Canadian Atlantic Fisheries Scientific Advisory Committee

Comite scientifique consultatif des peches canadienne dans l'Atlantique

CAFSAC Research Document 90/74

CSCPCA Document de recherche 90/74

White hake (*Urophycis tenuis*) from the southern Gulf of St. Lawrence: a review of the fishery in 1989

by

Douglas Clay

and

Thomas Hurlbut

Marine and Anadromous Fish Division
Department of Fisheries and Oceans
Gulf Fisheries Centre
P.O. Box 5030, Moncton, N.B.
CANADA, E1C 9B6.

ABSTRACT

The provisional nominal landings in 1989 totalled 5,128 tonnes, an increase of 33% from the 3,860 tonnes caught in 1988. Anecdotal information from 1988 and 1989 indicated that significant quantities of small fish were landed in recent years. Fishermen from the Northumberland Strait area (eastern PEI - St. Georges Bay) reported seeing more small fish in 1989 than in recent years.

A discriminant analysis of morphometric and meristic characters of white hake sampled from division 4T and adjacent divisions in 1986 indicated that white hake from NAFO Division 4T may be characterized by two distinct components:

(1) fish from the shallow inshore southern Gulf (depths <= 200 m), principally the Northumberland Strait area (the "Strait" component) and

(2) fish from along the Laurentian Channel in depths in excess of 200 m (the "Channel" component).

The two component hypothesis prompted several further questions that have been addressed. These included the distribution of landings that could be attributed to the two components of NAFO Division 4T, growth differences between the two components and catches in the neighbouring areas. Of the total white hake landings attributed to NAFO Division 4T, 83 to 89% come from statistical unit areas that represent only the inshore 'Strait' component. The majority of the remainder are believed to come from the 'Strait' component of unit areas that overlap the deep and shallow water areas. The International Observer Program data show that no large scale discarding of white hake from the deep water fisheries of the Laurentian or Esquiman Channels has occurred.

Previously the hake fishery in the Gulf was considered to be a by-catch fishery, however data presented here indicate that it is a directed fishery. From 1986 to 1989 the directed portion of the Gulf hake fishery was 69 to 75% of the total landings and 44 to 48% of the total effort (trips with some hake landed).

The southern Gulf fishery is an order of magnitude greater than the sum of all the fisheries in adjacent divisions and subdivisions (4R, 4S, 3Pn and 4Vn).

ANCOVA of the weights at length indicated a strong year effect within each sex and a weaker sex effect within a year. An analysis comparing fish caught from depths greater and less than 200 m indicates that within a year and by sex there is no significant difference in the weight at length ($p>0.05$).

In order to test for differences in growth between the two stock components an ANOVA was conducted on mean length at age by sex, year and depth (>< 200m). The analysis indicated differences for some ages and not for other ages. These results reflect an inability to identify a difference in growth for these two stock components for the most common ages in the population. A significant difference was observed in the age distributions for the two components but it was noted that the sample sizes in this latter analysis were small.

The following observations were made:

a) white hake in NAFO Division 4T are composed of at least two different stock components with minor biological differences,

b) the catch is almost all from the inshore component,

c) the research vessel data for these two components is limited and highly variable, and thus difficult to use for assessment calibration,

d) there are difficulties with the interpretation of trends in the commercial catch rate series derived from purchase slips (trip effort),

e) the white hake often comprises an 'alternate fishery' rather than a 'by-catch fishery', and

f) for this stock the reference catch should only be a guide - conservation should be achieved in conjunction with other means.

RÉSUMÉ

La valeur nominale provisoire des débarquements de 1989 atteint 5 128 tonnes, soit une augmentation de 33 % par rapport aux prises de 3 860 tonnes de 1988. Il a été rapporté en 1988 et 1989 que des quantités appréciables de petits poissons avaient été débarquées au cours des dernières années. Des pêcheurs de la région du détroit de Northumberland (est de l'I.-P.-É. et baie St-Georges) ont signalé avoir vu plus de petits poissons en 1989 qu'au cours des années précédentes.

Une analyse discriminante des caractères morphométriques et méristiques de merluches capturées dans la division 4T et les divisions voisines en 1986 a montré que celles de la division 4T de l'OPANO pouvaient être caractérisées en fonction de deux composantes distinctes:

1) les poissons de la partie côtière peu profonde du sud du Golfe (profondeur <= 200 m), surtout représentée par la zone du détroit Northumberland (composante du "detroit") et

2) les poissons se trouvant le long du chenal Laurentien à une profondeur supérieure à 200 m (composante du "chenal").

L'hypothèse des deux composantes a été à l'origine de plusieurs autres questions auxquelles on a tenté de trouver des solutions. Celles-ci comprenaient notamment la distribution des débarquements en fonction des deux composantes de la division 4T de l'OPANO, les écarts de croissance entre les deux composantes et les prises dans les zones voisines. Du total des débarquements de merluche que l'on considère provenir de la division 4T de l'OPANO, de 83 % à 89 % proviennent de zones statistiques qui ne représentent que la composante côtière du "détroit". Il semble que la majorité du reste des débarquements du "détroit" provienne de zones qui chevauchent des secteurs d'eaux profondes et peu profondes. Les données du programme international des observateurs indiquent qu'il n'y a eu aucun rejet généralisé de merluches capturées dans les eaux profondes des chenaux Laurentien ou Esquiman.

La pêche de la merluche dans le Golfe était antérieurement considérée comme une pêche formée de prises accidentelles, les données présentées dans le présent document montrent qu'il s'agit d'une pêche sélective. De 1986 à 1989, la portion sélective de la pêche de la merluche du Golfe représentait de 69 % à 75 % des débarquements totaux et de 44 % à 48 % de l'effort de pêche total (sorties où une certaine quantité de merluche a été capturée).

La pêche réalisée dans le sud du Golfe est d'un ordre de grandeur plus importante que la somme de toutes les pêches faites dans les divisions et sous-divisions voisines (4R, 4S, 3Pn et 4Vn).

Une analyse ANCOVA des poids selon la longueur a montré l'existence d'un important effet lié à l'année au sein de chaque sexe et d'un effet lié au sexe moins important au sein de l'année. Une comparaison de poissons capturés à année et par sexe, le poids selon la longueur ne présentait pas d'écart significatif ($p > 0,05$).

Une analyse ANOVA portant sur la longueur moyenne selon l'âge par sexe, année et profondeur (> < 200 m) a été réalisée afin de vérifier l'existence d'écarts de croissance entre les deux composantes de stock. L'analyse a montré l'existences d'écarts à certains âges seulement. Ces résultats reflètent l'incapacité de déceler un écart de croissance entre les deux composantes a été noté pour les distributions d'âges des deux composantes mais il a été signalé que les tailles des échantillons utilisés pour cette dernière analyse étaient faibles.

Il a été observé que:

a) les merluches blanches de la division 4T de l'OPANO se divisent en au moins deux composantes de stock distinctes présentant des différences biologiques mineures;

b) la composante côtière forme presque la totalité des prises;

c) les données obtenues par navires de recherche pour ces deux composantes sont limitées et fortement variables et donc difficiles à utiliser pour l'étalonnage d'une évaluation;

d) l'interprétation des tendances de la série des taux de prises commerciales obtenues à partie des bordereaux d'achat (effort par sortie) présente des difficultés;

e) la pêche de la merluche est souvent une pêche de "remplacement" plutôt qu'une pêche formée de prises accidentelles; et

f) les prises de référence de ce stock devraient servir uniquement de repère pour la prise de mesures de conservation, d'autres moyens devraient aussi être utilisés.

INTRODUCTION

The fishery for white hake (Urophycis tenuis, Mitchill) in the southern Gulf of St. Lawrence usually does not commence until May when the last of the sea ice has dispersed. Landings peak between July and September and decline through October and November (Table 1). Landings have ranged from a low of 3,616 tonnes in 1974 to a high of 14,039 tonnes in 1981 (Table 2 and Figure 1). TAC's (Total Allowable Catch) have never restricted the Gulf white hake fishery (Figure 2). The stock was not managed by a TAC until the precautionary quota of 12,000 tonnes was placed upon this stock in 1981 for the 1982 season. Recent assessments (Clay et al., MS 1986; Clay, MS 1987; Clay and Hurlbut, MS 1988) suggested long term yields in the range of 5,000 to 6,000 tonnes. The TAC for 1987 was reduced to 9,400 tonnes and for 1988 to 5,500 tonnes. It has remained at 5500 tonnes for 1989 and 1990.

This fishery is carried out mainly by small inshore vessels, and is strongly affected by weather and local market conditions. Winter ice conditions preclude inshore fishing from December through April of most years. Two main gear types are used in this fishery, the first group uses fixed gear, gillnets and longlines in the summer and in the fall. The second group uses mobile gear, small otter trawlers (<20m) and larger seiners. The majority of the fishery is conducted in Northumberland Strait, on the western end of P.E.I. and between P.E.I. and Cape Breton Island.

The provisional nominal landings in 1989 (Table 1) totalled 5,128 tonnes, an increase of 33% from the 3,860 tonnes caught in 1988 (Table 2). The gillnetter portion of the catches decreased in 1989, returning to approximately the same value as their historic proportion (Table 2). This shift in gear composition of the catch was taken up mainly by the seiner and small trawler components.

Anecdotal information from 1988 and 1989 indicated that significant quantities of small fish were landed in recent years. Fishermen in Northumberland Strait (eastern PEI - St. Georges Bay) reported seeing more small fish in 1989 than in recent years.

The 1989 groundfish sub-committee of CAFSAC concluded that available information for this stock was not adequate for annual adjustment of the reference catch and recommended that the stock definition be clarified with the associated implications for management. The sub-committee noted that 'this is mainly a by-catch fishery and little conservation benefit would be derived from restrictions on the fishery'. A restrictive TAC could lead to widespread discarding of the hake by-catch while directing for other higher priced species. This unrecorded mortality would delay any improvement in our ability to provide advice on this stock. This review of the current fishery is meant to address this observation and other comments on the stock structure of white hake in this management unit.

WHITE HAKE STOCK STRUCTURE

Previous analyses of the distribution of white hake in NAFO Division 4T using annual and seasonal resource survey data have identified two geographically separate concentrations of fish: an offshore group along the slopes of the Laurentian Channel and an inshore group from the southern Gulf (Koeller and LeGresley, 1981; Clay, in press; Clay and Hurlbut, MS 1989). To test the hypothesis that these groups represent discrete components (ie. stocks), discriminant function analyses were performed on eighteen morphometric and nine meristic characters of white hake sampled from NAFO Divisions 4RST in 1986 (Hurlbut and Clay, MS 1990).

Geographic differences in the morphology of white hake from this management unit were examined with three scenarios. Scenario one consisted of six selected areas: three from the Laurentian Channel (depths > 100 m) and three from the southern Gulf (depths <= 100 m). Scenario two contrasted samples from depths greater and less than 100 m, while scenario three used a 200 m boundary.

Although meristic characters provided some evidence for stock separation, the best statistical separation was obtained with morphometric characters in scenario three. Morphometric discriminant functions derived from "learning samples" for this scenario were able to correctly classify "test samples" with accuracies of 78 % for females and 77 % for males.

A greater relative snout length in fish sampled from the Laurentian Channel compared with those from the southern Gulf was the primary character difference. Head length contributed to the multivariate discrimination for females and length of the upper jaw and pre-anal length contributed to the discrimination between male white hake.

The majority of the specimens that were misclassified by the morphometric discriminant function of scenerio three (53 % of the misclassified females and 36 % of the misclassified males) were located near the 200 m depth 'boundary'. These misclassified specimens represented 26 % of the fish from this 'boundary' area.

The evidence from this investigation is consistent with the results of a limited tagging study conducted off eastern P.E.I. by Kohler (1971). His study indicated that white hake in the southern Gulf probably remain in the Gulf year round, with little mixture with white hake populations outside the Gulf. No fish from the Laurentian Channel or outside the Gulf were tagged.

The combined evidence from this analysis of morphological characters, seasonal and annual distributional studies and a tagging study indicates that white hake in NAFO Division 4T, are characterized by two distinct components composed of:

(1) fish from the shallow inshore southern Gulf (depths <= 200 m), principally the Northumberland Strait area (the "Strait" component) and
(2) fish from along the Laurentian Channel in depths in excess of 200 m (the "Channel" component) (Figure 3).

White hake in NAFO Division 4T have been assessed and managed as a "unit stock" for lack of evidence to the contrary. This study suggests that this management unit may no longer be appropriate. The implication of this study is that there is more than one component to the white hake currently being managed in NAFO Division 4T. Unfortunately this study does not indicate why white hake are physically different in the two depth zones - either genetic (reproductively isolated) or environmental determinants.

LANDINGS

White hake by statistical district

In the Gulf of St. Lawrence white hake are caught mainly by small inshore vessels that are not required to complete and submit log books. Therefore no estimate of landings and associated fishing effort by individual vessels is available. Trip landings are, however, recorded on the purchase slips for the inshore as well as other components of the fishing fleet. This data base generally only includes 75% to 95% of the official landings. The rest of the landings are reported on Supplemental 'A' and 'B' slips. These do not represent individual vessel days of activity - but rather 'roll ups' of one or more vessels over various time periods. The percentage of the catch recorded on these supplemental forms has decreased in recent years.

Directed effort was assumed to be any purchase slip (or trip) where over 50% of a vessels' landings were composed of one species (white hake in this case). From 1986 to 1989 the directed portion of the Gulf hake fishery was 69 to 75% of the total landings reported on purchase slips and 44 to 48% of the total effort (trips with some hake landed). Cod directed trips accounted for 25 to 33% of the total hake effort but only 10 to 15% of the landings. Plaice directed trips accounted for 8 to 12% of the hake effort and 3 to 7% of the landings. In past assessments all trips with less than 50 kg were removed in order to derive a commercial catch rate series. Reducing the data set in this way makes little difference in these values, as only about 1% of the landings are lost. When this is done, about 75%

of the landings are from the directed fishery. This is a different view of the fishery from that presented in recent years. The white hake fishery appears to be directed, however it is believed that in many cases the fishery is an 'alternate' fishery. That is, it is used to fill in periods between other, more economically lucrative fisheries (ie. lobster, scallop, etc.).

In each of the four main gear types in this fishery, the largest proportion of the landings are directed. The gillnet fishery has the highest proportion of directed trips, with the monthly proportion ranging as high as 75 to 80% (see 1989 - Figure 4). The directed fishery is most intense from June to October with gillnets having the highest percentage of directed trips in all months except September. The same months are most important when the data are assessed by Statistical District (Figure 5). The districts in the southeastern Gulf (districts 2, 3, 13, 87, and 88) have a longer season than those in the southwestern Gulf (districts 65, 66, 82, and 92).

Although there are large fluctuations on a week to week basis, the cumulative landings for the NAFO Division 4T hake fishery indicate that the longer term pattern has been more stable over the last four years (Figure 6). The large fluctuations in the weekly catches may have added "unnecessary noise" to the calculated abundance index used in earlier assessments.

Comparing the total landings from Division 4T with those of the surrounding Divisions (4R and 4S) and Sub-divisions (3Pn and 4Vn) (Figure 2) highlights the limited extent of the adjacent fisheries. In most years the southern Gulf fishery is an order of magnitude greater than the sum of the adjacent fisheries.

In order to confirm that there is no high hidden mortality on the over-wintering portion of the hake from Division 4T, the International Observer Program (IOP) data set was investigated for white hake catches (including discards) in NAFO Divisions 4RST and Sub-divisions 3Ps, 3Pn, and 4Vn. Of all the bottom trawl fishing sets from 1985 to 1989 reporting catches of hake (>6000 sets), over 70% had less than 100 kg (Figure 7). Using this data as an indicator of abundance, a density contour map of the area surveyed by the IOP was drafted. This analysis indicates a concentration of observed effort in the Laurentian Channel and adjacent shelf areas from St. Pierre Bank to Anticosti Island and into the Esquiman Channel to the north (Figure 8). The greatest densities of white hake occur on the southern tip of St. Pierre Bank, south of Burgeo Bank and on the east and west slopes of Cabot Strait. This indicates the presence of a contiguous biomass at depths of about 200 m and below in the Laurentian and Esquiman Channels. The International Observer Program data also showed that there was no large scale unreported mortality (discarding).

A limited investigation of data from the Quebec Observer Program using only sets from NAFO Division 4T with catches of cod between May and December 1989, indicates 10 of 104 sets contained white hake. From these 10 sets, 7 kg of hake were kept and 1110 kg were discarded. These two studies indicate that large vessels directing for cod and other species in Division 4T and adjacent areas are not catching significant quantities of white hake.

These fisheries follow a seasonal pattern of exploitation which is largely governed by the annual migration of white hake to and from the overwintering grounds in the Laurentian Channel (Clay, in press). The seasonal pattern shows the peak in landings occurs in midsummer (July and August) when the 'Strait' component has completed its movement to the shallow zone of the southern Gulf (Figure 9).

Eighty-three to 89% of the total white hake landings in the past four years have come from that part of the 'Strait' component of the NAFO Division 4T management unit comprising Unit areas 4Tg, 4Tj, 4Tl (Figure 10). Landings from unit areas 4Th, 4Tm, and 4Tn have been minor and variable in recent years (Table 3). The unit areas that encompass the 'Channel' component (ie. > 200 m depth) of the 4T management unit (Unit areas 4Tf, 4Tk, and 4To) produce 3 to 10% of the landings, however these unit areas also include some inshore shallow zones that probably produced the majority of the reported landings in these areas. Thus the major part of the hake fisheries in the Gulf of St. Lawrence and adjacent areas (ie. Sub-divisions 3Pn and 4Vn) exploit the 'Strait' component of the stock.

Commercial catch rates

A commercial catch rate series has been used in past assessments for VPA calibration. It has been assumed that each purchase slip represents one unit of fishing effort (day) because of the inshore nature of the hake fishery. As this model explained only 23% of the variation in 1989 and due to concerns regarding the by-catch nature of this fishery, the groundfish sub-committee of CAFSAC was reluctant to accept the resulting trend as being representative of the abundance of the stock rather than simply a reflection of the catch. (Which may in itself be indicative of trends in abundance - eg. an unregulated fleet of 'constant' effort.) The sub-committee in 1989 noted that the difficulty arising from the by-catch nature of this fishery index may be alleviated if a portion of the fleet directing for white hake could be found.

As a long term solution to this problem an Index Fishermen Program has been started in the southern Gulf of St. Lawrence. It is directed at cod in particular but is designed to collect data for other species at the same time. Of the 50 fishermen involved in this program, about one quarter are considered to be at least part white time hake fishermen.

A short term solution was investigated by trying to identify the percentage of directed trips (days) in the hake fishery. The gillnet fishery has the highest monthly percentage (75 to 80%) of directed trips. The districts that fish western PEI towards the Acadian Peninsula (Miscou Island) have a short season of directed fishing (Figure 4) while those on eastern PEI towards Cape Breton exhibit a longer season with the St. Georges Bay area having the highest percentage of directed trips for the longest time. This subset of the data (gillnet) was used in the 1989 assessment (Clay and Hurlbut, MS 1989) as in earlier assessments and provided trends consistent with the entire data set.

When we attempted to refine the abundance index used in previous assessments we noted an error in the coding of inshore otter trawlers (side and stern). Prior to 1984 a significant but unknown percentage of the stern trawlers were coded as side trawlers and visa versa. As a result, our data set is limited, if trawlers are to be used, to the period 1984 to present rather than 1978 to present, as used in previous assessments (Conversations with staff from the Statistics Branch indicate that distinction between the two gear types is correct for the period 1984 to present). Considering the high percentage of directed effort we believe it may be possible to improve upon the catch rate series used in previous assessments. In future assessments, when abundance indices are calculated the following points should be remembered.

The directed gillnet and stern trawl (OTB-2) fisheries should be selected for the following districts: Cheticamp (2), east St. Georges Bay (3), west St. Georges Bay (13), Souris (88), Tignish (82), and Sea Cow Pond (92). The weekly catch was observed to be highly variable (Figure 6). Earlier attempts to use data on this fine time scale may have introduced undue noise into the model, thus we recommend using the monthly time intervals: June to October.

AGE DETERMINATION AND COMMERCIAL SAMPLING

All commercial port samples from NAFO Division 4T came from fish caught in less than 200 m depth ('Strait' component of the stock). No samples came from Unit Areas 4Tf, 4Tk, or 4To (areas incorporating the 200 m contour) (Figure 10).

Commercial port samples of white hake were obtained according to protocols established in 1984 (Clay et al., MS 1985; Clay and Hurlbut, MS 1989). Samples were obtained from 2 sources:

1) the P.E.I. provincial Department of Fisheries and Labour provided 25 length frequency samples, and

2) the Department of Fisheries and Oceans (DFO) port samplers collected 47 length frequency samples with a total of 1,157 otoliths of which 1,102 provided acceptable age estimates.

The commercial port samples and research vessel survey (694 otoliths) provided the material in 1989 for estimates of growth. These estimates fell within the accepted range of size at age for white hake.

Quality control tests were conducted during the entire period of age determination, after every 200 to 250 otoliths. Intrareader agreement ranged from 83 to 91 % with a mean of 88% when repeat samples were re-aged. Agreement with the past control (contract) reader ranged from 71 to 91% with a mean of 80% when reference trays (50 previously aged otoliths) were re-aged.

Low sampling intensity did not allow an area by area breakdown of the landings. Sufficient samples were available to separate the aged samples into two gear groupings (Table 4). Otter trawls and seines were considered comparable as were gillnets and longlines.

Eight combinations of time and gear were chosen for the length frequency data from the available samples for 1989 (Table 4). The appropriate age-at-length key was used to determine the age composition of the length frequencies of landings in the eight time/gear combinations above.

The catch at age and the weight at age were calculated for each key (Table 5 and 6) by the computer system AGELEN (ver 3.21) for sexes combined. These data were added together for the final catch numbers at age and a weighted average (by numbers in each age group) calculated for the weights at age.

The mean length at age in 1989 (Table 7) and 1988 (Table 8) were compared and found to indicate a similar occurence of larger fish in the gillnet and longline fisheries.

RESOURCE SURVEY DATA

The annual September resource survey in the southern Gulf of St. Lawrence in 1989 was a random stratified 24 hour survey with 169 sets completed.

Previous analyses have found these data (derived from a cod/plaice oriented survey) to be variable for white hake and therefore the RV abundance has not been successfully used in the calibration of the assessment for this fishery. In an attempt to reduce this high variability Clay and Hurlbut (MS 1989) analysed the distribution of white hake in the research survey data and found a "ring" shaped distribution about the southern Gulf of St. Lawrence. This distribution prompted the hypothesis that two stock components might exist in the southern Gulf: a deep water (Laurentian Channel) component and a shallow water (Northumberland Strait) component.

If an index of abundance of the commercially fishable areas of the southern Gulf is the objective, then the "ring" portion of the southern Gulf (10 strata) is all that is necessary of the annual September resource survey (Figure 3). These ten strata, which occupy only 28% of the entire survey area account for over 90% of the hake caught. If separate indices of the two stock components are desired, then the above index must be split. The three deep water strata (>200 m) comprise the 'Channel' index and the remainder comprise the 'Strait' index. The 'Channel' component, which occupies 8% of the 21,308 km^2 survey area, has contributed 11 to 41% of the estimated survey population numbers in the past 4 surveys.

Limiting our analysis of the survey area to the ten selected hake strata, although not altering the quality of the data, it does reduce the coefficient of variation of the mean number per tow by approximately half. This, we believe, provides a more realistic indication of the variability in the data.

Using the 10 strata encompassing the "ring" distribution and the two component hypothesis presented in last years analysis (100 m boundary - Clay and Hurlbut, MS 1989) or this years analysis (200 m boundary - Hurlbut and Clay, MS 1990), the biomass estimates for the areas surrounding the Northumberland Strait (stata 403, 420, 422, 432, and 433) and the southern slope of the Laurentian Channel (strata 415, 425, 437, 438, and 439) remain variable in 1989 (Figure 11). Hake of these two components overwinter along the slope of the Laurentian Channel at depths below 200 m (Clay, in press). The degree of mixing between the two groups can only be conjectured at this time.

There was a serious mismatch in previous assessments when attempts were made to match the SPA and the RV biomass estimates. In the four years prior to 1986 (survey vessel _E.E. Prince_) the estimated biomass was about 2/3 of the estimate of the four years after 1985 (survey vessel _Lady Hammond_). There are several potential explanations for this apparent increase in population biomass. The depth and gear limitation of the smaller vessel (_E.E. Prince_) may have affected the earlier biomass estimates. Alternatively, there may have been a real increase in the biomass of both components of the stock, although information from the fishery does not support this latter conjecture.

The research vessel population at age, mean catch per tow (with C.V.'s) and weights at age are listed in Table 9, these are for the selected 'hake survey' of the southern Gulf. The age composition from the research survey indicates that the number of age classes available to support the fishery are reduced in 1989, although the number of recruits (3 year olds) in 1989 appears higher than observed in the past two years (Figure 12). The catch-at-age for white hake caught in the commercial fishery in 1989 indicates that 3 year olds were more abundant in 1989 than in 1988 but were less abundant than in 1987. For the first time, one and two year olds were present in the commercial samples in 1989.

GROWTH OF WHITE HAKE IN THE SOUTHERN GULF

Traditionally, fish that are sampled from commercial sources are not individually weighed. Therefore, the weight at age in the commercial fishery is calculated from the length weight regression estimated from the research vessel survey data. The data from the last five years (entire survey) are presented below:

Year	Cruise	Sex	'a'	'b'	n	r^2
1985	H141	Male	0.002357	3.282	289	0.973
1986	H159	Male	0.003319	3.222	1286	0.970
1987	H179	Male	0.003041	3.222	418	0.964
1988	H192	Male	0.002169	3.316	264	0.980
1989	H204	Male	0.004520	3.126	437	0.981
1985	H141	Female	0.002332	3.299	312	0.986
1986	H159	Female	0.003792	3.181	1006	0.978
1987	H179	Female	0.002318	3.289	406	0.978
1988	H192	Female	0.002108	3.319	230	0.986
1989	H204	Female	0.003643	3.181	282	0.988
1985	H141	Combined	0.002501	3.283	602	0.982
1986	H159	Combined	0.004441	3.143	2295	0.989
1987	H179	Combined	0.002607	3.261	824	0.975
1988	H192	Combined	0.003235	3.210	499	0.981
1989	H204	Combined	0.004574	3.122	723	0.984

ANCOVA of the weight at length indicates there is a strong year effect within a sex and a weaker sex effect within a year. A comparison of actual values indicates the maximum difference is 5% for females and about 20% for males. The same analysis for fish caught in water greater than 200 m depth <u>versus</u> fish caught in depths less than 200 m indicates that within a year and by sex there is no significant difference in weight at length ($p>0.05$).

In order to test for differences in growth between the two stock components, an ANOVA was conducted on mean length at age by sex, year and depth (>< 200m). Three years of data from the research vessel Lady Hammond and five ages were analysed: years 1986 to 1988 and ages 3 to 7. These data were collected on the annual September resource survey. A second analysis utilized data collected in 1986 on the same vessel in NAFO Divisions 4RST for ages 2 to 6 (data from Hurlbut and Clay, MS 1990).

The first analysis of the 3 years of data (Table 10), indicates there is a significant difference in growth by sex for ages 4 to 7 but not for age 3. There is a year class effect in ages 3 and 5 but not in ages 4 and 6, with age 7 being uncertain ($p=0.07$). There is no depth effect for ages 3, 6 and 7, but there is for ages 4 and 5. The second data set indicates an effect of sex on growth for ages 2, 5 and 6 but not for ages 3 and 4. There is an effect of depth on growth in ages 3 and 5 but not for ages 2 and 4 with age 6 being uncertain ($p=0.07$). This indicates an inability to identify a difference in growth for these two stock components for the most common ages in the population.

Data from 1986 and 1987 were analyzed with the Kolmogorov-Smirnov and Phi-square tests. The results indicate a significant difference ($P<0.05$) between the age distributions of the two stock components (Figure 13). The uneven and small sample sizes may be affecting this analysis (ie. 92 males in the 'Channel' and 1,010 in the 'Strait' component in 1986 and 69 and 278 respectively in 1987). In a limited earlier review of survey data collected in August and September of 1987 and 1988, from NAFO Divisions 4RST, Clay and Hurlbut (MS 1989) observed what appeared to be a shift to slightly larger fish in the more northerly divisions. This pattern is similar to the shift in age distribution observed for females in this analysis (Figure 13). In the same review, the authors observed that the biomass estimates were of the same magnitude for each of the three divisions. The mean biomass for 1987 and 1988 for the entire Gulf of St. Lawrence (Divisions 4RST) was approximately 30,000 tonnes.

ANCILLARY INFORMATION

Kohler (1971) conducted a tagging study in 1967 on the 'Strait' component of the white hake in the southern Gulf of St. Lawrence. Recaptures were 27% of the 2,271 fish that were released. Of the 603 recoveries, 600 were from depths less than 200 m. Three fish were recovered outside the Gulf, two from Banquerrau Bank in March and April of different years and one from St. Margarets Bay in August. Kohler's conclusion was that 'the main part of the southern Gulf of St. Lawrence hake population remains in the Gulf with little inter-mixing with hake populations outside'.

Markle et al. (1982) reviewed a variety of data and literature and summarized the life history of white hake in the Gulf of St. Lawrence and on the Nova Scotia shelf. An ichthyoplankton survey of the eastern portion of NAFO Division 4T, conducted during the first half of September (1979) indicated that white hake larvae (<18 mm SL) were found over the entire survey area, with high densities occurring in the Northumberland Strait and near the Laurentian Channel (unfortunately this was the northern limit of this survey). They found indications of spawning in May-June in the northeastern Gulf (Divisions 4RS) and in September from the southwestern Gulf (Division 4T) from surveys at these times of the year. Nepszy (1968) concluded that peak spawning occurred in the southern Gulf in June and July, and frequently continued into August and September. Markle et al. (1982) noted that there was some spawning prior to May in the northeastern Gulf. This observation, coupled with Musick's (1969) conclusion that New England and southern Nova Scotia shelf white hake spawn aperiodically (presumably with poor success) led them to hypothesize that spawn deposited in the Laurentian Channel area in early spring may drift around Cape Breton Island and onto the Nova Scotia shelf (Halifax area) by July. They concluded that 'the southwestern Gulf of St. Lawrence [white hake] may show a tendency for mass seasonal spawning in the summer. There is some evidence that deeper Gulf white hake spawn in late winter - early spring and that their larvae may be dispersed into the Atlantic.'

These data support the conclusion of two stock components but the question of their cause still remains.

INDUSTRY VIEW OF MANAGEMENT OPTIONS

An industry meeting was held in December 1989 to discuss reasons for the decline of the white hake fishery in the southern Gulf of St. Lawrence and what possible solutions could be considered. The concensus was that removals of small fish were probably a significant cause of the stock decline. This activity, particularly early in the fishery, was also considered to be a certain cause of low prices. Industry participants indicated that the price paid in late June and early July tends to set the price for the remainder of the season, which is the same time when a component of the fleet lands large catches of small and low priced fish.

The suggested solutions proposed by the industry representatives were:

- institute a minimum size (suggested as 18" from nose to round of the meat (approximately standard length)),

- regulate mesh size, increase it from the 4.25" at present,

- trip limit, one trip per 24 hr of 10,000 lbs,
- encourage some dressing of fish at sea, and
- disallow dual gear on a fishing vessel.

A 'Variation Order' was initiated on May 24 1990 to impose trip limits of 4536 kg (10,000 lbs) on the white hake fishery in the southern Gulf of St. Lawrence.

REFERENCES

Clay,D. (MS 1987) Assessment of Gulf white hake from NAFO division 4T in 1987 (Including an investigation of otolith size to fish length relationships). CAFSAC Res. Doc. 87/81, 57

Clay, D. In Press. Seasonal distribution of demersal fish (Osteichthyes) and skates (Chondrichthyes) in the southeastern Gulf of St. Lawrence. *In* J.-C. Therriault [ed.]. The Gulf of St. Lawrence: small ocean or big estuary? Can. Spec. Publ. Fish. Aquat. Sci. 113.

Clay,D., T.Hurlbut, and L.Currie (MS 1986) Assessment of Gulf white hake: NAFO Division 4T/1986. CAFSAC Res. Doc. 86/81, 46p.

Clay,D. and T.Hurlbut (MS 1988) Assessment of Gulf white hake from NAFO division 4T in 1988. CAFSAC Res.Doc. 88/63, 46p.

Clay, D., and T. Hurlbut. (MS 1989). Assessment of Gulf white hake from NAFO Division 4T in 1989 (Including an investigation of their distribution in the southern Gulf of St. Lawrence). CAFSAC Res. Doc. 89/52, 76p.

Hurlbut,T. and D.Clay (MS 1990). An investigation of white hake (*Urophycis tenuis*) population structure in the southern Gulf of St. Lawrence, NAFO Division 4T, using morphometric and meristic characters. CAFSAC Res. Doc. 90/68, 58p.

Koeller, P.A., and M. LeGresley. 1981. Abundance and distribution of finfish and squid from *E.E. Prince* trawl surveys in the southern Gulf of St. Lawrence, 1970-79. Can. Tech. Rept. of Fish. Aquat. Sci. 1028: 1-56.

Kohler, A.C. 1971. Tagging of white hake (*Urophycis tenuis*) in the southern Gulf of St. Lawrence. Int. Comm. Northw. Atl. Fish., Res. Bull. 8: 21-25.

Markle, D.F., D. Methven and L.J. Coates-Markle. 1982. Aspects of spatial and temporal cooccurrence in the life history stages of the sibling hakes, *Urophycis chuss* (Walbaum 1792) and *Urophycis tenuis* (Mitchill 1815) (Pisces: Gadidae). Can. J. Zool. 60:2057-2078.

Musick, J.A. 1969. The comparative biology of two American Atlantic hakes, *Urophycis chuss* and U.*tenuis* (Pisces, Gadidae). Ph.D. thesis, Harvard University, Cambridge.

Nepszy, S.J. 1968. On the biology of the hake (*Urophycis tenuis*, Mitchill) in the southern Gulf of St. Lawrence. MSc. thesis, McGill University, Montreal.

Table 1. Nominal landings (tonnes) of white hake from NAFO division 4T in 1989 by gear and month. All data are provisional statistics. Rounding of values results in inexact totals.

MONTH	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL
JANUARY	.0	.0	.0	.0	.0	
FEBRUARY	.0	.0	.0	.0	.0	
MARCH	.0	.0	.0	.0	.0	
APRIL	.0	.2	.0	3.0	.0	3
MAY	26.0	157.0	5.1	104.0	.0	292
JUNE	156.0	514.0	32.0	325.0	7.0	1036
JULY	328.0	164.0	238.0	564.0	11.1	1306
AUGUST	308.0	126.0	334.0	413.0	5.0	1186
SEPTEMBER	199.0	30.0	145.0	232.0	0.1	606
OCTOBER	95.0	169.0	131.0	163.0	0.1	558
NOVEMBER	9.1	61.0	36.2	35.0	.0	141
DECEMBER	.1	.0	.0	.0	.0	
TOTAL	**1120**	**1222**	**923**	**1838**	**25**	**5128**
PERCENT	**21.8**	**23.8**	**18.0**	**35.8**	**.0**	**100**

Table 2. Nominal landings (tonnes) of white hake from NAFO division 4T by gear and year and TAC (total allowable catch). All data from 1987 to 1989 are provisional.

YEAR	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL	TAC
1960						2015+	
1961						5333+	
1962						7244+	
1963						6546+	
1964	(Designation of landings by gear type for years 1960-1969 was not possible because gear types were not differentiated for these years).					6205+	
1965						4706"	
1966						7024	
1967						6550	
1968						4260	
1969						4208	

\+ referred to as hake unspecified in NAFO statistical bulletins
" referred to as red hake in NAFO statistical bulletins

YEAR	TRAWL	SEINE	LINE	GILLNET	OTHER	TOTAL	TAC
1970	1463	382	385	2149	1289	5668	
1971	1523	632	702	1622	1228	5707	
1972	1140	863	1604	1190	960	5757	
1973	2468	211	1045	1265	713	5702	
1974	1454	305	345	1100	412	3616	
1975	1576	306	324	1285	634	4125	
1976	1429	398	183	1147	601	3758	
1977	1227	408	231	1300	818	3984	
1978	1303	729	456	1829	508	4825	
1979	2826	912	479	3189	704	8110	
1980	3430	1615	832	4831	1715	12423	
1981	4733	1922	799	6174	411	14039	
1982	2885	994	1027	4625	245	9776	12000
1983	2141	906	753	2959	546	7305	12000
1984	1614	592	674	3631	81	6592	12000
1985	1639	1008	799	2480	88	6014	12000
1986	1316	676	1068	1884	4	4948	12000
* 1987	795	1339	1521	2292	275	6222	9400
* 1988	629	550	730	1938	14	3860	5500
* 1989	1120	1222	923	1838	25	5128	5500
1990							5500
1970 to 1989							
AVERAGE	**1836**	**799**	**744**	**2436**	**564**	**6378**	
PERCENT	**29**	**13**	**12**	**38**	**9**		
1989 Percent	**22**	**24**	**18**	**35**	**0**		

* provisional

Table 3. Nominal landings (tonnes) of white hake from NAFO Division 4T from 1986 to 1989 by Statistical Unit area. All data are taken from purchase slip files and thus will not sum to the statistics in Tables 1 and 2 as the Supplemental 'A' and 'B' forms are not included. See Figure 10.

Statistical Unit area	**1986**	**1987**	**1988**	**1989**
4Tf - Magdalen Is.	67	361	152	351
4Tg - Souris/Cheticamp	1435	3042	1736	2252
4Th - Northumberland Str.	18	47	39	92
4Tj - North shore PEI	324	291	255	250
4Tk - Orphan Bank	5	9	8	2
4Tl - Miramichi	732	832	490	586
4Tm - Chaleur Bay	85	70	42	32
4Tn - Gaspe	103	84	65	114
4To - St. Lawrence River	.03	.04	0	10
4Tu - unknown	1277	742	674	1077
Total purchase slip	**4046**	**5479**	**3461**	**4769**
Nominal catch	**4948**	**6222**	**3860**	**5128**

Table 4. Keys selected for gear/time combinations and their groupings to produce age at length keys for 1989 with at least 400 fish ages.
Lower table shows the keys and associated landings for catch composition applied to each of these age at length keys.

KEY	FISHERY/PERIOD	TYPE	SIZE	AGE/LENGTH KEY
1	OTB:Jan.- July	Length	1940	
		Age	222	
2	OTB:Aug.- Dec.	Length	1909	OTB/SNU: Jan.- Dec.
		Age	127	Lengths - 4997
3	SNU:Jan.- July	Length	808	Aged - 553
		Age	185	
4	SNU:Aug.- Dec.	Length	340	
		Age	19	
5	GN:Jan.- July	Length	3416	
		Age	87	
6	GN:Aug.- Dec.	Length	1551	GN/LL/MISC: Jan.- Dec.
		Age	159	Lengths - 7473
7	LL:Jan.- July	Length	771	Aged - 549
		Age	26	
8	LL:Aug.- Dec.	Length	1735	
		Age	277	

	....AL k e y......		...LF c a t c h...		
KEY	DATE	GEAR	DATE	GEAR	TONNES
1	01/12	OTB/SNU	01/07	OTB	510
2	01/12	OTB/SNU	08/12	OTB	611.2
3	01/12	OTB/SNU	01/07	SNU	835.2
4	01/12	OTB/SNU	08/12	SNU	386
5	01/12	LL/GN	01/07	GN	996
6	01/12	LL/GN	08/12	GN	843
7	01/12	LL/GN	01/07	LL+Misc	293.2
8	01/12	LL/GN	08/12	LL+Misc	651.4
				Total	5126

Table 5. Catch at age of white hake in NAFO division 4T as estimated from dockside sampling of the commercial fisheries in 1989. The eight keys refer to the keys of Table 3.

White Hake: Catch Numbers at Age (000's)

Age	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Key 7	Key 8	Sum	Var
1-2	5	0	0	0	0	0	0	0	5	0
3	8	0	0	0	0	0	0	0	8	4
4	28	35	17	18	0	1	0	10	109	69
5	88	126	81	65	33	54	6	78	530	292
6	94	99	107	76	127	151	43	72	769	450
7	54	51	91	53	172	129	59	58	668	371
8	18	21	44	11	51	32	9	28	214	113
9	3	7	10	0	20	13	5	14	73	40
10	0	1	4	0	1	1	1	2	11	7
11	0	1	2	0	1	2	1	5	12	6
12	1	0	0	0	0	0	0	4	5	1
13-14	0	1	3	0	0	0	0	1	5	1
Sum	299	342	360	224	406	384	124	272	2411	
(From Keys)										
No.in LF	1940	1909	808	340	3416	1551	771	1735		
No. Aged	553	553	553	553	549	549	549	549		
Mean Age	5.73	5.81	6.39	5.89	6.77	6.50	6.75	6.48		

Table 6. Weight at age (kg) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1989. The eight keys refer to the keys of Table 3.

White Hake: Weight at Age (kg)

Age	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Key 7	Key 8	Weighted Ave.Wt.
1	.11	.00	.00	.00	.00	.00	.00	.00	.11
2	.21	.00	.00	.00	.00	.00	.00	.00	.21
3	.40	.53	.62	.62	.00	.00	.00	.00	.40
4	.80	.93	.96	.91	1.11	.93	.87	.91	.90
5	1.19	1.14	1.21	1.17	1.56	1.47	1.68	1.20	1.24
6	1.64	1.59	1.71	1.71	2.01	1.84	2.07	1.68	1.78
7	2.48	2.49	2.69	2.37	2.58	2.43	2.43	2.60	2.52
8	3.45	3.88	3.57	3.11	3.34	3.46	2.96	3.86	3.51
9	4.89	5.86	5.15	4.69	3.40	3.69	3.15	4.81	4.27
10	7.79	8.06	7.85	.00	2.52	3.57	4.44	5.91	6.09
11	8.11	7.83	8.71	.00	3.17	2.97	4.15	6.93	6.10
12	10.24	.00	9.62	.00	.00	7.06	7.06	9.83	9.73
13	10.99	10.78	11.15	.00	.00	.00	.00	8.67	10.57
14	.00	.00	.00	.00	.00	.00	.00	8.80	8.80
Mean	1.71	1.79	2.32	1.72	2.45	2.19	2.36	2.40	2.13
(From Keys)									
No.in LF	1940	1909	808	340	3416	1551	771	1735	
No. Aged	553	553	553	553	549	549	549	549	
Mean Age	5.73	5.81	6.39	5.89	6.77	6.50	6.75	6.48	

Table 7. Length at age (cm) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1989. The eight keys refer to the keys of Table 4.

White Hake: Length at Age (cm)

Age	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Key 7	Key 8	Weighted Ave.Lt.
1	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
2	31.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0
3	38.1	41.7	44.0	44.0	0.0	0.0	0.0	0.0	38.2
4	47.3	50.0	50.4	49.6	53.0	49.9	48.8	49.7	49.3
5	54.1	53.3	54.3	53.8	58.8	57.8	60.3	54.2	54.7
6	59.8	59.2	60.6	60.7	63.8	62.1	64.7	60.2	61.3
7	68.1	68.1	69.9	67.3	69.1	67.8	68.0	68.9	68.5
8	75.9	78.8	76.8	73.5	75.2	75.9	72.4	78.7	76.3
9	85.0	90.1	86.5	84.1	75.4	77.3	73.4	83.9	80.7
10	99.0	100.1	99.1	0.0	69.0	75.4	80.3	89.4	89.4
11	99.8	99.0	102.4	0.0	73.8	71.0	77.8	93.9	88.9
12	108.1	0.0	106.0	0.0	0.0	96.0	96.0	106.5	106.2
13	110.6	109.8	110.9	0.0	0.0	0.0	0.0	102.5	109.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	102.9	102.9
Mean (From Keys)	58.9	59.7	64.9	60.0	67.7	65.1	67.1	64.9	63.6
No.in LF	1940	1909	808	340	3416	1551	771	1735	
No. Aged	553	553	553	553	549	549	549	549	
Mean Age	5.73	5.81	6.39	5.89	6.77	6.50	6.75	6.48	

Table 8. Length at age (cm) of white hake in NAFO division 4T estimated from dockside sampling of the commercial fisheries in 1988. The six keys refer to the keys of Table 3 in Clay and Hurlbut, MS 1989.

White Hake: Length at Age (cm)

Age	Key 1	Key 2	Key 3	Key 4	Key 5	Key 6	Weighted Ave.Lt.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	31.0	0.0	0.0	0.0	31.0
3	0.0	0.0	34.0	0.0	0.0	0.0	34.0
4	50.7	51.1	50.4	49.8	51.0	50.2	50.6
5	54.8	54.6	55.4	59.5	56.7	54.9	55.2
6	59.5	59.0	60.4	66.2	63.4	62.6	62.3
7	69.2	66.6	69.8	71.5	70.0	70.5	70.6
8	78.7	73.4	76.7	76.7	77.4	77.7	77.1
9	87.1	89.9	89.1	83.1	86.1	89.7	86.4
10	87.5	77.0	80.8	84.7	89.6	93.1	89.1
11	94.0	100.0	101.6	95.6	100.0	99.9	99.4
12	107.0	0.0	107.9	0.0	107.5	107.6	107.6
13	0.0	0.0	0.0	101.0	101.0	106.5	105.3
14	0.0	0.0	0.0	102.0	0.0	102.0	102.0
Mean (From Keys)	58.2	56.6	60.0	70.4	65.7	64.0	63.5
No.in LF	2362	778	1122	5339	4880	1347	
No.Aged	616	616	616	616	616	616	
Mean Age	5.6	5.4	5.8	6.8	6.3	6.2	

Table 9a. Population at age for white hake estimated from research vessel surveys in the southern Gulf of St. Lawrence (NAFO division 4T) (based on selected 'hake' strata).

Population at age (Survey) White hake

AGE	**RV <u>E.E. Prince</u> year 1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
0	0	0	0	0	0	186	41
1	108	0	0	91	13	1555	70
2	4050	559	379	912	459	1494	901
3	2751	4194	1434	2171	1175	1512	2212
4	4624	4060	2428	4658	1460	618	2737
5	3680	3594	3465	5258	841	387	2283
6	1349	1840	1374	3194	669	217	958
7	336	819	665	1242	314	80	360
8	141	141	222	385	171	100	282
9	42	36	147	268	0	0	95
10	83	0	82	22	29	0	73
11	0	18	0	30	0	0	23
12	0	97	23	0	0	0	0
13	0	0	33	69	0	0	0
total	**17164**	**15358**	**10252**	**18300**	**5131**	**6149**	**10035**

AGE	**RV <u>E.E. Prince</u> year 1985**	**RV <u>Lady Hammond</u> 1985**	**1986**	**1987**	**1988**	**1989**
0	52	8	818	0	15	729
1	180	18	2326	43	384	1658
2	3227	1722	11771	612	4974	3458
3	6848	5488	10351	1995	5094	7266
4	4380	5477	12467	2675	5429	3983
5	1159	4427	5895	1840	3776	2357
6	704	2339	1487	928	1258	1124
7	407	1331	634	211	552	284
8	130	867	231	50	93	42
9	101	423	118	38	34	17
10	33	542	48	25	15	13
11	0	56	22	0	0	0
12	16	113	27	17	10	0
13	0	188	0	5	0	0
total	**17237**	**22999**	**46195**	**8439**	**21634**	**20932**

Table 9b. Mean catch per tow for white hake estimated from research vessel surveys in the southern Gulf of St. Lawrence (NAFO division 4T) (based on selected 'hake' surveys).

Mean catch per tow (Survey) White hake

AGE	RV E.E. Prince year 1978	1979	1980	1981	1982	1983	1984
0	.00	.00	.00	.00	.00	.32	.08
1	.18	.00	.00	.16	.02	2.65	.13
2	6.89	.95	.65	1.55	.78	2.54	1.58
3	4.68	7.14	2.44	3.69	2.00	2.58	3.78
4	7.87	6.91	4.22	7.93	2.51	1.12	4.66
5	6.26	6.12	6.15	8.95	1.45	.74	3.89
6	2.30	3.31	2.51	5.44	1.19	.39	1.63
7	.57	1.39	1.23	2.11	.59	.24	.61
8	.17	.18	.44	.66	.31	.36	.48
9	.07	.06	.28	.46	.00	.00	.16
10	.14	.00	.15	.04	.05	.00	.12
11	.00	.03	.00	.05	.00	.00	.04
12	.00	.17	.05	.00	.00	.00	.00
13	.00	.00	.06	.12	.00	.00	.00
total	**29.14**	**26.08**	**18.18**	**31.20**	**8.91**	**11.07**	**17.17**

AGE	RV E.E. Prince year 1985	RV Lady Hammond 1985	1986	1987	1988	1989
0	.09	.02	1.60	.00	.03	1.43
1	.3	.03	4.55	.08	.75	3.24
2	5.39	3.68	23.03	1.20	9.73	6.77
3	11.44	11.55	20.25	3.90	9.96	14.22
4	7.31	10.92	24.39	5.23	10.62	7.79
5	1.94	8.70	11.53	3.60	7.39	4.61
6	1.18	4.60	2.91	1.81	2.46	2.20
7	.68	2.66	1.24	.41	1.08	.56
8	.22	1.75	.45	.10	.18	.08
9	.17	.84	.25	.07	.08	.03
10	.05	1.12	.12	.03	.03	.03
11	0	.12	.05	.00	.00	.00
12	.03	.23	.00	.02	.02	.00
13	0	.25	.07	.01	.00	.00
total	**28.79**	**45.03**	**90.44**	**16.46**	**42.33**	**40.95**

Table 9b. con't
Coefficient of variation of mean catch per tow for white hake estimated from research vessel surveys in the southern Gulf of St. Lawrence (NAFO division 4T) (based on selected 'hake' surveys).

Coefficient of variation of mean catch per tow (Survey) White hake

AGE	RV E.E. Prince year 1978	1979	1980	1981	1982	1983	1984
0						33.11	33.26
1	35.20			82.10	100.00	42.84	32.16
2	37.86	50.05	41.39	45.63	31.64	20.74	27.90
3	53.15	47.43	37.85	42.99	26.87	17.47	28.30
4	46.48	43.71	12.96	45.10	30.55	14.35	24.06
5	33.88	34.80	18.17	39.68	30.12	18.45	21.93
6	20.67	43.05	21.50	40.72	33.65	35.63	21.36
7	17.40	43.64	25.56	43.55	26.90	12.35	24.10
8	48.52	46.21	47.54	46.90	42.48	12.14	26.70
9	24.89	50.37	31.14	59.71			27.96
10	24.89		33.53	49.36	39.51		27.96
11		100.00		51.11			40.30
12		54.62	100.00				
13			51.29	75.42			

AGE	RV E.E. Prince year 1985	RV Lady Hammond 1985	1986	1987	1988	1989
0	99.99	100.00	56.49		55.06	83.16
1	55.87	63.82	28.04	36.30	34.93	62.98
2	52.05	61.95	15.34	29.14	40.37	24.35
3	35.70	49.20	25.60	26.40	25.20	18.93
4	29.58	36.01	42.01	25.00	19.84	19.20
5	30.85	37.30	32.67	22.20	14.18	18.42
6	29.47	34.11	18.34	19.58	13.20	25.63
7	33.30	38.10	21.67	37.01	13.47	37.37
8	42.58	45.38	30.95	56.96	24.70	37.94
9	44.92	49.60	29.94	41.06	51.40	70.80
10	70.14	59.94	39.47	48.20	78.70	100.00
11		85.84	50.78			
12	100.00	60.86		43.10	100.00	
13		82.10	61.42	100.00		

Table 9c. Weight at age (kg) of white hake from research vessel surveys in the southern Gulf of St.Lawrence (NAFO division 4T) (based on selected 'hake' strata).

Mean weight at age (Survey) White hake

AGE	RV <u>E.E. Prince</u> year 1978	1979	1980	1981	1982	1983	1984
0							.252
1	.196			.070	.044	.158	.187
2	.280	.315	.343	.242	.361	.326	.316
3	.419	.448	.487	.470	.602	.602	.554
4	.914	.781	.984	.852	.994	1.070	.881
5	1.446	1.340	1.317	1.280	1.291	1.804	1.352
6	1.814	1.761	1.695	1.745	1.825	2.121	1.902
7	2.205	2.026	2.060	2.185	2.707	2.962	2.387
8	3.921	3.679	3.093	3.114	2.884	3.237	3.025
9	2.216	2.891	2.473	3.201		4.118	2.719
10	2.216		2.115	3.276	2.216		5.079
11		4.635		10.906			3.346
12		2.363	8.410				
13				9.952			

AGE	RV <u>E.E. Prince</u> year 1985	RV <u>Lady Hammond</u> 1985	1986	1987	1988	1989
0	.013	.006	.048		.046	.047
1	.105	.080	.122	.112	.128	.080
2	.206	.192	.218	.197	.213	.208
3	.304	.246	.391	.440	.403	.422
4	.714	.498	.692	.689	.685	.593
5	1.159	.774	1.085	1.169	1.045	1.006
6	1.705	1.089	1.738	1.959	1.745	1.564
7	2.382	1.625	2.450	2.743	2.489	2.338
8	2.156	2.115	3.065	3.825	3.502	3.275
9	3.824	2.279	3.523	5.865	5.629	4.631
10	4.535	2.611	5.384	5.965	8.547	6.127
11		4.688	5.534			
12	7.208	3.743	7.471	7.365	8.666	
13		4.835				

Table 10. The probabilities (P) from ANOVA conducted on mean length at age for separate ages by sex, depth, and year class. Two data sets were analysed, the first is taken from the annual resource surveys (1986 to 1989) of the southern Gulf of St. Lawrence. The second set from 1986 covers the three divisions of the Gulf (Bold face values are significant ($p<0.05$)).

Years 1986 to 1988 (NAFO Division 4T)

Effects		Age 3	4	5	6	7
Year class	P=	**.05**	.10	**.02**	.10	.07
Depth	P=	.16	**.00**	**.00**	.07	.17
Sex	P=	.26	**.00**	**.00**	**.00**	**.00**

1986 (NAFO Division 4RST)

Effects		Age 2	3	4	5	6
Depth	P=	.43	**.02**	.67	**.03**	.07
Sex	P=	**.00**	.81	.64	**.00**	**.04**

Figure 1. Nominal landings by gear and year (from 1970) of white hake from NAFO Division 4T.

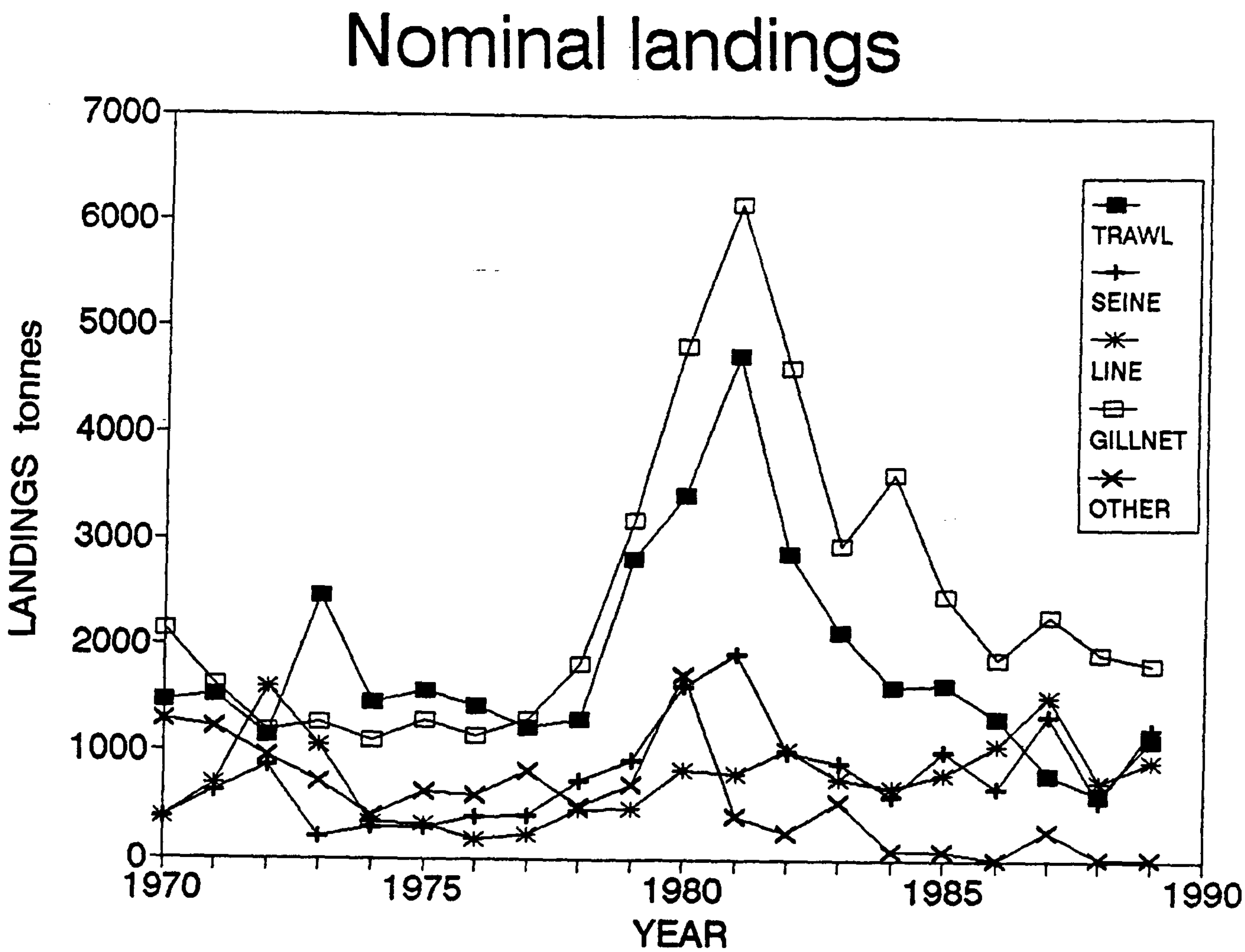
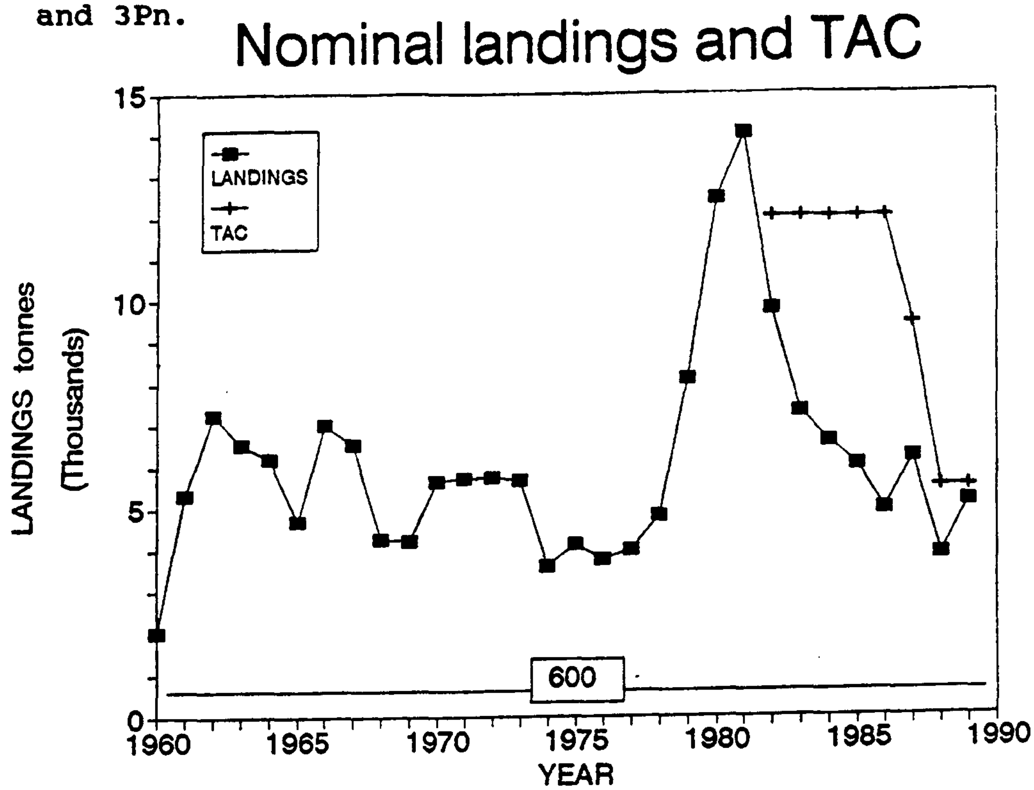


Figure 2a. Nominal landings by year (from 1960) and TAC (total allowable catch) of white hake from NAFO Division 4T. The 600 t line indicates the scale of Figure 2b.

2b. Nominal landings by year (from 1965) of white hake from NAFO Divisions 4R and 4S and Sub-divisions 3Ps and 3Pn.



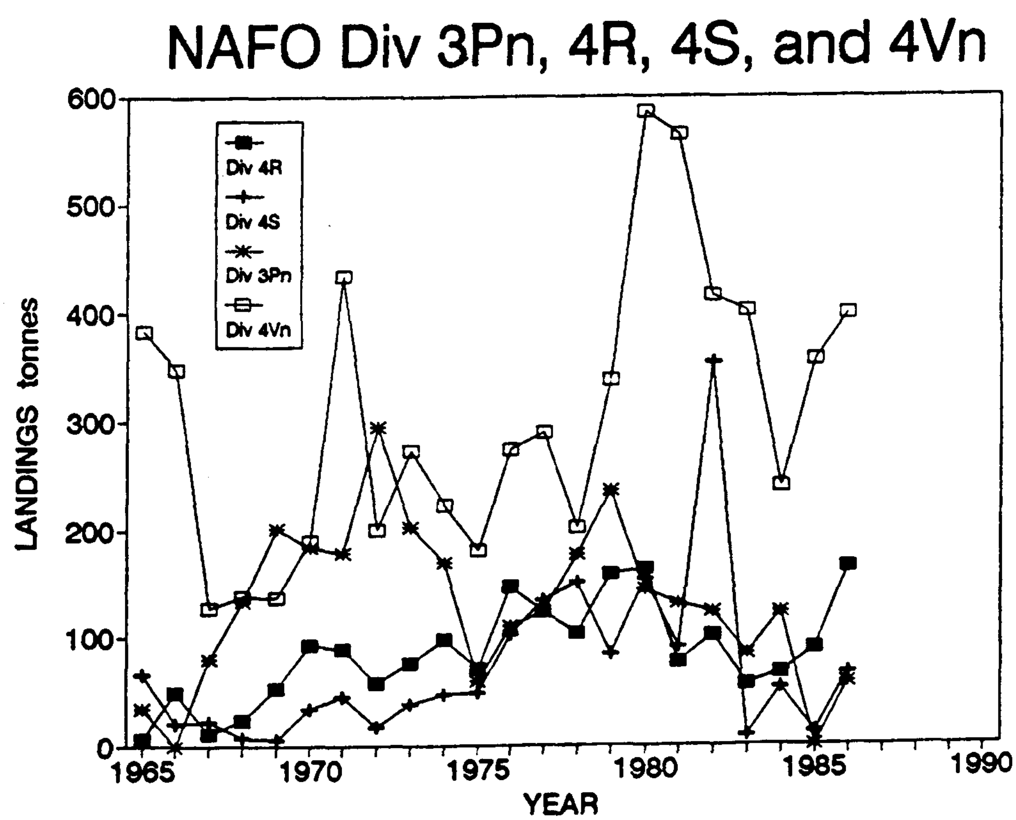


Figure 3. Strata boundaries used in the annual September resource survey of the southern Gulf of St. Lawrence. Strata 415, 425, and 439 comprise the portion of the survey area over 200 m deep. These three strata and strata 437 and 438 comprise what was hypothesised to be the deep water component before this years' analysis identified the 200 m contour as the best boundary. The five crosshatched inshore strata comprise what was referred to as the 'Strait' component.

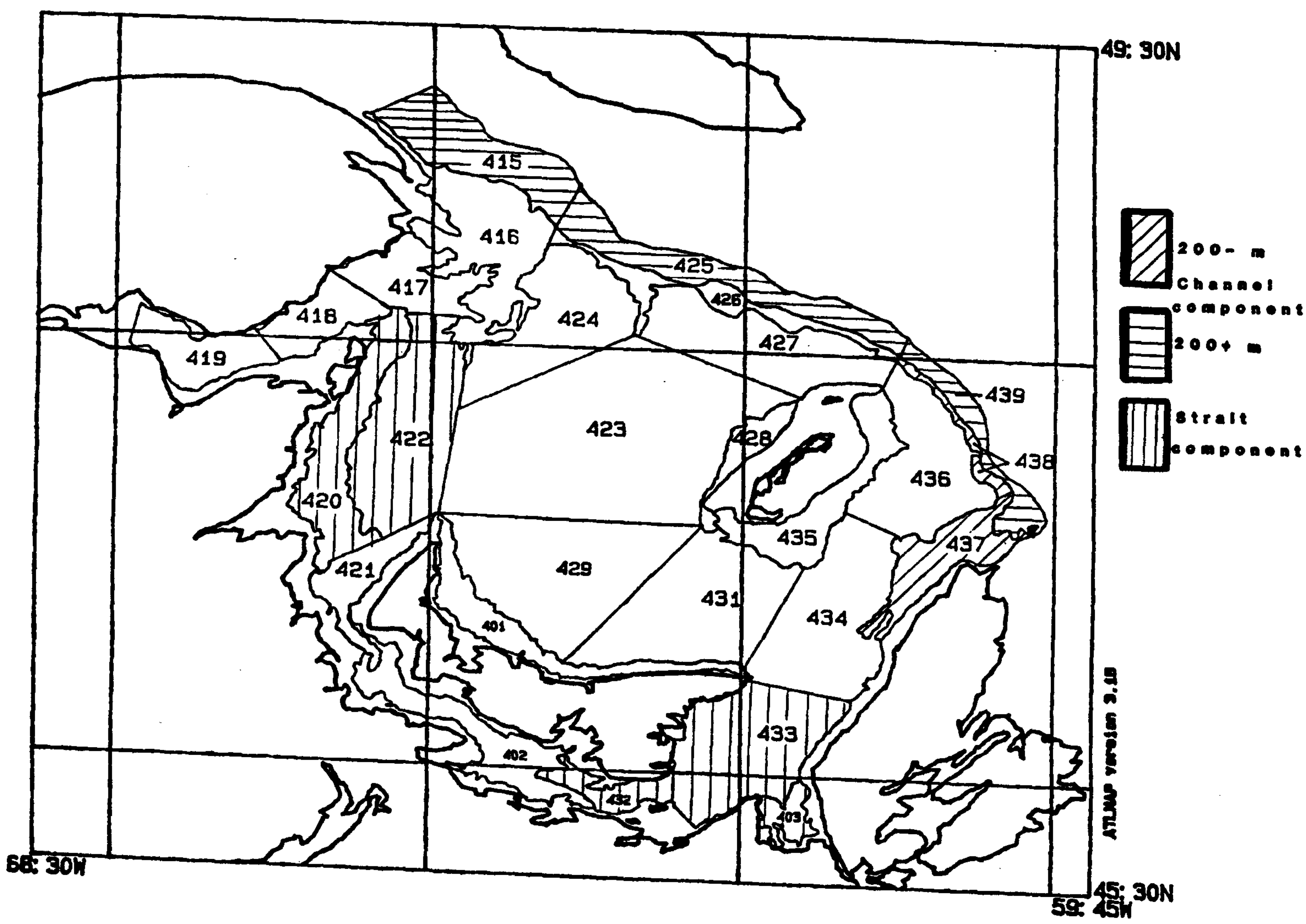


Figure 4. The percentage of monthly hake directed trips (trips with over half the catch white hake) by gear in 1989. The legend codes are: OTB-2 - stern trawler, SNU - Scottish and Danish seiners, GN - gillnetter, and LL - longliner.

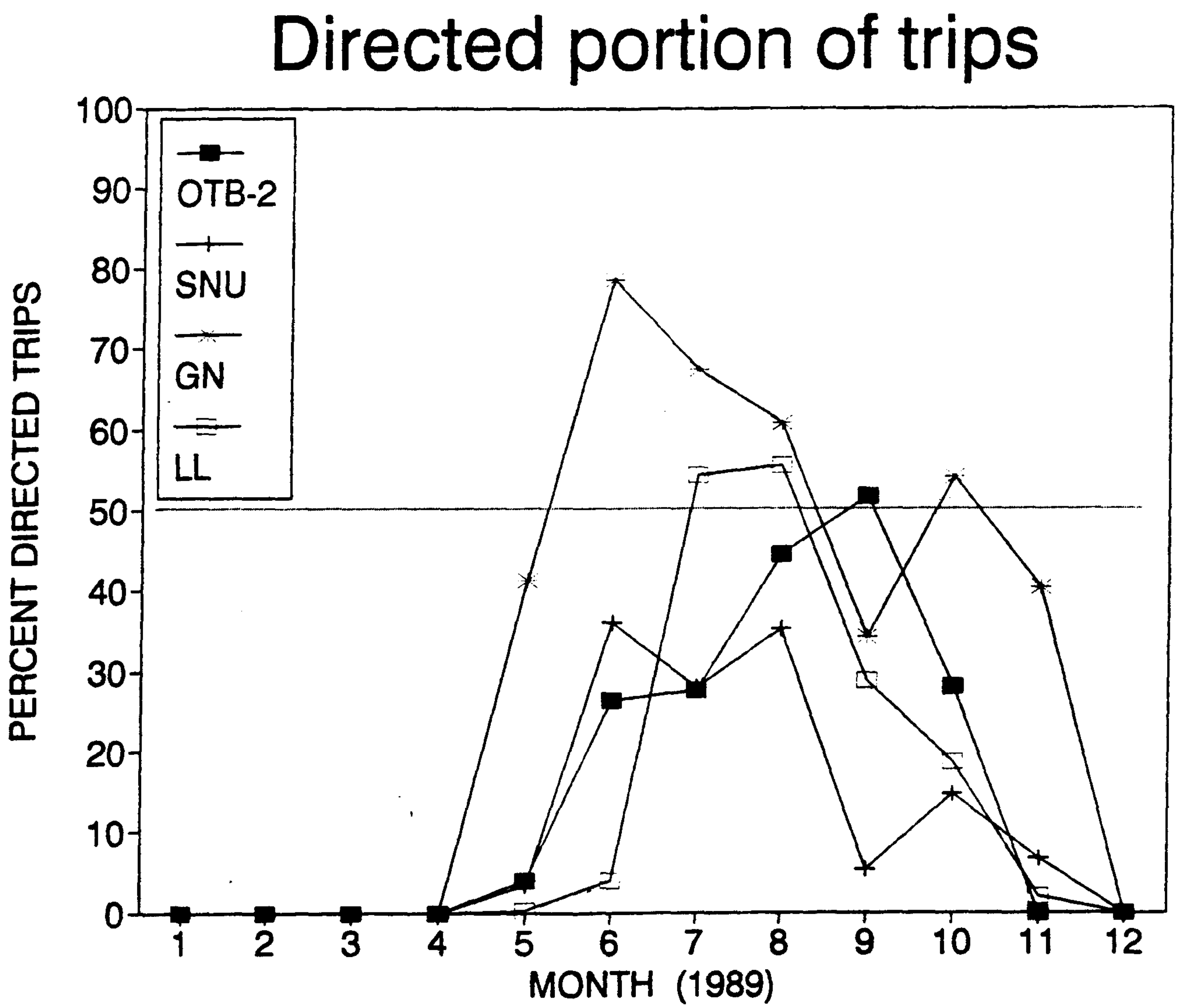


Figure 5a. The percentage of hake directed trips (trips with over half the catch white hake) by statistical district in 1989. These districts are in the southeastern Gulf of St. Lawrence.

5b. The percentage of hake directed trips by statistical district in 1989. These districts are in the southwestern Gulf of St. Lawrence.

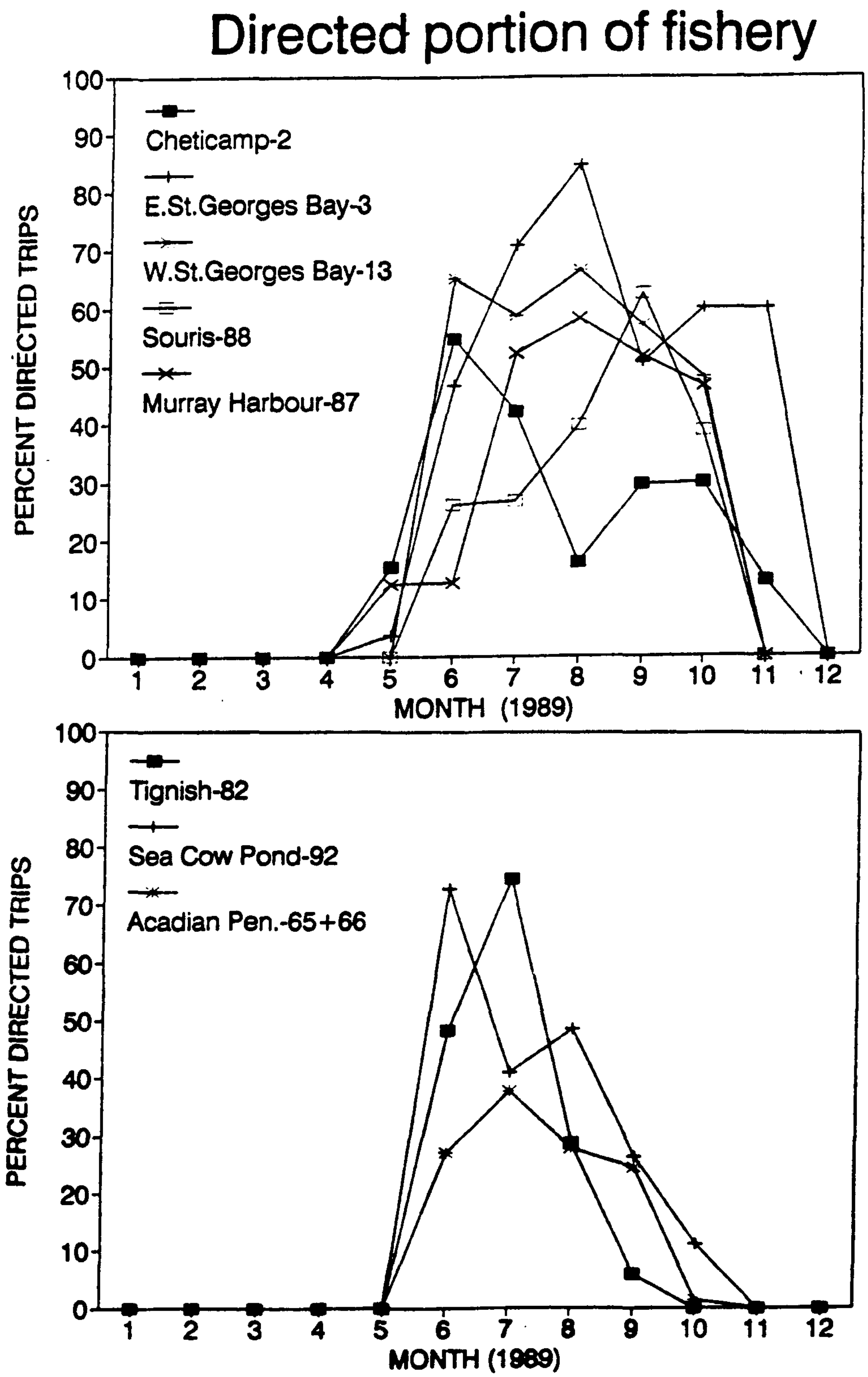


Figure 6. Landings of white hake from NAFO Division 4T by week from 1986 to 1989. Julian week is a sequential counting of the weeks of the year from 1 to 52.

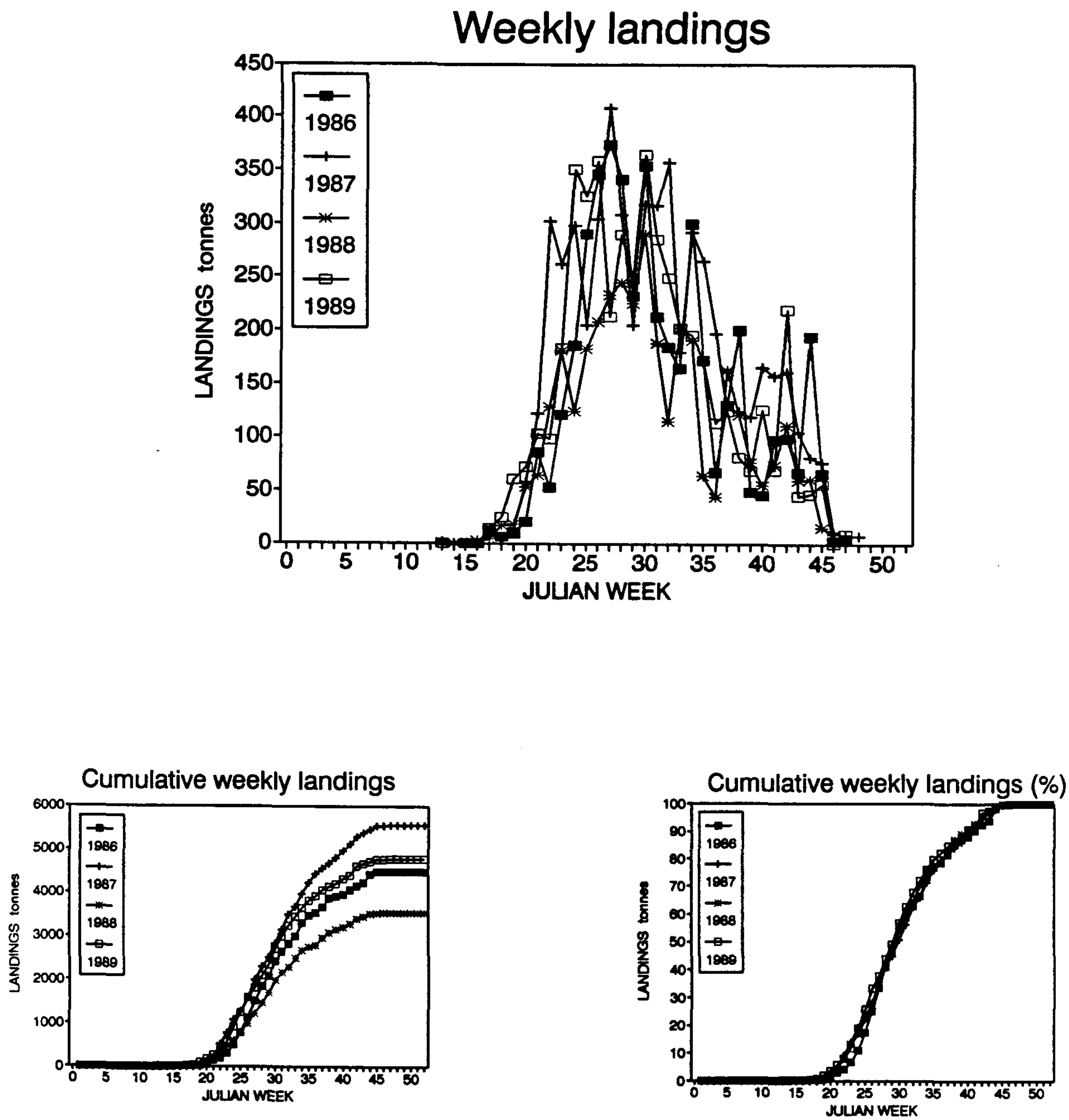


Figure 7. Maps of white hake sampling sites and catches (kg) from observed trips on commercial trawlers by the International Observer Program (IOP). This data represents fisheries in NAFO Divisions 4RST and Sub-divisions 3Ps, 3Pn and 4Vn from 1985 to 1989.

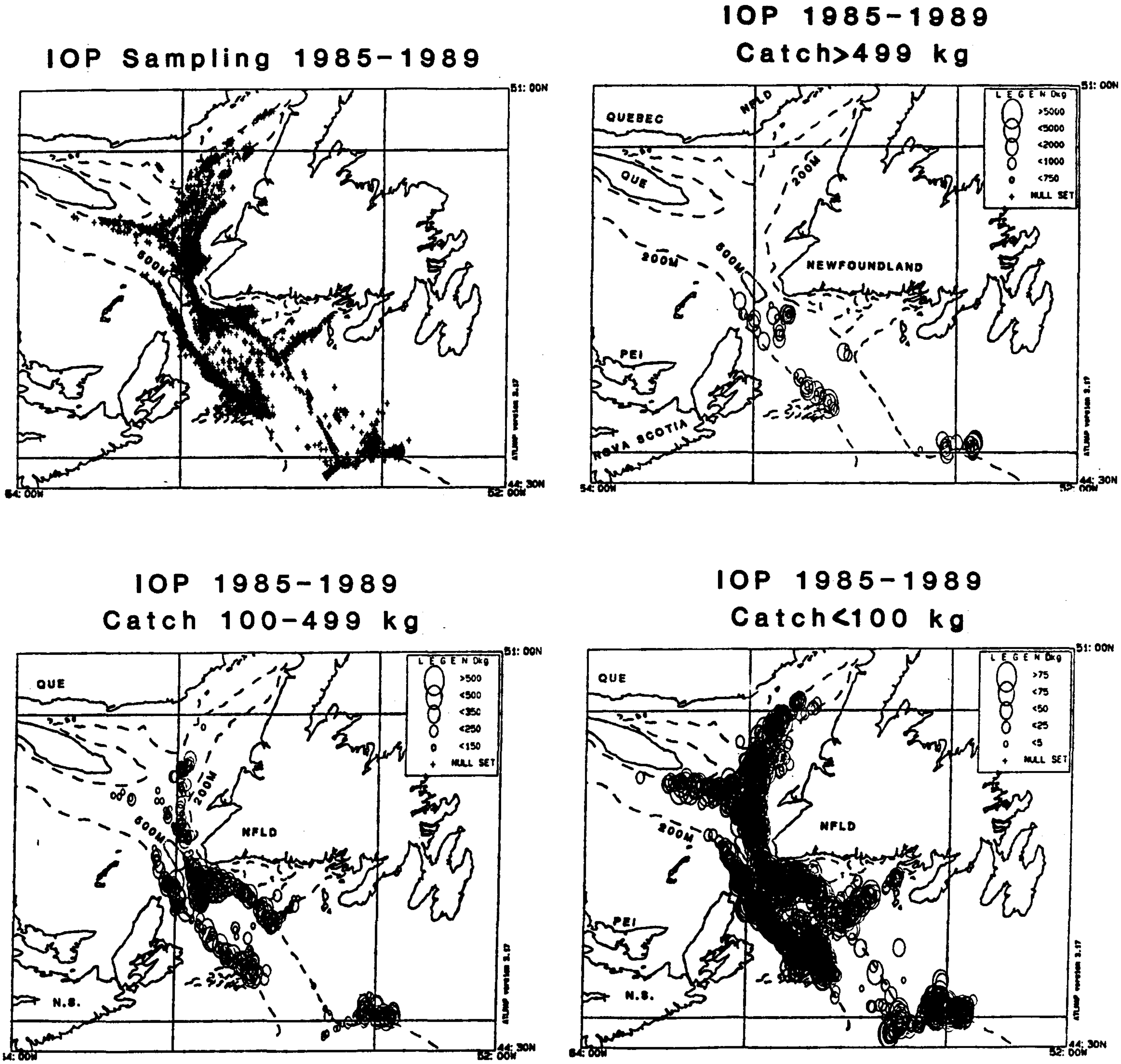


Figure 8. Areas of concentration (density contours) of white hake from the International Observer Program (IOP) data (See Figure 7).

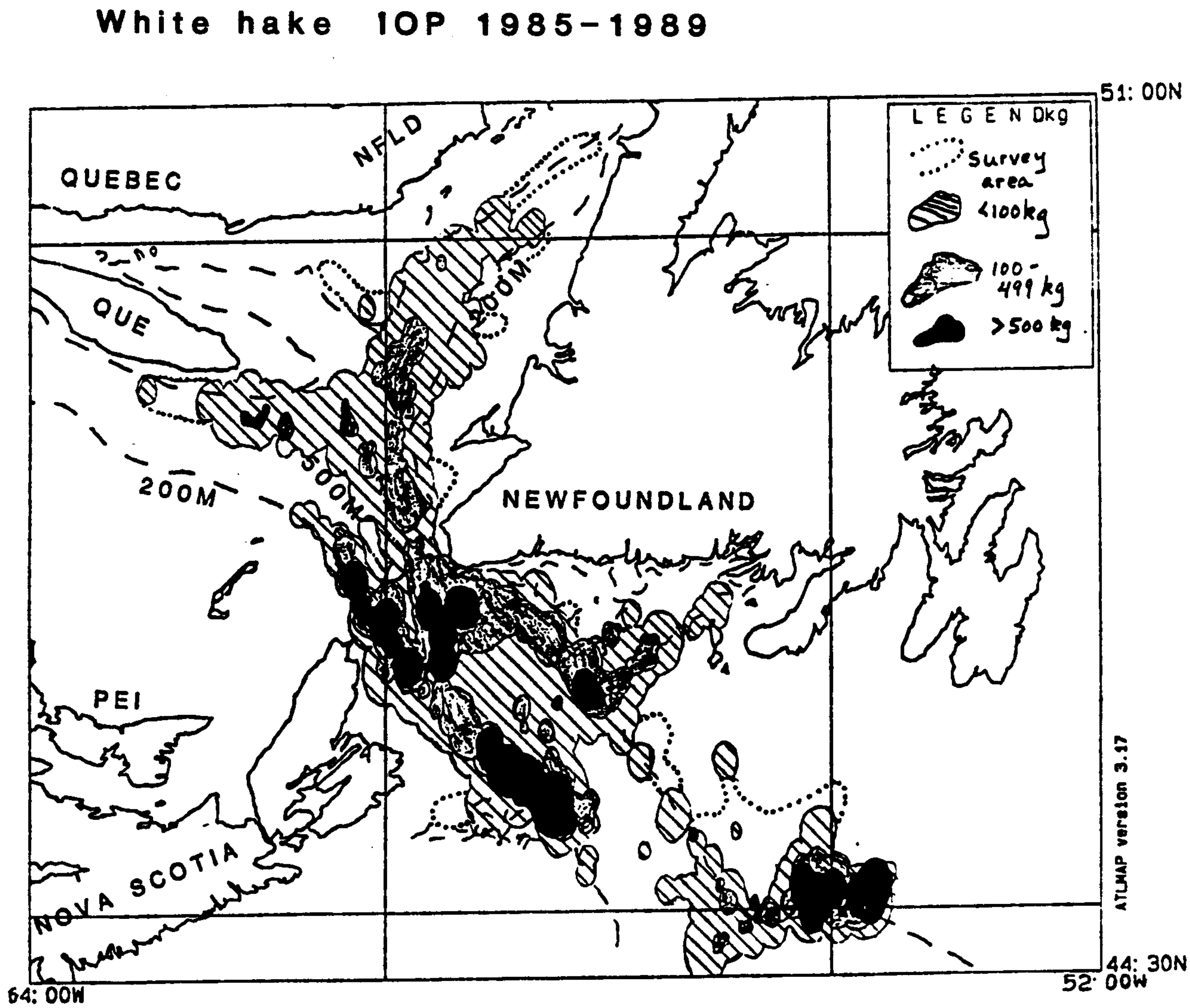


Figure 9. Monthly landings for the hake fishery in NAFO Divisions 4RST and Sub-divisions 3Pn and 4Vn from 1965 to 1984. In the figure January of each year is over the '1' in the year.

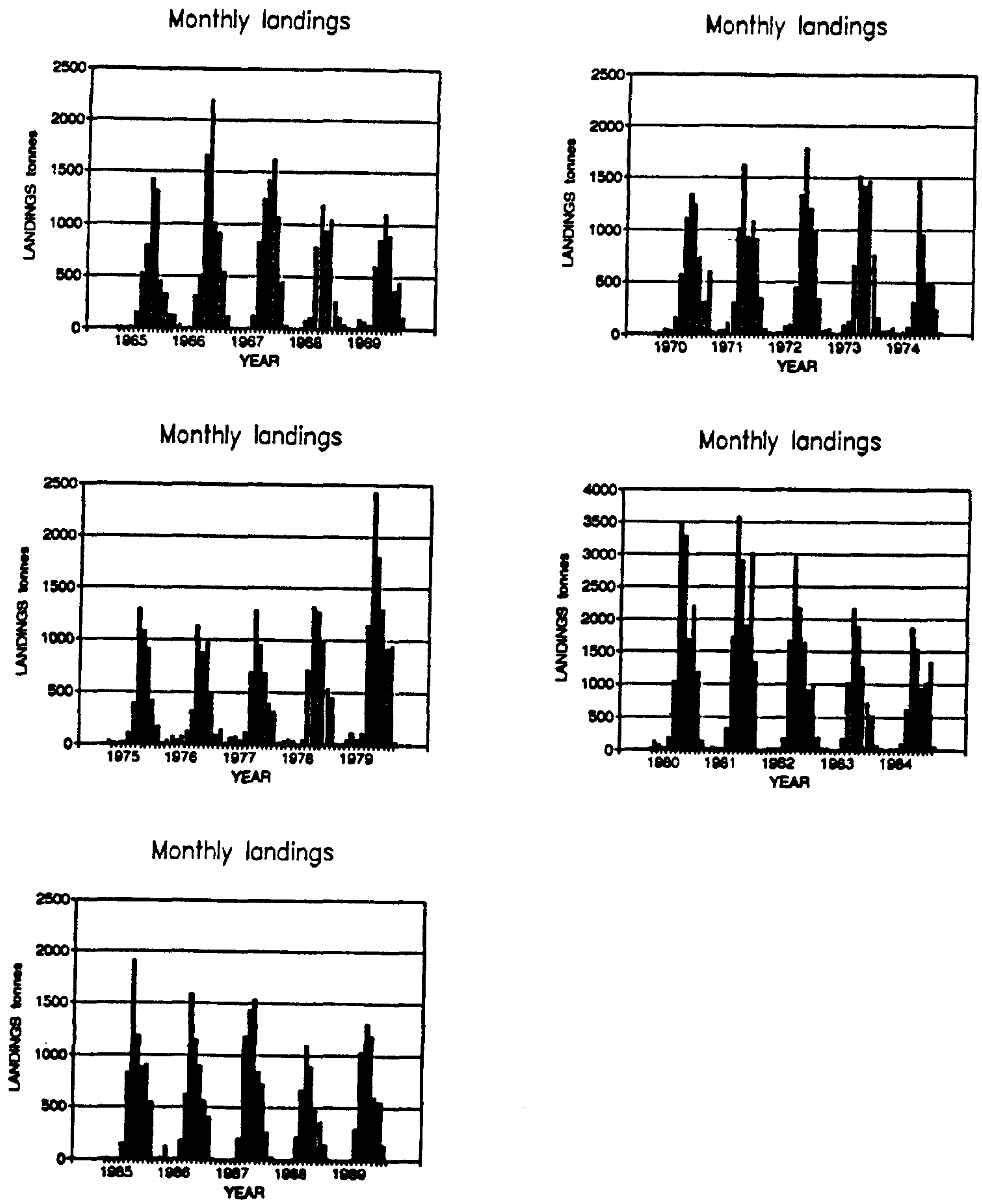


Figure 10. The Unit areas (4Tf, etc.) and the survey strata (see Figure 3) for the southern Gulf of St. Lawrence. The inner contour of the outer 3 strata is 200m.

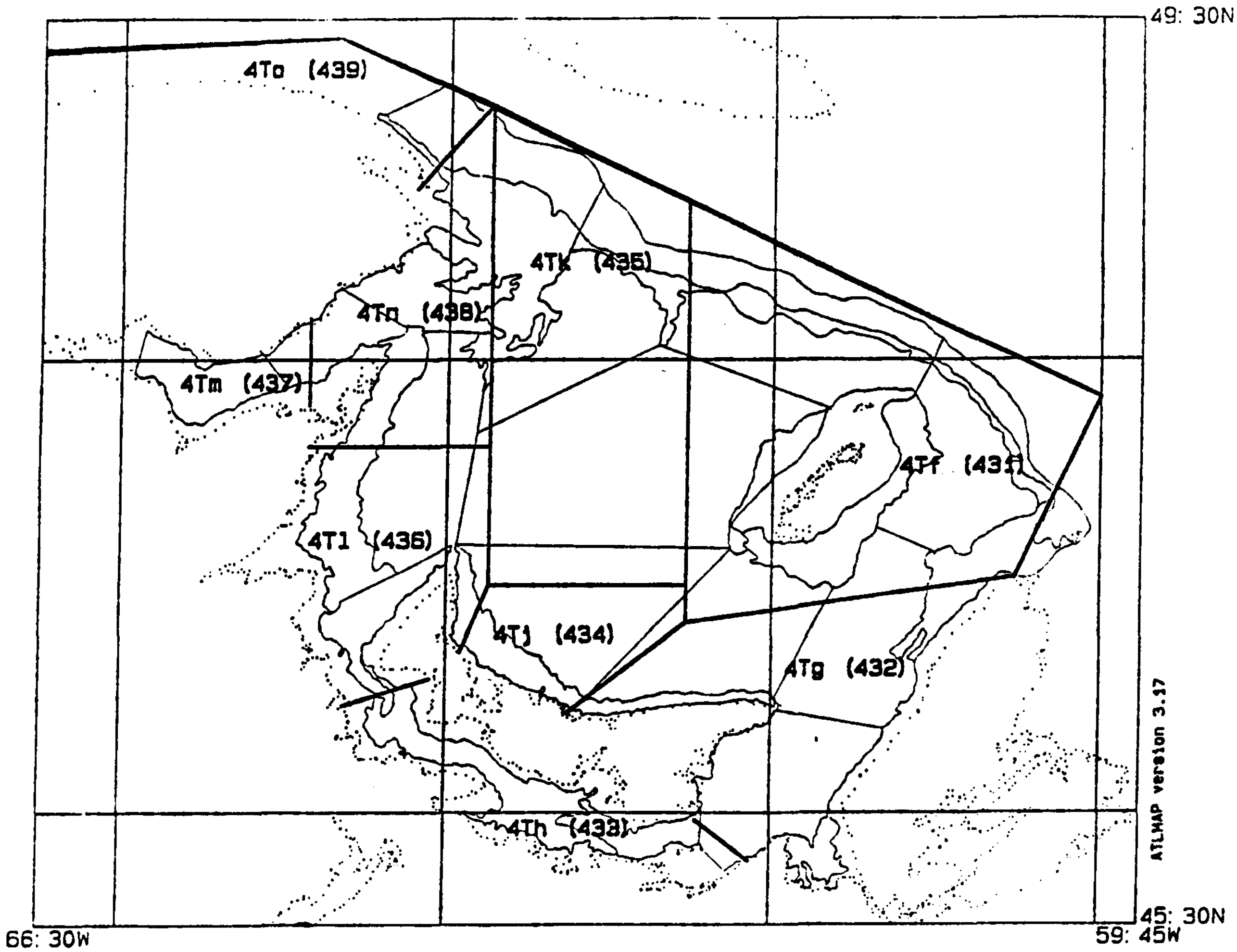


Figure 11a. The estimated population biomass of white hake in the southern Gulf of St. Lawrence and the estimated proportions in the two components as hypothesised in the 1989 assessment (Clay and Hurlbut, MS 1989).

11b. The estimated population biomass of white hake in the southern Gulf of St. Lawrence and the estimated proportions in the two components as defined by the 200 m depth contour.

Note:- the break in the two sets of data points in these figures for 1985 is a result of the comparative fishing experiment between the RV E.E. Prince and RV Lady Hammond.

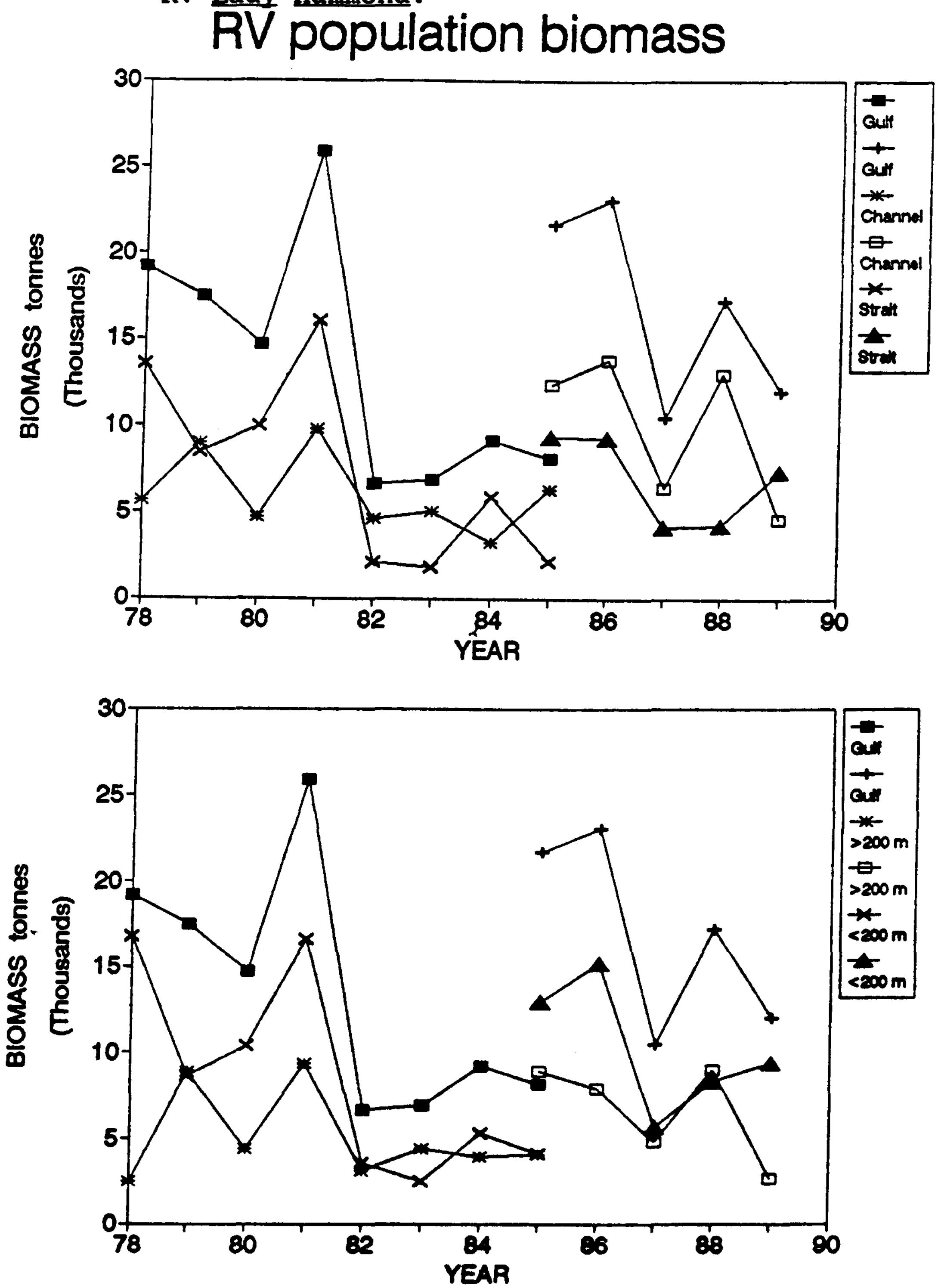


Figure 12. Population at age of white hake from NAFO Division 4T from the September resource survey, 1985 to 1989.

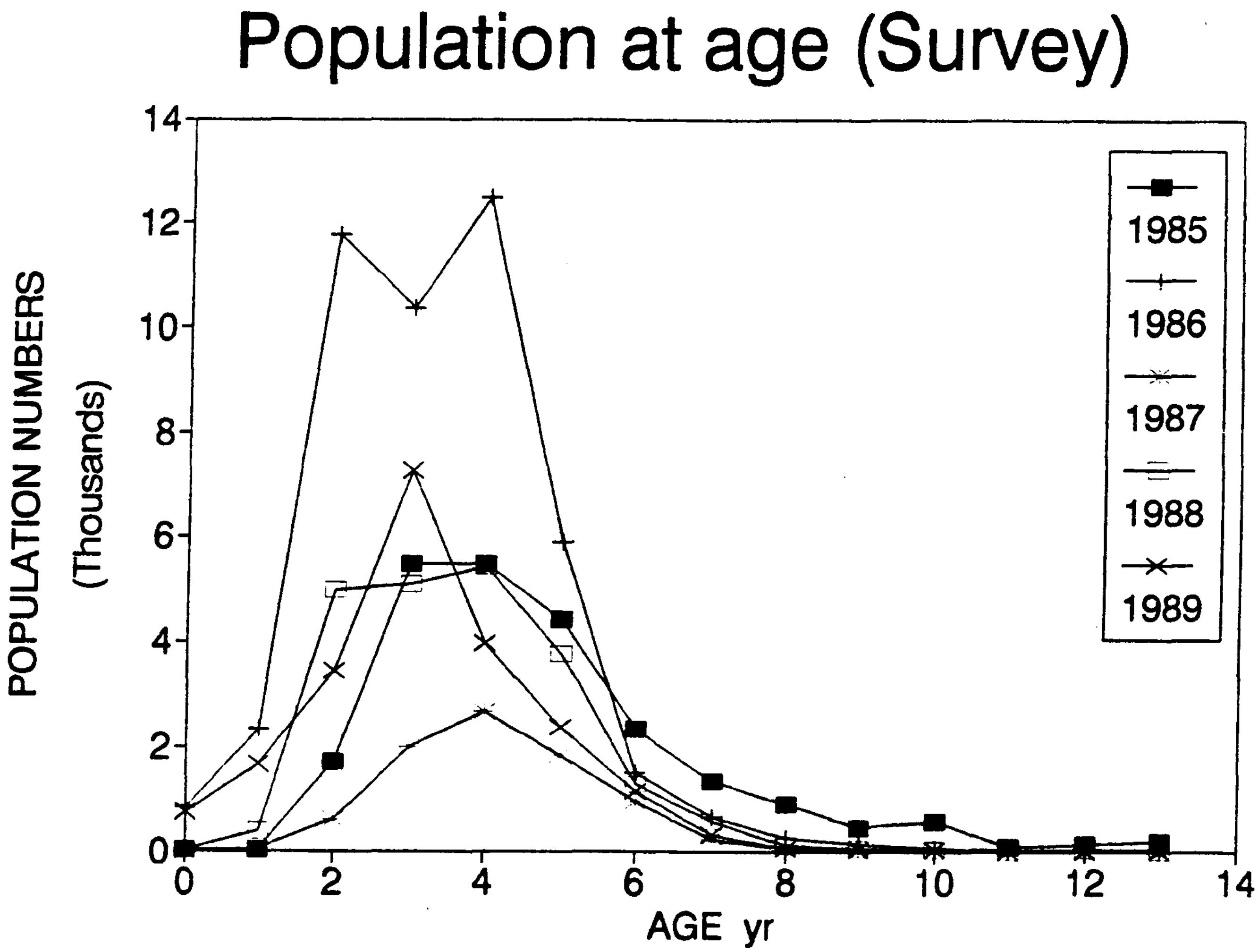


Figure 13. Age distribution of white hake in NAFO Division 4T in 1986 and 1987 by sex and water depth. (Channel > 200 m; Strait < 200 m).