Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

C S A S | ***S C C S***

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2007/012 | **Document de recherche 2007/012**

Ecologically and biologically significant areas for demersal fishes in the southern Gulf of St. Lawrence

Zones d'importance écologique et biologique pour les poissons démersaux dans le sud du golfe du Saint-Laurent

D.P. Swain and H.P. Benoît

Fisheries and Oceans Canada, Gulf Fisheries Centre,
P.O. Box 5030, Moncton, NB, E1C 9B6

ISSN 1499-3848 (Printed / Imprimé)

Canada

ABSTRACT

The goal of this report is to identify ecologically and biologically significant areas (EBSAs) for demersal fishes in the southern Gulf of St. Lawrence based on the guidelines in CSAS Ecosystem Status Report 2004/006. This was done using data from research surveys and fishery statistics. Here we focus our presentation on areas that possess higher than average significance. Seven potential EBSAs for demersal fish in the southern Gulf of St. Lawrence are described and ranked as a function of perceived priority.

RÉSUMÉ

Le but du présent rapport est de relever les zones d'importance écologique et biologique (ZIEB) pour les poissons démersaux dans le sud du golfe du Saint Laurent, conformément aux lignes directrices présentées dans le Rapport sur l'état des écosystèmes 2004/006 du SCCS. Pour ce faire, on a utilisé des données issues de relevés scientifiques et de statistiques sur les pêches. Dans le présent document, nous concentrons notre présentation sur les zones qui possèdent une importance supérieure à la moyenne. Sept ZIEB potentielles pour les poissons démersaux dans le sud du golfe du Saint Laurent sont décrites et classées en fonction de leur priorité perçue.

INTRODUCTION

The goal of this report is to identify ecologically and biologically significant areas (EBSAs) for demersal fishes in the southern Gulf of St. Lawrence (sGSL). We have attempted to follow the approach outlined in DFO (2004). In particular, life history activities (e.g., spawning, feeding, migration or overwintering of particular species) which occur over a relatively wide area and do not discriminate particularly significant zones were given little weight in determining EBSAs.

In this paper, we focus on areas that possess higher than average significance based on the guidelines in DFO (2004). We then rank these areas into three categories: high, moderate and lower priority. It is important to note that the "lower priority" areas we identify still possess an ecological or biological significance that is greater than that of other non-EBSA areas in the southern Gulf.

METHODS

Data Sources

Data are from 1) the annual bottom-trawl survey of the sGSL, conducted each September since 1971 (Benoît and Swain, 2003; Hurlbut and Clay, 1990), 2) a bottom-trawl survey of the Northumberland Strait area, conducted in July-August since 2000 (M. Hanson, personal communication), 3) bottom-trawl surveys of the nGSL and Cabot Strait areas conducted in January 1980-1994 and January 1994-1997, respectively (Chouinard and Hurlbut, in prep), and 4) fishery statistics on the spatial and seasonal distribution of catches (Poirier, 2001).

Species

Some summary statistics were based on all demersal fishes caught in the September survey (see below), but most analyses focused on a subset of these species, comprised of 1) commercially-fished species, 2) species at risk, and 3) species regularly caught in the survey but having a limited distribution. Species for which an index of distribution (D_{95}, Swain & Sinclair 1994) was usually less than 5000 km^2 were selected for the latter category. Commercially-fished species were chosen because these are the main species for which the geographic location of many important life-history processes is known and because they tend to be the dominant species at their trophic level. On the other hand, species at risk were chosen because of their potentially high ranking on the EBSA criterion axis of *Fitness Consequences* (DFO, 2004). For their part, species with limited distributions were chosen as the ones that would rank highly on the criterion axis of *Aggregation* and therefore be most useful in discriminating areas.

The species selected were:

1. Commercial species

- *Gadus morhua:* Atlantic cod, morue franche
- *Urophycis tenuis:* white hake, merluche blanche
- *Hippoglossoides platessoides:* American plaice, plie canadienne
- *Pseudopleuronectes americanus:* winter flounder, plie rouge
- *Glyptocephalus cynoglossus:* witch flounder, plie grise
- *Limanda ferruginea:* yellowtail flounder, limande à queue jaune

2. Species at risk

- *Anarhichas denticulatus:* northern wolffish, loup à tête large **Threatened**
- *Anarhichas minor:* spotted wolffish, loup tacheté **Threatened**
- *Anarhichas lupus:* Atlantic wolffish, loup atlantique **Special concern**
- *Leucoraja ocellata :* winter skate, raie tachetée
- *Amblyraja radiata :* thorny skate, raie épineuse
- *Malacoraja senta :* smooth skate, raie à queue de velours

3. Species with a limited distribution

- *Melanogrammus aeglefinus:* haddock, aiglefin
- *Enchelyopus cimbrius:* fourbeard rockling, motelle à quatre barbillons
- *Cryptacanthodes maculatus:* wrymouth, terrassier tacheté
- *Tautogolabrus adspersus:* cunner, tanche-tautogue
- *Macrozoarces americanus:* ocean pout, loquette d'Amérique
- *Scophthalmus aquosus:* windowpane, turbot de sable

The two threatened wolffish species were rarely caught in the September survey and were not used to identify EBSAs.

Data Summaries

Distribution of the selected species was mapped for each survey in 5-yr blocks. For most species separate maps were produced for all sizes and for juvenile sizes[1]. These maps are available from M.-N. Bourassa and C. Savenkoff (Pêches et Océans Canada, Institut Maurice-Lamontagne, 850 route de la Mer, Mont-Joli, Québec, G5H 3Z4, Canada). In addition to these maps, previous atlases of distribution were consulted (Poirier 2001, Swain & Benoît 2001, Benoît et al. 2003, Darbyson & Benoît 2003, Chouinard & Hurlbut in prep.). These include maps of commercial fishing catches which reflect seasonal changes in the distribution of targeted fishes. Additional contour maps of distribution were produced for this working paper using the data visualization software ACON (http://www.mar.dfo-mpo.gc.ca/science/acon). Shaded contours were drawn

[1] Catches were not separated into juveniles and adults for northern and spotted wolfish, smooth skate, wrymouth, and windowpane.

using Delaunay triangles. In most cases, contour intervals were based on the 10th, 25th, 50th, 75th and 90th percentiles of the non-zero catch data.

Summary statistics

The following summary statistics were used:

1. Total biomass, all demersal fishes
2. Species richness – number of species, all demersal fishes
3. Aggregation index – catch rate (fish/tow) of each species scaled to percentiles within 5-yr periods; summed over all species caught in a tow
    a) All demersal fishes
    b) Adults, selected species
    c) Juveniles, selected species

RESULTS AND DISCUSSION

Distribution maps were inspected for all the selected species. Most of these fishes were widely distributed, both as juveniles and adults and in both summer and winter. EBSAs were identified based on 1) a number of species with restricted distributions during important life history activities and/or 2) areas where a large number of species congregated at relatively high densities.

EBSA 1: The Cape Breton Trough
Priority: High

This area (Fig. 1) was selected because of its importance as 1) a migration corridor for cod and other species (e.g., white hake), 2) summer grounds for witch flounder and white hake (deepwater stock component[2]), and 3) an area of high biodiversity.

The Cape Breton Trough is the main route taken by sGSL cod during their migration into the Gulf in April-May and their migration out of the Gulf in November (inferred from the distribution of fishery catches, Fig. 2). The bulk of the sGSL cod population funnels through this area in dense aggregations each spring and fall. This area also represents an important migration route for a number of other species, in particular the inshore stock component of white hake (Fig. 3).

Juvenile witch flounder are distributed throughout the deep waters of the channels in the nGSL. Adult witch flounder also occupy these deep waters in

[2] White hake in the sGSL comprise two stock components, a shallow-water component occurring in inshore areas of the sGSL in summer and a deep-water component occurring in waters deeper than about 200 m throughout the year (Hurlbut & Clay 1998). The two components differ morphologically (Hurlbut & Clay 1998), have different parasite loads (Melendy et al. 2005), and appear to spawn in different areas and seasons (Hurlbut & Clay 1998).

winter, but move into shallower waters to feed in summer. The Cape Breton Trough has been an area containing relatively high densities of adult witch flounder during this season since the onset of monitoring in 1971 (Fig. 4). The geographic distribution of witch flounder in the sGSL contracted in the 1990s and 2000s, and the Cape Breton Trough now comprises their principle feeding grounds in the sGSL, containing most of the adults that move into the sGSL in summer. This area also contains the highest concentrations of the deepwater stock component of white hake in the sGSL in summer and early fall (Fig. 5).

The Cape Breton Trough is also currently an area of relatively high demersal fish biomass (Fig. 6) and diversity (Fig. 7) during the summer and early fall feeding season. The species contributing to the high diversity in this area include species with a limited distribution in the sGSL and species at risk (Atlantic wolfish, Special Concern) or potentially at risk (thorny and smooth skates, under consideration by the Committee on the Status of Endangered Wildlife in Canada [COSEWIC]) (Fig. 8).

EBSA 2: St. Georges Bay
Priority: High

This area (Fig. 1) was selected primarily because of its importance for the inshore stock component of white hake. The abundance of white hake in the sGSL declined dramatically in the early 1990s. For adult white hake (fish $\geq$ 45 cm in length), percent declines are estimated to be 75-88% depending on the time period used (T. Hurlbut, DFO Moncton, pers. comm.). The fishery for white hake in the sGSL has been under moratorium since 1995, and the species is under consideration by COSEWIC for listing as at risk.

The geographic range of white hake in the sGSL contracted as their abundance declined, and St. Georges Bay is now the only area containing significant concentrations in summer and early fall of adult white hake of the inshore stock component (Fig. 9). In addition to being the summer feeding grounds for most of the remaining adults in the inshore stock component, this area is thought to now be the principle spawning ground for this stock component (T. Hurlbut, DFO Moncton, pers. comm.). During the September survey, this area also now contains the highest densities of juveniles for the inshore stock component (Fig. 10) and appears to be the principle nursery ground for the remaining juveniles in inshore areas.

In addition to its importance for white hake, this area also contains relatively high abundances of juveniles (Fig. 11) and/or adults (Fig. 12) of several other demersal fishes based on catch rates in the September survey (e.g., winter flounder, yellowtail, plaice, juvenile cod, cunner, ocean pout, fourbeard rockling).

EBSA 3: Western Northumberland Strait
Priority: High

This area (Fig. 1) was selected primarily because of its importance for winter skate. Winter skate in the sGSL comprise a unique population, differing from winter skate elsewhere in key life history and ecological characters (e.g., maturation at 40-45 cm in the sGSL, 75 cm elsewhere; see details in Swain et al. 2006). Catch rates of adult winter skate in the September survey have declined by 96% since 1971, and the sGSL population has been recommended for listing as endangered by COSEWIC (Swain et al. 2006).

The distribution of winter skate within the September survey area contracted as their abundance declined (Figures 13 and 14; Swain et al. 2006), and they are now rarely caught in the September survey. A concentration of winter skate occurs in the western Northumberland Strait in summer (Fig. 15). About 45% of the remaining winter skate in the sGSL are estimated to occur in this area in summer (Swain et al. 2006).

This area also contains relatively high densities of a number of other species with restricted distributions in the sGSL, in particular white hake and windowpane (Fig. 16).

EBSA 4: Southern slope of the Laurentian Channel in the Cabot Strait area
Priority: High

Many of the demersal fishes occurring in the sGSL in summer overwinter in the warm deep water of the Laurentian Channel (e.g., cod, white hake, plaice, witch flounder, thorny skate). Most of these fishes are widely distributed throughout the Laurentian Channel in winter (based on the distribution maps produced from the January survey data). However, sGSL cod overwinter in a restricted area, along the 200-m depth contour in the Cabot Strait area. This is indicated by both the distribution of fishery catches in winter (e.g., Fig. 2) and by catches in the January surveys in the mid-1990s (Fig. 17). Aggregations typically occur in the vicinity of St. Paul Island and to the southeast in Northwest Atlantic Fisheries Organization (NAFO) Subdivisions 4Vn and northern 4Vs (4Vsb). During this time of year, the entire sGSL cod population occurs in dense aggregations covering a relatively small area. The fish feed little and their condition is declining (Schwalme & Chouinard 1999), making them particularly susceptible to perturbation. For these reasons, this area (Fig. 1) was selected as a high-priority EBSA.

EBSA 5: Shediac Valley region
Priority: Moderate

This area (Fig. 1) was selected because of its importance as a nursery area (Fig. 11) and an area of relatively high demersal fish biomass during the summer and

early fall feeding season (Fig. 6). This area is an important nursery ground for several species (e.g., cod, plaice, winter flounder, yellowtail flounder) though juveniles of these species also occur at substantial densities in other areas (Swain & Benoît 2001). This is also an area of consistently high demersal fish biomass, due in large part to both juveniles and adults of these same species. However, substantial biomasses of these species also occur in other areas (Benoît et al. 2003). Because alternate areas are also used by the demersal fishes concentrated in this area in September, the priority or significance of this EBSA is considered to be only moderate.

EBSA 6: Southern slope of the Laurentian Channel, Gaspé to Cape Breton
Priority: Lower

This is an area of high species richness for demersal fishes (Fig. 18) and an area where abundance is relatively high for many of these fishes (Fig. 7). However, this is a relatively large area, and the species contributing to the importance of this area (e.g., fourbeard rockling, longfin hake, white hake, marlin-spike grenadier, hagfish, witch flounder, turbot, thorny skate, smooth skate, mailed sculpin, redfish) tend to be widely distributed through it. These species also occur outside of this zone in other areas of the GSL, in some cases at higher densities. For these reasons, the priority or significance of this EBSA is considered to be lower than that of EBSAs 1 - 4.

EBSA 7: Chaleur Bay
Priority: Lower

This is also an area of high species richness (Fig. 18) and relatively high abundance for a substantial number of demersal fishes (Fig. 7), though total demersal fish biomass in this area is currently low (Fig. 6). The species that currently occur in this area at relatively high abundance and contribute to the high diversity of this area include greenland cod, threespine stickleback, snakeblenny, daubed shanny, eelpouts, plaice, winter flounder, Atlantic sea poacher, alligatorfish, arctic hookear sculpin, spatulate sculpin, longhorn sculpin, shorthorn sculpin, mailed sculpin, lumpfish, Atlantic spiny lumpsucker and various seasnails. Each of these fishes is also currently abundant in some other area of the sGSL (Benoît et al. 2003). Thus, the priority or significance of this EBSA is considered to be lower than that of EBSAs 1 - 4.

ACKNOWLEDGEMENTS

We thank Marie-Noëlle Bourassa and Claude Savenkoff for producing the hundreds of maps of demersal fish distribution that were examined in our analysis.

REFERENCES

Benoît, H.P., Darbyson, E. & Swain, D.P. 2003. An atlas of the geographic distribution of marine fish and invertebrates in the southern Gulf of St. Lawrence based on annual bottom-trawl surveys (1971-2002). Can. Data Rep. Fish. Aquat. Sci. 1112.

Benoît, H.P. and D.P. Swain. 2003. Standardizing the southern Gulf of St. Lawrence bottom-trawl survey time series: adjusting for changes in research vessel, gear and survey protocol. Can. Tech. Rep. Fish. Aquat. Sci. no. 2505: iv + 95 pp.

Chouinard, G.A. & Hurlbut, T. [in prep.] An atlas of the January distribution of selected marine fish species in Cabot Strait, 1994-1997.

Darbyson, E. & Benoît, H.P. 2003. An atlas of the seasonal distribution of marine fish and invertebrates in the southern Gulf of St. Lawrence. Can. Data Rep. Fish. Aquat. Sci. 1113.

DFO, 2004. Identification of ecologically and biologically significant areas. DFO Can. Sci. Advis. Sec., Ecosystem Status Rep. 2004/006.

Hurlbut, T., and D. Clay. 1990. Protocols for research vessel cruises within the Gulf Region (demersal fish) (1970-1987). Can. Manuscr. Rep. Fish. Aquat. Sci. 2082: 143p.

Hurlbut, T. & Clay, D. 1998. Morphometric and meristic differences between shallow- and deep-water populations of white hake (*Urophycis tenuis*) in the southern Gulf of St. Lawrence. Can. J. Fish. Aquat. Sci. 55: 2274-2282.

Melendy, J., McClelland, G. & Hurlbut, T. 2005. Use of parasite tags in delineating stocks of white hake (*Urophysis tenuis*) from the southern Gulf of St. Lawrence and Cape Breton Shelf. Fish. Res. 76: 392-400.

Poirier, G.A. 2001 Summary of commercial catches of selected species in 4Tfg and 4Vn from 1986 to 2000. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/121.

Schwalme, K. & Chouinard, G. A., 1999. Seasonal dynamics in feeding, organ weights, and reproductive maturation of Atlantic cod (*Gadus morhua*) in the southern Gulf of St. Lawrence. ICES J. Mar. Sci. 56**:** 303-319.

Swain, D.P. & Benoît, H.P. 2001. Geographic distribution of selected marine fish in September in the southern Gulf of St. Lawrence based on annual bottom-trawl surveys. DFO Can. Sci. Advis. Sec. Res. Doc. 2001/118.

Swain, D. P. & Sinclair, A. F. 1994. Fish distribution and catchability: what is the appropriate measure of distribution? Can. J. Fish. Aquat. Sci. 51: 1046-1054.

Swain, D.P., J.E. Simon, L.E. Harris & H.P. Benoît. 2006. Recovery potential assessment of 4T and 4VW winter skate (*Leucoraja ocellata*): biology, current status and threats. DFO Can. Sci. Advis. Sec. Res. Doc. 2006/003.

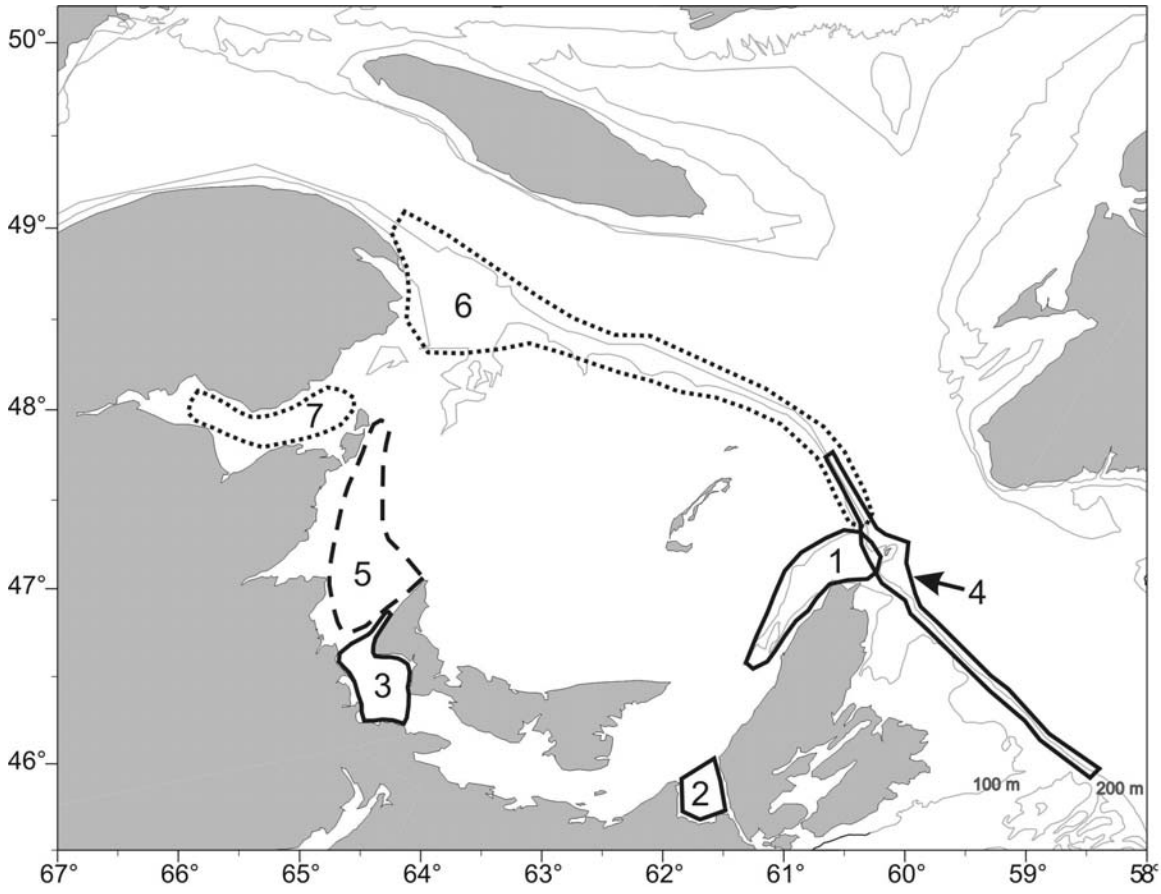

Figure 1. Proposed ecologically and biologically significant areas for demersal fishes in the southern Gulf of St. Lawrence. 1. Cape Breton Trough, 2. St Georges Bay, 3. western Northumberland Strait, 4. southern slope of the Laurentian Channel in the Cabot Strait area, 5. Shediac Valley region, 6. southern slope of the Laurentian Channel, Gaspé to Cape Breton, 7. Chaleur Bay. Line type signifies priority: solid = high, dashed = medium, dotted = lower.

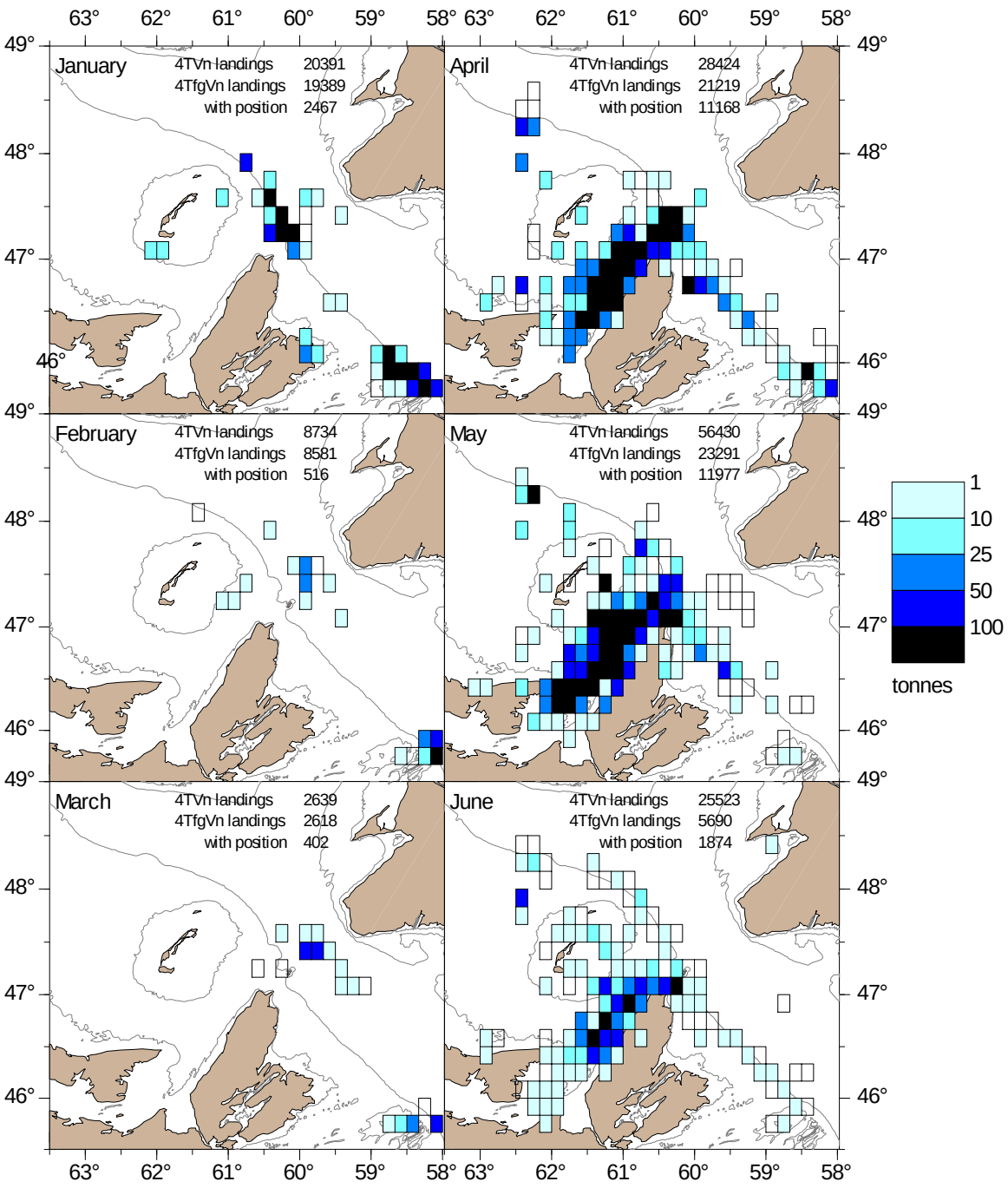

Figure 2a. Cod landings in mobile gear in 4TfgVn (Jan - June, 1986 - 1990), taken from Poirier (2001).

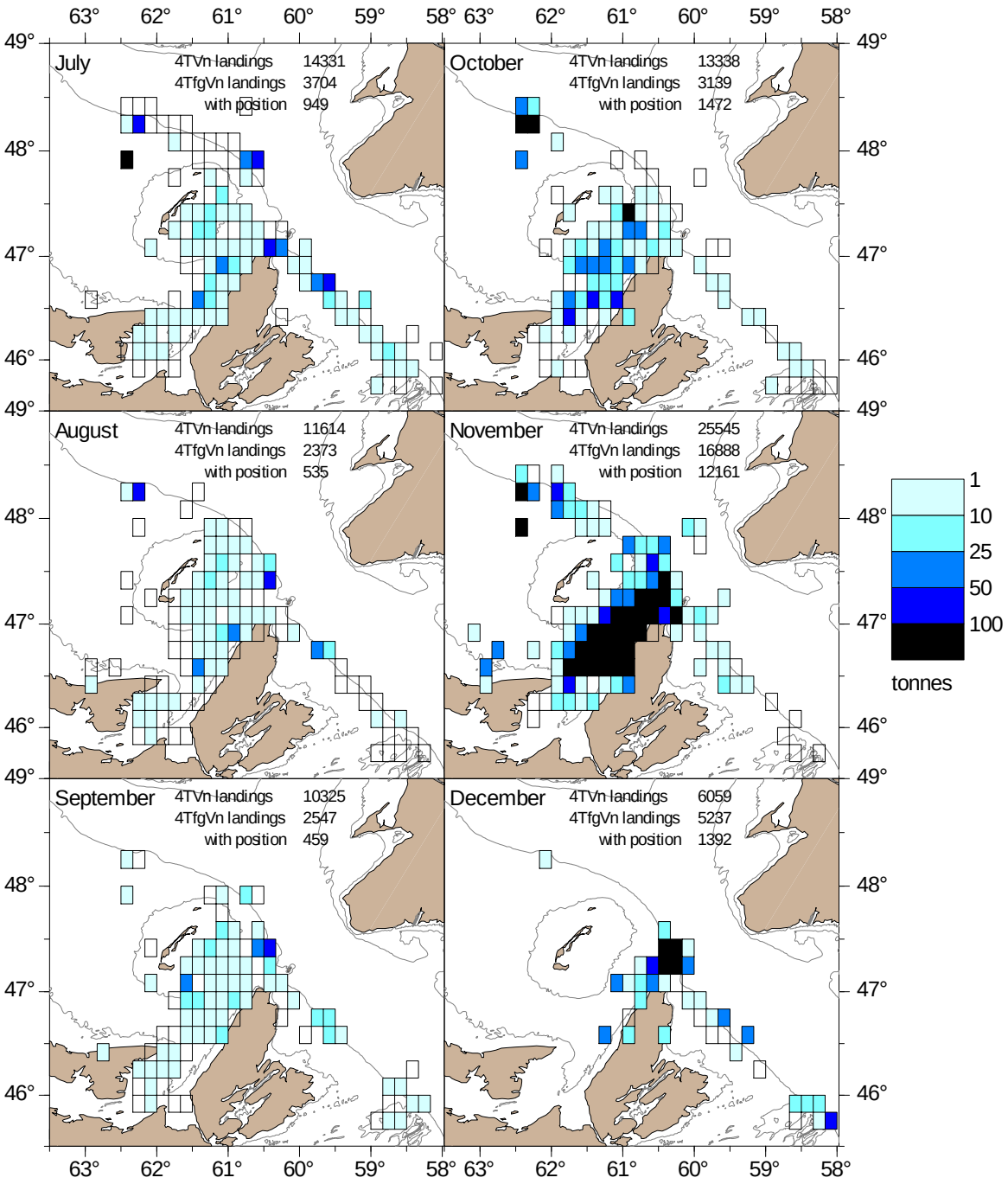

Figure 2b. Cod landings in mobile gear in 4TfgVn (Jul - Dec, 1986 - 1990), taken from Poirier (2001).

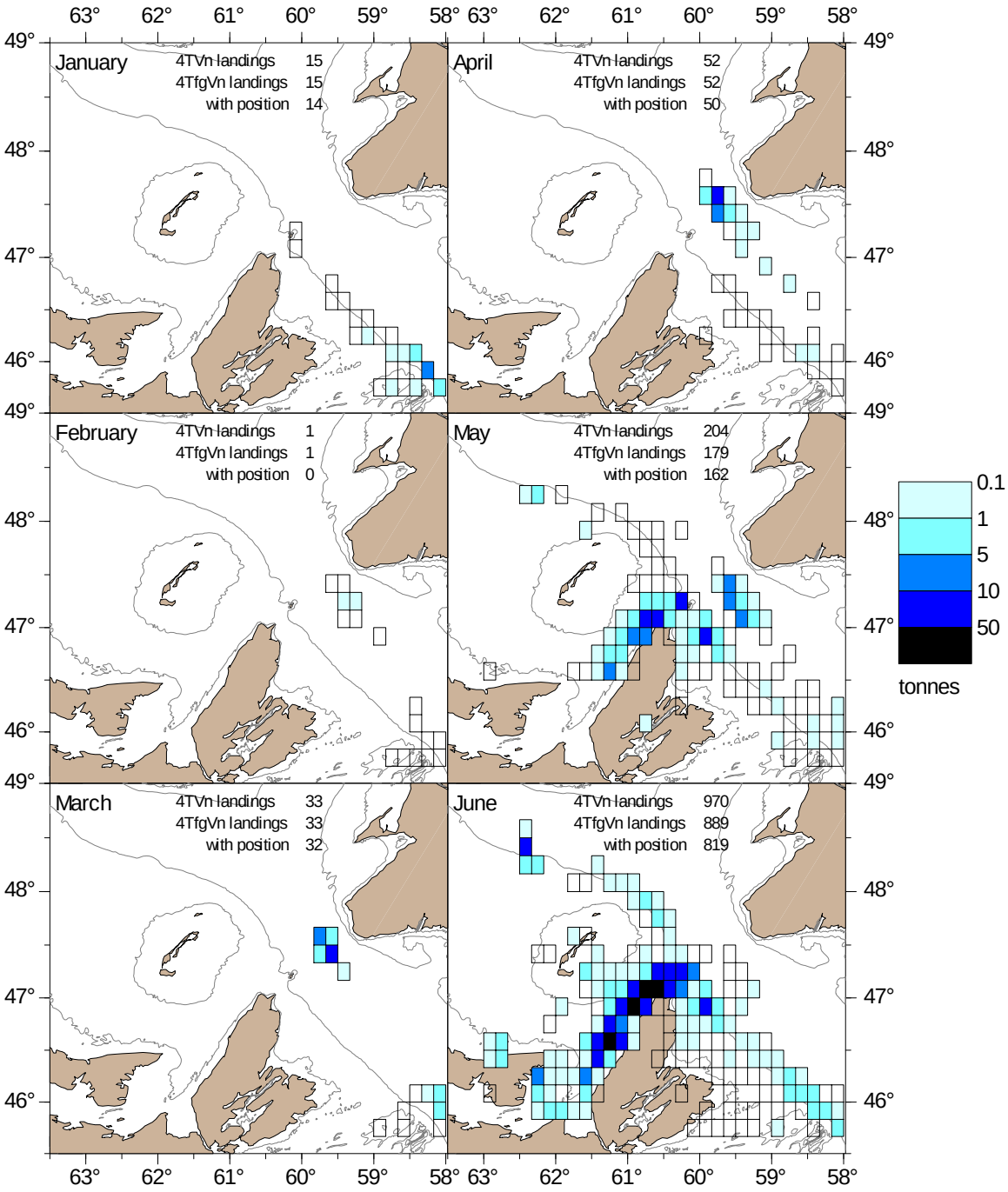

Figure 3a. White hake landings in mobile gear in 4TfgVn (Jan - June, 1991-1995), taken from Poirier (2001).

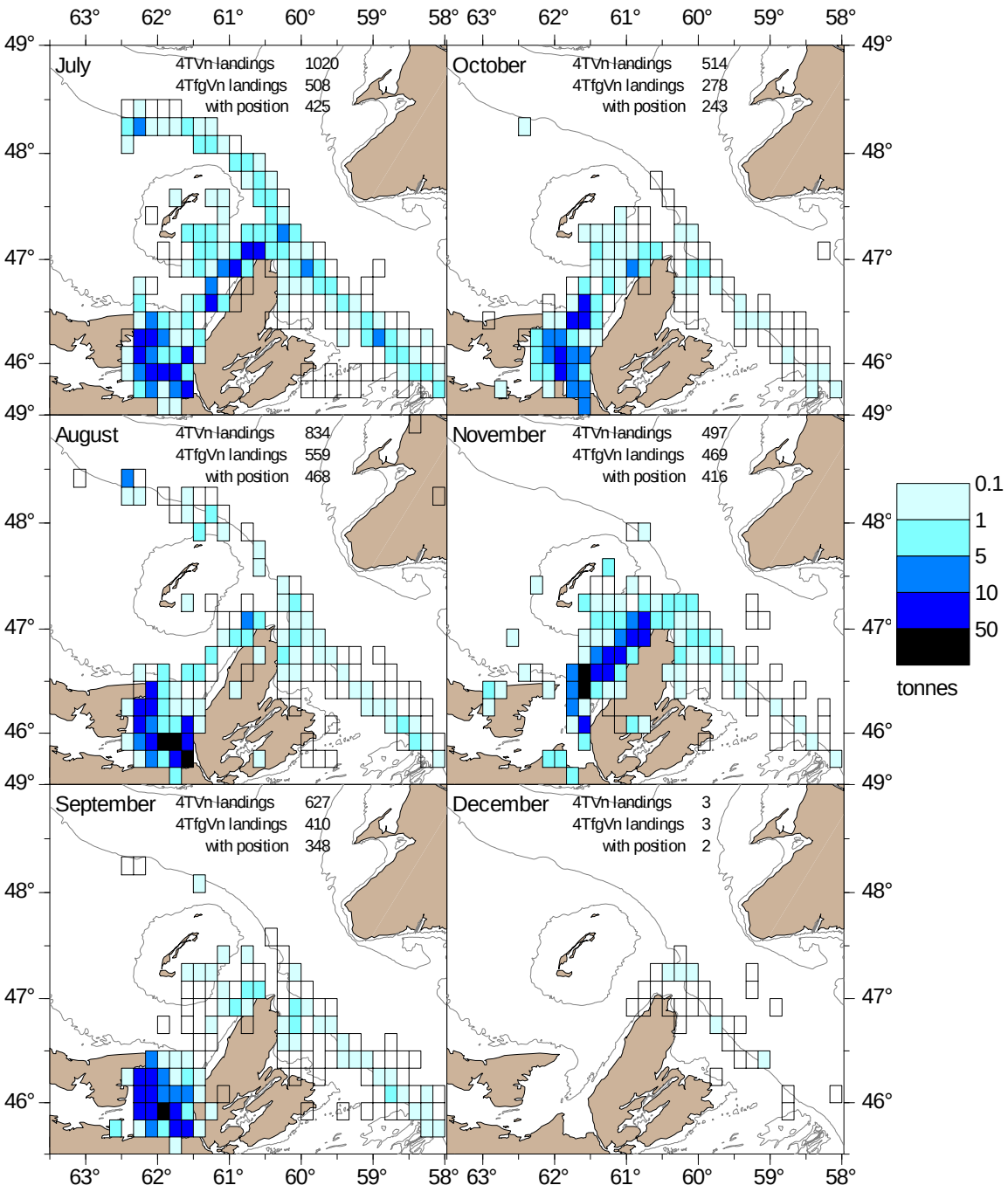

Figure 3b. White hake landings in mobile gear in 4TfgVn (Jul - Dec, 1991 - 1995), taken from Poirier (2001).

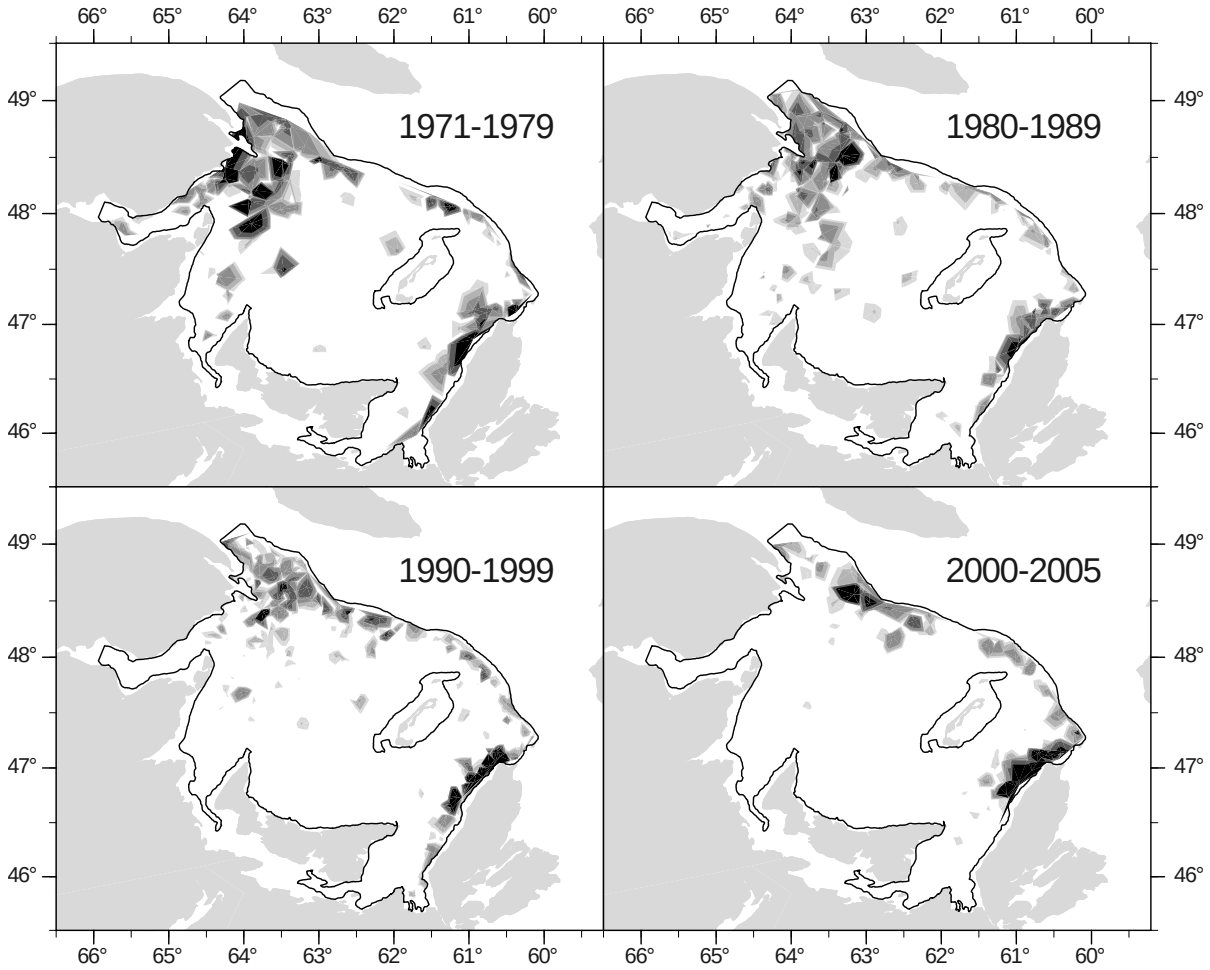

Figure 4. Distribution of adult witch flounder (i.e., fish ≥ 35 cm in length) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1971-2005 period. Darker shading indicates higher density.

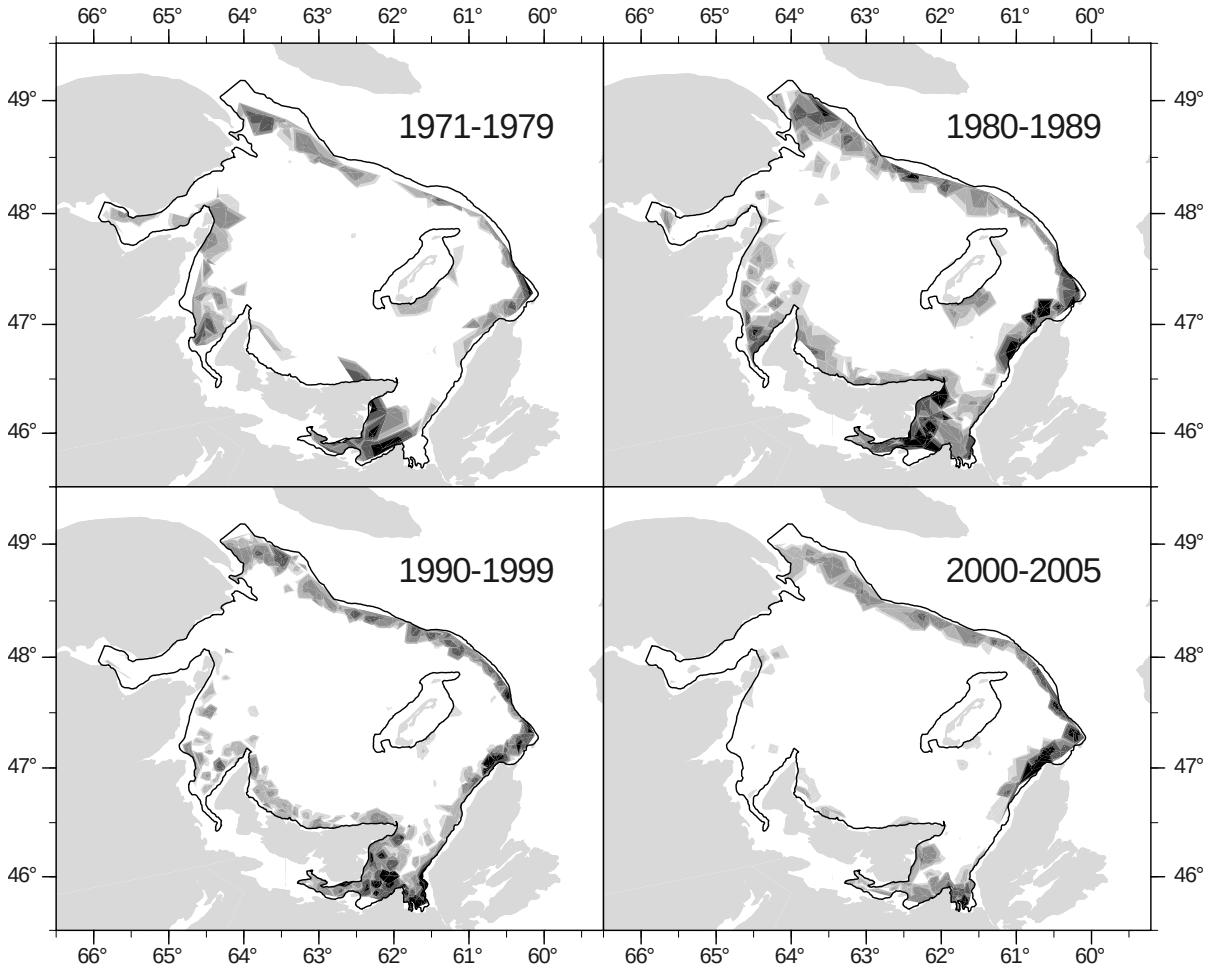

Figure 5. Distribution of white hake (all sizes) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1971-2005 period. Darker shading indicates higher density.

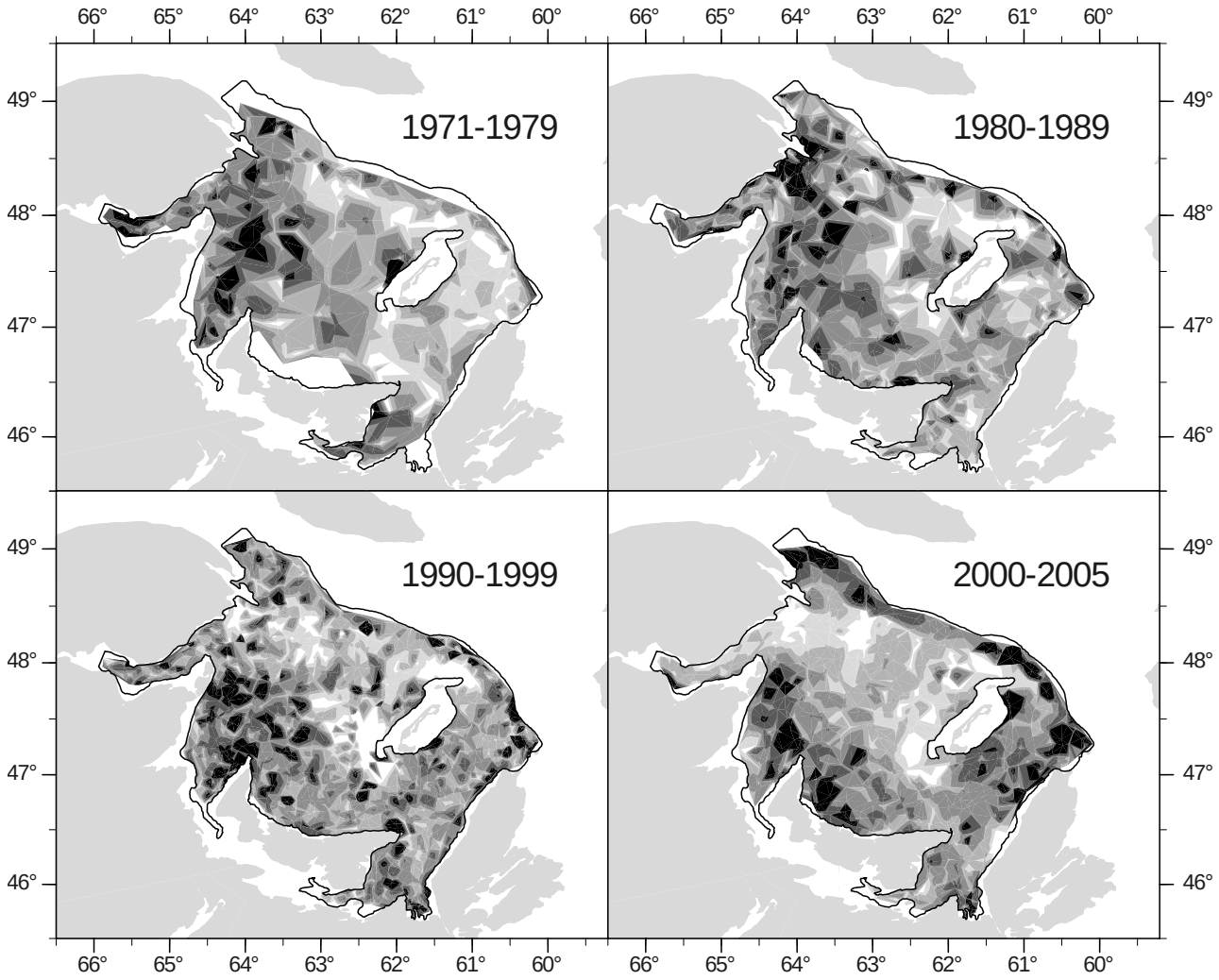

Figure 6. Demersal fish biomass (all species, kg/tow) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates in each decade. Darker shading indicates higher biomass.

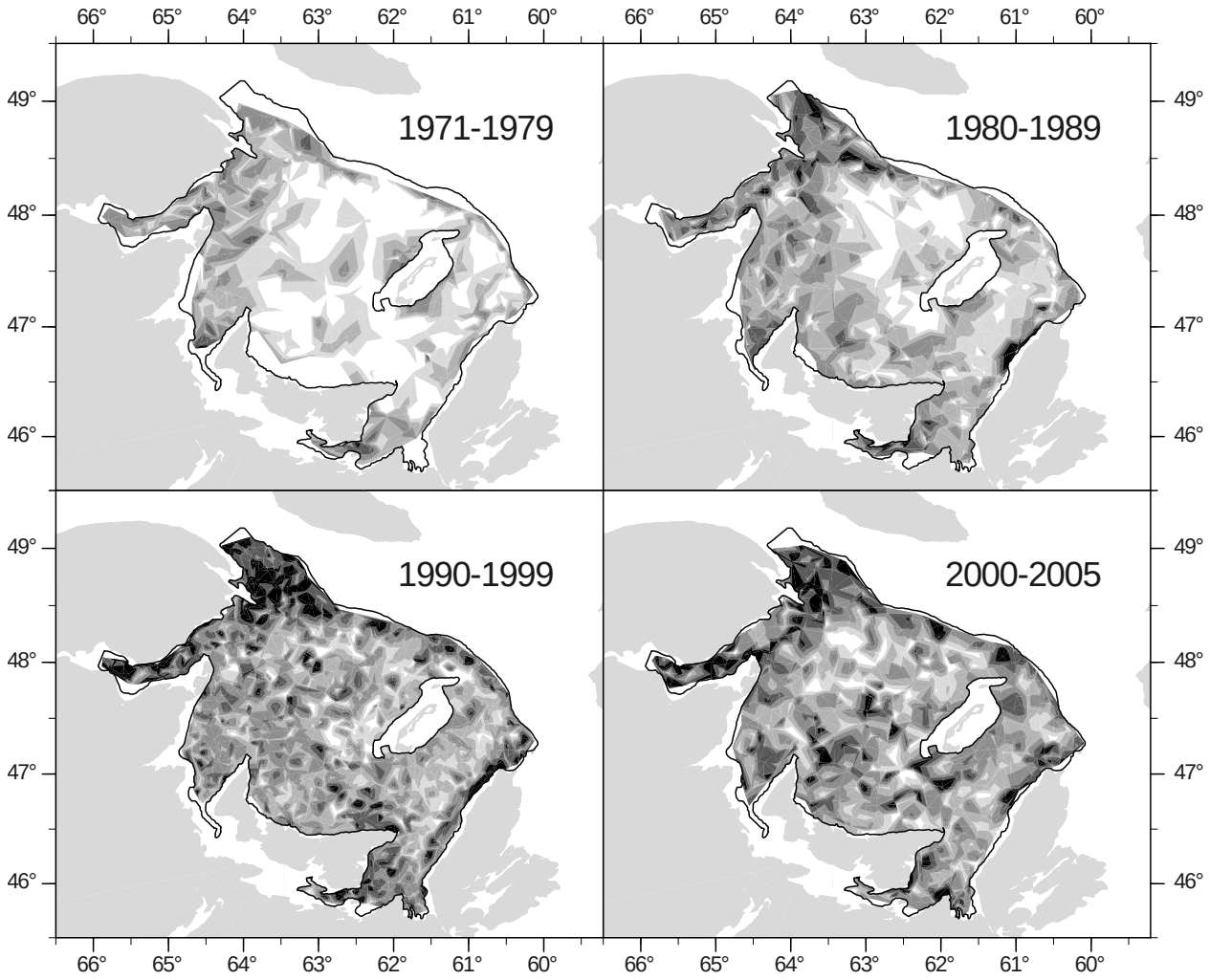

Figure 7. Demersal fish aggregation index (all species, all sizes) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of the index over the 35-yr period. Darker shading indicates higher aggregation.

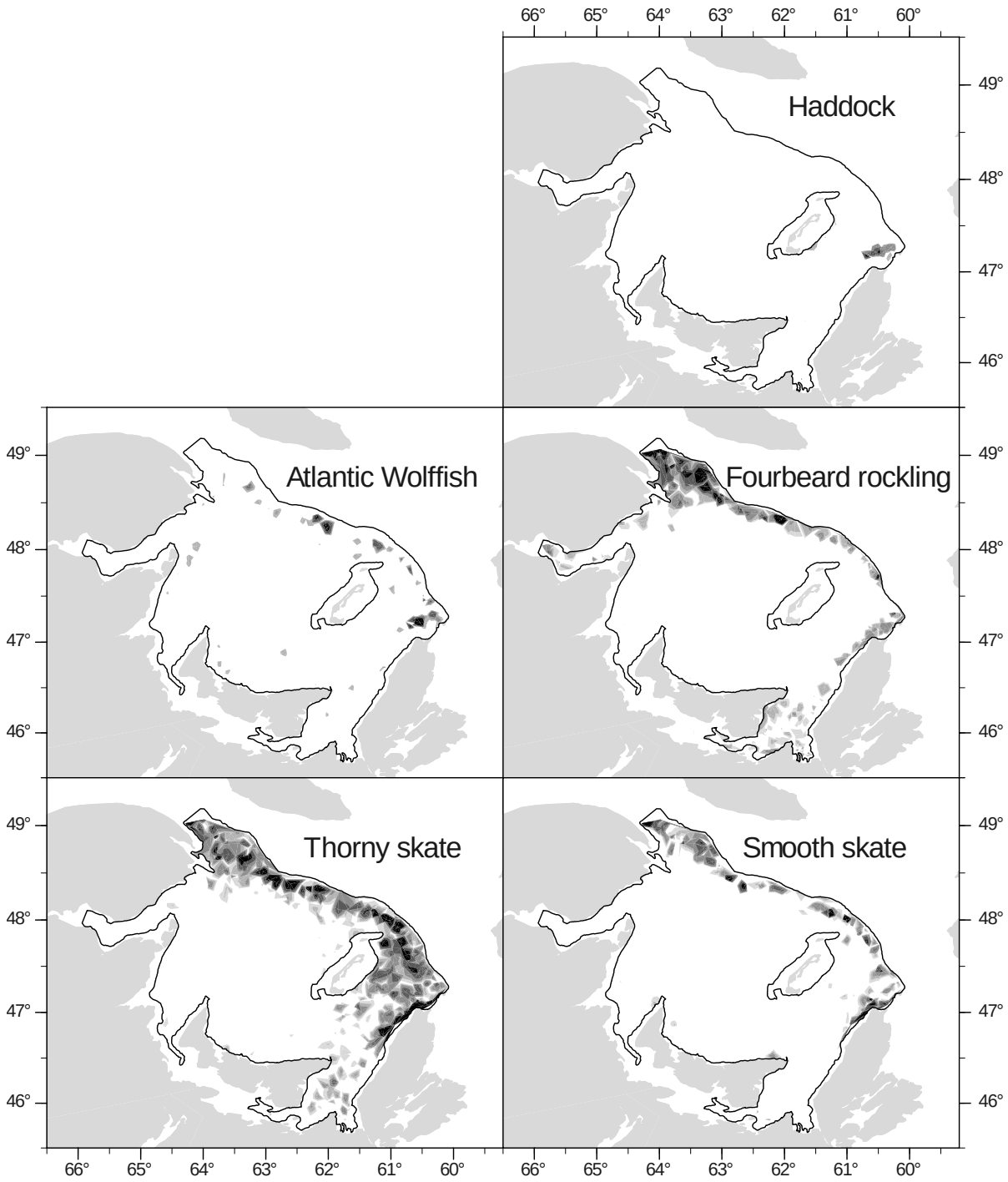

Figure 8. Distribution of selected demersal fishes (fish/tow, all sizes) in the southern Gulf of St. Lawrence in September in 1995-2005. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1995-2005 period. Darker shading indicates higher density.

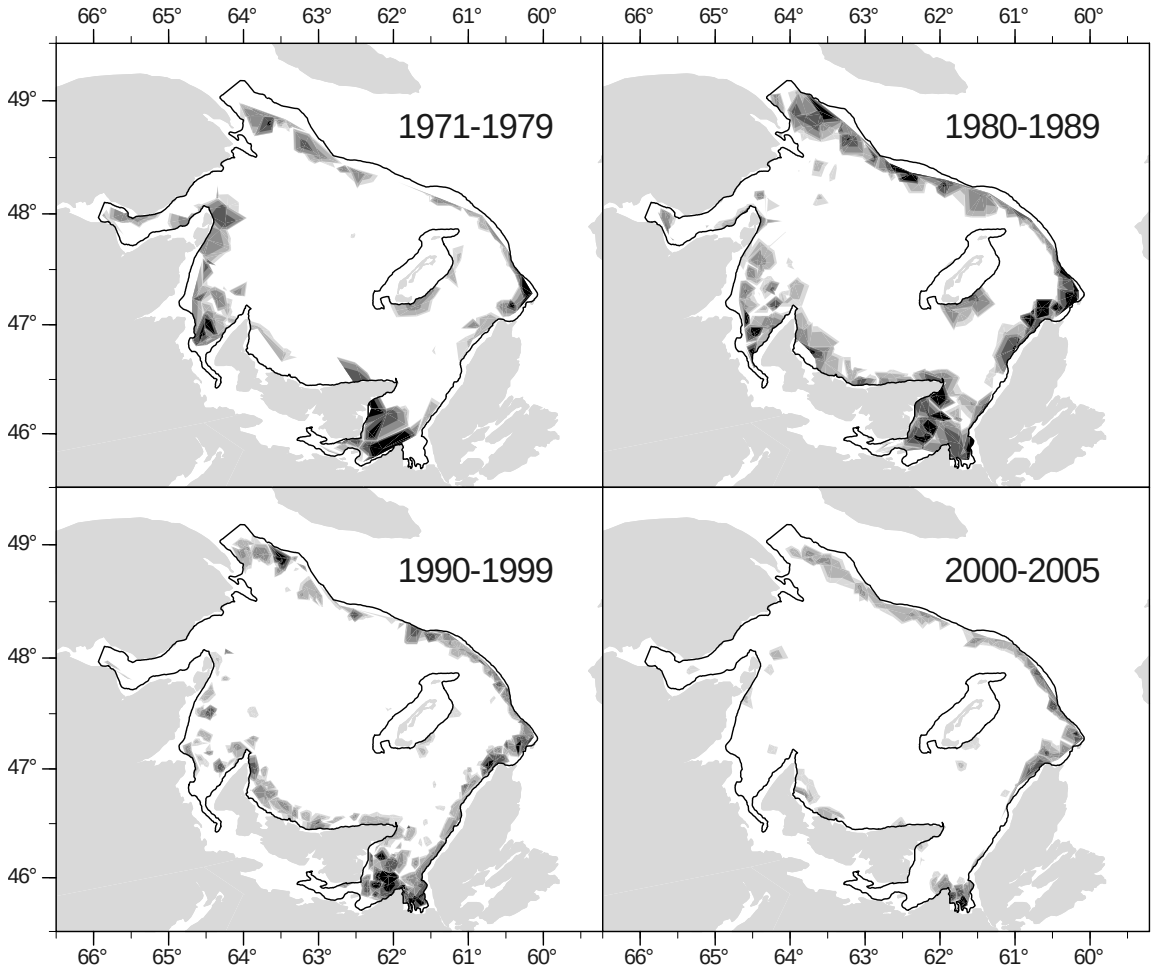

Figure 9. Distribution of adult white hake (i.e., fish ≥ 45 cm in length) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1971-2005 period. Darker shading indicates higher density. Note that St. Georges Bay was not sampled in 1971-1983.

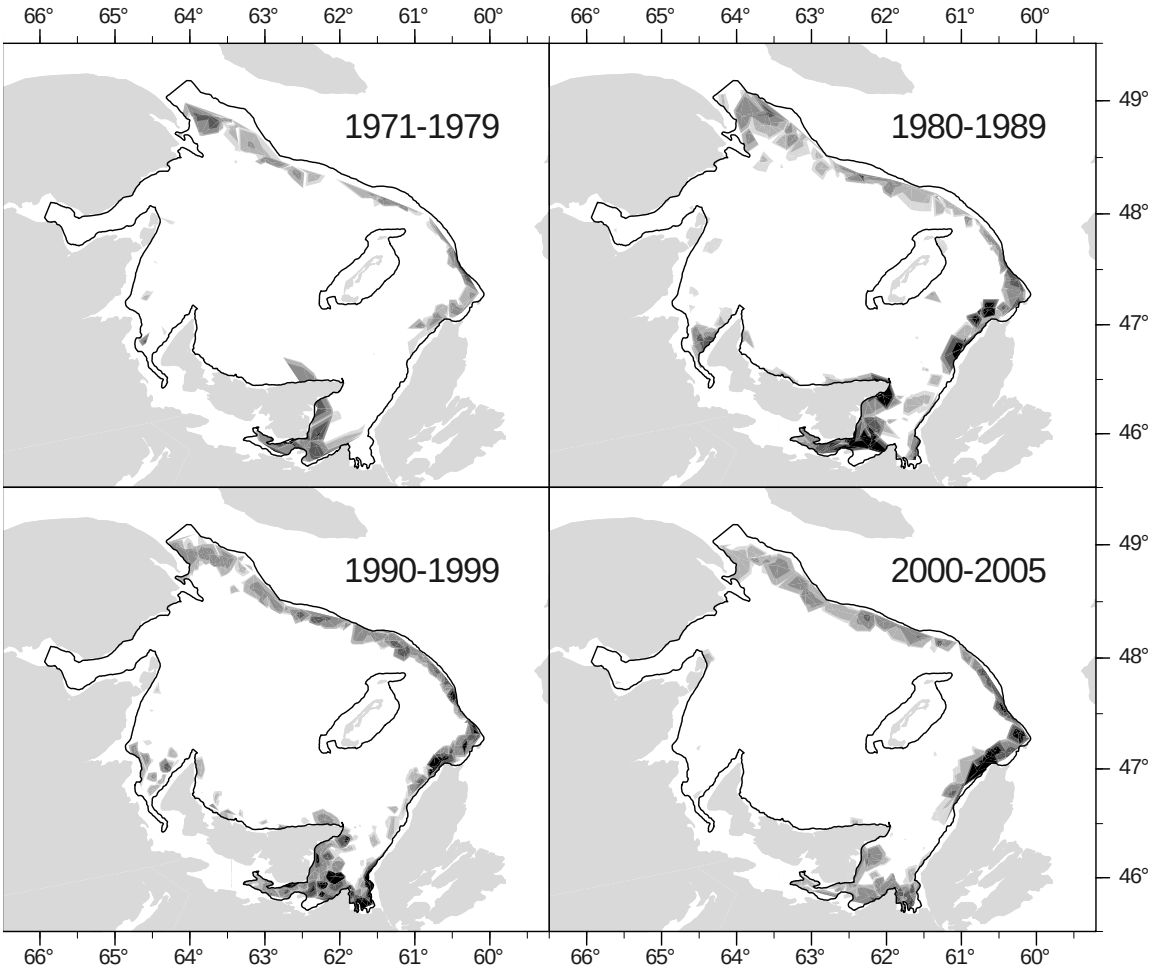

Figure 10. Distribution of juvenile white hake (i.e., fish < 45 cm in length) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1971-2005 period. Darker shading indicates higher density. Note that St Georges Bay was not sampled in 1971-1983.

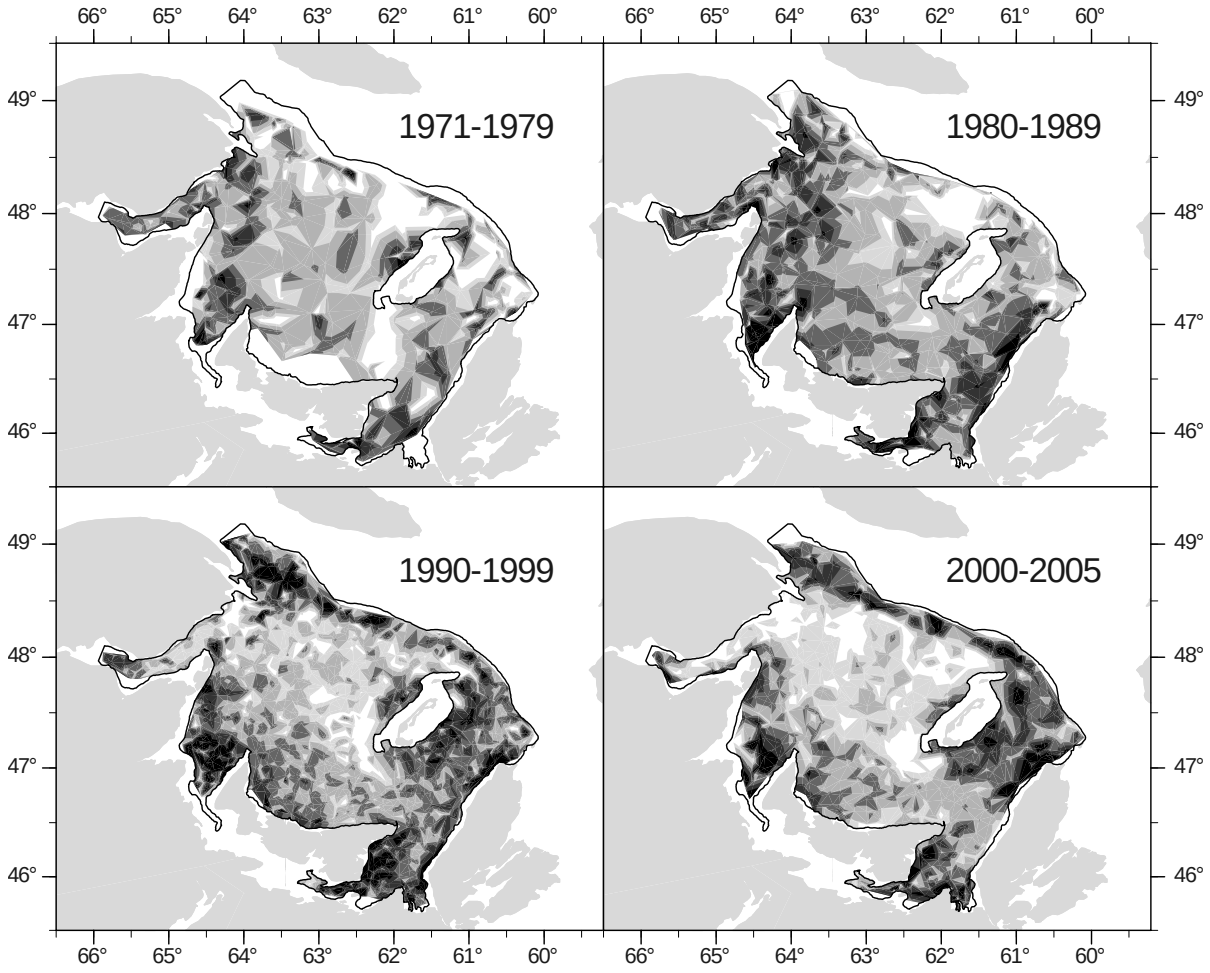

Figure 11. Aggregation index for juveniles of selected species (see text) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of the index during the 1971-2005 period. Darker shading indicates higher aggregation. Note that St Georges Bay was not sampled in 1971-1983.

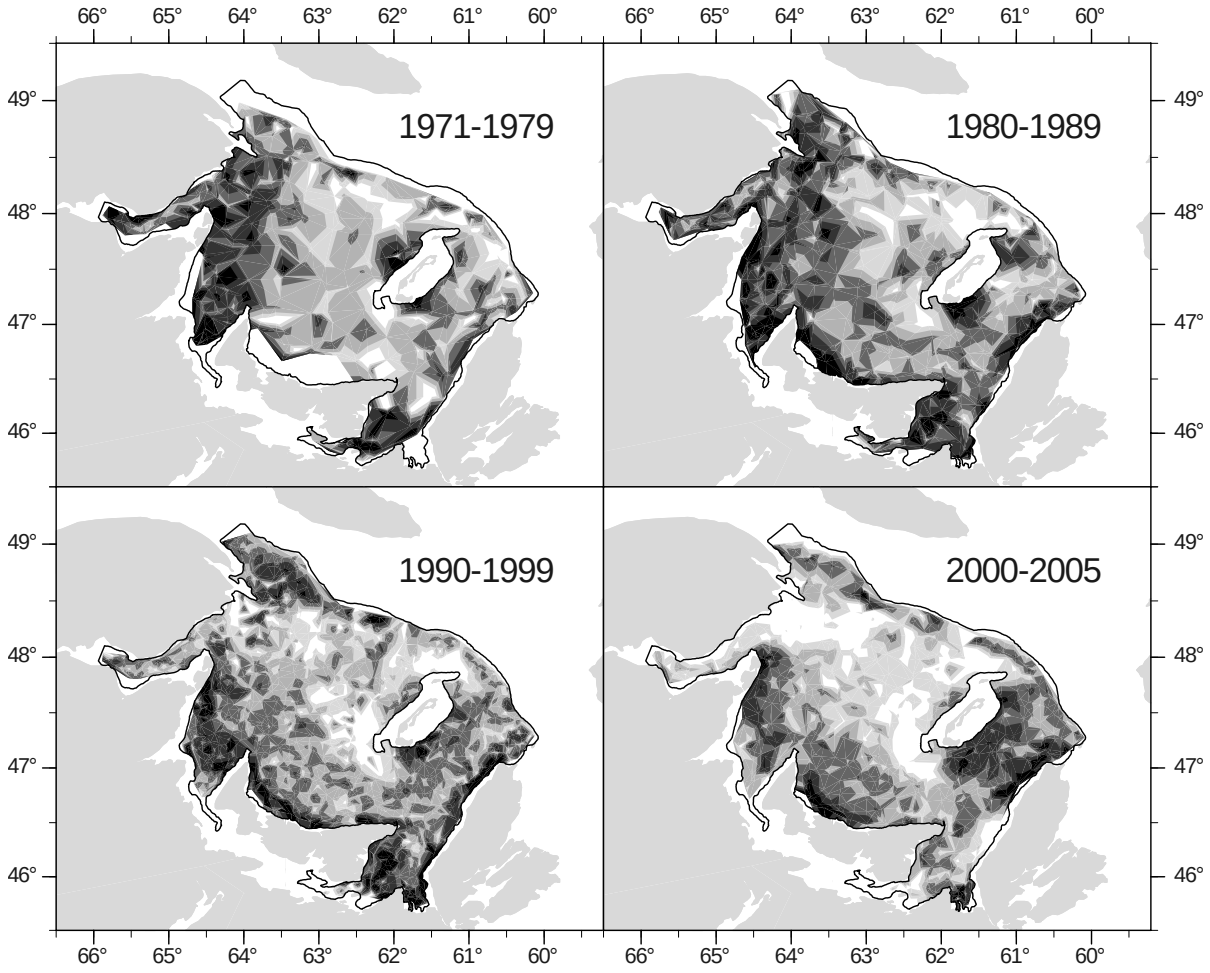

Figure 12. Aggregation index for adults of selected species (see text) in the southern Gulf of St. Lawrence in September in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of the index during the 1971-2005 period. Darker shading indicates higher aggregation. Note that St Georges Bay was not sampled in 1971-1983.

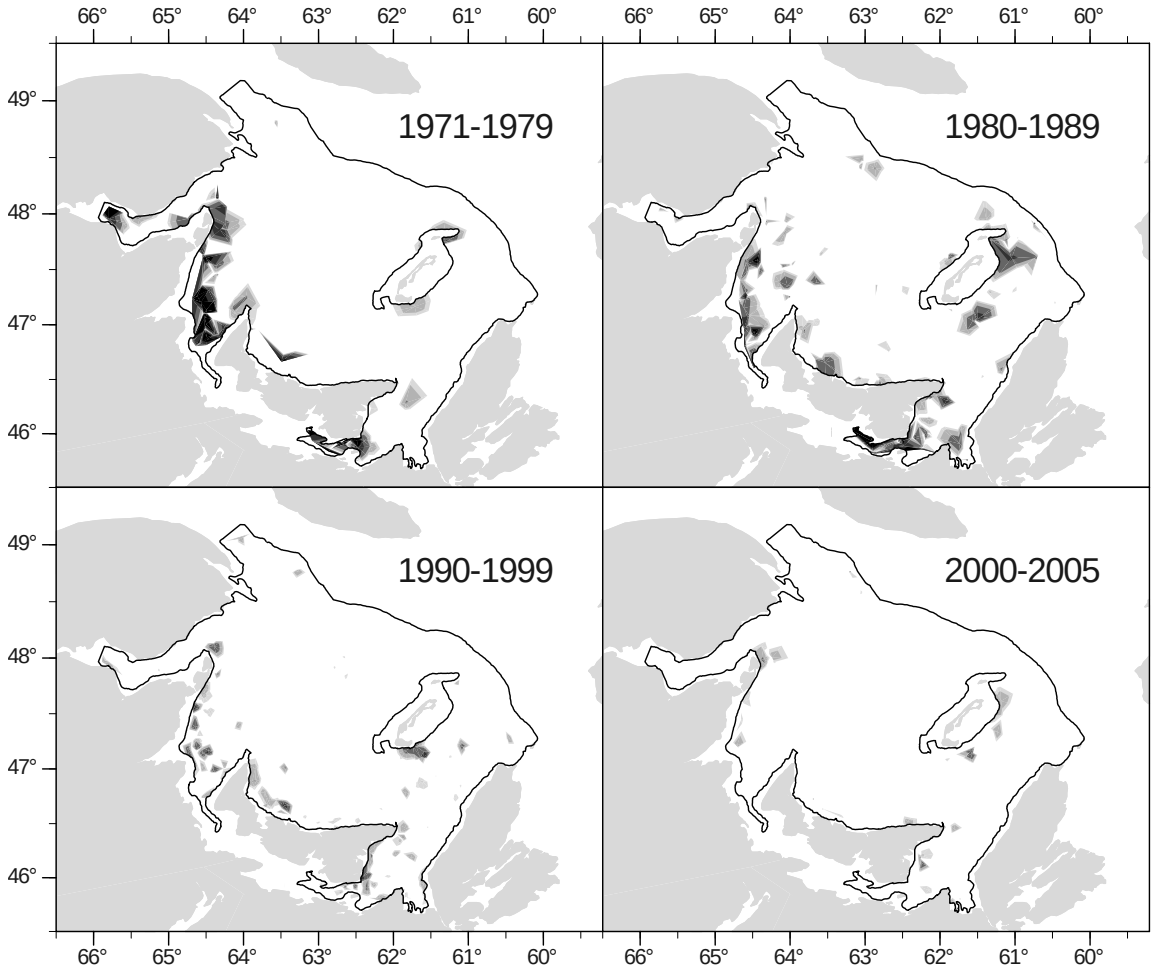

Figure 13. Abundance and distribution of adult winter skate (i.e., fish ≥ 42 cm in length) in the September survey of the southern Gulf of St. Lawrence in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1971-2005 period. Darker shading indicates higher density. Note that St Georges Bay was not sampled in 1971-1983.

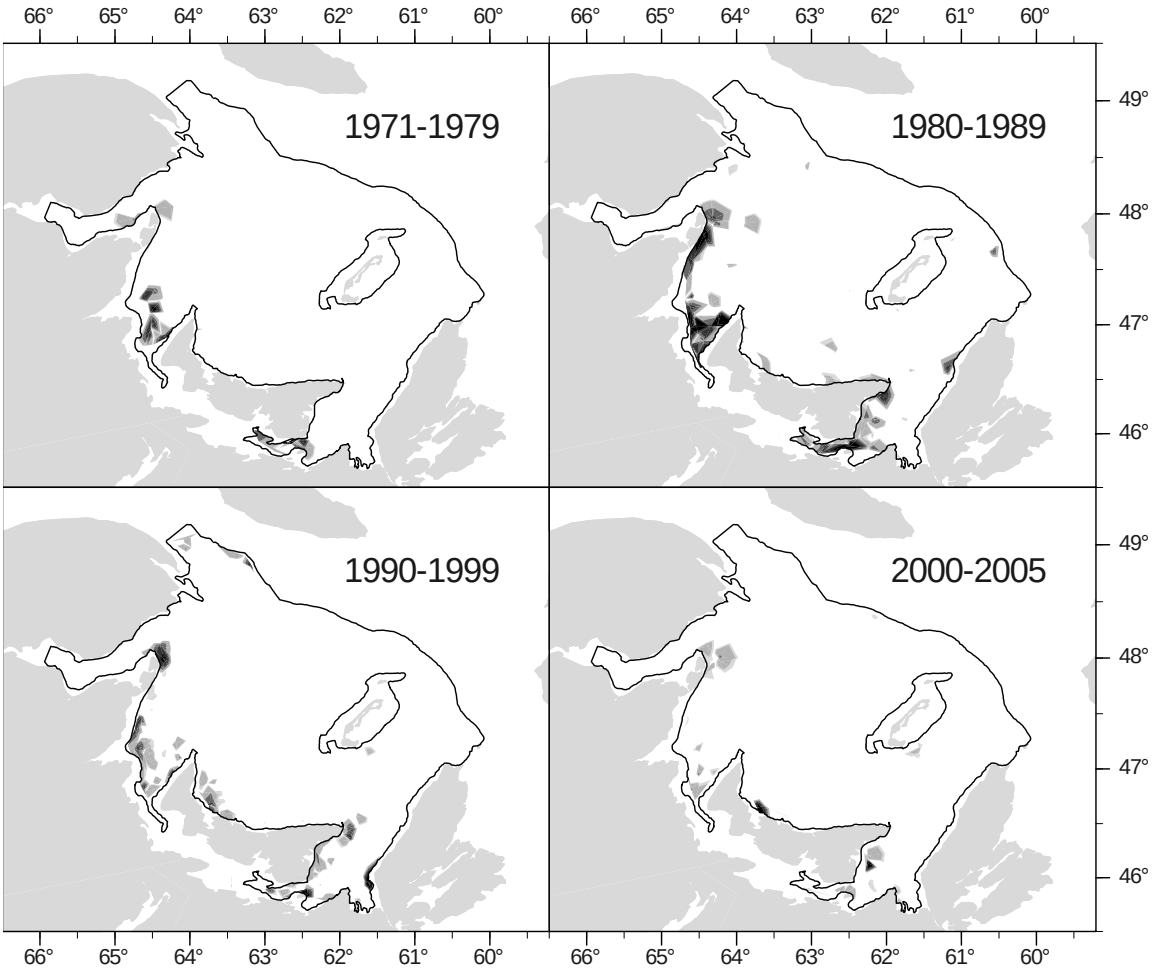

Figure 14. Abundance and distribution of juvenile winter skate (i.e., fish < 42 cm in length) in the September survey of the southern Gulf of St. Lawrence in four periods. Shading is based on the 10th, 25th, 50th, 75th, and 90th percentiles of catch rates (fish/tow) during the 1971-2005 period. Darker shading indicates higher density. Note that St Georges Bay was not sampled in 1971-1983.

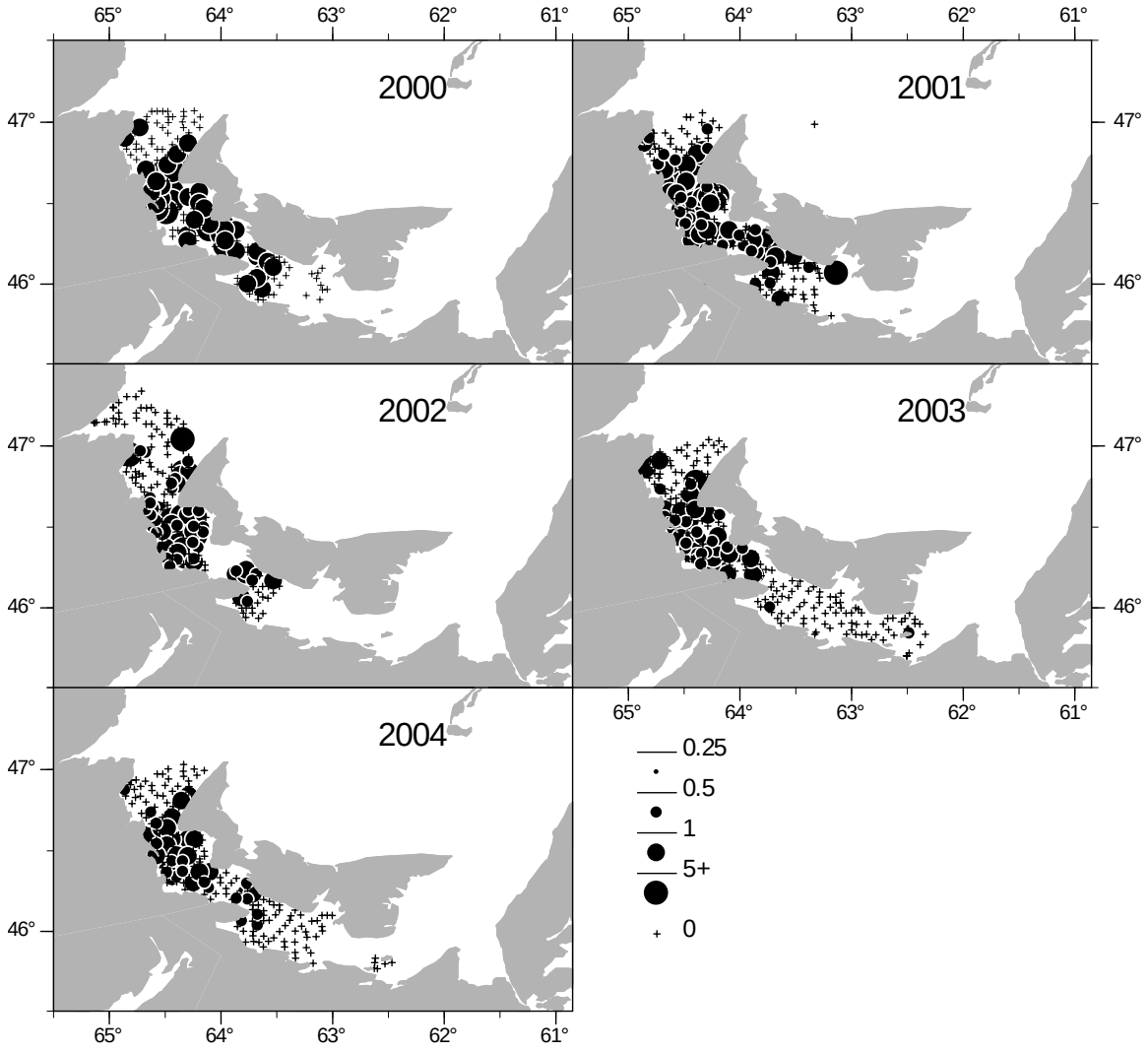

Figure 15. Catches of winter skate (fish/km towed) in the July-August survey of the Northumberland Strait.

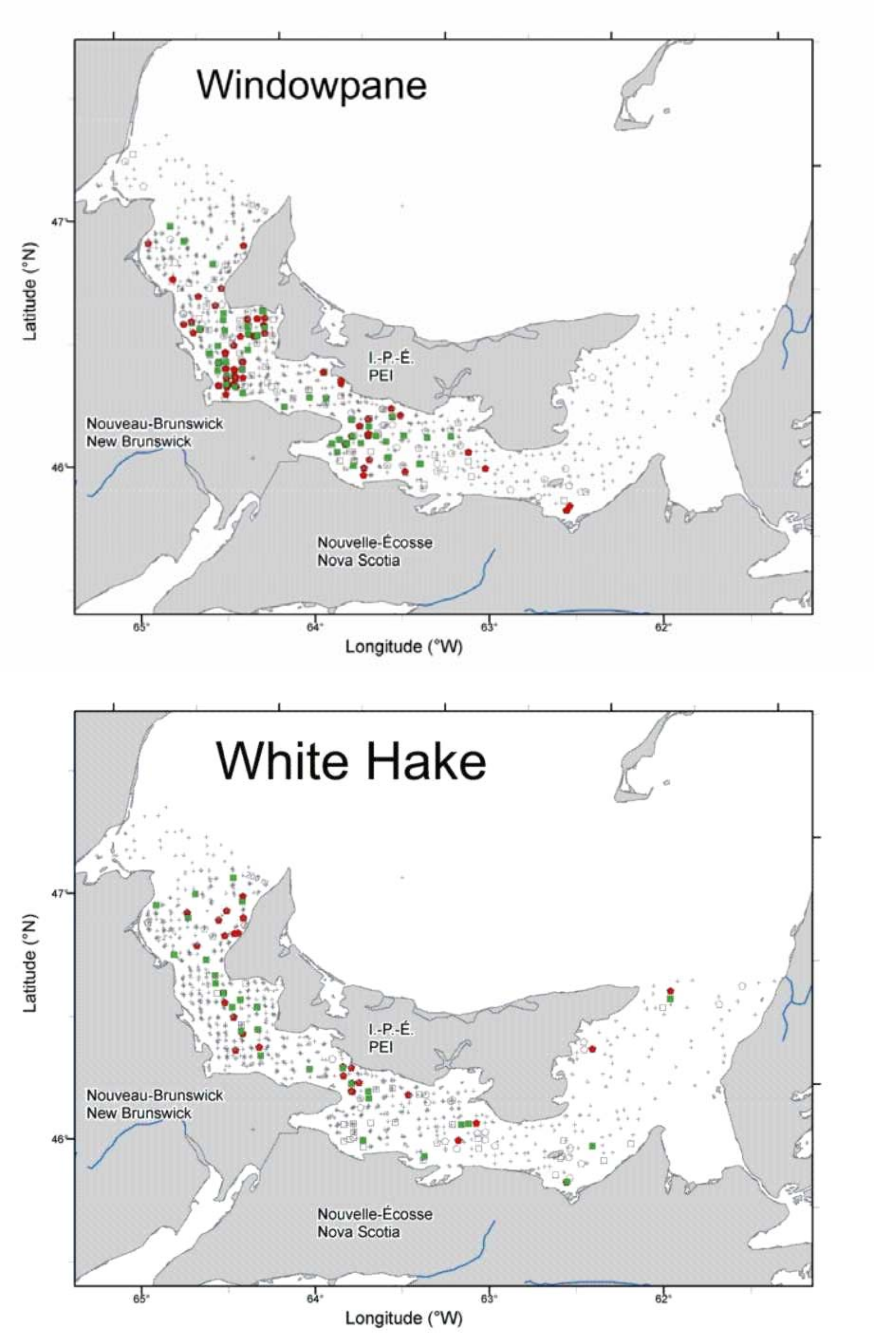

Figure 16. Catch rates of windowpane and white hake in the July-August surveys (2001-2005) of the Northumberland Strait. Symbol indicates percentile (open pentagon: <25%; open square: 25-50%; filled square: 50-75%; filled pentagon: >75%). Crosses indicate zero catch.

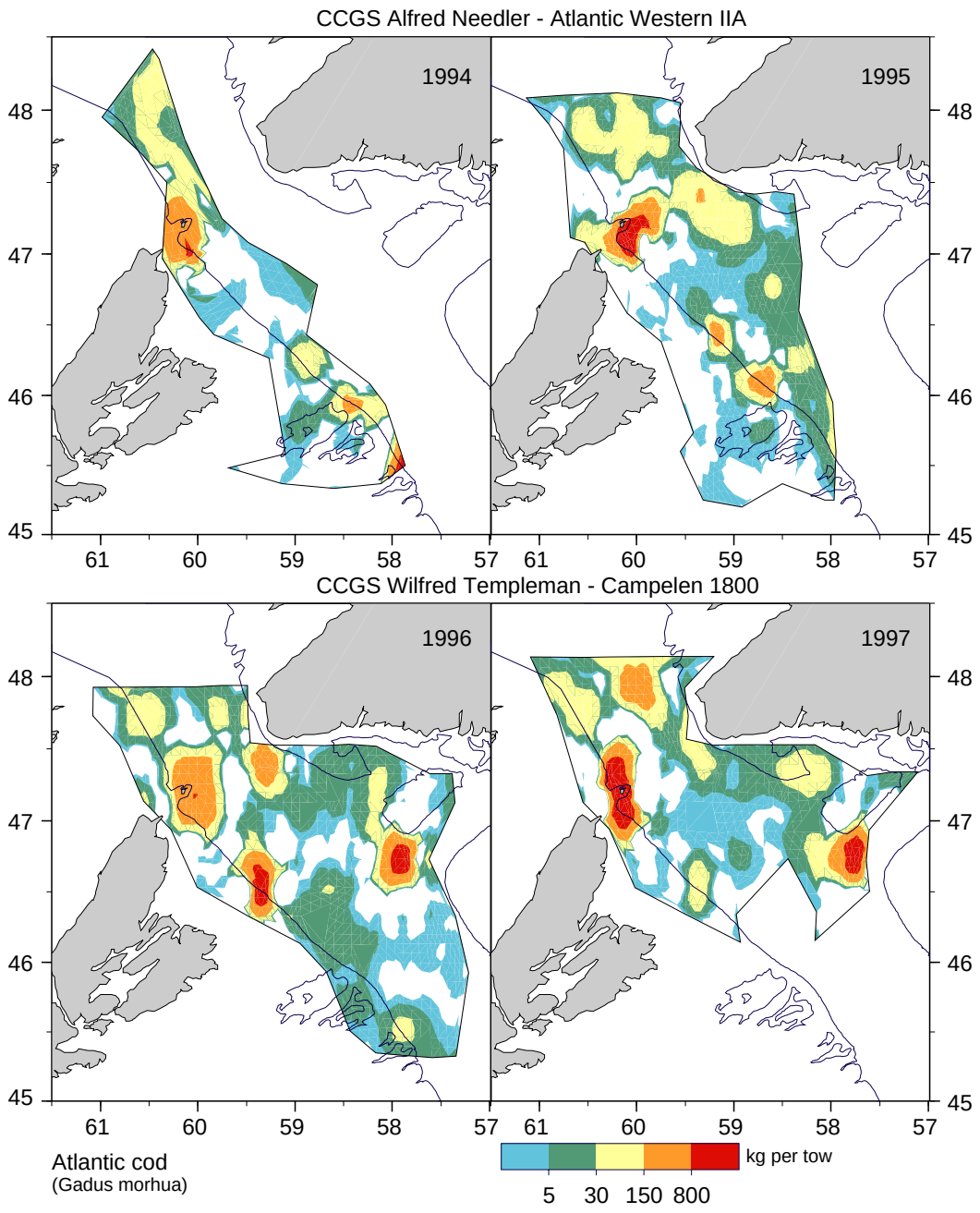

Figure 17. Catch rates of cod (kg/tow) in January surveys of the Cabot Strait area (from Chouinard & Hurlbut, in prep).

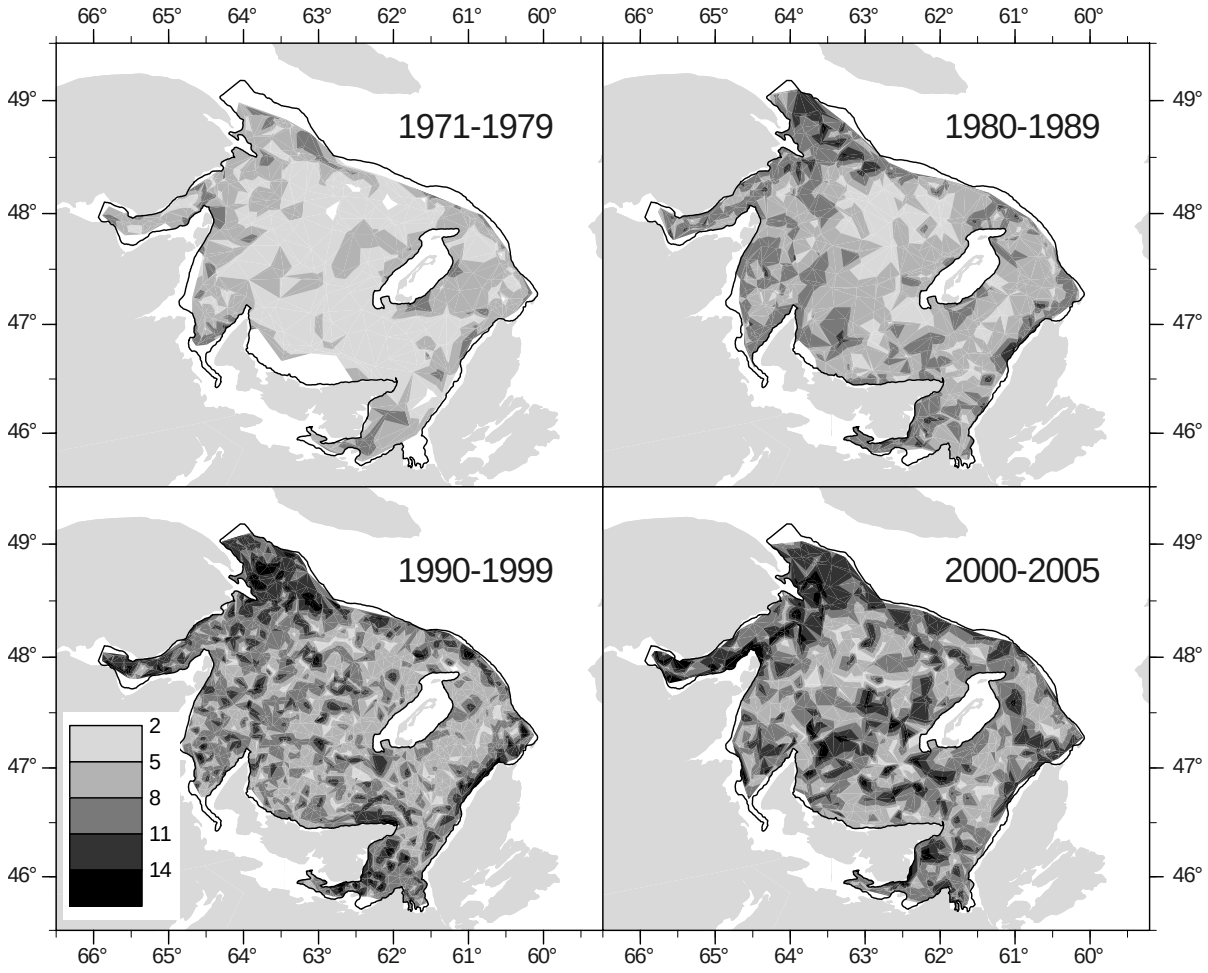

Figure 18. Species richness (number of species per tow) of demersal fishes in September in the southern Gulf of St. Lawrence.