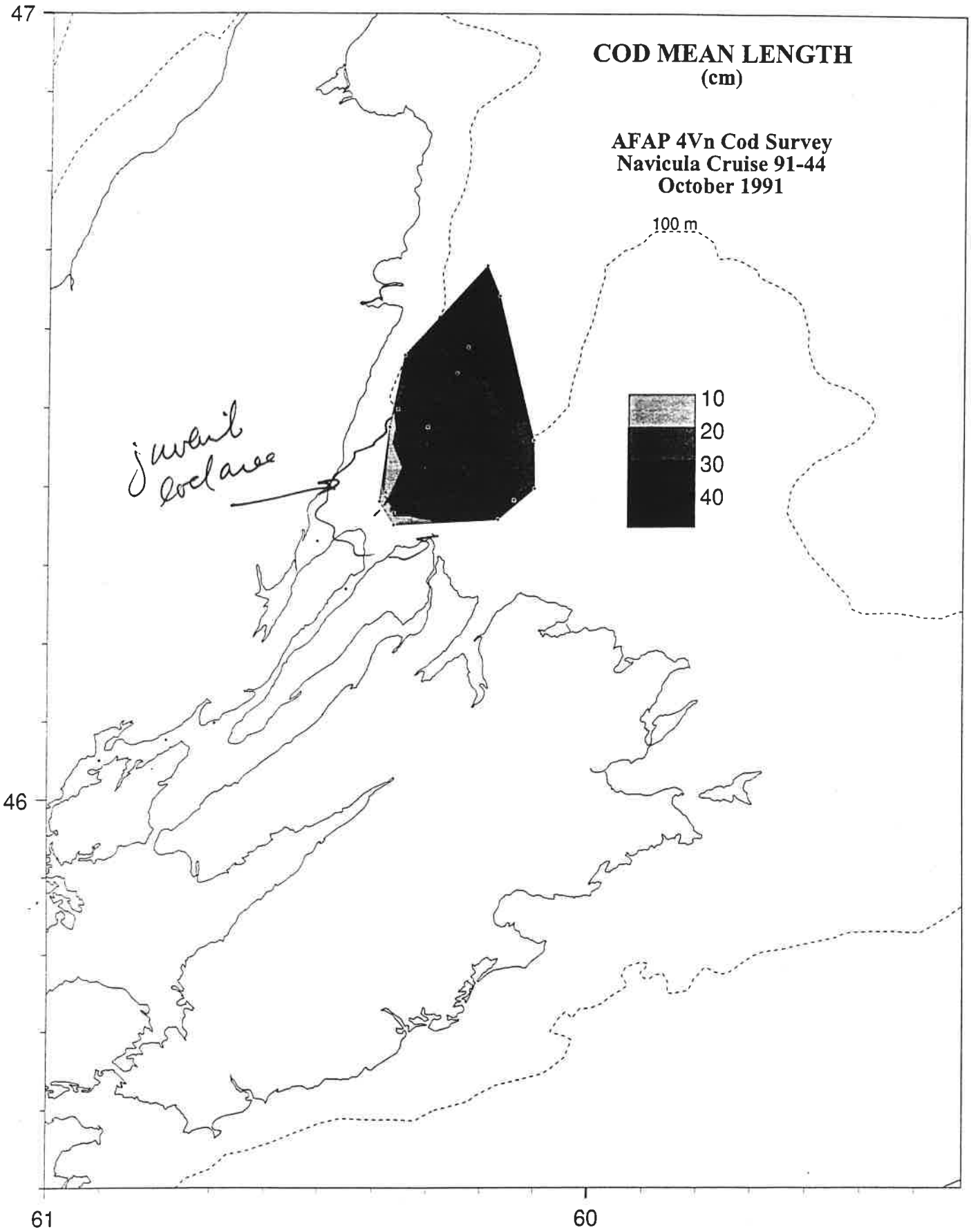

COD MEAN LENGTH
(cm)
AFAP 4Vn Cod Survey
Navicula Cruise 91-44
October 1991
100 m
10
20
30
40
47
46
61
60

Figure 16

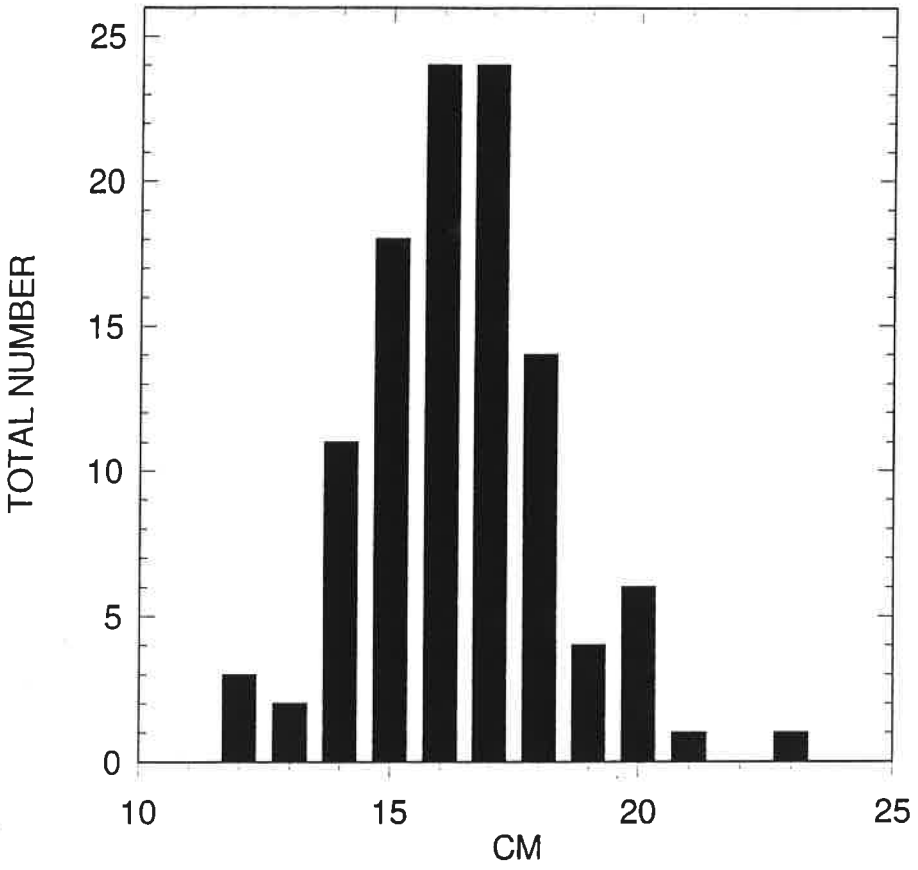



Figure17. Length frequency of cod from bottom tow. adjacent to Bird Islands, Sydney Bight; July 5, 1991.

years of better than average recruitment in the late 70's sustained the fishery throughout most of the 80's; however, with only one better than average year-class in the 80's, the inevitable occurred and the population went into steep decline. Fig 13 should be interpreted with caution, bearing in mind the inherent year to year variability in research catches. However, although the magnitude of deviations cannot be reliably compared between years, historically, positive deviations after age 1 have generally been shown to coincide with good year-classes.

## INSHORE SURVEY

An inshore research survey has been carried out in the western half of Sydney Bight since 1991. One of the aims of this survey is to monitor the abundance of juvenile cod in the area. A region of juvenile aggregation was found near the Bird Islands. Cod in this location are invariably in the 7-20 cm length (one & two yr-old) range. Other than a location in the Bras d'Or Lakes, this was the only place in the survey area where one year-old fish were found consistently. The abundance of young fish was much greater in 1990 than in the two subsequent years when very few young cod were found (Fig 14). With only three years to compare in this series it is not possible yet to say whether this is a

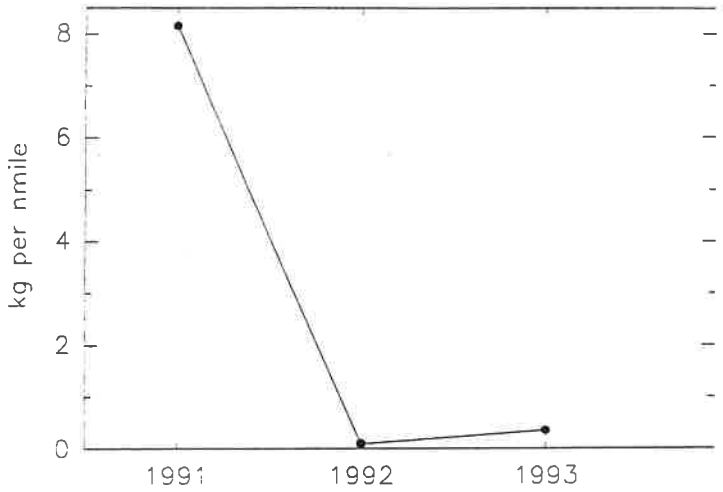



Figure 14. Abundance of one year-old cod off Bird Islands, Sydney Bight.

reliable index. Nevertheless, the decrease in one year-olds seen in the inshore survey is consistent with the decline in abundance of two-year-olds from the July survey. With little to compare it to, the 1991 inshore survey value cannot be interpreted as other than higher than the values of the subsequent two years. One year-old cod rarely show up in the July groundfish survey in 4Vn and their abundance in this survey is normally not a good indicator of recruitment (only four occurrences since 1970, two of which corresponded with good year-classes). Nonetheless, one year-old cod were present in the 1991 July survey, although subsequently in 1992 and 1993 the numbers of two and three year-old cod were lower than average. It is of interest to note here that the 1990 year-class in adjacent 4VsW also appears better than average.

distribution by maturity stage of cod from the DFO July groundfish survey reveal a concentration of ripe and spawning fish in Sydney Bight (Mohn, draft this WG). Thus there is no doubt that cod spawn in Sydney Bight. Commercial vessels exploit the concentrations of spawning fish and four different surveys over the past 35 years have documented the presence of eggs at the same time in the same locality.

## *JUVENILE COD*

### *Overview*

Juvenile cod appear to settle close to the area where they were spawned and thereafter, do not move far from their nursery area for at least the first two years of their life. The areas of concentration of age 1 cod are more or less coincident with the identified spawning areas for cod; Shediac Valley - Chaleur Bay, eastern Prince Edward Island - Western Cape Breton, to the west of the Magdalen Islands and western Sydney Bight.

### *Gulf of St. Lawrence*

The distribution of cod by age (1-8) was described for 1971 to 1981 by Tremblay & Sinclair (1985). Discrete centres corresponding to the areas named above can be seen at age from age 1 to about 3 (Figs 7, 8 & 9). Thereafter, as the cod age the distributions become more diffuse (Fig 10). Since 1981 groundfish surveys in the Gulf show much the same pattern (Chouinard et al 1991); discrete concentrations of young (ages 1 to 3) cod were located in the Shediac Valley and off the Magdalen Islands (Fig 11). Aggregations of young cod were also found in the Bay of Chaleur and off eastern PEI; however, these young fish were mixed in with older fish. Recent surveys specifically targeting juvenile cod support early findings (Jean 1962) that very young cod do not move far from the nursery ground and gradually take part in adult migrations to an increasing extent as they grow older (Hansen? ).

### *Sydney Bight*

Groundfish research survey.

Incidences of small cod occurring in groundfish survey trawls can be found in Figs 12 & 13. It is immediately apparent that the number of young cod occurring in 4Vn is much lower than the numbers for the Gulf. Of 356 sets taken in 4Vn over 25 years, only 92 had cod <26 cm in length. Part of the reason for this is probably the timing of the two surveys. The Gulf survey occurs in September and the Scotian Shelf survey in July. At this age and during the late summer, young cod are growing rapidly; thus more age 1 cod would be vulnerable to the trawl gear in September than in July purely due to size difference. This effect can be seen in Chouinard et al (1991). The difference in catch of cod <30 cm between a survey in July and another in September is marked (Figs 14 & 15). It would appear at least twice as many juveniles were taken during the latter cruise. Probably the main reason for the low number of young cod occurring in 4Vn July

groundfish surveys is that this survey appears not to sample the area preferred by juvenile cod. In only one year out of the 25-year time series were there substantial numbers of age 1 cod caught (Table 2). In 1984 the one year-old cod were caught in the south-west region of Sydney Bight.

Table 2. Mean number per tow of age 1 cod from July research survey.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1970 | 0 | 1976 | 0 | 1982 | 0 | 1988 | 0.61 |
| 1971 | 0 | 1977 | 0 | 1983 | 0 | 1989 | 0 |
| 1972 | 0 | 1978 | 0 | 1984 | 2.83 | 1990 | 0 |
| 1973 | 0 | 1979 | 0 | 1985 | 0 | 1991 | 0.27 |
| 1974 | 0 | 1980 | 0 | 1986 | 0 | 1992 | 0 |
| 1975 | 0 | 1981 | 0.33 | 1987 | 0 | 1993 | 0 |

Recent inshore juvenile cod surveys near Bird Islands in this area revealed concentrations of one and two year-old cod. Of the 356 sets taken by groundfish surveys in Sydney Bight, only about four or five of the sets could be considered to be in this area frequented by juvenile cod. The month effect noted above in Figs 14 & 15 can also be seen here. Two surveys were made in 1984, summer and autumn. . In July, the mean number of small cod per set taken in this area was 22. Purely by chance, a September cruise had a set in almost the same location; this time, 106 cod less than 26 cm were taken. Other concentrations of small cod, less than 26 cm long but older than age 1, were found on the north-west and south-east edges of Smokey Bank and further east in the area of St. Anne's and Scaterie Banks.

Inshore survey.

Inshore surveys were run in the western half of Sydney Bight from 1991 to 1994. Concentrations of small cod were found consistently near the Bird Islands to the south of the survey region. The average size of cod here was about 15 cm, with the smallest being 7 cm (probably 0-group). These surveys showed that the size of cod increased in both a northerly and easterly direction away from the Bird Island area (Figs 16 & 17). In the spring cod of about 30 cm and over (probably three to four year-old fish) were mixed in with the smaller cod; whereas in the autumn, larger cod were absent from these areas, except for the furthest north ('Gutter" stations). It is possible that some smaller Gulf cod which do not migrate as far have not yet begun the return trip by May.

Comparison of 4T and 4Vn distributions.

Recently, continuous surveys run by the Gulf region through both 4T and 4Vn, and also surveys run almost concurrently by Scotia Fundy and Gulf region in 4Vn and eastern 4T,

# 4VN COD

## LENGTH FREQUENCY – INSHORE SURVEY

## SPRING

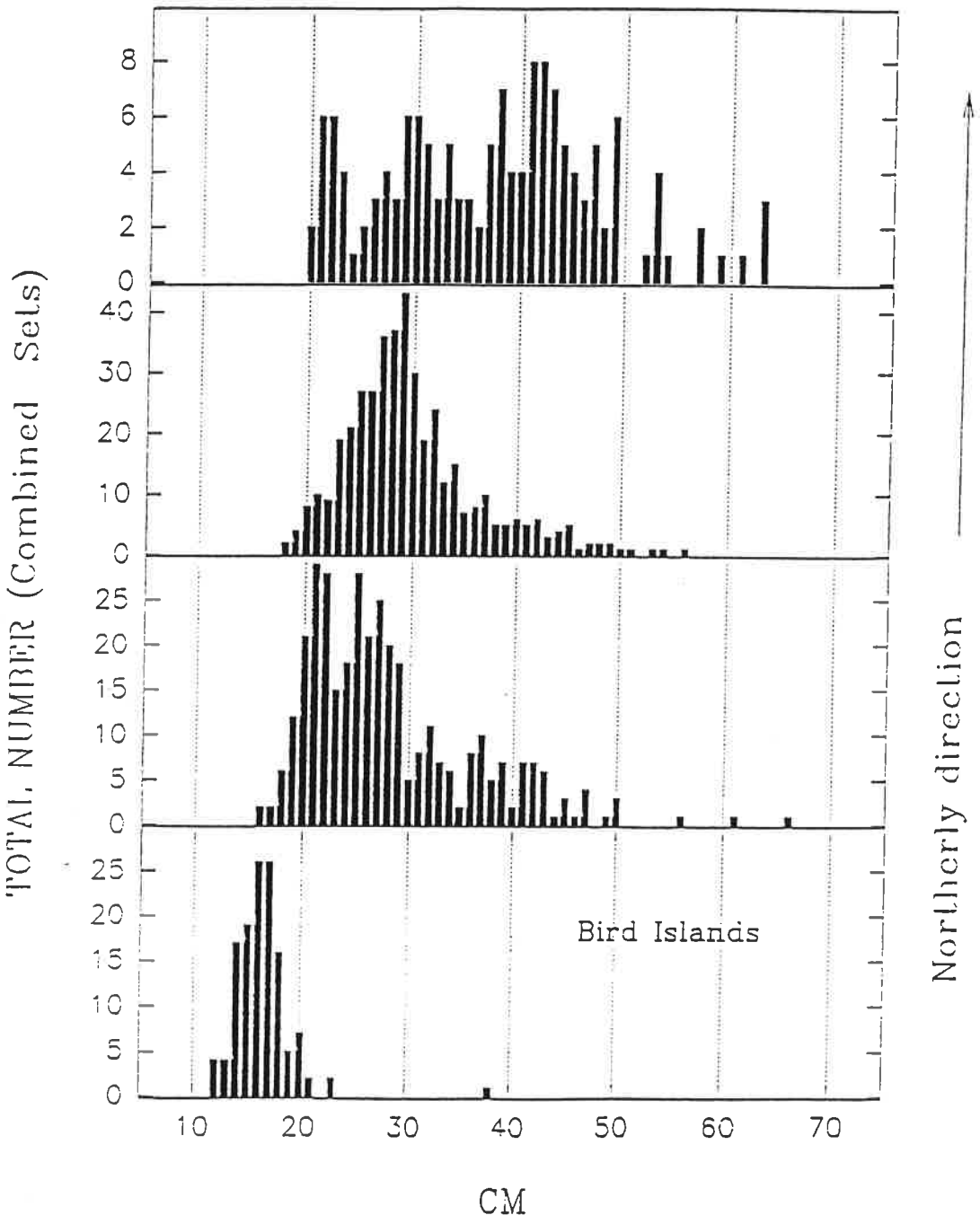



FIG 16



DFO Atlantic Fisheries Res. Doc. 95/16

# 4VN COD

## LENGTH FREQUENCY – INSHORE SURVEY

### AUTUMN

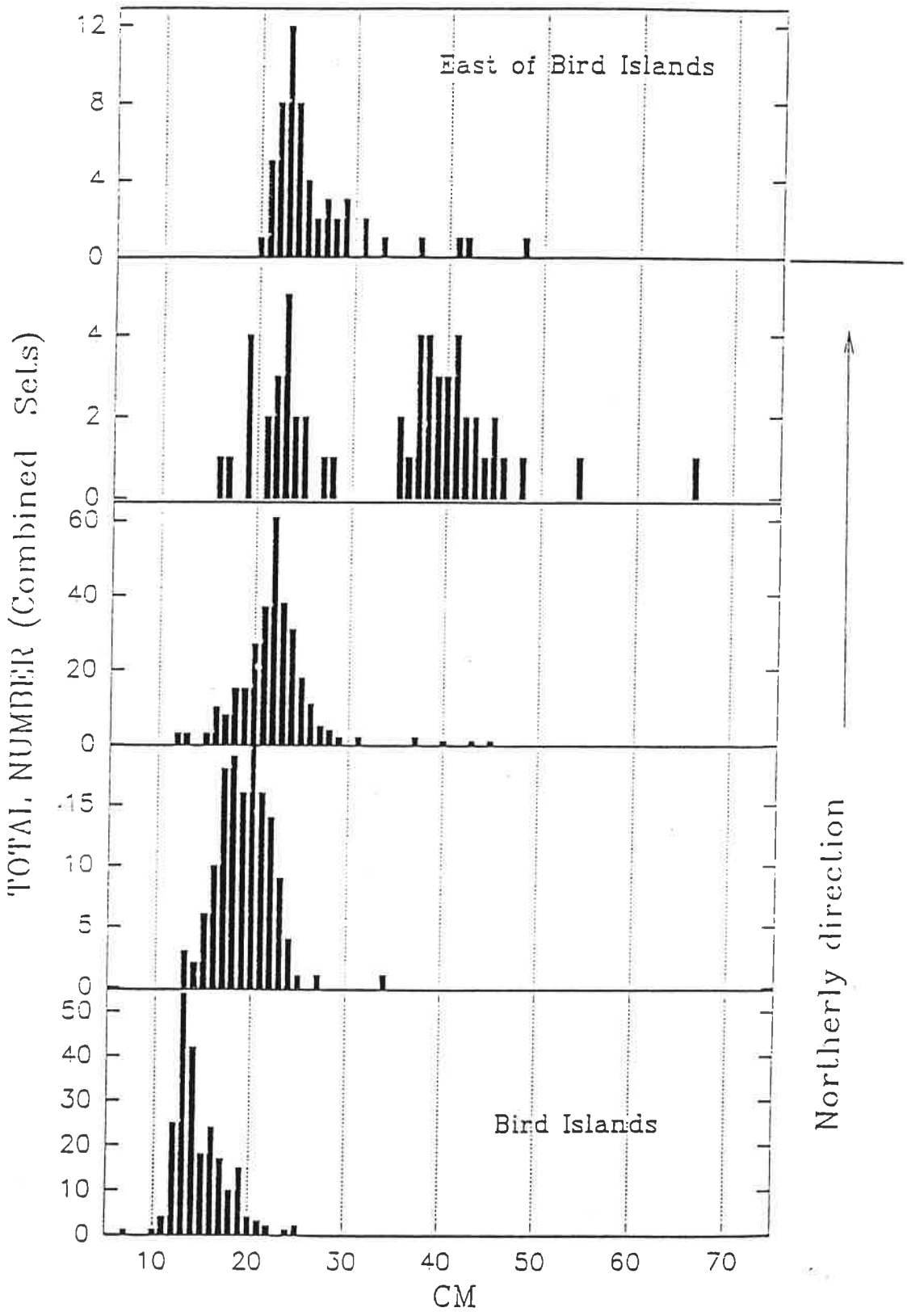



FIG 17



DFO Atlantic Fisheries Res Doc. 95/16

of catch per set by age can be found in Appendix C. The average length of cod caught was about 50 cm. and the length frequency distribution was more or less unimodal. Very few fish over 60 cm were taken (Fig 4), which has been the case since the late eighties.

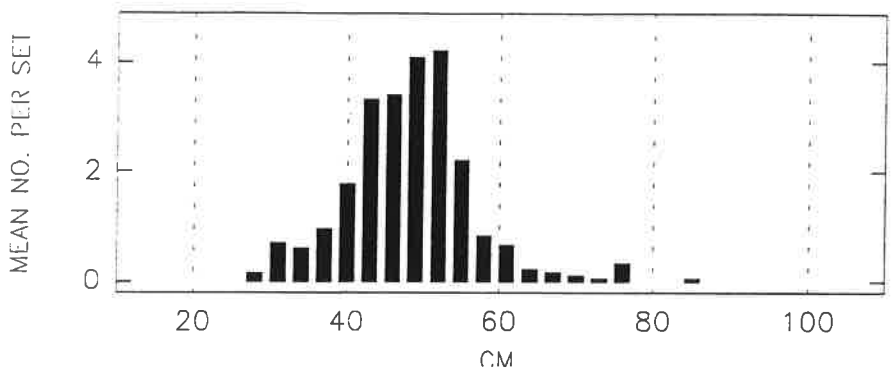



Fig 4. Length frequency of 4Vn cod - July 1994 groundfish research cruise.

## INSHORE SURVEY

A two-part inshore survey was begun in Sydney Bight in 1991; an ichthyoplankton component was abandoned early in 1992 due to reduction of funding but a bottom trawl program has continued at a reduced level until present. The trawl survey has consistently found 0-group and 1 year-old cod in the Bird Island area. These fish are present in the area from at least May to October after which time they disappear and presumably move to deeper water to overwinter. The 4Vn inshore survey is an important adjunct to the July groundfish survey since it can provide additional information. The latter does not provide good evidence of the presence of young cod because it does not sample the shallow water area favoured by these juveniles. Although too early to tell, it is probable the inshore survey will be able to provide a good recruitment index.

In September 1994, the numbers of one year-old cod (1993 year-class) were the highest in the short time series (Fig 5). Their length frequency mode was at 12 cm. (Cod 16 cm and less are counted as one year-olds for this index.) In addition, these small fish were found over a larger area.

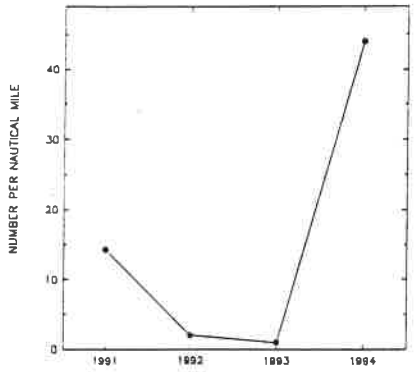



Fig 5. Recruitment index (1 yr-old cod)

This stock continues to suffer from low levels of recruitment; the last good year-class was 1987. The historical time series of catch per set by age can be found in Appendix C. The dominant length mode in survey catches was 40 cm. Very few fish over 60 cm were taken (Fig 4), which has been the case since the late eighties.

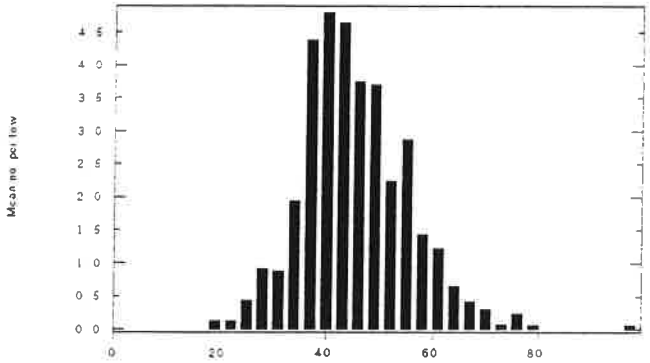



Fig 4. Length frequency of 4Vn cod - July 1995 groundfish research cruise

## INSHORE SURVEY

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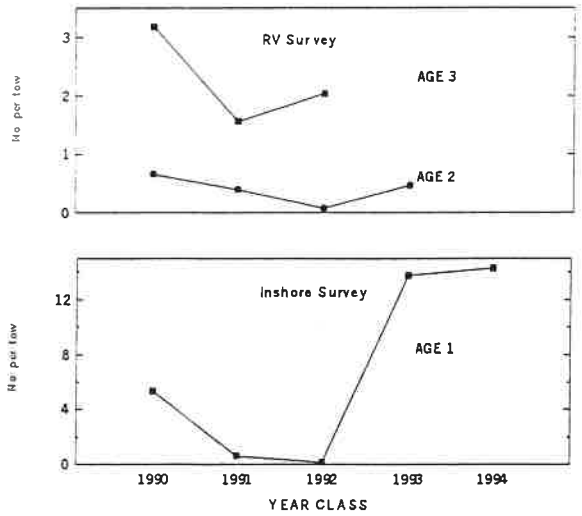


Fig 5. Relative year-class strength of 4Vn cod.

because it does not sample the shallow water area favoured by these juveniles. In the past two years, the numbers of one year-old cod (average length 12 cm) were at least twice the level of the previous three years. The relative abundance of year-classes as seen by the inshore survey agrees reasonably well with their subsequent relative abundance as seen in the July RV survey as 2 and 3 yr-olds (Fig 5). However, the time series is still too short to say whether the results of the inshore survey can provide a good index of recruitment.

## SENTINEL SURVEY

The sentinel survey forms an adjunct to DFO groundfish surveys that have been carried out in this area during the past two decades. The 4Vn sentinel survey is conducted during the summer and again in the autumn by commercial longliners following a random design, stratified by depth, similar to that used by the July groundfish survey. Three surveys have now been completed; September 1994, and July and September 1995. The area surveyed by the sentinel survey was the same as the DFO survey with the exception of there being no sets over 100 fathoms and the stratification schemes being slightly different. The July survey uses three strata: <50 fath., 50 - 100 fath., and >100 fath. The sentinel survey also employs three strata; however, the deep stratum was dropped, the mid-depth was retained and the shallow stratum was divided in two. Hence the sentinel strata are; <30 fath., 30 to 50 fath. and 51 to 100 fath. The geographic distribution of cod caught in all three surveys was similar, with the exception of relatively high

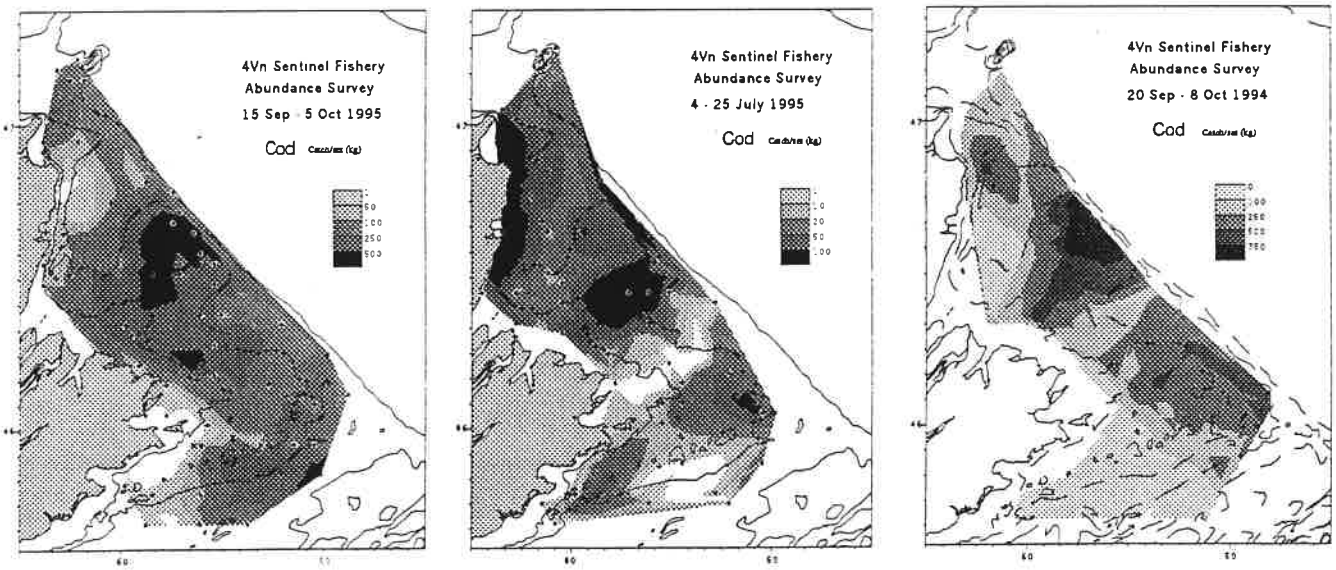


Fig 6. Sentinel Survey 4Vn Cod Distribution.

concentrations of fish along the north-east Cape Breton shore in the western part of Sydney Bight during July in 1995 (Fig 6, note different abundance scales). However, although the catch rates in September of 1994 and 1995 were virtually identical (110.1 and 108.3 kg/1000 hks, respectively), the catch rate during July 1995 (22.8 kg/1000 hks) was much lower (Fig 7). This appears to be a

## APPENDIX 11

Responses to Habitat Management Division's questions.

Management Considerations

1. **"...should [Site A Revised] be continued as per the conditions issued in the Authorization, and will there be a significant adverse impact on the overall well-being of the cod stock which seasonally occupies the area?"**

It is concluded that dumping could continue because even were this prime juvenile habitat, the impact on cod would be unmeasureable and the number killed, given the number required for recruitment, would be infintesimally small though few if any would be killed directly by falling reef material.

2. **"...the definition of preferred cod habitat."**

Juvenile cod (<11 cm total length) habitat *per se* was not defined, but indications are that juvenile cod tend to occur in waters from <1 m to <35 m deep, with a rugged, boulder-strewn bottom covered with macrophytes.

3. **"...what evidence is there that Site A Revised, specifically contained that habitat?"**

Though juvenile cod are found at this site, one would not predict their occurence here based solely on the nature of the habitat.

4. **"...how does the placement of pebble to cobble material destroy that habitat?"**

Given that juvenile cod were at Site A Revised, suggests that changing the habitat could be detrimental. However, the highest juvenile densities would likely not be found on what might ultimately be deemed as marginal habitat. They would tend to be found on the more rugged, macrophyte habitat closer to shore or to the north Site A Revised. Hence, increasing the ruggedness of this habitat would alter it, but likely not destroy it for juvenile cod.

5. **"...if it's destroyed would it have a significant negative impact on the productive capacity of the stock?"**

Site A Revised is so small (0.16 $km^2$) in relation to the total area (1,500 $km^2$) occupied by juvenile cod <15 cm in length, that the impact would be insignificant. As well, the numbers required for recruitment are so large that even were a few killed, the impact would be insignificant.

**6. "...what evidence is there that cod are being destroyed."**

There is no evidence cod have been killed, though it would be most difficult to discern mortalities unless they were high. The "bow wave" generated by the falling material would likely illicit an escape response in the fish and they would tend to scatter prior to being struck.

**7. "...if all cod are presumed killed at Revised Site A, what impact will this have on the stock?"**

Rough analysis done on probable numbers present in the water column along with the width of the discharge and total time of free fall through the water column suggests the impact would be insignificant.