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Plankton and Nekton of the Northeast Newfoundland Shelf and Grand Banks in 1996 Compared to 1994 and 1995

by

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Abstract

A comprehensive broad-scale survey of temperature, plankton, and nekton of the marine pelagic environment was carried during late summer 1996 including inshore and offshore areas from southern Labrador to the southern Grand Banks. Conditions are compared among smaller subareas and with similar surveys carried out in 1994 and 1995. Area and/or year accounted for significant variation in 21 of the 22 variables examined. Area differences were generally associated with latitudinal or inshore/offshore clines. Surface and 50m temperatures in 1996 were intermediate between those of the two previous years. The mean total zooplankton dry weight biomass in 1996 was similar to that of 1995, both years being significantly higher than 1994. Total nekton was dominated by capelin and Arctic cod. Mean total nekton biomass significantly lower than the previous two years. Mean abundance of Arctic cod and capelin was similar in 1996 to 1995, both years being significantly lower than 1994. The abundance of pelagic 0-group Atlantic cod decreased significantly each of the past two years. Significantly higher abundances of white hake, sculpins and seasnails were taken in 1996 than the previous 2 years. Daynight differences accounted for significant variation in over 1/2 the biological variables examined. Longer time series will help clarify whether these changes represent natural year to year variability or if they represent longer term trends.

Résumé

Un relevé détaillé de grande envergure de la température, du plancton et du necton du milieu pélagique marin des eaux côtières et hauturières de la zone s'étendant du sud du Labrador au sud des Grands Bancs a été réalisé à la fin de l'été 1996. Les conditions déterminées sont comparées avec celles de sous-zones plus petites et avec celles notées au cours de relevés semblables effectués en 1994 et 1995. La zone ou l'année, ou les deux, expliquaient l'importante variation notée pour 21 des 22 variables examinées. Les écarts entre zones étaient généralement associés à des couches de variation connexes au changement de latitude ou au passage entre les eaux côtières et hauturières. Les températures en surface et à 50 m notées en 1996 se situaient entre celles des deux années antérieures. La biomasse moyenne totale du zooplancton (poids sec) en 1996 était semblable à celle de 1995, mais les valeurs de ces deux années étaient de beaucoup supérieures à celle de 1994. Le necton total était dominé par le capelan et le saida. La biomasse totale moyenne du necton était de beaucoup inférieure à celle des deux années précédentes. L'abondance moyenne du saida et du capelan de 1996 était semblable à celle de 1995, mais de beaucoup inférieure à la valeur de 1994. L'abondance des morues de l'atlantique pélagiques du groupe 0 a diminué de façon appréciable au cours de chacune des deux dernières années. Des niveaux d'abondance passablement plus élevés de merluche blanche, de chabot et d'escargots ont été notés en 1996 par rapport aux deux années précédentes. Les écarts jour-nuit expliquaient l'importante variation notée pour plus de la moitié des variables biologiques examinées. Une série chronologique plus longue permettra de préciser si ces variations correspondent à une variabilité naturelle interannuelle ou si elles reflètent des tendances à plus long terme.

Introduction

Anderson and Dalley (1997) described the marine pelagic environment off Newfoundland and Labrador (NAFO Divisions 2J3KLNO) for the late summers of 1994 and 1995. Information was collected from a single broad scale multispecies survey carried out each year. The survey was originally designed to measure the abundance of pre-recruit Atlantic cod during the pelagic juvenile fish stage, and to measure the pre-recruit abundance of Northwest Atlantic capelin at the larval stage (0-group) and as one year old capelin (1+). In addition, it was designed as a multispecies measure of the state of the pelagic ecosystem. The purpose was to provide a baseline with which results of future surveys could be compared in order to understand short and long term variations in the pelagic environment. This comprehensive broadscale survey was completed again in 1996.

The purpose of the present document is to describe the temperature, plankton and nekton biomass and structure (particularly pelagic O-group fish) in this large zoogeographic area during late summer in 1996. Temperature, various measures of plankton and nekton biomass, and nekton species, or groups of species, are statistically examined for differences among years (1994, 1995, and 1996) and also for differences throughout seven smaller subareas of the large zoogeographic area surveyed. Variation in catches between daylight and dark is also examined for the 19 biological variables.

Materials and Methods

The standard sampling protocol at each of 147 stations occupied from August 18 - September 5, 1996 included: 1) a Seabird-25 CTD (Conductivity/Temperature/Depth, with flourometer) profile was obtained to a maximum of 500 m depth or to within ~ 5m of bottom where depth was less than 500m. 2) a standard double oblique bongo tow to 100m and 3) a 30 min IYGPT (International Young Gadoids Pelagic Trawl) tow that slowly oscillated between 20 to 60m depth. The study area, survey design, sampling gear, and methods are described in Anderson and Dalley (1997). The RV Teleost (72 stations) covered the northern part of the survey area and the RV W. Templeman (75 stations) the southern portion in 1996. Due to budget constraints a complete ichthyoplankton sort was not done on the bongo samples from the 1996 survey. Species data from the bongos is therefore presented for capelin and herring only. These were subsampled and measured at sea. Consistent with the previous 2 years one half of the total plankton biomass from one side of the bongo was divided into 3 size categories, (>2mm, 1-2mm, and <1mm), dried for 24 hours at ~ 75°C, and weighed to the nearest milligram.

To examine differences in the distribution of the various parameters throughout the large survey area, the area was subdivided into seven smaller subareas (Figure 1). The smaller areas were based on predominant geographical features (e.g. banks), closeness to shore, and latitude. Seven areas were consistently sampled all three years. The Northeast Newfoundland Shelf was divided into 4 subareas: 1) ISN or the inner shelf, northern, 2) BIBI or Belle Isle Bank, 3) ISS or the inner shelf, southern, and 4) FIBI or Funk Isle Bank. All of the large inshore bays and stations within ~ 54km of shore constituted the inshore 5) INSH, and 6) NGB and 7) SGB represent the northern and southern Grand Banks, respectively. An analysis of variance was carried out with the measured parameters (i.e. temperature, zooplankton biomass and total nekton biomass, species, or groups of species abundance) as the dependent variable, and 1) area and 2) year as independent variables. The models (SAS Institute Inc.1989) were run to include interaction between the two main effects (area and year). If the interaction term between the two independent variables was not significant the model was rerun without interaction. Areas and years were ranked from highest to lowest in each case. An a posteriori Studentized Maximum Modulus (GT2) test was performed to indicate significant differences between areas and years, for each dependent variable. To investigate diel differences in the biological variables a second model was run with year and daynight (daylight or darkness) as independent variables. Again, another model, without interaction, was run if the interaction between the two independent variables was not significant. All biological variables were standardized to the volume of water filtered, and $logged_{10}$ prior to the analysis of variance.

Results

Results of analysis of variance indicated that there was a statistically significant ($P<0.05$) relationship between 21 of the 22 variables examined and geographic area and/or year of survey, in the overall model (Table 1). For witch flounder only, which had low catch rates, there was no significant relationship. The partial F-value attributable to area was significant in the same 21 variables and the partial F-value attributable to year was significant in 17 of the 22 cases. There were significant differences in mean catch rates among years for all variables except sand lance, redfish, American plaice, yellowtail flounder or witch flounder. Geographic area accounted for much more variation in mean surface temperature than did yearly differences but at 50 meters the variation attributable to area and year were approximately equal. Area accounted for more variation in total zooplankton dry weight and total nekton wet weight than did year, but year rather than area, accounted for more variation in dry weight of the largest (>2mm) and smallest (<1mm) size fractions of zooplankton from the bongos. Area accounted for more variation in mean catch rate than year in 11 of the 14 fish species/groups. For Atlantic cod, sculpins and turbot the annual variation was greater than that attributable to geographic area. Details of the significant differences between areas and years from the Studentized Maximum Modulus (GT2) test is presented in Appendix 1.

The interaction of the two main effects in the anova was significant in all relationships except the nekton wet weights, capelin, redfish, and yellowtail and witch flounder but in most cases the partial F-value attributable to interaction was low compared to the main effects, white hake being the exception (Table 1).

Daynight differences in temperatures were not investigated. Total zooplankton dry weight, and the weight of the largest and midsize fractions were greater during darkness than daylight while day night differences of the smallest size fraction (<1mm) were not detectable ($P>0.05$). Significant daynight differences ($P<0.05$) were found for capelin, redfish, blennies, squid, seasnail, American plaice, and yellowtail. Of these species only redfish had significantly higher catch rates during daylight.

Surface temperatures during the 1996 survey ranged from a mean of 8.0°C on Belle Isle Bank to 17.5°C on the southern Grand Bank and the distribution of surface temperatures (Figure 2, left panel) indicates a definite gradient from north to south. The contours also indicate warmer water inshore compared to the adjacent shelf areas with coldest water being near the shelf edge. Surface temperatures on the southern Grand Bank were significantly higher than the inshore and the northern Grand Bank, which were not different, but were warmer than the southern portion of the Northeast Newfoundland Shelf which was warmer than the northern portion. Surface temperatures were significantly warmer in 1994 than in 1996 which in turn were significantly higher than 1995.

In 1996 temperatures at 50 m ranged from a mean of -0.63°C at the southern portion of the inner Northeast Newfoundland shelf to a mean of 2.20°C in the inshore. The 50m temperature contours (Figure 2, right panel) show a similar gradient to the surface waters with slightly warmer water on the southern Grand Banks and inshore. At 50 meters the southern Grand Bank and the inshore were significantly warmer than all other areas except that there was no difference in the inshore and the northern Grand Bank. There was no difference in mean temperature at 50m in 1995 and 1996, both of which were significantly warmer than 1994.

Total dry weight biomass of zooplankton in 1996 (Figure 3, left) indicates maximum biomass values in the northern parts of the area with relatively high biomass also occurring in the bays. Lowest weights generally occurred on the southern Grand Banks. The distribution of biomass of all three size fractions (Figures 3 and 4), particularly the midsize fraction (Figure 4, left) showed a general gradient of decreasing weights from north to south. The largest size fraction (Figure 3, right) had highest weights occurring near the Labrador coast and towards the shelf break. The distribution of biomass in the smallest size (<1mm) fraction (Figure 4, right) had highest weights to the extreme north of the survey area and the inshore. Minimum weights were obtained on the eastern portion of the Grand Banks.

Subsampling one side of the bongos while aboard the research vessels allows us to plot distributions of capelin and herring larvae. Consistent with the previous two years, capelin larvae (Figure 5, left) showed a definite gradient of decreasing abundance with distance from shore. Highest densities occurred on the inner, southern portion of the NE Newfoundland shelf. Lengths of capelin larvae sampled in 1996 range from 4 - 19 mm with peak abundances occurring around 10mm. Herring larvae (Figure 5, right) were few in numbers and restricted in distribution to White Bay and off the Avalon Peninsula.

The total wet weight of nekton (including jellyfish) caught in the IYGPT trawl in 1996 (Figure 6, left) indicates relatively high variability throughout the study area. There is, however, a general decrease in wet biomass from north to south (see appendix). Maximum values occurred inshore although there was one large catch on the southern Grand Bank. The total wet biomass, including jellies, is available for all three years.

The total wet weight with jellies removed (Figure 6, right) again indicates a decrease in biomass from north to south (note appendix). In this case, however, biomass is relative low in the inshore indicating the predominance of jellyfish in the inshore area. The wet biomass with the jellyfish removed is available for 1995 and 1996 only.

Consistent with 1994 and 1995 capelin and Arctic cod were the two most important species constituting the biomass of the IYGPT trawl catches (Table 2). In terms of numbers capelin made up ~ 72% of all fish caught and occurred in ~ 40% of the sets. Arctic cod made up <10% of all fish in terms of numbers but occurred in 55% of the sets. Squid occurred in 56.5% of all sets, generally in low numbers. Sculpins (~ 13 species of Cottidae), seasnails (~ 4-5 species of Liparidae), and alligatorfish (3 species of Agonidae) occurred fairly frequently but in relatively low numbers.

Capelin, the most abundant species, were distributed throughout the inshore and central latitudes, being absent from the northern and southern extremities of the survey area (Figure 7, left). Peak abundances were found off Bonavista Bay. The length frequency distribution indicated a predominance of one year olds, with lower numbers of two year olds.

Although sand lance had a relatively low incidence of occurrence, they were distributed from the most northern to the most southern latitudes surveyed (Figure 7, right). Highest concentrations were found on the northern Grand Bank. Lengths ranged from 20mm to 200mm.

Atlantic cod (Figure 8, left) were quite restricted in their distribution in 1996, mostly to the inshore, off the tip of the great Northern peninsula, White Bay, Bonavista Bay and on the southern Grand Banks. Pelagic 0-group Atlantic cod were notably absent from Trinity and Conception Bays Lengths ranged from 26 to 62mm., the modal length being 42mm.

Arctic cod, one of the more dominant fish species, was widely distributed throughout the survey area in 1996 (Figure 8, right), except for the southern areas. Highest abundances occurred nearshore off southern Labrador and decreased to zero on the southern Grand Bank (note significance differences in Appendix). Results of the GT2 test indicated significantly lower catch rates each of the past two years. Lengths ranged from 20 to 60 mm with the mode in the length frequency distribution between 35 and 40mm.

Redfish (Figure 9, left), indicated at least 2 distinct distributions in 1996, one to the north centered around Funk Isle Bank, the other with higher densities, on the southern Grand Bank. Length of juvenile redfish ranged from 20 to ~ 60mm with a mode between 35 and 40mm.

White or common hake (Figure 9, right) with relatively low catch rates, were mostly restricted to the southern Grand Banks, occurring sporadically at central latitudes in 1996. Lengths ranged mostly from ~30mm to 70mm and centered around 45 to 50mm.

Shannys and blennies (~ 4 spp.) of the family Stichaeidae were distributed throughout the northern portion of the survey area in 1996 (Figure 10, left). Highest abundances occurred near shore, off Labrador and northern Newfoundland. Except for those in Bonavista Bay none were taken in the other large inshore bays. Three modes in the length frequency which ranged from 23 to 103mm, may represent different species.

Sculpins making up ~ 13 species of the family Cottidae were mainly a northern group in 1996 (Figure 10, right) with low numbers taken in several sets on the southern Grand Bank. Maximum numbers were taken off southern Labrador. The length frequency distribution was bimodal with peaks at ~ 30 and 44mm.

Squid, a major invertebrate constituent of the nekton, were widely distributed throughout the area (Figure 11 left), highest abundances occurring to the north and outer part of the shelf at central latitudes. There was also a distinct distribution on the Grand Banks.

Seasnails, several species of the family Liparidae, were also distributed mainly to the north (Figure 11, right) with maximum catches being taken on the inner part of the shelf. Lower numbers were also taken in several pockets on the Grand Banks. The length frequency distribution centered around 35mm.

American plaice (Figure 12, left) occurred sporadically and in low numbers in 1996 from the northern to the southern areas and also inshore. Sizes of American plaice ranged from 17 to 35mm.

Yellowtail flounder were taken in low numbers and were restricted to the southern Grand Banks in 1996 (Figure 12, right). Length ranged from 23 to 27 mm.

Turbot (Figure 13, left) were restricted to the northern extremity, the outer shelf area, and a single station inshore in 1996. None were taken on the inner shelf or the Grand Banks. Lengths of these juveniles ranged from 35 to ~ 80 mm with a peak at ~ 65mm.

Witch flounder (Figure 13, right) were also taken in low numbers in 1996 and were also restricted to the southern Grand Banks. Witch ranged in length from 43 - 54mm.

Discussion

Area and year accounted for significant variation in temperature, 3 size fractions of zooplankton biomass from the bongos, total wet biomass in the IYGPT catch, and all species or groups examined, except for redfish which had distinct distributions in northern and southern areas, and witch and yellowtail, both of which were caught in relatively low numbers.

Area generally accounted for more variation than year. However for temperature at 50 meters, zooplankton biomass of the >2mm, and the < 1mm size fractions, annual variation exceeded that attributable to area. Also, of the fish species examined, annual variation was greater than area variation for three groups only: Atlantic cod, sculpins, and turbot. Significant differences between areas were generally associated with latitudinal or inshore/offshore clines.

Daynight accounted for significant variation in zooplankton biomass caught in the bongos, total wet weight biomass of the IYGPT, and approximately 1/2 of the species groups examined, including American plaice, blennies, capelin, redfish, seasnails, squid, and yellowtail. Only redfish were caught in significantly higher numbers during daylight.

In comparison to the two previous years surface temperatures in 1996 were significantly higher than 1995 but lower than 1994. In contrast, mean temperatures at 50m in 1995 and 1996 were higher than 1994.

The mean total zooplankton biomass in the bongos was significantly higher in 1996 and in 1995. Mean biomass of the largest size fraction was higher in 1995 than 1996 or 1994. Mean biomass of the mid-size fraction was significantly higher in 1996 than 1994, but 1995 was not significantly different from either other year.

The mean wet nekton biomass including jellyfish was significantly less in 1996 than either 1995 or 1994. The wet biomass, with jellies removed, was significantly lower in 1996 than 1995 (1994 not available).

Mean catches of pelagic 0-group Arctic cod were significantly lower in 1995 and 1996 than 1994. Atlantic cod decreased significantly in 1995 and again in 1996. Mean catch numbers of squid were also lower in 1996. There were significantly higher catches of capelin (1+) in 1994, than 1996 or 1995. There were significantly more sculpins, seasnails and white hake than the previous two years. It is not possible at this stage, however to ascertain whether or not these annual differences are characteristic of normal variability or if in fact they may be indicative of longer term trends.

This survey collects information on physical conditions and all levels of productivity in the pelagic ecosystem. The data set contains a wealth of information on several commercial pelagic and groundfish species in their first year of life. It also contains information on numerous other non-commercial species, the distribution and abundance of which may serve as indicators of longer-term general ecosystem conditions and changes in it. The survey is an attempt to increase our knowledge of marine ecosystems and annual variability in ocean conditions in the Newfoundland Region and provides a basis to monitor changes in the pelagic environment in the future.

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Table 1. Relative overall abundance and incidence of occurrence of dominant fish species caught in the IYGPT during the pelagic 0-group survey in 1996.

Species	**Scientific Name**	**Relative Abundance(%)**	**Incidence(%)**
Capelin	Mallotus villosus	71.9	40.1
Arctic cod	Boreogadus saida	9.7	55.1
Lanternfish	Myctophidae	7.0	2.0
Squid	Cephalopoda	3.0	56.5
Sand lance	Ammodytes sp.	2.5	27.2
Sculpins	Cottidae	2.3	42.9
Seasnails	Liparus sp.	1.4	52.4
Alligatorfish	Agonidae	1.0	53.7
Shannies Blennies	Stichaeidae	0.3	27.9
Redfish	Sebastes sp.	0.2	17.0

Table 2. Results of analysis of variance carried out on each of the 22 independent variables measured during the 1994-1996 pelagic 0-group surveys. Year and geographic area are used as dependent variables. Shown are the maximum and minimum means for each dependent variable, the R-square explained by the model, the overall F-value and associated probability, as well as the partial F-value (and probability) and associated with each independent variable. The partial F-value and probability attributable to interaction of the two main effects is also shown, if the interaction factor was significant. Also the partial F-value attributable to daynite from a separate model, using year and daynite, as independent variables, is shown. ** indicates a significant interaction of main effects in the latter model.

Dependent Variable	Min mean	Max mean	r^2	Overall F-value / prob	Partial F Area / Prob.	PartialF Year / Prob.	Interaction factor	Daynite Partial-F
°C 0m	7.3	18	0.83	73.0 0.0001	152.6 (.0001)	69.4 (.0001)	17.1 (.0001)	N/A
°C 50m	-1.3	3.1	0.46	12.4 0.0001	25.1 (.0001)	25.9 (.0001)	3.7 (.0001)	N/A
Zootot	1.8	14.5	0.49	14.0 0.0001	34.9 (.0001)	5.5 (.005)	2.7 (.002)	24.62 0.0001
Zoo >2	1	5.6	0.34	7.7 0.0001	12.8 (.0001)	15.3 (.0001)	1.8 (.050)	35.53 0.0001
Zoo 1-2	0.2	7.5	0.54	17.5 0.0001	50.1 (.0001)	3.3 (.0394)	2.8 (.0014)	16.55 0.0001
Zoo <1	0.4	2.9	0.47	12.8 0.0001	20.6 (.0001)	27 (.0001)	2.5 (.0048)	3.58 0.0594
Nekton1 with	1.54	17.37	0.29	15.5 0.0001	18.2 (.0001)	8.0 (.0004)	N.S.	7.40 0.0069
Nekton2 w/0	1.08	13.77	0.33	15.1 0.0001	15.4 (.0001)	10.2 (.0017)	N.S.	10.62** 0.0013
Capelin	0	2475.2	0.21	9.8 (.0001)	10.9 (.0001)	5.3 (.0056)	N.S.	37.4 0.0001
Sand lance	0	112	0.25	4.94 (.0001)	10.1 (.0001)	1.4 (.2574)	2.6 (.0027)	0.11 0.74
Atlantic cod	0	15.2	0.33	7.05 (.0001)	12.02 (.0001)	16.91 (.0001)	3.49 (.0001)	0.00 0.9704
Arctic cod	0	813	0.46	12.27 (.0001)	31.86 (.0001)	15.81 (.0001)	2.98 (.0006)	1.81 0.179
Redfish	0	97.1	0.1	4.13 (.0001)	5.18 (.0001)	0.90 (.4057)	N.S.	4.32 0.0384
White hake	0	3.6	0.25	4.84 (.0001)	5.8 (.0001)	3.14 (.0449)	4.33 (.0001)	2.06 0.152

Table 2. (con't) Results of analysis of variance carried out on each of the 22 independent variables measured during the 1994-1996 pelagic 0-group surveys. Year and geographic area are used as dependent variables. Shown are the maximum and minimum means for each dependent variable, the R-square explained by the model, the overall F-value and associated probability, as well as the partial F-value (and probability) and associated with each independent variable. The partial F-value and probability attributable to interaction of the two main effects is also shown, if the interaction factor was significant. Also the partial F-value attributable to daynite from a separate model, using year and daynite, as independent variables, is shown. ** indicates a significant interaction of main effects in the latter model.

Blennies	0	14.3	0.25	4.80 (.0001)	9.54 (.0001)	6.30 (.0021)	2.15 (.0142)	30.24** 0.0001
Sculpins	0	254.4	0.43	16.08 (.0001)	20.6 (.0001)	42.1 (.0001)	9.4 (.0001)	0.19 0.6662
Squid	0.5	291.1	0.49	14.19 (.0001)	29.93 (.0001)	20.82 (.0001)	3.06 (.0004)	10.03 0.0017
Seasnail	0.25	67.1	0.39	9.46 (.0001)	18.80 (.0001)	14.92 (.0001)	3.54 (.0001)	14.79 0.0001
A.plaice	0	1.7	0.17	3.03 (.0001)	4.87 (.0001)	0.85 (.4286)	1.97 (.0266)	7.15 0.008
Yellow tail	0	1.4	0.07	2.92 (.0037)	3.72 (.0014)	0.61 (.5461)	NS	4.99 0.0262
Turbot	0	2.9	0.41	10.16 (.0001)	18.62 (.0001)	24.89 (.0001)	3.85 (.0001)	0.96 .3275
Witch	0	0.5	0.03	1.03 (.4130)	1.14 (.3398)	0.89 (.6672)	NS	1.33 0.250

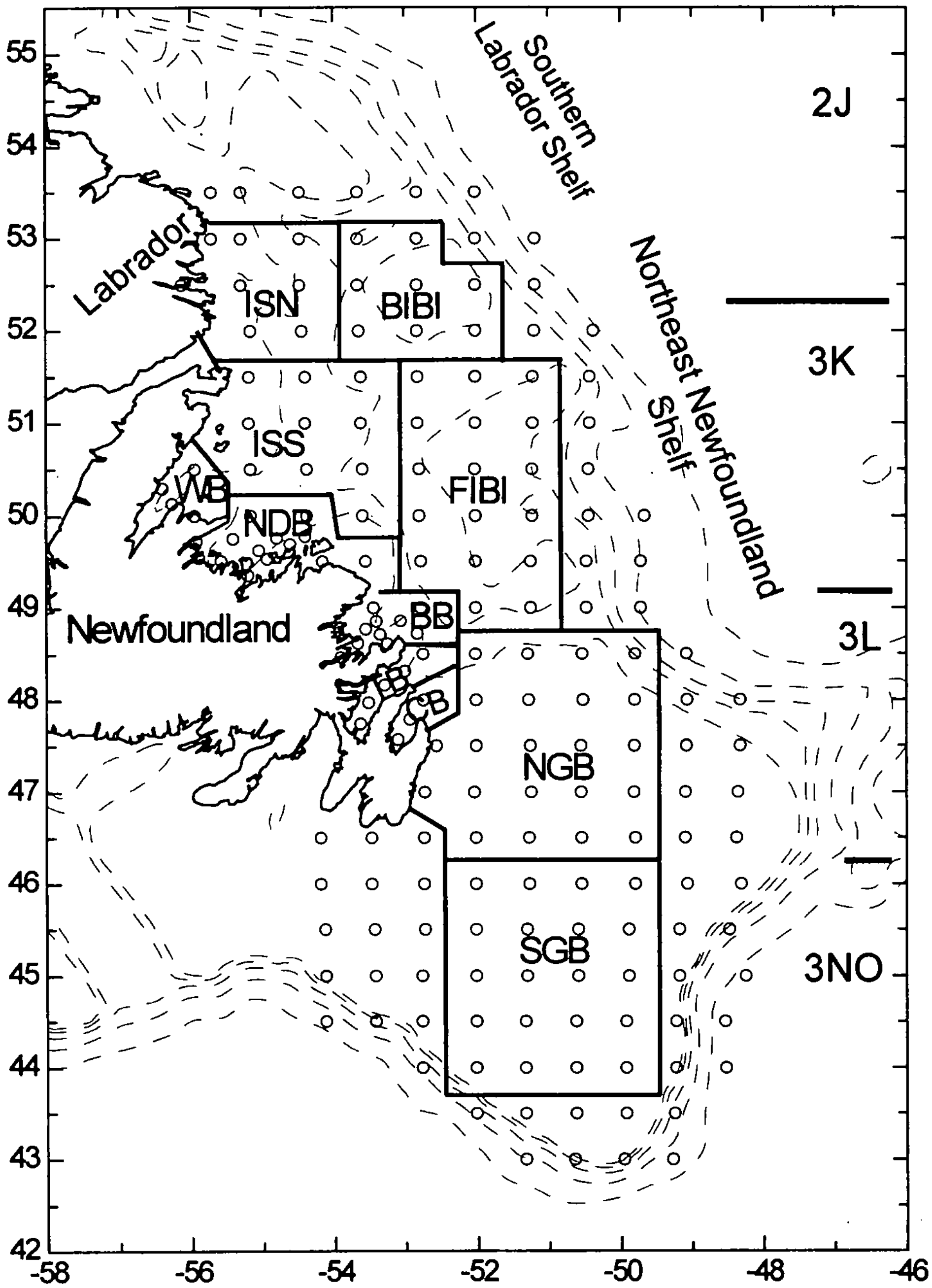

Figure 1. Survey area showing stations sampled during the 1996 pelagic 0-group survey on the Southern Labrador Shelf, Northeast Newfoundland Shelf, and Grand Banks. Each of the seven subareas are indicated. (ISN = inner shelf, northern; BIBI = Belle Isle Bank; ISS = inner shelf, southern, FIFI = Funk Isle Bank, INSH = inshore, NGB = Northern Grand Bank, SGB = Southern Grand Bank).

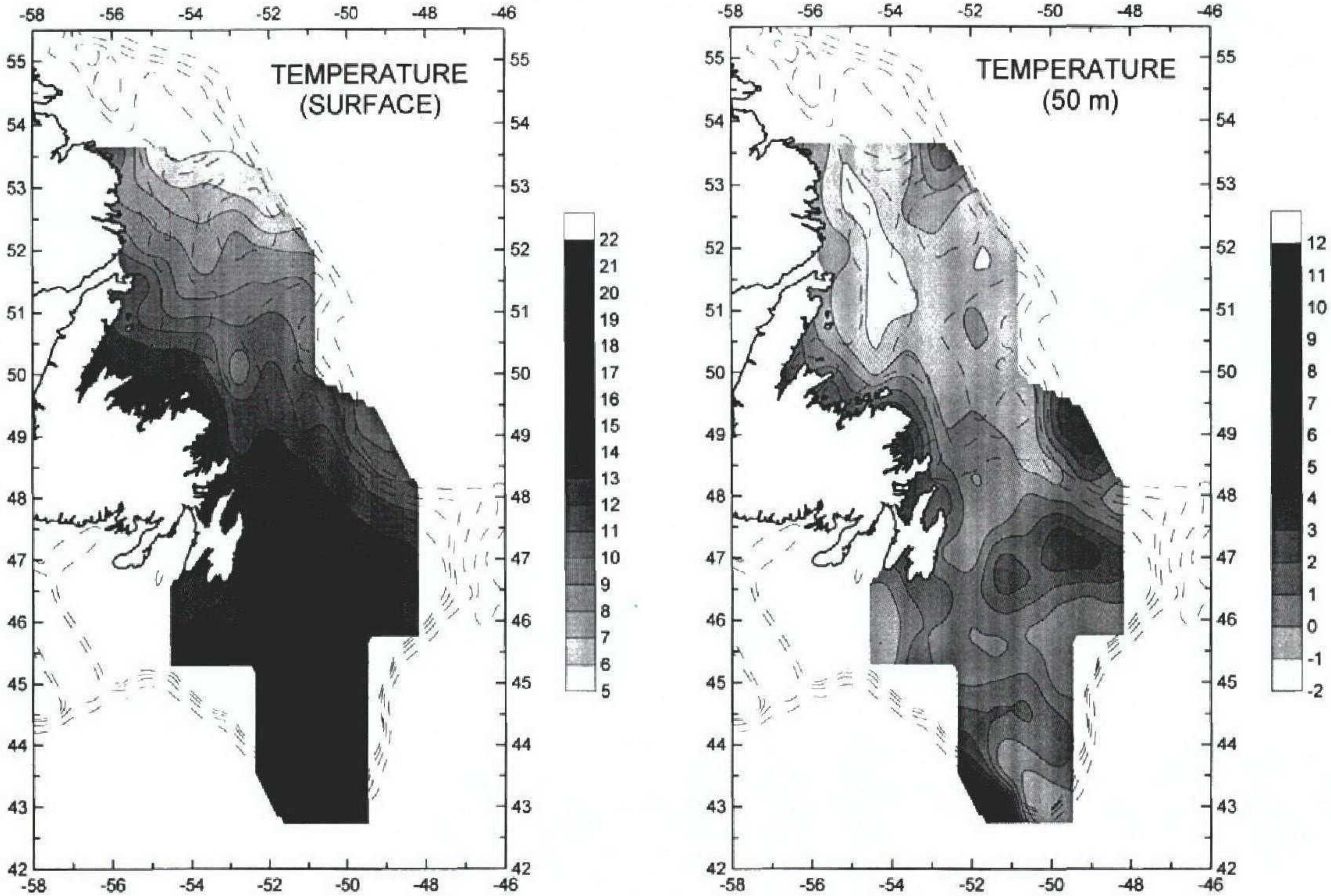

Figure 2. Distribution of surface temperatures (°C), left panel, and 50m, right panel, during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL.

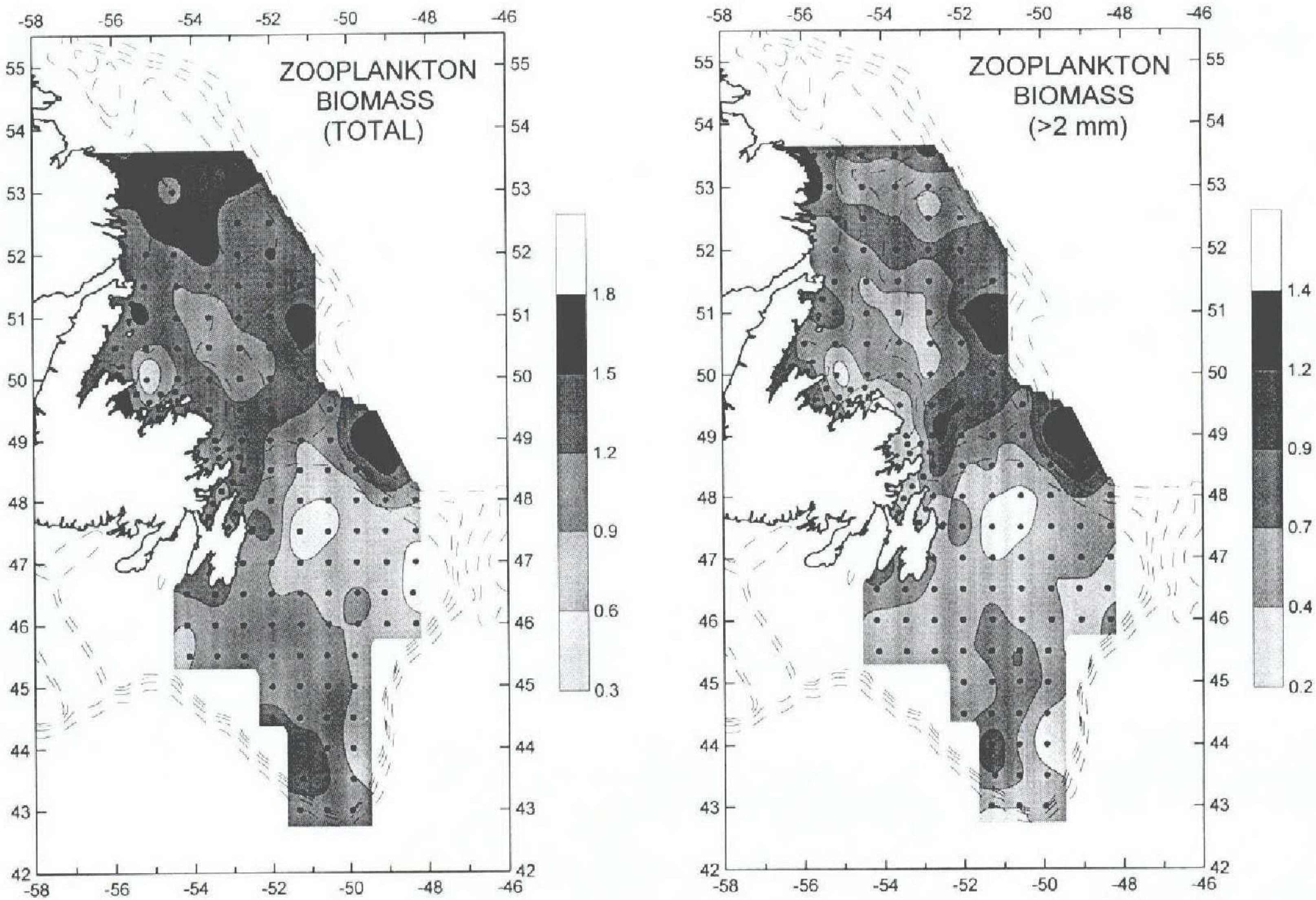

Figure 3. Distribution of total invertebrate zooplankton biomass (gDW m^{-3}), left panel, and for the large size fraction (>2mm), right panel, caught in bongos during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL.

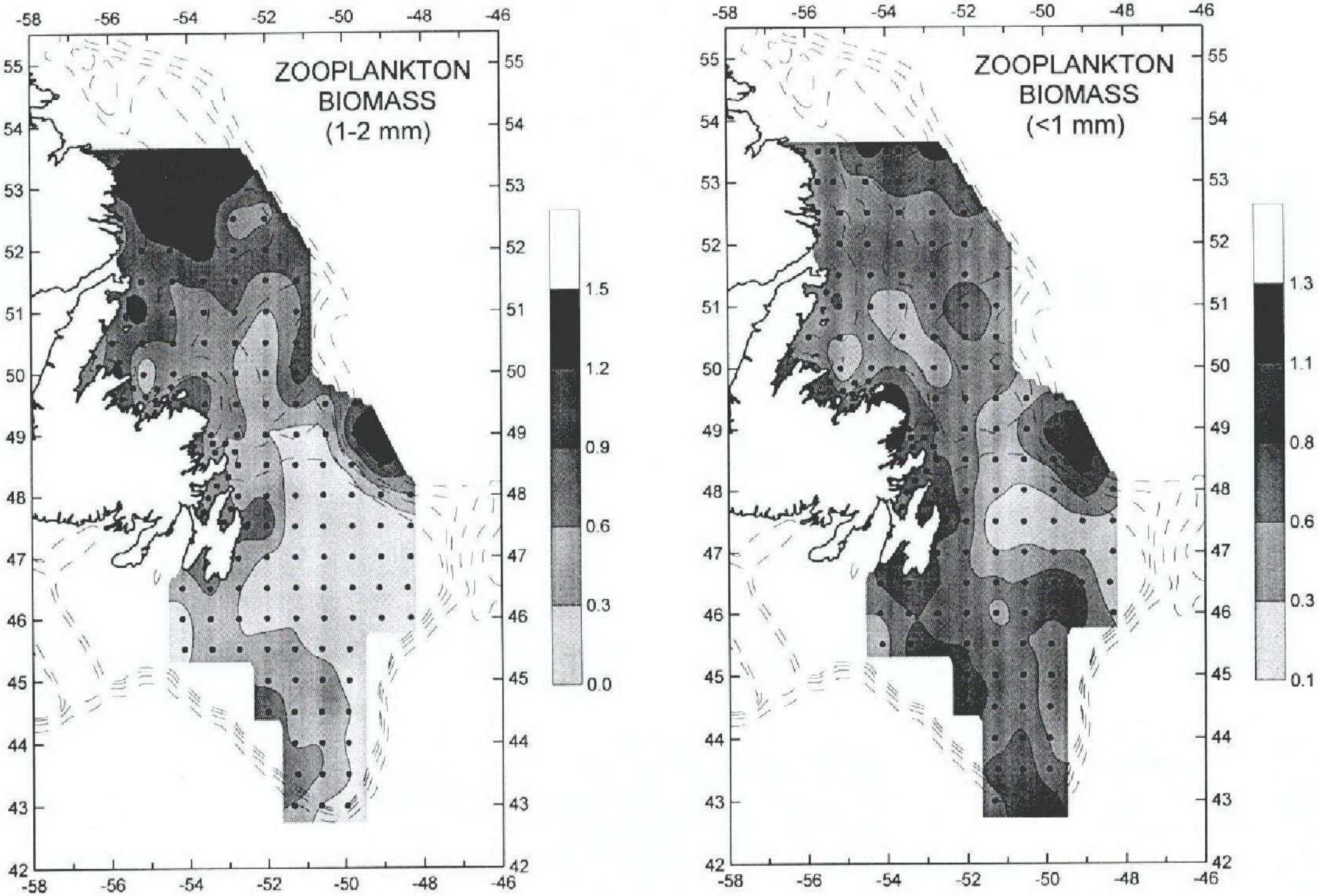

Figure 4. Distribution of the midsize fraction (1-2mm) of invertebrate zooplankton biomass (gDW m^{-3}), left panel, and for the small size fraction (<1mm), right panel, caught in bongos during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL.

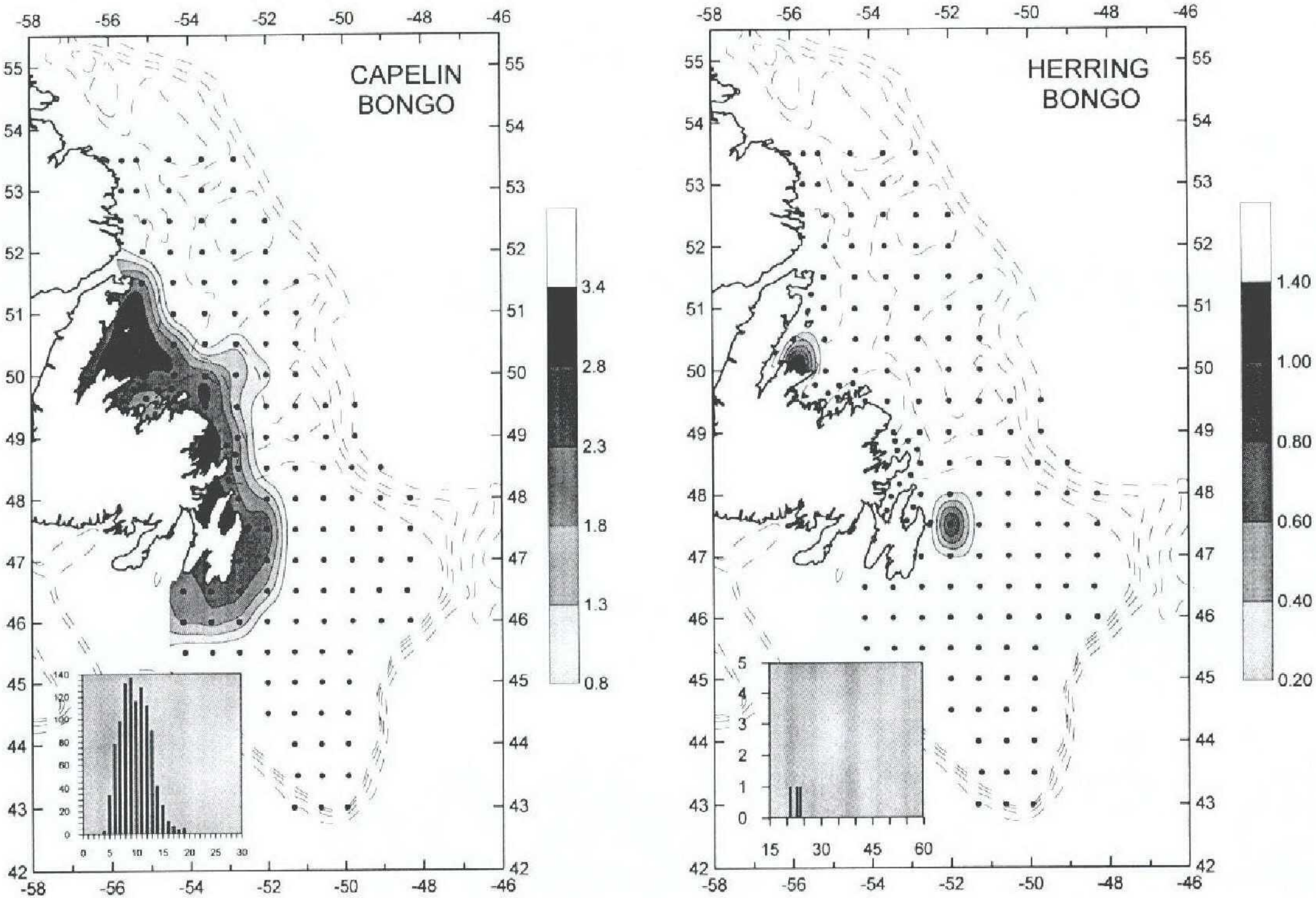

Figure 5. Distribution of capelin larvae ($\log_{10}$ number $10^3\ m^{-3}$) left panel, and herring, right panel, caught in the bongos during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL.

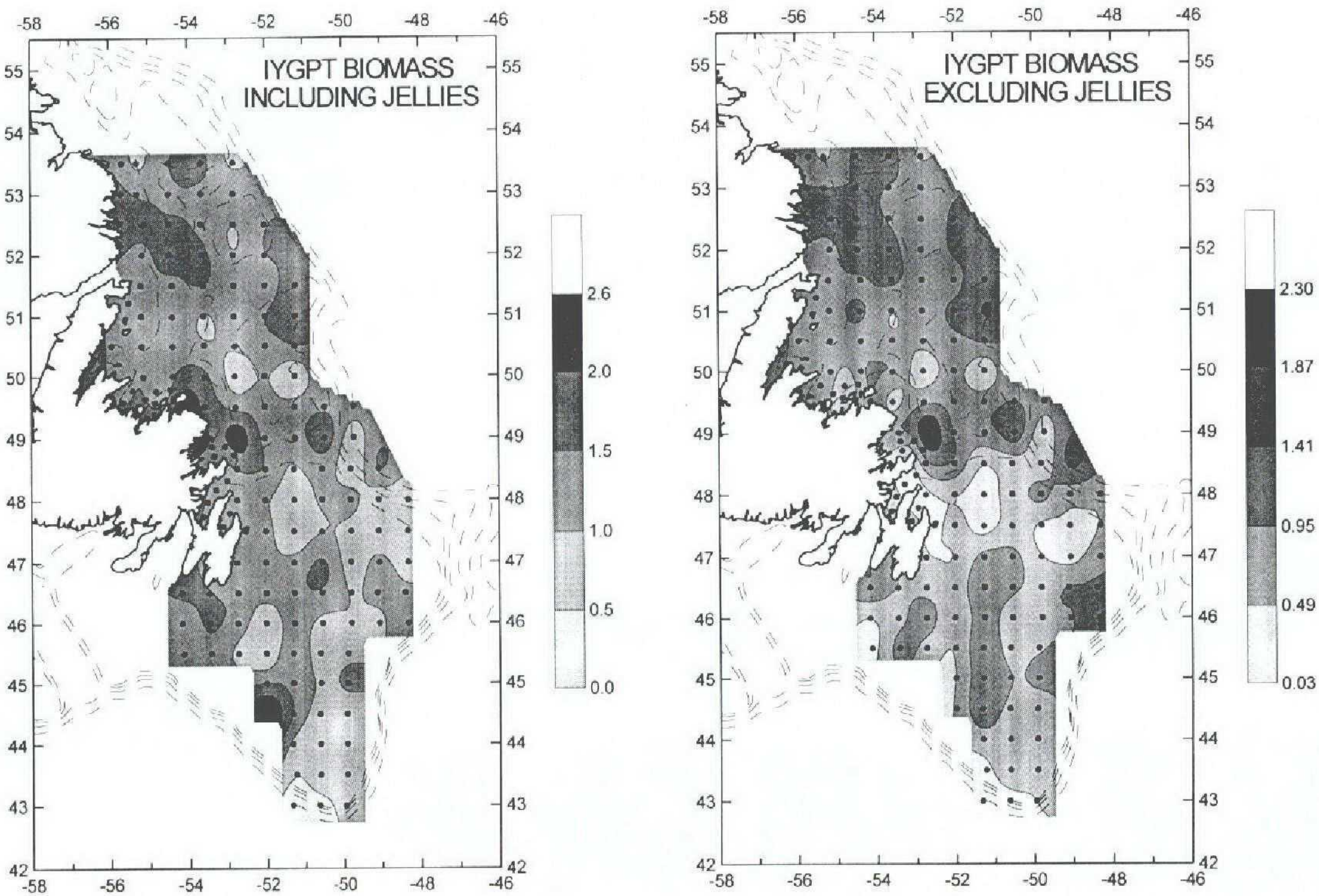

Figure 6. Distribution of total nekton biomass (kgWW/tow) with jellyfish included, left panel, and without jellyfish, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL.

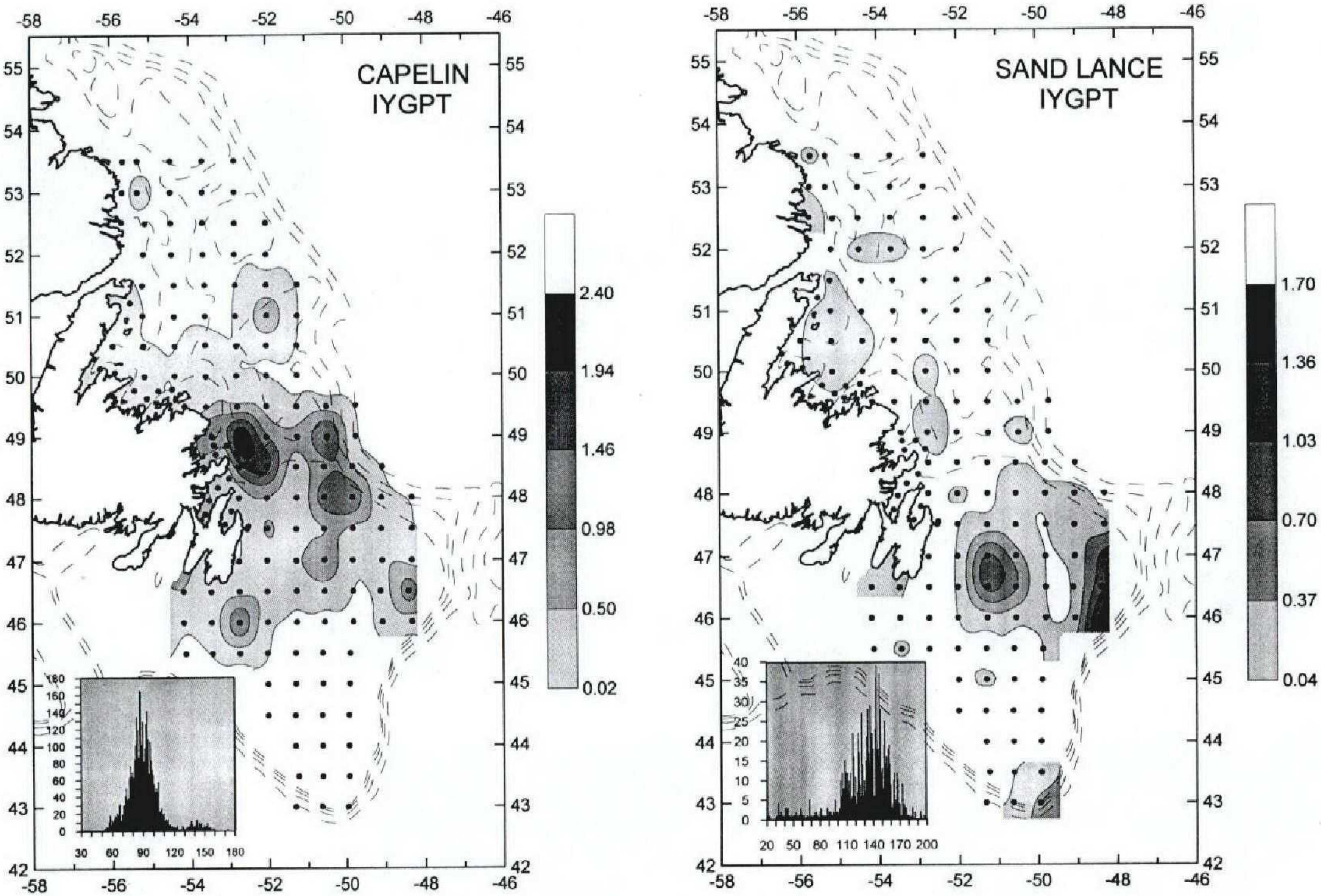

Figure 7. Distribution of capelin ($\log_{10}$ number 10^4 m^{-3}), left panel, and sandlance, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

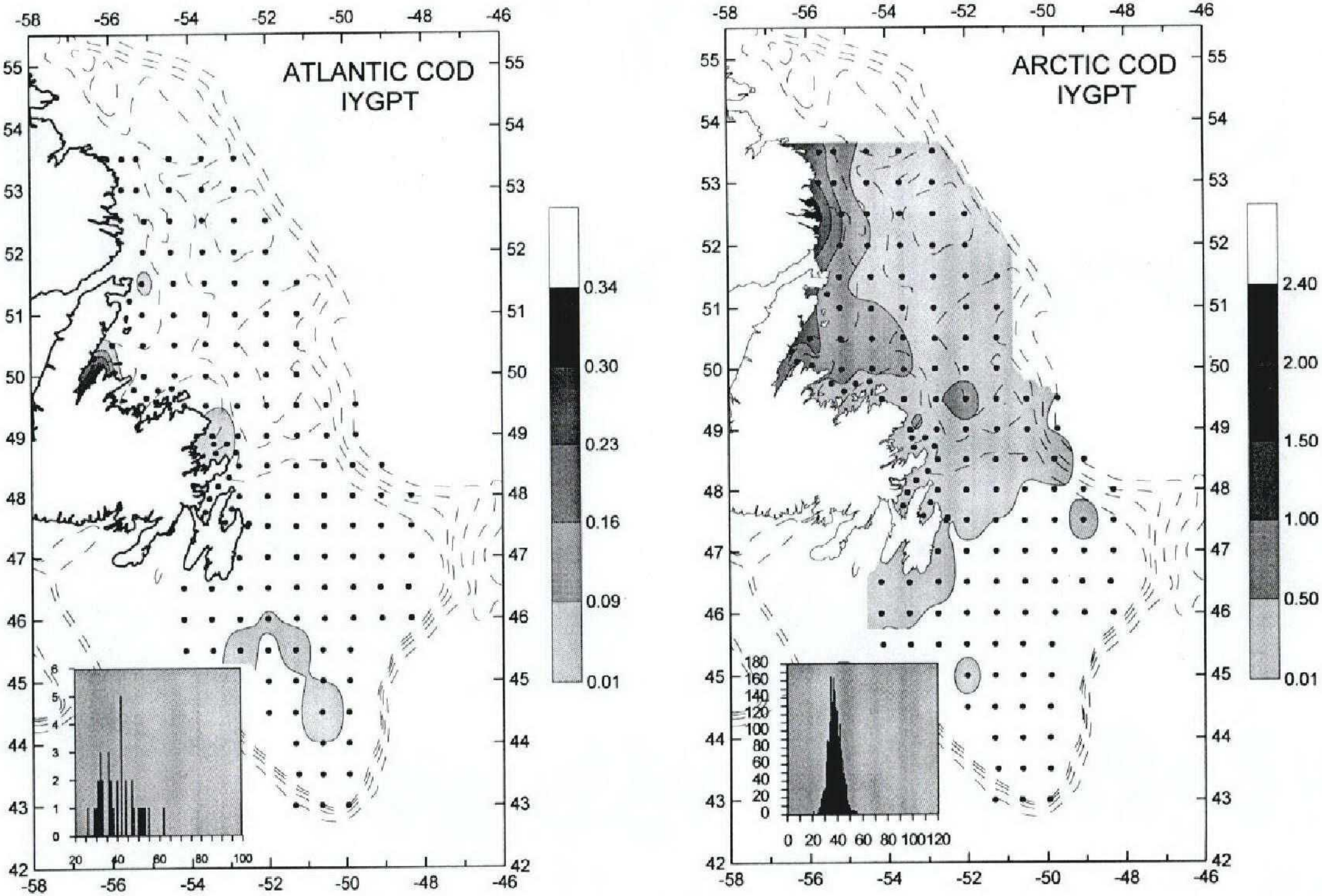

Figure 8. Distribution of pelagic 0-group Atlantic cod ($\log_{10}$ number 10^4 m^{-3}), left panel, and Arctic cod, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

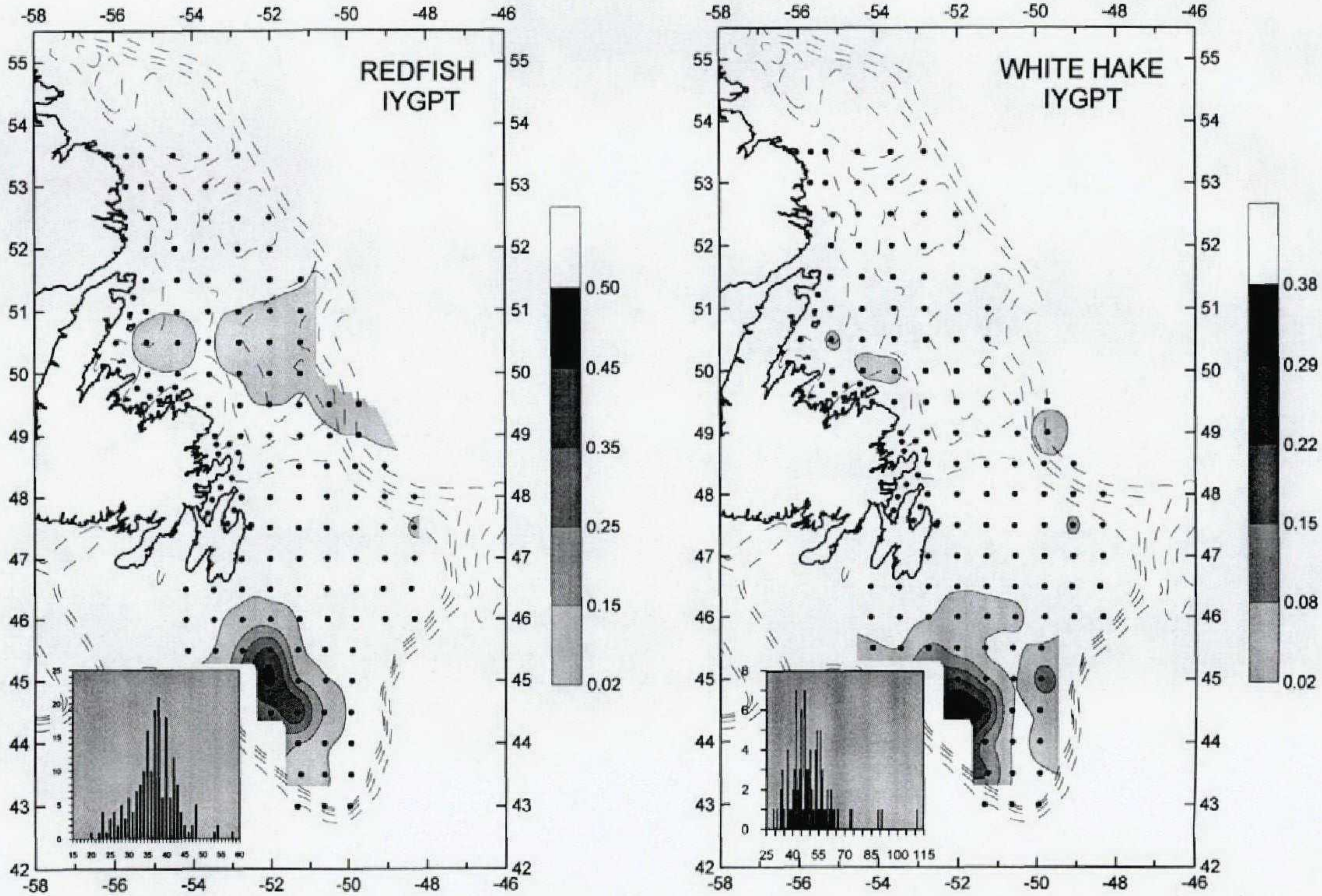

Figure 9. Distribution of redfish ($\log_{10}$ number 10^4 m^{-3}), left panel, and white or common hake, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

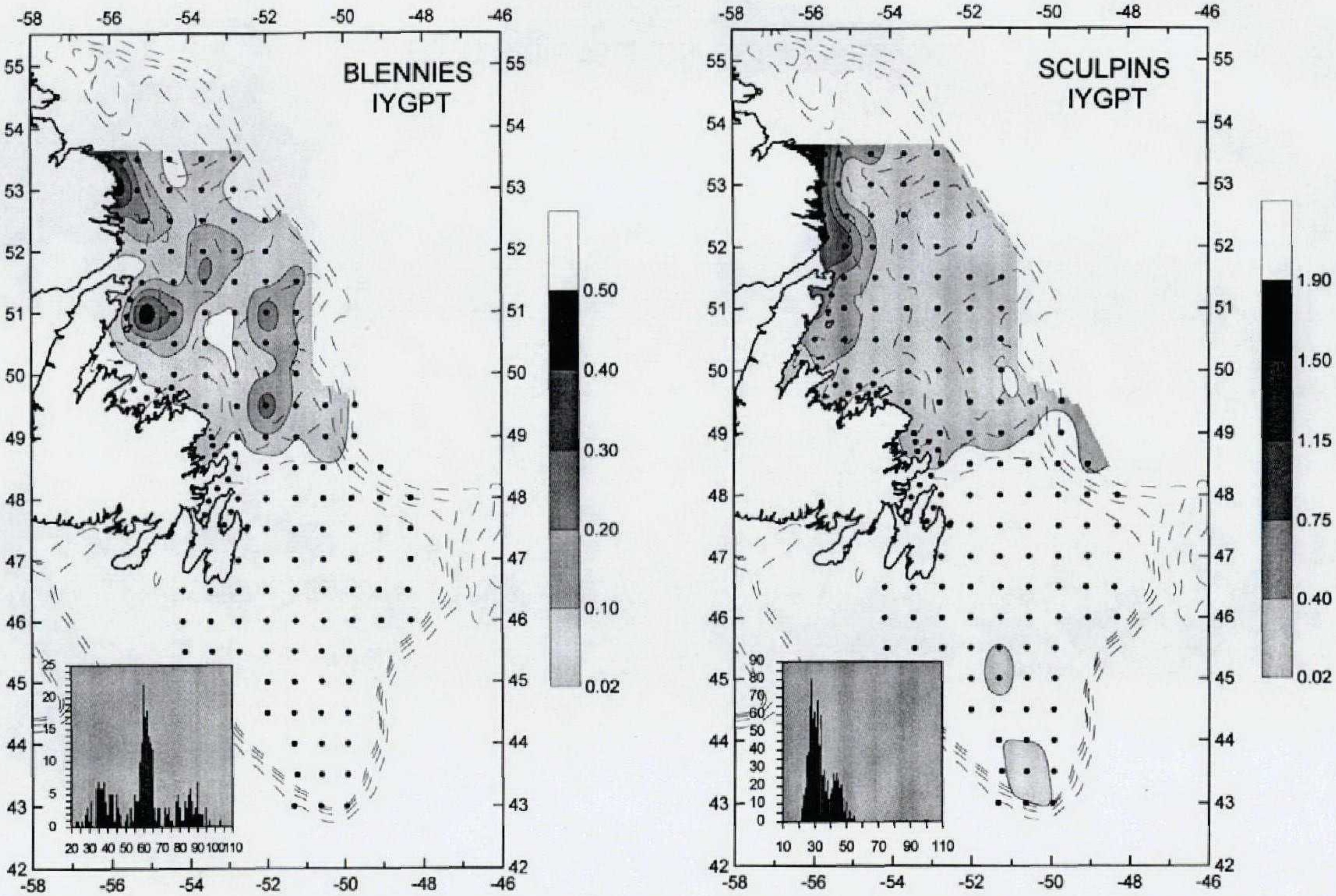

Figure 10. Distribution of blennies ($\log_{10}$ number 10^4 m^{-3}), left panel, and sculpins, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

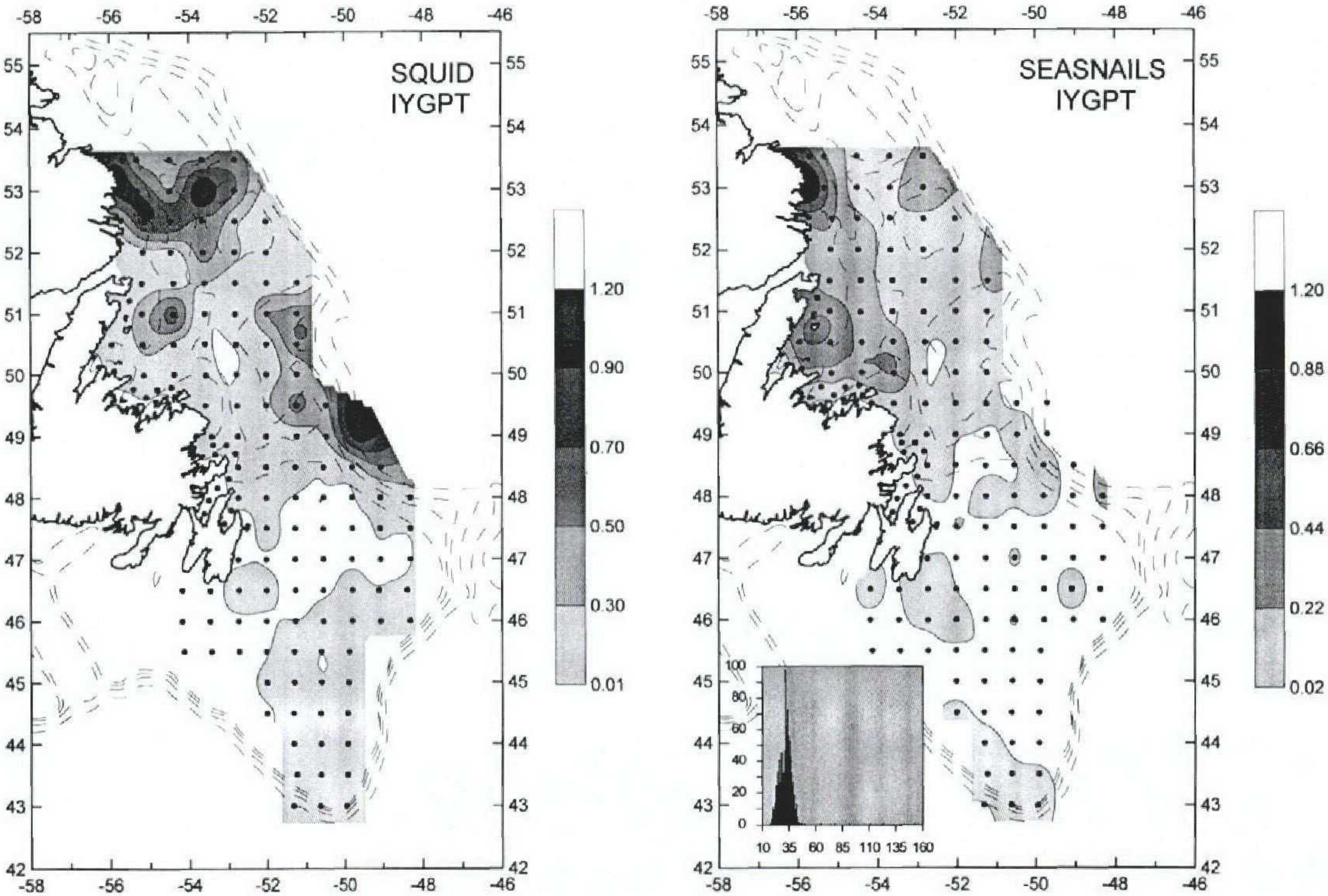

Figure 11. Distribution of squid ($\log_{10}$ number $10^4\ m^{-3}$), left panel, and seasnails, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

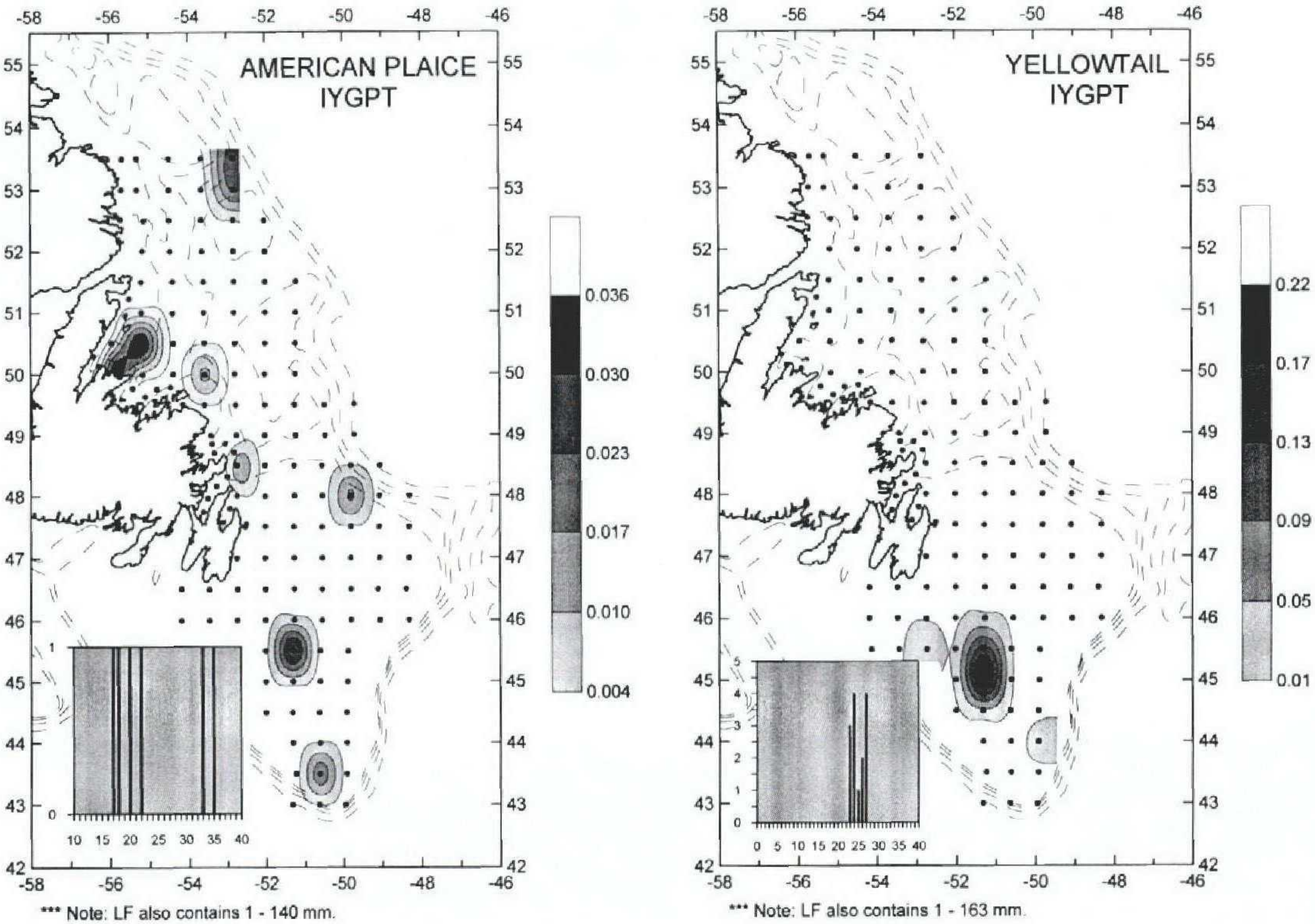

Figure 12. Distribution of pelagic 0-group American plaice ($\log_{10}$ number 10^4 m^{-3}), left panel, and yellowtail flounder, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

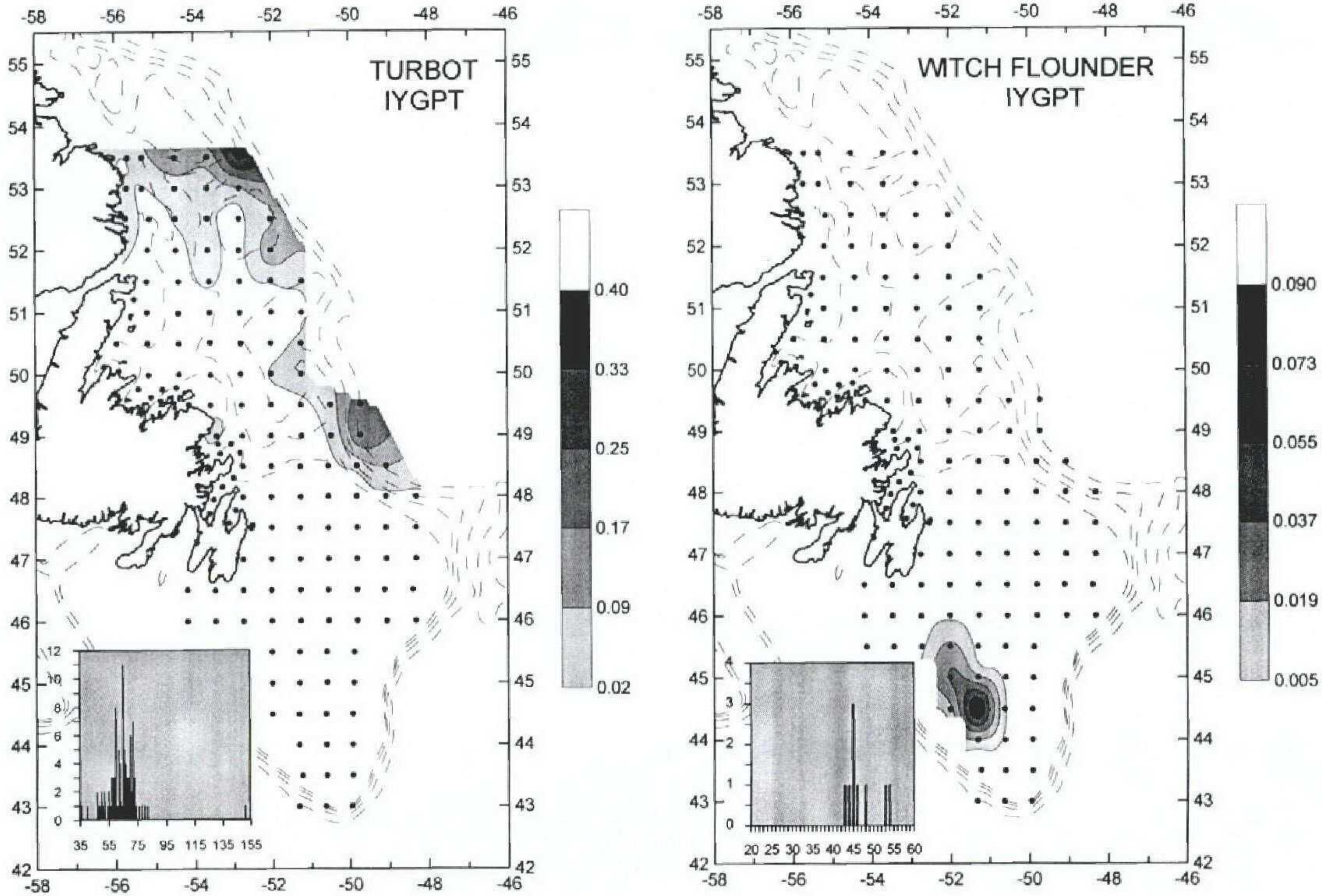

Figure 13. Distribution of turbot ($\log_{10}$ number 10^4 m^{-3}), left panel, and witch flounder, right panel, from the IYGPT during the 1996 pelagic 0-group survey in NAFO Divisions 2J3KL. Length frequency distribution (mm) of animals captured is shown in bottom left hand corner of each panel.

Appendix 1. Results of the Studentized Maximum Modulas test to isolate significant differences of dependent vaiables between subareas and years. Ranking is from highest to lowest. A comma between years represent no significant difference a '> ' represents a significant difference between years. Areas joined by the same line are not significantly different.

TEMPERATURE (0m)
SGB>INSH>NGB>FIBI,ISS>ISN>BIBI

94>96>95

TEMPERATURE (50m)
SGB>INSH >NGB>BIBI>ISN>ISS>FIBI

95,96>94

TOTAL ZOOPLANKTON
BIBI>ISN>ISS>FIBI>INSH>NGB>SGB

96,95>94

ZOOPLANKTON >2MM
ISN>ISS>FIBI>BIBI>INSH>NGB>SGB

95>96,94

ZOOPLANKTON 1-2MM
BIBI>ISN>ISS>FIBI>INSH>NGB>SGB

96>95>94

ZOOPLANKTON < 1MM
BIBI>INSH>ISS>ISN>FIBI>SGB>NGB

96>95,94

TOTAL NEKTON BIOMASS (Jellies Included)
INSH>ISN>ISS>BIBI>FIBI>NGB>SGB

95,94>96

TOTAL NEKTON BIOMASS (NO JELLYFISH, 95 AND 96 ONLY)
ISN>BIBI>ISS>FIBI>INSH>SGB>NGB

95>96

CAPELIN
NGB>INSHORE>FIBI>ISS>SGB>ISN>BIBI

94>96,95

SAND LANCE
NGB>SGB>ISS>ISN>INSHORE>BIBI>FIBI

95,94,96 **NSD**

ATLANTIC COD

INSH>ISS>BIBI>ISN>FIBI>NGB>SGB

94>95>96

ARCTIC COD
ISN>INSH>ISS>BIBI>FIBI>NGB>SGB

94>95,96