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Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses

Délimitation des concentrations de corail et d'éponge dans les régions biogéographiques de la côte est du Canada au moyen de l'analyse spatiale

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ABSTRACT

Concentrations of sea pens, small and large gorgonian corals and sponges on the east coast of Canada have been identified through spatial analysis of research vessel survey by-catch data following an approach used by the Northwest Atlantic Fisheries Organization (NAFO) in the Regulatory Area (NRA) on Flemish Cap and southeast Grand Banks. Kernel density analysis was used to identify high concentrations. These analyses were performed for each of the five biogeographic zones of eastern Canada. The largest sea pen fields were found in the Laurentian Channel as it cuts through the Gulf of St. Lawrence, while large gorgonian coral forests were found in the Eastern Arctic and on the northern Labrador continental slope. Large ball-shaped *Geodia* spp. sponges were located along the continental slopes north of the Grand Banks, while on the Scotian Shelf a unique population of the large barrel-shaped sponge *Vazella pourtalesi* was identified. The latitude and longitude marking the positions of all tows which form these and other dense aggregations are provided along with the positions of all tows which captured black coral, a non-aggregating taxon which is long-lived and vulnerable to fishing pressures.

RÉSUMÉ

On a délimité les concentrations de plumes de mer, de petites et grandes gorgones, et d'éponges sur la côte est du Canada par le biais de l'analyse spatiale des données sur les prises accessoires recueillies lors des relevés effectués par navire de recherche. L'analyse a adopté une approche de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO) dans la zone de réglementation du Bonnet Flamand et le sud-est des Grands Bancs. On a eu recours à une analyse du noyau de densité afin de délimiter les hautes concentrations. De telles analyses ont été réalisées pour chacune des cinq zones biogéographiques de l'est du Canada. Les plus grandes colonies de plumes de mer ont été découvertes dans le chenal Laurentien qui coupe le golfe du Saint-Laurent, alors que les grands regroupements de gorgones ont été trouvés dans l'Arctique de l'Est et le nord de la pente continentale du Labrador. De grosses éponges en boule de plusieurs espèces de *Geodia* se trouvaient le long des pentes continentales au nord des Grands Bancs, tandis qu'on a identifié sur le Plateau néo-écossais une seule population de grosses éponges en forme de tonneau de l'espèce *Vazella pourtalesi*. On fournit la latitude et la longitude marquant les positions de tous les traits qui forment ces colonies et d'autres concentrations denses, ainsi que les positions de tous les traits de chalut qui ont permis de remonter à la surface du corail noir, un taxon que l'on ne retrouve pas en regroupement, qui est d’une grande longévité et vulnérable à la pression de la pêche.

INTRODUCTION

The United Nations General Assembly (UNGA) Resolution 61/105 calls upon “States to take action immediately, individually and through regional fisheries management organizations and arrangements, and consistent with the precautionary approach and ecosystem approaches, to sustainably manage fish stocks and protect vulnerable marine ecosystems, including seamounts, hydrothermal vents and cold water corals, from destructive fishing practices, recognizing the immense importance and value of deep sea ecosystems and the biodiversity they contain.”

To provide States and Regional Fisheries Management Organizations (RFMOs) with guidance for implementing Resolution 61/105, the Food and Agriculture Organization (FAO) sponsored an Expert Consultation in Bangkok, Thailand in September 2007, which resulted in a set of “International Guidelines for the Management of Deep-Sea Fisheries in the High Seas” (FAO 2009). Annex 1 of the FAO Guidelines provides examples of species groups, communities and habitat-forming species which may contribute to forming vulnerable marine ecosystems (VMEs). The guidelines also describe characteristics of VMEs to aid in their definition, including morphological and life-history traits amongst others.

In 2008, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) adopted the scientific criteria (Decision IX/20) for identifying ecologically or biologically significant marine areas (EBSAs) in need of protection (Annex I) and scientific guidance for designing representative networks of marine protected areas (Annex II). The criteria for identification of EBSAs are based on seven attributes:

1. Uniqueness or rarity
2. Special importance for life history of species
3. Importance for threatened, endangered or declining species and/or habitats
4. Vulnerability, fragility, sensitivity, slow recovery
5. Biological productivity
6. Biological diversity
7. Naturalness,

while the required properties and components for MPA networks are:

1. Ecologically and biologically significant areas
2. Representativity
3. Connectivity
4. Replicated ecological features
5. Adequate and Viable sites.

The Northwest Atlantic Fisheries Organization (NAFO) is the RFMO responsible for international fisheries in the high seas of the Northwest (NW) Atlantic, and it must respond to the UNGA Resolution and to the CBD COP Decisions. Accordingly, NAFO (2008a) identified candidate VMEs in its Regulatory Area (NRA) on the Flemish Cap and surrounds, using the FAO (2009) guidelines (then in draft form). Distributional maps of deepwater corals, sponges and fish species within the NAFO fishing footprint which met the criteria were produced, with candidate VMEs identified based on both the location of benthic attributes and where the overlap was the greatest amongst all three components.

The NAFO Fisheries Commission further requested that the Scientific Council (SC), through its working groups, identify significant concentrations of coral and sponge in the NRA. This request for information on specific ecosystem components is also consistent with the need to identify EBSAs in the high seas, and indeed there are many similarities between the FAO Guidelines for identifying VMEs (FAO 2009) and the COP Decision IX/20 Annex 1 attributes listed above. However, the intent of NAFO was to protect the benthic habitat features associated with the VMEs. NAFO has also closed areas on seamounts to protect assumed VMEs on those features.

Canada is legally required to address the same international agreements as NAFO. In this report, the NAFO methodology for determining significant concentrations of coral and sponge is applied to Canadian waters on the Atlantic coast, the Eastern Arctic and the Gulf of St. Lawrence. The methodology is applied separately to five biogeographic zones within those waters. This large area will contain differences in species composition and the physical environment, among regions and from that of the NRA. Consequently, while the methodology is the same as that used by NAFO, the thresholds identifying significant concentrations of coral and sponge differ for each biogeographic zone.

NAFO METHODOLOGY FOR DETERMINATION OF SIGNIFICANT CONCENTRATIONS OF CORAL AND SPONGE

NAFO developed a methodology for the determination of significant concentrations of coral and sponge taxa which meet the FAO guidelines for vulnerable marine ecosystem components (FAO 2009). This methodology was established over a series of meetings by NAFO scientific working groups commencing in March 2008 and ending in May 2009. The reports from those meetings and their relevant contents are provided in Table 1. All reports of the NAFO Working Group on the Ecosystem Approach to Fisheries Management (WGEAFM) were presented to the NAFO Scientific Council and the main elements were extracted for the SC reports. Those SC reports are not listed in Table 1 as they provide no new content.

It is noteworthy to recognize that as experience was gained, the methodology advanced; however, there was no opportunity to revisit the earlier analyses. This is only critical in the application of the methodology for determining significant concentrations of corals and sponge. The later benefited from GIS (Geographic Information System) analyses (Kenchington et al. 2009) which introduced a spatial dimension to the cumulative catch distribution.

The cumulative catch distribution, used to determine what constituted a significant coral catch (see below), has no spatial element. Spatial aggregation of large catches was first noted when the significant concentrations of sea pens and large gorgonians were plotted on a map. The locations of the significant coral catches were highly aggregated. The WGEAFM (NAFO 2008b) acknowledged this by grouping those areas into “key locations”.

Sponges also form highly aggregated distributions known as sponge grounds. Outside of these aggregations, the sponges are broadly distributed at low density. Kenchington et al. (2009) formalized a process whereby the area encompassing nearby (in the NAFO context within 25 km of each other) catches of similar weight is used to determine the weight threshold distinguishing catches from the sponge grounds and those of the broader distribution of individual sponges outside of the sponge grounds. This threshold is visualized by dividing the data into weight bins and comparing the area encompassing those catches (referred to as the polygon area) with that produced by successively lower weight classes (Figure 1). Typically the largest catches show little increase in area as they define the sponge grounds. The weight class below that which produces a marked increase in area (relative percent increase) is viewed as the weight threshold for identification of the sponge ground. The associated polygon for this area is an estimate of the area occupied by the sponge ground. The use of spatial analyses introduces a biological property (habitat area) to the decision making process, whereas the selection of quantiles used for the coral was essentially a management decision (Penney et al. 2008, Kenchington et al. 2009). Further, by constructing a model using ArcGIS tools, the determination of weight thresholds based on spatial analyses could be automated (Kenchington et al. 2009), thereby, reducing the subjectivity of the approach.

To date, spatial analysis has not been applied by NAFO to the corals (sea pens, small gorgonians or large gorgonians), but there is an intent to do so in the near future, prior to the re-evaluation of the closed areas by NAFO in 2011. At the February 2010 meeting of the NAFO WGEAFM, spatial analysis was applied to the sea pens (Murillo et al. 2010); however, these results will not be presented to the NAFO SC until June 2010. It is expected that the spatial analyses will lower the threshold used to identify significant concentrations of sea pens and small and large gorgonians. This is because NAFO chose the upper 97.5% (sea pens, small gorgonians) and 90% quantiles (large gorgonians) which only capture the extreme catches at the tail end of the distribution. However, lowering the coral thresholds may not identify substantially larger area as the large catches are expected to be within the coral beds.

This report utilizes the NAFO methodology as it was applied by NAFO to select the significant concentrations of corals and sponge in the reports detailed in Table 1. It is recognized that for the reasons stated, the thresholds determined for coral are likely to be too liberal. Therefore, where possible, the spatial analyses used by NAFO for sponges were also applied to the coral.

GENERAL METHODOLOGY

In brief, the general NAFO methodology was as follows:

1. Determination of the appropriate conservation unit (species or species groups) using FAO (2009) guidelines for identification of vulnerable marine ecosystem components and consideration of gross morphology and biomass,
2. Determination of the location of significant concentrations of each of the coral groups using the cumulative research vessel catch distribution and appropriate quantiles (based on expert opinion), and
3. Determination of the location of significant concentrations of sponge grounds using spatial analyses supported by examination of the cumulative catch curves.

NAFO used only research vessel survey data to draw their conclusions, as the observer data was considered to be unreliable for this purpose. Data were analysed from stratified random trawl surveys conducted by DFO Newfoundland and Labrador (NL) Region and by the European Union (EU) from 2000 to 2007, with most of the EU survey data coming from the 2006 and 2007 Spanish surveys where a benthic specialist was on board to collect data on invertebrate by-catch. There was no evidence that older survey data contained larger catches or that coral and sponge habitat had been fished out from areas with previously high catches.

For both corals and sponges, data for the entire NRA were combined (from both Canadian and Spanish/EU sources) to produce single threshold values for each conservation unit. Statistical analyses of the catches validated this combination of data. Once the locations of significant concentrations of coral and sponge were established, the NAFO Working Group of Fisheries Managers and Scientists (WGFMS) evaluated those locations against the fishing footprint as determined from Vessel Monitoring System (VMS) positions, and produced co-ordinates to protect the maximum number of significant concentrations of coral and sponge while having a minimal impact on fishing activities (NAFO 2009b). WGFMS considered the size of the aggregations, null data and black coral distribution in their determination of area boundaries.

These closure areas were subsequently adopted by the Fisheries Commission at their 2009 meeting in Bergen, Norway (NAFO 2009c), with 11 areas covering 2500 square nautical miles closed to bottom fishing activities to protect sponge grounds, sea pen fields and large gorgonian corals, as well as black coral habitat within the fishing footprint of the NRA. Details of each of the three steps follow.

Determination of the Conservation Unit

The various NAFO working groups concluded that for corals the following taxa formed the conservation units:

- Sea pen fields (Pennatulaceans),
- Small gorgonians (*Acanella arbuscula* was the only species in the NRA within this group),
- Large gorgonians (Sea fans: genera: *Primnoa*, *Paragorgia*, *Keratoisis*, *Paramuricea*; *Radicipes,* etc.),
- Cerianthid anemone fields,
- Antipatharians (black corals), and
- Reef-building corals (e.g., *Lophelia pertusa*).

Of these, reef-building corals such as *Lophelia pertusa* had not been reported for the NRA and cerianthid anemone data were not available for analyses. Consequently, the NAFO approach focused on sea pens, black corals and gorgonian corals only. However, *Lophelia pertusa* does occur within the Canadian Exclusive Economic Zone (EEZ), and the only known reef in Atlantic Canada is in the DFO Maritimes Region. The *Lophelia* reef is located on southeast Banquereau Bank and was heavily damaged by fishing prior to its discovery. In 2004, the entire reef area was protected (Cogswell et al. 2009) and the area is known as the *Lophelia* Conservation Area. Given this protection status and unique distribution no additional analyses of this taxon are reported here.

Given that the morphology and biomass differs greatly between the conservation units, but is relatively homogeneous within each unit, it was not necessary to develop different threshold values for each species. This point is very important as it allowed the use of data with coarser identifications, greatly increasing the size of the data set available for analyses. Further, cluster analyses of the coral species composition of the catches showed a weak but clear tendency for species of similar morphology to be caught together. This is consistent with the habitat requirements for the coral taxa. Sea pens and small gorgonians are known to be found on soft bottoms, while the large gorgonian species are more commonly attached to rock. Consequently, for both species groups to be caught in the same tow, the tow would have to traverse both soft and hard bottoms. Thus, the conservation units are also very practical units for commercial operators to work with as minimal sorting of the catch is required.

The joint ICES/NAFO Working Group on Deepwater Ecology (WGDEC) reviewed the sponge taxa occurring at depths of 200 to 2000 m in the NW Atlantic against the FAO criteria for VME component species (ICES 2009). They produced a list of 25 sponge taxa which dominate sponge grounds (numerically and/or in biomass) in the North Atlantic. Most sponges at these depths are not rare species; however, the dense aggregations of sponges, known as sponge grounds, are less common and are very vulnerable to destruction from bottom tending-fishing gear (ICES 2009). In the NRA and the wider North Atlantic, the large sponge catches observed in research vessel surveys are dominated by large structure-forming sponges which form these sponge grounds. Typically sponge grounds are composed of one or two of the larger species and many other smaller but abundant associated sponge species. These large sponges in the

NRA are predominately *Geodia* species, which are large ball-shaped sponges that can reach diameters of 50 cm and clog fishing nets (Figure 2). The WGDEC concluded that sponge grounds are the appropriate conservation unit for the NRA and that they can be identified through biomass alone, without need to identify individual sponge species.

Sponges within the NRA are predominately northern species living in water below 200 m. It is known that different sponge communities inhabit waters above 200 m and areas such as the southern Gulf of St. Lawrence, the Scotian Shelf and the Grand Banks will have different species compositions from those of the NRA where sponges are found mainly in deep water. These shallow water species will include a variety of morphological forms which may not aggregate in the same way as the deeper water sponge grounds. Further, *Geodia* species which dominated the catches in the NRA have not been reported for the southern Gulf of St. Lawrence and only isolated individuals have been observed on the Scotian Shelf. Species composition of sponges should be considered prior to applying the NAFO methodology for determination of significant concentrations. In this report, we include what information is known on species composition and consider it in interpreting our analyses.

Other Species Groups with Coral-like Morphology

While the conservation units identified by NAFO can be applied to the Canadian EEZ, other species may be present which meet the FAO Guidelines (FAO 2009) for vulnerable marine ecosystem components. Most notably, stylasterid hydrozoans (sometimes referred to as lace corals) have been identified by FAO (2009) as a taxon that can meet their criteria for VME components. Lace corals form delicate tree-like structures which branch in one plane, and are listed on Appendix II of the Convention on International Trade in Endangered Species (CITES). Stylasterids may be present in the Canadian Arctic but are not currently in the DFO database (see Cogswell et al. 2009). As they are very similar to gorgonian corals in their morphology, biomass and tendency to aggregate, the NAFO approach for determining significant concentrations of these species should be applicable.

Similarly, there are also ascophoran bryozoans which have a calcareous outer wall and would likely meet the FAO Guidelines for vulnerable marine ecosystem components. These have been identified from the Gulf of St. Lawrence and the Scotian Shelf but data are too sparse for analyses.

Determination of Significant Concentration of Corals

For sea pens, small gorgonians and large gorgonians, NAFO used the cumulative catch distributions (see Figure 3) to select thresholds for mapping significant concentrations. For each group, the majority of catches were small, with only a few very large catches. The WGEAFM acknowledged that it had no biological basis for selection of threshold values, but considered that the 97.5% quantile (upper 2.5% of catches) was an appropriate level for sea pens and small gorgonians, while the 90% quantile (upper 10% of catches) was chosen for large gorgonians. The lower quantile for the large gorgonians was justified on the basis that these organisms are easily broken and many of the smaller catches may be composed of broken larger colonies. Selection of a lower threshold was considered precautionary for that conservation unit (NAFO 2008b).

The threshold values corresponding to these quantiles were:

Pennatulaceans (sea pens)	1.6 kg per tow using a Campelen trawl
Small gorgonians	0.2 kg per tow using a Campelen trawl
Large gorgonians	2.0 kg per tow using a Campelen trawl (NAFO 2008b)

All catches above each threshold value for each group were mapped. For those locations where high concentrations of corals were identified, a two-step process was employed to provide a buffer zone around them. The first step was to consider an error margin in the identified location due to differences between gear and vessel positions, accuracy in the GPS positioning, etc. It was considered that a 2 nm radius around the putative position provided a safe margin on these grounds (NAFO 2008b). An additional 2 nm buffer zone was applied to allow for protection of the site. In total, this process rendered a 4 nm radius around the reported significant tow location (NAFO 2008b). Clusters of "significant" catch locations were identified as "key locations" and their co-ordinates presented.

Null (zero catch) data were also used to delineate the boundaries of the key locations. Where single high catches surrounded by null catches were observed, they were not considered key locations. This was the case for two sites on the tail of the Grand Banks where single isolated catches of small gorgonians (*Acanella arbuscula*) were observed (NAFO 2008b).

Antipatharians (black corals) in the NRA were not amenable to this approach because they do not aggregate to the same degree. Black corals are very rare within the NRA and occur as isolated individuals. Once removed in the catch, there *may be* no other black coral colonies in the area, although the habitat is proven suitable for colonization and *likely* contains other individual colonies. This was demonstrated during the 2009 CCGS Hudson mission (HUD2009-030) which used photographic gear to survey areas in the NRA (which were known through trawl catches to be black coral habitat). A single transect identified over 10 individuals, which was more than the 3 that had been observed using the trawl gear in that location (E. Kenchington, pers. obs.). NAFO considered the known distribution of black coral when selecting areas to close for protection and ensured that black coral habitat was included in the conservation areas (NAFO 2009b).

Determination of Significant Concentration of Sponges

Two methods were applied to identify significant threshold values for sponge grounds. These were the GIS-based method (Kenchington et al. 2009) mentioned above and the cumulative distribution approach used for the analysis of coral data (NAFO 2008b). The position of the sponge catch weights were plotted in ArcGIS 9.2 using the UTM projected coordinate system North American Datum 1983 Zone 23. A quadratic kernel function as described in Silverman (1986) was used to create a smooth raster surface using the Kernel Function in ArcGIS 9.2 (Kenchington et al. 2009). Polygon areas surrounding catches of equal or greater weight were then calculated (Kenchington et al. 2009 with modifications discussed below). The relative increase in area occupied by successive weight thresholds was used to delineate the sponge grounds, if present, from the general distribution of sponges at lower density.

The cumulative distribution was used as supporting evidence and two additional properties of the curve were considered other than the quantiles. These were the point of maximum curvature (Stirling and Zakynthinaki 2008) and the location of discontinuities in the data series (NAFO 2008b). The point of maximum curvature represents the area of greatest change in the curve, while discontinuities, especially in the mid-weight range, may distinguish sponge grounds from cumulative catches of isolated individuals. However, only the spatial method has a firm biological reference, that is, habitat area. There are no particular points of concern in applying these methods to the Canadian EEZ other than potential technical considerations such as adjustments of the search radius used by the model (see Kenchington et al. 2009) and consideration of the morphology of the species composition in each area. These are discussed as the issues arise.

TECHNICAL MODIFICATIONS OF THE GIS-BASED METHOD OF KENCHINGTON ET AL. (2009)

Model Builder, an ArcGIS 9.2 utility, was used to complete the majority of steps necessary to determine threshold values for sponge distributions in the NRA (Kenchington et al. 2009, NAFO 2009a). That model still required considerable manual input to generate the area occupied by polygons encompassing catches of successive weight thresholds. Here we present improvements to the model which more fully automate the process.

The original model from Kenchington et al. (2009) is shown in Figure 4. It required manual input to complete the final steps of the analysis which were time consuming. Here we present modifications to the model designed to automate the manual steps of selecting the contour polygons which most tightly encompass the subset of points within a given weight threshold. The weight thresholds chosen are largely reliant on the range of by-catch weights seen in the data. The cumulative catch curve can be used to indicate the transition zone between the small and large catches. Generally, equal bin size thresholds are selected over this transition zone with larger bins chosen within the putative sponge grounds where stability of area is expected and decreasing the threshold will have minimal effect on area. Once critical threshold values are assessed it may be necessary to produce finer scale bins to confirm the selection if too many weight classes were inadvertently binned.

The “Select Layer by Location” tool (Figure 5A) is used to select contour polygons that “Completely Contain” the data points for the weight interval dataset feeding the model (Figure 5B). In order for the “Select Layer by Location” tool to function properly, the density contour polygons from the first model must be converted to a layer (Figure 5C). This step creates an output with all “donut” polygons containing at least one data point from the chosen threshold, including the outermost polygon (Figures 5D and 6A). Using the “Polygon to Line” tool, the output “donut” polygons (Figure 6B) were then converted to contour polylines (Figures 5E and 6C). Using the “ET Polylines to Polygons” tool, the polylines are converted back to “full” polygons with the “donut” holes filled in (Figures 5F and 6D).

The resulting overlapping polygons from Figure 6D are then amalgamated using the “Dissolve” tool to produce the outcome, “Final Area Polygon” (Figures 5G and 6E). The remaining steps of the model (Figure 5H and I) are necessary to add an additional “square kilometres” area field to the feature class attribute table. The first step (H) adds the field and the second step (I) calculates the field by dividing the default “metres squared” shape area by 1,000,000. The final output is the feature class with calculated area in km^2 for the desired weight thresholds. The last step, not yet included in the model, involves using the “Merge” tool to aggregate the area information from each weight threshold into one feature class. The attribute table is then exported to an Excel file to produce graphical displays.

BIOGEOGRAPHIC ZONES

NAFO applied their methodology to the NRA which has a similar species composition of both coral and sponge across its extent. When considering the application of the NAFO approach for determining significant concentrations of coral and sponge across the vast area of the Northwest Atlantic, it was recognized that the assumption of similar species composition would not be valid. Rather than divide the area by political boundaries (e.g., DFO regions), biogeographic zones where used.

A number of biogeographic classification systems have emerged in the past decade with differing spatial scales (highly regional to global), approach (based almost entirely on previous work to based on quantitative analyses of extant data), and scope (consideration of one ecosystem dimension versus all possible data sources) (cf. DFO 2009). In Canada, three government departments and the Canadian Council of Resource Ministers each had different marine biogeographic classification systems developed over different periods of time for different purposes. A national workshop held in June 2009, including experts from all three government departments, reviewed existing biogeographic classification systems which encompass Canadian waters and reached consensus on the division of marine waters within the Canadian EEZ into 12 biogeographic zones or ecoregions (Figure 7, DFO 2009). These zones were linked to physical oceanographic and geological features underpinned by the control these have on species distributions, rendering them fully appropriate as regional areas within which to apply the NAFO approach for determining significant concentrations of coral and sponges. Five biogeographic zones are considered in this report: Eastern Arctic, Hudson Bay Complex, NL-Labrador Shelves, Gulf and Scotian Shelf (Figure 7), although data available for the Eastern Arctic and Hudson Bay Complex does not provide complete spatial coverage of those zones and data from NL-Labrador Shelves and the Scotian Shelf are restricted to less than 1500 m depth.

APPLICATION OF NAFO METHODOLOGY FOR DETERMINATION OF SIGNIFICANT CONCENTRATIONS OF CORAL AND SPONGE TO CANADIAN BIOGEOGRAPHIC ZONES

In the following sections, the NAFO approach for the determination of significant concentrations of coral and sponges is applied to each of the five biogeographic zones within the Canadian EEZ in the NW Atlantic and Eastern Arctic. The layout for each section is the same to facilitate comparisons among zones. Because of the nature of the analyses, each section has a large number of maps. These have been produced to illustrate data distribution, the density maps of the corals and sponges and the outcomes of the analyses, including contrasting results for different threshold levels. A map of the Northwest Atlantic with NAFO Divisions and subdivisions and the place names of offshore banks and other features mentioned in the text are presented in Figure 8.

All data come from research vessel surveys and were provided by DFO. The data have been deposited in the Atlantic Canada Coral Database (Cogswell et al. 2009) held at the Bedford Institute of Oceanography. However, in two special cases, data from observers on commercial vessels were used in addition to indicate presence of a taxon in an area not covered by the research vessel surveys. Those data were not included in the quantitative analyses. Every effort was made to use only reliable data. For example, null record, that is catches which did not report coral or sponge by-catch, were only used where there were a number of other tows from the same survey that did report coral or sponge by-catch, thereby reducing the number of null records produced from a failure to record the taxa. The research vessel data is very good for identifying high concentrations of coral and sponge within the fishing footprint as it is fisheries independent and can locate concentrations in areas where fishing does not occur due to the stratified random designs used throughout. However, they are restricted to depths of about 1500 m and so *they do not show the full distribution of coral and sponge* which can be much deeper. This will be particularly true along the continental margins. For example, Cogswell et al. (2009) has a much more comprehensive list of coral taxa from the Scotian Shelf Biogeographic Zone than is reported here. This is because that report includes records from video surveys down to 2500 m. Nevertheless, for the present management application the research vessel survey data is the best suited.

In applying the NAFO methodology to each Biogeographic Zone, it is important to emphasize that the evaluation of significance is determined within each zone and not across zones. As a result, the threshold values used to distinguish significant catches differ. Some of this will be because the species composition differs among zones and some will be because the area is a low density zone for dominant species. Across-zone comparisons and discussion follows the within-zone assessments (see Overview).

DENSITY INTERPOLATION MAPS

Amongst the maps produced in this report are interpolated density maps for coral and sponge. To produce these maps, a smoothly curved surface is fitted over each biomass point using a circular neighbourhood (radius 25 km). The surface value is highest where the point is located and is zero at the perimeter of the circle, diminishing uniformly from the centre. The density at each output grid cell is then calculated by summing the values of all the kernel surfaces where they overlay the grid cell center. The default value in ArcGIS 9.2 for the grid cell was used and is defined as 1/250th of the smallest axis of the data extent. Like the output from other interpolation tools available (e.g., Kriging, Inverse Distance Weighted (IDW), etc.), Kernel Density Analysis creates a raster output that reflects kg/unit area. Unlike the other interpolation tools, kernel density analysis does not assign any additional weight or influence in the averaging process to points closer to the center of the cell being estimated than to points on the periphery. The kernel density method *is designed to highlight areas of high concentration*. For this reason it is sometimes referred to as “hot spot” analysis. Null records are not used in the calculations. Consequently, while the density maps have critical links to biomass, they should not be used to derive biomass estimates. They are used to produce the polygon areas around high concentrations for calculating threshold values for which this method is best suited.

EASTERN ARCTIC

Corals

Data Sources and Distribution

The southern portion of the Eastern Arctic Biogeographic Zone is well sampled, but there are areas in the northern portion of NAFO Division 0A and in the deeper water below 1500 m throughout that are not surveyed (Figure 9).

Data from the Eastern Arctic Biogeographic Zone comes from several sources (Table 2). Eight surveys were conducted from 1999 through to 2009 (Treble et al. 2000, Treble 2002, Treble 2009), using a stern trawler (MV *Paamiut*) fitted with an Alfredo III bottom otter trawl equipped with rockhopper ground gear. These deep water multispecies surveys covered depths of 400 m to 1500 m and initially targeted Greenland halibut (*Reinhardtius hippoglossoides*) with sampling of shrimp species added in 2006. In 2006 and 2008, two surveys were conducted in southern Division 0A (Baffin Bay south of 73.5N) using two different trawl gears: a Cosmos shrimp trawl for the shallow water between 100 m and 800 m, and the Alfredo III trawl between 400 m and 1500 m (Treble 2009). In 2008, the vessel *Paamiut* carried both trawl gears and the surveys were done on the same cruise (PA2008-7, Table 2). In 2009, the Alfredo otter trawl was modified with a tagging box instead of the normal cod-end (Table 2) for use during a Greenland Halibut tagging exercise, in which 19 tows were made in NAFO Division 0B although only one of these tows was verified as having coral. Tow length with the Alfredo III trawl is 30 minutes at 3 knots, producing tows of approximately 2.78 km. Tow length with the Cosmos gear is about half that distance, as although the speed is similar, tow duration is 15 minutes.

Data were also available from other shrimp surveys, most notably from the Northern Shrimp Research Foundation (NSRF) and DFO joint industry/government shrimp surveys in NAFO Divisions 2G and 0B (see Figure 8). Those surveys were conducted on an industry vessel with DFO providing the scientific advice on sample design and analysis of the data collected. The first of an on-going annual survey was conducted in the summer of 2005 (BAL2005100, Table A1) and data were available for analysis through to 2008. The NSRF/DFO surveys provide additional information on the null data. On these surveys there are essentially two nets, the main trawl cod end and a Linney bag attached to the belly of the trawl. Linney bags collect what goes through the trawl mesh and are there to get a signal of small shrimp; however, they also provide information on coral by-catch that passes through the meshes. These data show that data recorded as null data using the data from the main trawl cod end has a 32.6% error, that is 32.6% (range 20.6 to 42.6%) of the Linney bags (N=482) contained coral when no coral were found in the main trawl cod end. Although these results are specific to this area and this gear type, it reinforces the importance of not interpreting null data to mean coral absence on the bottom. Null data are only indicative of a lack of coral, but coral may be present at least in small quantities. The NSRF/DFO surveys are conducted in the Resolution Island area from 63°W to 66°W and 60°30'N to 63°N, and in NAFO Division 0B (DFO 2007a, 2008). The former extends into the Hudson Bay Complex Biogeographic Zone and those records were selectively removed from this analysis. It should be noted that in 2008 the Shrimp Fishing Area 2EX study area (the majority of NAFO Division 0B) was sampled with a modified Campelen trawl. The foot gear was increased to 21" (from 14") and the fishing line floated, further extending the opening off bottom, which may have affected the catch of some species. In 2007, a few sets from the DFO-conducted shrimp survey using Cosmos trawl gear in Shrimp Fishing Area 3 (SFA 3) occurred in the Eastern Arctic Biogeographic Zone and these were considered here (see DFO 2008).

Collectively, these surveys provided 541 records of coral and 500 null records (no coral) from depths between 100 m and 1482.5 m. In addition, 8 records where large coral catches were made, but not weighed, are indicated on the distribution map. These were not included in any of the analyses. The coral taxa are distributed throughout the survey area (Figure 9) with the large gorgonians, small gorgonians, sea pens and black coral along the slopes and in deeper water, and the soft corals and scleractinians (labelled "other" in the map) on the shelves. Null records are found throughout the survey area.

There are a large number of records of coral from the Fisheries Observer Program (FOP) for this area (Table 2) and these data have a different spatial coverage from the research vessel surveys. Figures 10, 11 and 12 illustrate both the research vessel survey data and the FOP data for each of the sea pens, small gorgonians and large gorgonians, respectively. The data are shown as proportional circles for each data set, but because of differences in gear type and fishing duration, the size of the catches cannot be meaningfully compared between data sets. The commercial catches underlie the research vessel catches as these are generally larger and would otherwise mask the latter catches. Research vessel catches are not decomposed by gear type. For the sea pens, the FOP data show that there are large catches of sea pens along the slope east of Resolution Island, which are not detected in the research vessel survey data (compare Figures 9 and 10). Similarly, the FOP data show an important area for small gorgonians west of NAFO Division 1D (see Figure 8 for location), which is not represented in the research vessel survey catches (compare Figures 9 and 11). The large gorgonian coral catches represented in the FOP data are localized to an area east of Resolution Island, which is considered further by Wareham et al. (2010) and a large catch in Division 0A in the vicinity of the area where the research vessel surveys also recorded large gorgonian by-catch (compare Figures 9 and 12).

Species Composition

The species composition of coral from the Eastern Arctic Biogeographic Zone as captured in the research vessel surveys is similar to that of the NL-Labrador Shelves Biogeographic Zone (see Table 44 in the Overview section). Twenty-one taxa are recorded (Table 3) with soft corals (Alcyonacea, Nephtheidae) being the most frequently reported (N=257 sets), followed by sea pens (N=171 sets) and gorgonians (N=91 sets with weights plus 6 additional sets without weights) [set numbers for combined taxa and therefore differ slightly from Table 3 where individual taxa are listed – some occurred in the same sets]. All four conservation units assessed by NAFO are present, that is sea pens, small gorgonians, large gorgonians and black corals. Data from the Fisheries Observer Program (Table 2) introduced 5 new taxa: the small cup coral *Vaughnella margaritata*, the large cup coral *Desmophyllum dianthus*, the large gorgonian *Radicipes gracilis*, and the black corals *Stauropathes arctica* and *Bathypathes* sp.

Analyses

The data available for analyses are drawn from multiple research vessel surveys in different areas using different gear types (Table 2). For the most part, the multispecies surveys are spatially separated from the shrimp surveys and the different gears are generally operated at different depths. For the purposes of this report, it will be important to separate the different gear types for each conservation unit when performing the kernel density analyses so that the catchability of the different gears do not confound the results.

However, it would be an advantage to be able to combine data so as to have more data points within a given geographic area. The data could be standardized through comparison of the same fishing area with different gear types and one or other catch prorated. With our dataset, this could be performed in an area east of the Cumberland Peninsula on Baffin Island at water depths between 400 and 800 m where both Cosmos and Alfredo gear were used (Treble 2009).

In this area, the comparison is further limited by the number of records for each conservation unit. There are only 6 small gorgonian catches and 1 large gorgonian catch available for comparison, and so these taxa cannot be assessed. For the sea pens, there are 73 records of species from 64 tows, 37 with Alfredo gear and 27 with Cosmos gear. While the data set is not large, it does at least allow a first comparison of the sea pen catches with the two trawl gears. The sea pen catch weights were first log10-transformed to achieve normality (Shapiro-Wilk W Test 0.985, P=0.641; Figure 13) although the variances remained unequal (Levene's F ratio 6.166, P=0.016; Figure 10) with the samples from the Alfredo gear showing greater variance. Therefore, an unequal variance Welch's t-test (the t-value is the square root of the F) was applied. This test showed that there was no difference in mean sea pen catch between the two gear types (t =1.467, P=0.148). Further, a rank sum (non-parametric Wilcoxon test) of the untransformed data was non-significant (P=0.242). Median catch was 0.042 kg with Cosmos gear and 0.067 kg with Alfredo gear.

Therefore, it is possible that the Cosmos and Alfredo trawl sea pen catches could be treated as one data set for analysis since their average sea pen catches are not detectably different. However, the area of comparison was small relative to the survey area of both gear types and the power to detect a difference was also small (27% with transformed data, 53% with untransformed data). Therefore, the data were treated separately by gear type.

The distributional properties of the data are presented in Tables 4 and 5 by conservation unit. For the sea pens, the distributions for catches for each of the three gears used are reported (Table 4), while for small and large gorgonians most of the data were collected using Campelen trawls and so only that gear type is reported (Table 5). NAFO used the 97.5% quantile to define significant concentrations of sea pens and small gorgonians, and the 90% quantile to define significant concentrations of large gorgonians. Only 4 sea pen catches, 4 large gorgonian catches and 1 small gorgonian catch meet those criteria (Table 6). This is in part because of the shape of the cumulative catch curves (Figures 14 and 15). Where the curves are steeper there are fewer medium-sized catches and the 97.5% quantile value lies closer to the median and further from the maximum catch. This can be seen in the sea pen data by comparing the quantile distribution in Table 4 with the cumulative curves in Figure 14 by gear type. The catch curve produced with Alfredo III trawl catches is much steeper than that produced with the Campelen trawl catches (Figure 14) and the 97.5% quantile is further from the maximum catch, whereas in Campelen trawl catches the 97.5% quantile is equal to the maximum catch. The start positions of the catches which fall within the corresponding quantile thresholds are provided in Table 6 and illustrated in Figure 16.

Spatial Analysis of Coral

Sea Pens

The spatial analysis of the sea pen data used the interpolated density maps shown for each gear type (Cosmos, Alfredo and Campelen trawls) in Figures 17, 18 and 19. It can be seen that each gear type covers different geographic areas. The Cosmos gear which sampled the shallower water shows the greatest number of high density areas (Figure 17) while fewer high density areas were identified in the areas sampled with the Alfredo (Figure 18) and Campelen gears (Figure 19).

Polygon areas were extracted from the kernel density contours for each gear type. For the surveys using a Cosmos trawl, the areas occupied by 6 different weight threshold bins are illustrated in Figure 20. The greatest change in area occurs in going from 0.25 to 0.1 kg of catch, where the area increases by a factor of 3.32 from 1169 km^2 to 3877 km^2. However, this difference is established by only one data point and so it is not considered to be a robust estimate of the sea pen field area. The next largest change in area occurs between 0.1 and 0.05 kg, where the area increases by a factor of 1.59 from 3877 km^2 to 6173 km^2 and is established by over 10 data points. These polygon areas are shown in Figure 21. There is no change in area for 3 of the polygons using the lower threshold value, but 1 new polygon is established and there is a large increase in area of another polygon. Consequently, we consider that the 0.1 kg threshold identifies the sea pen fields from the broader distribution of sea pens as sampled by Cosmos gear in this area.

For surveys using Alfredo trawls, the areas occupied by 9 weight thresholds are indicated in Figure 22. The greatest change in area occurs in going from 0.25 to 0.1 kg of catch, where the area increases by a factor of 3.56 from 2325 km^2 to 8283 km^2. These polygon areas are shown in Figure 23 and are established by 9 data points and therefore are considered robust. The

0.25 kg catch weight is considered to be the threshold for locating significant concentrations of sea pens using Alfredo gear in the Eastern Arctic Biogeographic Zone.

For surveys using Campelen trawls, the areas occupied by 5 weight thresholds are indicated in Figure 24. The greatest change in area occurs in going from 0.05 to 0.01 kg of catch, where the area increases by a factor of 21.02 from 437 km^2 to 9189 km^2. These polygon areas are shown in Figure 25 and are established by 16 data points and therefore are considered robust. The 0.05 kg weight threshold is considered to be the threshold value for identifying sea pen fields with Campelen trawls in this area.

The positional information for all of the tows for each gear type at or above these thresholds is provided in Table 7. They occur over depths from 109 to 1374 m.

Small Gorgonians (Acanella arbuscula and Anthothela grandiflora)

The kernel density map for small gorgonians is illustrated in Figure 26. The highest concentrations are located east of Resolution Island and east of the Cumberland Peninsula on Baffin Island in Davis Strait. The polygon areas represented by 5 weight bins are illustrated in Figure 27. The greatest change in area occurred between 0.05 kg and 0.01 kg where polygon area increased 70 fold from 120 km^2 to 8433 km^2. The polygon areas represented by these 2 thresholds are shown in Figure 28 and are established by 15 data points and therefore are considered robust. The positional information for the 2 tows at or above the 0.05 kg threshold is provided in Table 7. Both are at depths of about 560 m.

Large Gorgonians

The kernel density map for large gorgonians is illustrated in Figure 29. The highest concentrations are located east of Resolution Island in Davis Strait. The polygon areas represented by 8 weight bins are illustrated in Figure 30. The greatest change in area occurred between 15 kg and 0.5 kg where polygon area increased 3.9 times from 1091 km^2 to 4260 km^2. The polygon areas represented by these 2 thresholds are shown in Figure 31. The positional information for the tows at or above the 15 kg threshold is provided in Table 7. The depth range of those records is from 562 to 930 m.

The location of all of the catches of sea pens, small gorgonians and large gorgonians at or above the threshold values calculated by the above spatial analyses are illustrated in Figure 32 and their positions presented in Table 7. These include those identified through the cumulative catch curves (Table 6), as well as those identified through spatial analyses. All black coral records are also provided.

Sponges

Data Sources and Distribution

The southern portion of the Biogeographic Zone is well sampled but there are areas in the northern portion of NAFO Division 0A and in the deeper water below 1500 m throughout that are not surveyed. The data for sponges comes from the same multispecies and shrimp surveys as detailed above for the coral with the exception of 2 records from the DFO-NL Region multispecies surveys which extended into this biogeographic region (Table 8). These 13 surveys provided 581 records of sponge and 477 null records (no sponge) from depths between 105 m and 1484 m. The sponges are distributed throughout the sampled area especially along the slopes and with absences in shallower areas on the shelves (Figure 33).

Species Composition

The vast majority of catches, and especially the large catches, collected the large ball sponge *Geodia* spp. (Figure 34). Staghorn sponge (large branched sponges) and several other types have been seen in the area. Sponges on the surveys have not been identified to species.

Analyses

The sponge by-catch data available for analyses are drawn from multiple surveys in different areas using different gear types (Table 8) as was the case for the coral by-catch data (see above). A similar comparison of gear types was performed in a common area east of the Cumberland Peninsula on Baffin Island at water depths between 400 and 800 m where both Cosmos and Alfredo gear were used (Treble 2009). In this area, there are 118 sponge catches made with Alfredo gear and 63 with Cosmos gear which can be compared. The sponge catch weights were first log10-transformed to achieve normality (Shapiro-Wilk *W* Test 0.989, *P*=0.168) and the variances were found to be equal (Levene's *F* ratio 0.199, *P*=0.656) despite the unequal sample sizes. The mean catches were found to differ significantly from each other (*t* =2.146, *P*=0.033), with the Alfredo gear taking greater catches of sponge. Further, a rank sum (non-parametric Wilcoxon test) of the untransformed data was also significant (*P*=0.019). Median catch was 0.514 kg with Cosmos gear and 1.9 kg with Alfredo gear (nearly 4 times greater). Therefore, there was no question of combining the sponge catch data from the different fishing gears. The quantiles of the catch distributions of the sponges are presented in Table 9 and the cumulative catch distributions are illustrated in Figure 35, both by gear type (Alfredo, Cosmos and Campelen trawl).

Kernel density maps of sponge biomass (kg) were produced separately for each gear type. Figure 36 illustrates the interpolated density of sponge caught with Alfredo III gear. High concentrations are found east of Resolution Island and east of Cumberland Peninsula. The polygon areas represented by 12 weight bins are illustrated in Figure 37. The greatest change in area occurred between 70 kg and 50 kg where polygon area increased 2.9 times from 1586 km^2 to 4528 km^2. The polygon areas represented by these two thresholds are shown in Figure 38. The positional information for the tows at or above the 70 kg threshold is provided in Table 10. The depth range of those records is from 500 to 1404 m.

The kernel density map of sponges caught with a Campelen trawl is indicated in Figure 39, and shows a high concentration east of Hall Peninsula on Baffin Island, with smaller concentrations east of Resolution Island. The polygon areas extracted from this data are presented in Figure 40. Here, the largest increase in area (1.9 fold) occurs between 40 and 35 kg, with the area increasing from 14,511 to 27,601 km^2. This difference in area between these threshold values is illustrated in Figure 41. The positional information for the tows at or above the 40 kg threshold is provided in Table 10.

Lastly, the kernel density map of sponges caught with a Cosmos trawl is indicated in Figure 42. There is only one high density area and that occurs in the southern portion of NAFO Division 0A. The polygon areas extracted from this data are presented in Figure 43. Here, the largest increase in area (2.87 fold) occurs between 40 and 10 kg, with the area increasing from 1844 to 5301 km^2. This difference in area is illustrated in Figure 44. The positional information for the tows at or above the 40 kg threshold is provided in Table 10.

The locations of all of the catches of sponges at or above the threshold values calculated by the above spatial analyses are illustrated in Figure 45 and their positions presented in Table 10.

HUDSON BAY COMPLEX

Corals

Data Sources and Distribution

Research vessel data of coral by-catch from the Hudson Bay Complex Biogeographic Zone is restricted to Hudson Strait and Ungava Bay in the eastern portion of the Zone. In 2007 and 2009, DFO conducted shrimp surveys using a Cosmos shrimp trawl in this area, which is known as Shrimp Fishing Area 3 (SFA 3) (see DFO 2008). The surveys were stratified-random as for the Eastern Arctic. Tow duration was 15 minutes at 3 knots. Two species of shrimp, northern shrimp (*Pandalus borealis*) and striped shrimp (*P. montagui*), occur in SFA 3, although striped shrimp is the dominant species (DFO 2008). These shrimp surveys have a small number of records that extend east of the Hudson Bay Complex Biogeographic Zone and those were not included in the assessment of this area (but see Eastern Arctic Biogeographic Zone above). Three other records for this biogeographic zone were collected with Campelen trawl gear in 2006 during the surveys of the Resolution Island Study Area (RISA). These were collected from joint industry/government shrimp surveys (see details in the Eastern Arctic Biogeographic Zone data source described above). They were included as coral presence in the distribution map but not in the proportional representation of the catch (Figure 46). The coral are distributed throughout the surveyed area over the entire depth range sampled (99 to 966 m; Table 11, Figure 46). However, the largest catches are in Ungava Bay with one large catch at the opening of Hudson Strait south of Nottingham Island (Figure 46).

Species Composition

With one exception, the coral collected during the research vessel surveys are all soft corals of the family Nephteidae (Table 12). The one exception was the catch of the sea pen, *Anthoptilum grandiflorum* (Figure 46). Soft corals, as the name implies, have no rigid outer skeleton, and they are able to retract their polyps when disturbed. These corals are found over most of the NAFO area and are particularly abundant on the banks there (Fuller et al. 2008) and elsewhere in eastern Canada (Wareham et al. 2004; see also individual sections of this report). They are frequently caught in trawl gear and *Gersemia* sp. comprises much of the invertebrate by-catch during bottom trawling in the North Pacific (Krieger 2001).

Gersemia rubiformis is gonochoric and broods its larvae (Henry et al. 2003). The extent to which this species naturally undergoes asexual reproduction is not known. Some nephtheids are adapted to disturbance and have evolved a fugitive life history by increasing the ability of asexual propagules to migrate into open spaces and act as pioneers of recently disturbed habitats (Karlson et al. 1996). Henry et al. (2003) experimentally demonstrated that *G. rubiformis* can survive repeated disturbances caused by rolling and crushing, although a weakening of the stalk was eventually produced and colonies may have prematurely aborted planulae producing daughter colonies that had high mortality in the lab.

Direct removals of soft corals as by-catch can quickly depopulate an area (Prena et al. 1999, Moran and Stephenson 2000, Kenchington et al. 2001) and, in some locations, abundance and/or biomass of soft corals have been shown to be higher in unfished areas compared with nearby fished areas (Kaiser et al. 2000, McConnaughey et al. 2000), although Gilkinson et al. (2004) found no detectable effects of hydraulic clam dredging on this species on Banquereau Bank. Syms and Jones (2001) demonstrated that experimental removal of high densities of soft corals caused no significant changes in the associated fish communities (diversity) and that the heterogeneity of habitat generated by soft corals was indistinguishable from equivalent habitat formed by rock alone. However, Edinger et al. (2009) in a preliminary examination of relationships between corals and groundfish in NAFO Divisions 2GH and 0B found a statistically significant association of juvenile Northern shrimp and snow crab with soft corals, although they were careful not to infer that this pattern was a reflection of biological interaction.

Considering all of this information NAFO concluded that soft corals were not foundation species for VMEs (NAFO 2008a). Consequently, they were not analyzed further here.

Sponges

Data Sources and Distribution

Research vessel data of sponge by-catch from the Hudson Bay Complex Biogeographic Zone is also restricted to the Hudson Strait and Ungava Bay area in the eastern portion of the Zone. In 2007 and 2009, DFO conducted shrimp surveys using a Cosmos shrimp trawl in this area, which is known as Shrimp Fishing Area 3 (SFA 3) (see DFO 2008). Six other records for this biogeographic zone were collected with Campelen trawl gear in 2006, 2007 and 2008, as part of the Resolution Island Study Area surveys conducted jointly by industry and DFO (see details in the data descriptions for the Eastern Arctic Biogeographic Zone above). Those were considered for presence of sponge but were not used for spatial analyses due to the different gear type and small number of records. The sponges are distributed throughout the surveyed area and occurred over the entire depth range of the SFA 3 survey from 108 to 968 m (Table 13, Figure 47). Within this distribution there are relatively larger catches, particularly in Ungava Bay.

Species Composition

Although the sponges from the SFA 3 surveys have not been identified to species level, field observations suggest that the species composition is similar to that of the adjacent areas of the Eastern Arctic Biogeographic Zone, that is large round *Geodia*-like sponges with some large branched sponges and other forms present (T. Siferd, pers. comm.).

Analyses

Analyses used only the 2007 and 2009 data from the shrimp surveys using Cosmos shrimp trawls (see above) to avoid confounding the effects of gear type on the kernel density analysis. The sponges in the Hudson Strait and Ungava Bay area (Figure 47) occur at low biomass, with the maximum catch recorded as 4.6 kg. In contrast, the maximum catch with Cosmos gear in the Eastern Arctic Biogeographic Zone was 603.8 kg (see Table 45 in the Overview Section). Given the species composition described above, it is likely that this distribution represents low density occurrence of isolated individuals or very small aggregations of the large-structure forming species, as opposed to low density of smaller sponge species with large abundance but low biomass. The higher biomass catches are for the most part solitary (Figure 48), with the exception of a small area west of Resolution Island and south of the southern point of the Meta Incognita Peninsula on Baffin Island (Figure 48). This interpretation is supported by the shape of the cumulative catch distribution curve (Figure 49) and quantile breakdown of the catches (Table 14) which indicates that although there are large numbers of very small catches there are also reasonable numbers of medium-sized catches reflective of small aggregations (all relative to a low maximum catch).

This underlying distribution negates that application of the spatial analysis approach for determination of sponge grounds, since no sponge grounds appear to be present. However, we proceeded to apply the methodology so that we could examine how the method performed in such a situation. The area occupied by selected catch thresholds is indicated in Figure 50. The greatest percent increase in area occurs between the polygon area occupied by catches of 2 kg and above (346 km^2) and of 1 kg and above (4738 km^2). The next largest percent increase occurs between 0.4 kg and 0.3 kg (Figure 50). In other situations, these thresholds have been used with confidence to delineate sponge grounds; however, examination of the construction of the polygon areas through various threshold levels showed that these two key thresholds and other lesser ones were largely influenced by single data points on the periphery of the search radius causing the large increase in area. We conclude that these thresholds are not robust estimates of sponge ground area. Spatial analysis provided no additional information beyond the individual data points from the surveys.

The positions of the catches above the 97.5% quantile of the sponge catch distribution (3.028 kg) are indicated in Table 15. However, at this point no ecological significance can be applied to these locations.

NL-LABRADOR SHELVES

<u>Corals</u>

Data Sources and Distribution

Data on coral by-catch from demersal fish surveys undertaken by DFO-NL Region have all used a Campelen-1800 shrimp trawl and followed a stratified random survey design with 15 min tows (Kulka et al. 2006) with a few records from the Quebec Region surveys also using this gear, extending into this Biogeographic Zone (Table 16). Data from the “Canadian EEZ Survey” carried out in 2007, 2008 and 2009 by the Instituto Español de Oceanografía, Vigo, Spain, were kindly provided by F.J. Murillo for the Canadian portion of the surveys. Those surveys also used Campelen trawls but were of 30 min tow duration. NAFO (2008a) determined that this difference in tow duration did not result in a significant difference in coral by-catch weight. A few records in the southern portion of this biogeographic zone were collected with a Western IIA trawl by DFO-Maritimes Region. These stations along the Laurentian Channel were surveyed using the CCGS *Teleost* in 2004 and 2005, CCGS *Wilfred Templeman* in 2005 and the CCGS *Alfred Needler* in 2006 (Table 16). Because there are so few records using the Western IIA trawl, the data were not separately analyzed by gear type. A number of records were also available from the NSRF and DFO joint industry/government shrimp surveys in NAFO Divisions 2G and 0B, which extended into the NL-Labrador Shelves Biogeographic Zone. Those surveys were conducted on an industry vessel with DFO providing the scientific advice on sample design and analysis of the data collected. The first of an on-going annual survey was conducted in the summer of 2005 using Campelen trawls (BAL2005100, Table A1) and data were available for analysis through to 2008.

There are 2010 records containing coral from 81 research vessel survey missions from 2002 through to 2009, although most of the data is from 2003 to 2007 (Table 16). There are also 2541 records from these same missions which did not report coral in the cod end of the trawl (null catches). Coral (all taxa) are patchily distributed with large areas on the Grand Banks and the northeast Newfoundland Shelf having no coral recorded in the research vessel catches (Figure 51).

Species Composition

The database contains 38 coral taxa for the NL-Labrador Shelves Biogeographic Zone (Table 17). Sixty-one percent of the records are of soft corals belonging to the family Nephtheidae. These are not considered to be vulnerable to fishing gear to the same degree as other corals and so were not considered further by NAFO (see comments in the Hudson Bay Biogeographic Zone Coral Section above). Sea pens comprised the next largest taxon with 11 taxa contributing to 18% of the records. Small gorgonians (species of *Acanella* and *Anthothela*) accounted for 7.4% of records, large gorgonians comprised 9% of records, black corals (Antipatharians) comprised only 0.01% of records, and small cup corals (solitary scleractinians) comprised 0.04%.

Analyses

The coral records were divided into each of the NAFO coral conservation units, that is sea pens, small gorgonians, large gorgonians and black corals and the weights of individual species within each of these groups (Table 17) summed for each trawl set. For each conservation unit except for the black coral, the cumulative catch distribution was plotted (Figure 52) and the data quantiles extracted (Table 18). The cumulative distributions of the sea pens and large gorgonians have very few medium-sized catches and a small number of very large catches. The distribution of the small gorgonians is less binary with more intermediate catches reported. NAFO chose the 97.5% quantiles to indicate significant catch thresholds of sea pens and small gorgonians and the 90% quantile for large gorgonians (Table 18). Those values are 2.402 kg, 0.2796 kg and 1.54 kg, respectively. The location of the significant catches are illustrated in Figures 53-55 for sea pens, small gorgonians and large gorgonians, while all records of black corals are illustrated in Figure 56. All taxa are markedly associated with the continental slopes. Positions of significant catches as determined from the cumulative catch curves are provided in Table 19.

<u>Spatial Analysis of Coral</u>

Sea Pens

The spatial analysis of the sea pen data used the interpolated density plots shown in Figure 57. Application of the spatial model produced the polygon areas illustrated in Figure 58. The largest percent change in area occurs between the 0.4 and 0.3 kg thresholds where there is an increase of 275%.

Figure 59 illustrates the location and difference in size between the polygon areas produced from these two threshold values. The area occupied by catches greater than 0.4 kg is 5,663 km^2 while the area occupied by catches greater than 0.3 kg is 15,587 km^2. The majority of this area increase occurs as a spatial extension of the sea pen habitat in the Laurentian Channel, as opposed to the establishment of new areas. The 0.4 kg threshold was used to indicate significant catches of sea pens. This is considerably lower than the 2.402 kg of the 97.5% threshold used by NAFO. The locations of significant catches of sea pens using this spatial approach are illustrated in Figure 60 and their positions are provided in Table 20.

Small Gorgonians (Acanella spp., Anthothela spp.)

The spatial analysis of the small gorgonian data used the interpolated density plots shown in Figure 61. Application of the spatial model produced the polygon areas illustrated in Figure 62. The largest percent change in area occurs between the 0.3 and 0.2 kg thresholds where there is an increase of 571%. Figure 63 illustrates the location and difference in size between the polygons produced from these two threshold values. The area occupied by catches greater than 0.3 kg is 377 km^2 while the area occupied by catches greater than 0.2 kg is 2153 km^2. The locations of significant catches over the 0.3 kg weight threshold are shown in Figure 64 and the associated positions are provided in Table 21.

Large Gorgonians

The spatial analysis of the large gorgonian data used the interpolated density plots shown in Figure 65. Application of the spatial model produced the polygon areas illustrated in Figure 66. The large gorgonian taxa are not broadly distributed and so the 25 km search radius rarely picks up additional data points except for in the northern-most part of the zone. Consequently, the polygon areas are very tight around the data points. The largest percent change in area occurs between the 0.3 and 0.2 kg thresholds where there is an increase of 300%. The area occupied by catches greater than 0.3 kg is 13,658 km^2 while the area occupied by catches greater than 0.2 kg is 40,963 km^2. There are 10 data points contributing to this aerial expansion. The second largest percent change in area occurs between the 0.4 and 0.3 kg thresholds where there is an increase of 289%. Figure 67 illustrates the location and difference in size between the polygon areas produced from these two threshold values. The area occupied by catches greater than 0.4 kg is 4,731 km^2 while the area occupied by catches greater than 0.3 kg is 13,658 km^2. This increase is due to 8 data points. NAFO used a more precautionary level for the large gorgonian coral on the basis of their vulnerability to fishing gear and the fact that small pieces typically break off leaving damaged colonies on the bottom. Therefore, we have selected the 0.3 kg threshold as the indication of significant concentrations. This is lower than the 1.54 kg identified using the 90% quantile level (Table 18). Locations of significant catches (≥0.3 kg) are illustrated in Figure 68 and their positions provided in Table 22.

Sponges

Data Sources and Distribution

The data available for analysis of sponge in the NL-Labrador Shelves Biogeographic Zone covers 15 years (1995-2009) and has very good spatial coverage for most of the area at depths from 40 to 1494 m (Table 23, Figure 69). Areas below 1500 m and in coastal waters along the Labrador coast are not sampled. There were 1721 records of sponges in the catch and 3142 records without sponges from the same surveys. As for the coral, most of this large data set (Table 23) was collected from DFO–NL Region surveys using the Campelen trawl on various CCGS vessels following a stratified random design (Kulka et al. 2006) with a few records from the Quebec Region surveys also using this gear, extending into this Biogeographic Zone (Table 23). A number of records were also available from the NSRF and DFO joint industry/government shrimp surveys in NAFO Divisions 2G and 0B which extended into the NL-Labrador Shelves Biogeographic Zone. Those surveys were conducted on an industry vessel with DFO providing the scientific advice on sample design and analysis of the data collected. The first of an on-going annual survey was conducted in the summer of 2005 using Campelen trawls (BAL2005100, Table 23) and data were available for analysis through to 2008. However, there are 22 records collected with Western IIA trawl gear (Table 23) from the Nova Scotia side of the Laurentian Channel. Most of those catches were less than 3 kg, with one catch of 6.6 kg and one of 19 kg. Because of the great imbalance in sample size between the gear types (98.7% of records were made with Campelen trawl gear), the small catches made with the Western IIA, and the non-overlapping area preventing comparative analyses, the data were not separated by gear type.

Species Composition

The species composition of sponge from the research vessel surveys in the NL-Labrador Biogeographic Zone has not been described; however, the size of the catches strongly implies that the sponge grounds along the slope waters are composed of *Geodia* species as are found in the NRA (Figure 2). Species determinations are ongoing at present and full details of the sponge taxa present should be available in 2010. A preliminary list of taxa is provided in Table 24.

Analyses

The data for sponges showed little evidence of local depletion through the time series. The same high density sponge grounds appeared both in the 1990–2002 and 2003–2009 time periods in the same general areas (Figure 70). Therefore, the entire data set was used for analyses. The interpolated density map (Figure 71) shows that sponges are found throughout the area but increase northwards, with the largest concentrations along the Labrador Slope between Funk Island Bank and Hamilton Bank, and Saglek Bank, with no large aggregations on the Grand Banks or shelves. Large areas of the Grand Banks have no sponges.

Spatial analyses on this distribution illustrate an interesting application of the methodology as the sponge grounds form a linear feature along the Labrador Slope. Nearest neighbours are identified either along the depth contour or on the shelves but the two areas do not bridge until the 8 kg threshold level and even then the two areas never completely coalesce until the 3 kg threshold level.

The polygon areas produced from successive threshold weight levels are graphically displayed in Figures 72 and mapped in Figure 73. Those results indicate that the threshold for determining significant concentrations of sponges is *between 200 and 170 kg* per tow. Catches of 200 kg and greater occupy an area of 6067 km^2, while catches 170 kg and greater occupy an area of 9371 km^2. This represents a 150% increase in area in moving from 200 kg to 170 kg. The only larger percent increase other than the initial step is between 300 and 200 kg. Looking more closely at the differences between those two levels in the polygon area (Figure 74) it can be seen that by moving to 200 kg an entire new sponge ground is created along the slope to the south of Hawks Saddle (see Figure 8 for place names). Therefore, using the 200 kg threshold as the indicator of significant sponge grounds is more precautionary and this threshold was applied here.

The cumulative distribution of sponge catches (Figure 75) was assessed for data gaps. Between 100 and 200 kg catch weights, there is a data gap between 180 and 200 kg where no catches are recorded. There are only 5 records between 170 and 180 kg, 9 from 140 to 170 kg and 9 from 110 to 140 kg. Between 100 and 110 kg there are 20 records. The point of maximum curvature appears to be about 80 kg. The 97.5 % quantile is 207.3 kg and greater and the 90% quantile is 40 kg and greater (Table 25).

Together, these results support a threshold value of 200 kg of sponge per tow as indicative of sponge grounds. There are 51 records which meet this criterion. The co-ordinates for those positions are listed in Table 26 and are plotted Figure 76. These locations lie between 600 and 1200 m on the continental slope.

GULF

Corals

Data Sources and Distribution

The data available for analysis of coral in the Gulf Biogeographic Zone covers 19 years and is dominated by records from the southern Gulf of St. Lawrence (Table 27, Figure 77). There are 1538 records with corals and 2066 null records from the same surveys that did not report corals.

The trawl gear used was predominately the Western IIA in the southern Gulf and the Campelen trawl in the northern Gulf after 2004 (Figure 77). The DFO trawl surveys for demersal fish in the northern Gulf of St. Lawrence began in 1990 on the CCGS *Alfred Needler*. Since 2004, this survey has been carried out on the CCGS *Teleost*. The change in vessel also involved a change in gear from a URI (University of Rhode Island) shrimp trawl to a Campelen trawl and a change in tow duration from 24 to 15 minutes (Bourdages et al. 2007). In general, the surveyed area includes the NAFO Divisions 4RS, Subdivision 3Pn, as well as strata deeper than 183 m (100 fathoms) in Division 4T, including the Lower St. Lawrence Estuary (see Kulka et al. 2006). Data on coral from these surveys was sparse prior to 2006, when a greater emphasis was placed on reporting invertebrate by-catch to facilitate ecosystem studies. Consequently, data from the earlier surveys (prior to 2006) were used to indicate presence of coral only (Figure 77, Table 27). Data on coral by-catch collected with the CCGS *Teleost* using a Campelen trawl after 2006 was quantitatively assessed here. Annual demersal trawl surveys have been conducted in the southern Gulf of St. Lawrence in September since 1971. Surveys used a stratified random design, with stratification based on depth and geographic region (Kulka et al. 2006). Data on coral by-catch using a Western-IIA trawl are included from surveys with the CCGS *Lady Hammond* in 1990-1991, the CCGS *Alfred Needler* from 1992-2002, the CCGS *Wilfred Templeman* in 2003, both the *Alfred Needler* and the CCGS *Teleost* in 2004 and 2005, and the CCGS *Teleost* from 2006 to 2008 (data from 2009 were not yet available). The target fishing procedure in all years was a 30 min tow at 3.5 knots (Kulka et al. 2006). A small number of coral records are included in the Gulf Biogeographic Zone from the Sydney Bight area surveyed by DFO-Maritimes Region. Those data were all collected following a stratified random design using the Western-IIA trawl from the CCGS *Alfred Needler* in 2003, 2006 and 2009, the CCGS *Teleost* in 2005 and 2007, and the CCGS *Wilfred Templeman* in 2008 (Table 27).

Species Composition

Eighteen coral taxa are represented in the database (Table 28). These taxa are not mutually exclusive with some only identified to Class, Order or Genus. Fifty percent of the records are of soft coral (Alcyonacea), which are not considered vulnerable species (Fuller et al. 2008). Sea pens (Order Pennatulacea) and large gorgonians are considered to be VME components, but only the former are present in sufficient quantities for analyses. Sea pens comprise 47% of the records. Most of the sea pens are of the genus *Pennatula*, which are known to produce sea pen fields (Cogswell et al. 2009). Different species of sea pens have been reported in the Gulf of St. Lawrence (Table 28 and Cogswell et al. 2009) from those of the NRA (Fuller et al. 2008). However, they all share a similar morphology and tendency to aggregate and so differences in species composition are not thought to be an important factor in applying the NAFO approach to determine significant concentrations of sea pens. No black coral (*Antipatharia*) have been reported from the Gulf Biogeographic Zone.

Analyses

An analysis of the sea pen catch weights between the Campelen and Western IIA trawl showed a significant difference in the catches (P=0.005, *T* test assuming variances not equal). The Western IIA trawl caught more coral than the Campelen and the variance in the catch weight was larger (P<0.0001, Levene's Test).

There is overlap between the surveys along the southern margin of the Laurentian Channel which in theory would allow for the calculation of a conversion factor to one or other gear type and permit a single analysis of the data (Figure 77). However, the area of overlap is small and specific to one habitat type (slope) and consequently any attempt to apply a conversion factor derived from these data would introduce other biases, consequently, the two gear types were treated separately.

Applying the NAFO methodology to the sea pen data by gear type produced the cumulative distribution shown in Figure 78. The distribution is typical of a species that is highly aggregated. The majority of the catches are small and only a small number of catches are high, with few intermediate catches. The quantiles for this distribution are presented in Table 29, also by gear type.

NAFO applied the 97.5% quantile to identify significant concentrations of sea pens in the NRA. This would equate to a weight threshold of *46.45 kg* with Western IIA trawl gear and *15.99 kg* with Campelen trawl gear (Table 29). The locations of significant sea pen catches for each gear type (i.e., catches greater than 46.45 kg and 15.99 kg) based on these values are illustrated in Figure 79 and co-ordinates for the start and end positions of the significant tows are given in Table 30. All of the significant sea pen catches were of *Pennatula borealis* or Pennatulacea O. spp. and the largest sea pen field occurs along a slope between 300 and 400 m depth (Figure 79). Examination of the location of significant sea pen catches by year (not shown) showed no temporal change in location of large catches.

NAFO compared and contrasted results using the 90% quantile as a threshold for sea pens. The distribution of catches greater than the 90% quantile for each gear type is illustrated in Figure 80. Most of the catches are in the same area as the significant catches defined by the 97.5% quantile.

<u>Spatial Analysis of Coral</u>

The interpolated densities of Pennatulaceans were mapped separately for the southern and northern Gulf due to differences in gear type used in the surveys and associated differences in catchability described above. Their distribution is largely centered on the Laurentian Channel as it cuts through the Gulf of St. Lawrence. There are no sea pens from the southern portions of the Gulf of St. Lawrence, although they occur north of the Channel (Figures 81 and 82). The records of small catches of sea pens in tows outside of the Channel in the southern Gulf (Figure 82) may represent hold-overs of sea pens caught in the gear meshes or footgear from previous tows in the Channel. It has been observed that after leaving a deepwater area, old sea pens remain in the cod end for a few sets. While rotten sea pens are discarded before weighing, in some instances they may find their way into the catch record - blurring the boundary of their on-bottom distribution (H. Benoit, pers. comm.).

The spatial analysis model was applied and the density layer for each gear type and the resulting polygon areas produced are illustrated in Figure 83. The data were examined for temporal change within gear types and no trends were observed. For the northern Gulf, the greatest change in the area occupied by successive thresholds comes between 7 and 6 kg of sea pen weight, where there is a 236% increase in area (Figure 84). The polygon area occupied by catches greater than 7 kg is 4001 km^2, while the polygon area occupied by catches greater than 6 kg is 9434 km^2. Therefore, 7 kg was used as the threshold for the Campelen gear. Significant concentrations above these thresholds are illustrated in Figure 85 and their co-ordinates listed in Table 31.

For the southern Gulf of St. Lawrence, the greatest change in the area occupied by successive thresholds comes between 8 and 7 kg of sea pen weight with another potential threshold between 15 and 10 kg (Figure 86). The latter thresholds are preceded by a data gap between 30 and 20 kg which supports the selection of that threshold (no intermediate catch weights). Therefore, 15 kg was used as the threshold for the Western IIA gear from the southern Gulf of St. Lawrence. This threshold produced area polygons totalling 1764 km^2 (Figure 86). Significant concentrations above these thresholds are illustrated in Figure 87 and their co-ordinates listed in Table 31.

As expected the threshold values determined through spatial analyses are much lower than the 97.5% quantile used by NAFO. For the northern Gulf, 15.99 kg was the value for the 97.5% quantile and 3.81 was the value for the 90% quantile. Spatial analysis identified 7 kg which lies between those values. For the southern Gulf, the 97.5% quantile was at 46.45 kg and the 90% quantile was at 8.65 kg. The spatial analysis identified 15 kg which also lies between those quantiles and is considerably less than the 97.5% value.

Sponges

Data Sources and Distribution

The data available for analysis of sponges in the Gulf Biogeographic Zone covers 19 years and is dominated by records from the southern Gulf of St. Lawrence (Table 32). There were 1834 records with sponges and 3120 records of catches with no sponge from the same surveys. The trawl gear used was predominately the Western IIA but as for the coral the Campelen trawl was used for surveys of the northern Gulf after 2004 (Figure 88). In 1994 mobile gear sentinel fisheries were established in the northern Gulf of St. Lawrence creating a partnership between the fishing industry and DFO to assess cod stocks. Nine commercial trawlers participate in this survey using a stratified random sampling protocol similar to that used by DFO. Otter trawls fitted with rockhopper gear were adjusted and standardized in 1997 with the adding of restrictor cables, which maintain a constant trawl opening during fishing operations (DFO 2007b). After 1999 data on sponge by-catch were recorded (Table 32) and those data are used here to indicate presence of sponge (Figure 88). The DFO trawl surveys for demersal fish in the northern Gulf of St. Lawrence began in 1990 on the CCGS *Alfred Needler*. Since 2004, this survey has been carried out on the CCGS *Teleost*. The change in vessel also involved a change in gear from a URI (University of Rhode Island) shrimp trawl to a Campelen trawl and a change in tow duration from 24 to 15 minutes (Bourdages et al. 2007). In general, the surveyed area includes the NAFO Divisions 4RS, Subdivision 3Pn, as well as strata deeper than 183 m (100 fathoms) in Division 4T, including the Lower St. Lawrence Estuary (see Kulka et al. 2006). Data on sponges from these surveys was sparse prior to 2006 when a greater emphasis was placed on reporting invertebrate by-catch to facilitate ecosystem studies. Consequently, data from the earlier surveys (prior to 2006) were used to indicate presence of sponge only (Figure 88, Table 32). Data on sponge by-catch collected with the CCGS *Teleost* using Campelen trawl after 2006 was quantitatively assessed here. Annual demersal trawl surveys have been conducted in the southern Gulf of St. Lawrence in September since 1971. Surveys used a stratified random design, with stratification based on depth and geographic region (Kulka et al. 2006). Data on sponge by-catch using a Western-IIA trawl are included from surveys with the CCGS *Lady Hammond* in 1990-1991, the CCGS *Alfred Needler* from 1992-2002, the CCGS *Wilfred Templeman* in 2003, both the *Alfred Needler* and the CCGS *Teleost* in 2004 and 2005, and the CCGS *Teleost* from 2006 to 2008 (data from 2009 were not yet available). The target fishing procedure in all years was a 30 min tow at 3.5 knots (Kulka et al. 2006). A small number of sponge records are included in the Gulf Biogeographic Zone from the Sydney Bight area surveyed by DFO-Maritimes Region. Those data were all collected following a stratified random design using the Western-IIA trawl from the CCGS *Alfred Needler* in 2002 and 2009, the CCGS *Teleost* in 2007 and the CCGS *Wilfred Templeman* in 2008 (Table 32).

The distribution of sponges from these surveys indicates that sponges are found throughout the Gulf Biogeographic Region but may be sparse at the bottom of the Laurentian Channel (Figure 88).

Species Composition

Fuller (unpub. MS) provides a list of 34 species recorded from the Gulf of St. Lawrence combining data collected by herself and those published in Lambe (1896) and elsewhere. Species composition of the sponge catches from the 2003 research vessel survey (TEM2003352, Table 32) of the southern Gulf of St. Lawrence (Figure 89) are available. Table 33 lists the species identified from that survey by Susanna Fuller, Dalhousie University (unpub. MS). This table was prepared by extracting the species identifications attached to the survey data and then extracting information on them from the table in Fuller (unpub. MS). Some taxa in the data did not appear in her draft report and presumably will be added when the report is finalized. Taxonomic classification, species names, authorities and ordering follows that of Hooper and Van Soest (2002) and have been altered from the Fuller (unpublished) manuscript as appropriate. Species names and authorities have changed considerably since the publication of Lambe (1896). Families and genera are alphabetically listed. All 21 taxa belong to the Class Demospongiae.

At least twenty-five large, structure-forming sponges are associated with sponge grounds between 200 and 2000 m in the North Atlantic (ICES 2009), including some of the species documented by Fuller for the southern Gulf of St. Lawrence (Table 33). In the NRA, the sponges which contributed most to the biomass were the large *Geodia* and abundant *Thenea* species (Fuller et al. 2008), although a detailed examination of sponge composition of the research vessel catches there has not yet been completed. The morphology of the common sponges from the shallower waters of the southern Gulf of St. Lawrence identified by Fuller (Table 33) differs from the rounded, solid, ball shape of the deeper-living *Geodia* species. The species captured in the 2003 research vessel trawl survey (Table 33) include a wide range of morphologies from encrusting and cushion-shaped to massive and branching (Fuller unpub. MS, Figures 90, 91).

It is important to establish whether or not the logic followed by NAFO for the species of the NRA applies to this mixed morphology assemblage of sponges. The majority of sponge catches from the 2003 survey included only a single sponge taxon, and a maximum of 3 taxa per tow were collected (Figure 89). This indicates that the taxa listed in Table 33 do not form the mixed sponge communities noted in the deeper waters of the NRA and North Atlantic. It would be possible to calculate and compare catch thresholds separately by morphological type (Table 33) if the catch composition for the surveys were available for a greater time period. For the purposes of this report all Porifera were treated as a single taxon; however, it is possible that the threshold level produced will be conservative for sponge concentrations composed of large branching taxa (e.g., Figure 90) and liberal for the smaller, cushion-shaped or encrusting taxa (e.g., Figure 91). However, this is not necessarily the case for the last, should the biomass spread in the diameter of the prostrate taxa be similar to that of the height of emergent forms.

Analyses

An analysis of the sponge catch weights between the Campelen and Western IIA trawl showed a significant difference in the catches (P=0.016, *T* test assuming variances not equal). The Campelen trawl caught more sponge than the Western IIA and the variance in the catch weight was larger (P<0.0001, Levene's Test). As for the coral (see above) the two gear types were treated separately.

Unlike the data for coral, the data for sponges from the Western IIA trawls from the southern Gulf of St. Lawrence showed evidence of local depletion through the time series. Consequently those data were separated into two time periods, 1990–2002 and 2003-2009 (Table 32). There was no analytical basis for determining these time frames; rather the most recent 7 year period was selected to give good spatial and temporal coverage. Kernel density maps for each period are presented (Figures 92 and 93). Comparison of the sponge density distribution for each of those two time periods shows that a sponge area south of Wood Islands in the southeast corner of PEI has been significantly reduced (compare Figure 92 with the lower panel of Figure 93) along with another area north of PEI.

Data from the northern region of the Gulf fished with Campelen gear began in 2006, and this gear type was used to select the data for the kernel density analyses. The kernel density map for the Campelen trawls is presented in Figure 94 and shows a number of areas where the sponges are highly aggregated.

The spatial analyses applied to the Campelen trawl by-catch and to the 2003-2009 data from the Western IIA trawls indicated that the threshold for determining significant concentrations of sponges is between 2 and 1 kg per tow for the northern Gulf and between 3 and 2 kg per tow for the southern Gulf (Figure 95). From these analyses the threshold values for identifying significant sponge grounds are 2 and 3 kg, respectively.

The total area of the Gulf of St. Lawrence is approximately 236,000 km^2. In the northern Gulf, catches of 2 kg and greater occupy an area of 19,602 km^2, while catches of 1 kg and greater occupy an area of 37,901 km^2 representing a 193% increase (Figure 95). In the southern Gulf for the 2003-2009 time period catches of 3 kg and greater occupy an area of 6,911 km^2, while catches of 2 kg and greater occupy an area of 26,247 km^2. These areas are graphically illustrated in Figure 95 and spatially illustrated in Figures 96 and 97. It is clear that when the threshold is crossed there is a large increase in area for both gear types.

Comparing these results from the southern Gulf to the 1990-2002 period (Figure 95), the earlier period produced a threshold between 3 and 4 kg (207% increase in area). The area of sponge ground occupied by catches of 4 kg and greater during this earlier period was 20,379 km^2, considerably larger than the current area occupied above the threshold value. This indicates that there has been a loss of about 13,470 km^2 of significant sponge areas over the past two decades in the Gulf Biogeographic Zone. The reasons for this loss cannot be determined here. Possible mechanisms which could explain this loss include direct and indirect removals due to bottom tending fishing gear (see ICES 2009 for a review of the effects of fishing on sponges), natural variation in recruitment, environmental change, etc.

NAFO compared their results from the spatial analyses with the metrics drawn from the cumulative sponge catch curve (Figure 98). For the recent period (2003-2009) the 97.5%

quantile is 6.9 kg and the 90% quantile is 1.7 kg (Table 34) for the catches with the Western IIA in the southern portion of the Gulf Biogeographic Zone. Equivalent values for the northern Gulf samples caught with Campelen trawl gear from 2006-2009 are 11.9 kg and 3.7 kg. The point of maximum curvature appears to be at about 2.5 kg for the southern Gulf where Western IIA trawls were used and 5 kg for the northern Gulf where Campelen trawls were used (Figure 98), while the first break in the cumulative curve appears between 5 and 6 kg with the Western IIA and between 7 and 11 kg with the Campelen trawls.

Considering all of these data the significant catch thresholds for identifying significant sponge grounds are 2 kg and 3 kg for the Campelen catches in the northern Gulf (2006-2009) and the Western IIA catches (2003-2009) in the southern Gulf regions, respectively. These values are drawn from the spatial analyses which have a more robust basis for selection than those selected from the cumulative frequency curves. The locations of the significant sponge catches which meet or exceed these threshold levels are indicated in Figure 99 along with the location of smaller and null sponge catches. The positions of these tows are provided in Table 35.

SCOTIAN SHELF

Corals

Data Sources and Distribution

The data available for analysis of corals in the Scotian Shelf Biogeographic Zone covers 8 years beginning in 2002 (Table 36). There were 262 records with corals and 1486 records of catches with no coral from the same surveys. According to Tremblay et al. (2007), protocols for recording invertebrate by-catch were not consistently followed on the research vessel surveys until 2005. Null data prior to 2005 were therefore not considered.

All surveys in this time series were conducted with Western IIA trawls with tow positions following a stratified random design (Kulka et al. 2006). A large area off southwest Nova Scotia is excluded from the surveys due to rough bottom. The data were extracted from the Maritimes Region Virtual Data Centre (VDC): http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth. In this Biogeographic Region the data are restricted to the shelf and upper slope with most of the area in deeper water extending out to the EEZ not surveyed (Figure 100). Within the surveyed area the corals have a scattered distribution (Figure 100).

Species Composition

The research vessel survey data contains 14 coral taxa (Table 37). As for other Biogeographic Zones, the largest numbers of records are of Alcyonacea (soft corals) with 37% of the records, followed by the sea pens (17%) and large gorgonians (16%). Small gorgonians are not as common (3%) and black corals have not been reported in the research vessel catches, although they are known to occur in the area (Cogswell et al. 2009). Unfortunately, 15% of the records are only coarsely identified as Anthozoa in this Biogeographic Zone, rendering them unsuitable for our analyses.

Analyses

Only the sea pens and large gorgonians were present in sufficient numbers for quantitative analyses. For the sea pens, the 97.5% quantile of the catch distribution occurs at 1.0 kg (Table 38). The cumulative frequency distribution (Figure 101) shows that most of the catches are less than 0.1 kg with a few larger catches with large data gaps between records. These data gaps may be artefacts of the weighing precision which at the higher end are measured to 0.0 kg while at the lower end they are measured to 0.0000 kg. Only two records meet this threshold value and the details of their positions are provided in Table 39 and mapped in Figure 102.

The by-catch of large gorgonian corals were considered significant if they were equal to or greater than the 90% quantile which in this case is 0.559 kg (Table 38). The cumulative frequency distribution shows a large number of small catches less than 1 kg, and a few large catches with large data gaps at the tail end of the distribution (Figure 103). Only 4 records had catches above the 90% quantile (Table 39) and these are located in the Northeast Channel and on southeast Banquereau Bank (Figure 104).

Spatial Analyses of Coral

The spatial analysis of the sea pen data used the interpolated density plots shown in Figure 105. There is a relatively high concentration of sea pens west of Middle Bank on the eastern Scotian Shelf. The largest percent change in area occurs between the 0.1 and 0.05 kg thresholds where there is an increase of 515%, where the area increases from 1011 km^2 to 5211 km^2 (Figure 106). The polygon areas for the 0.2 kg, 0.1 kg and 0.05 kg thresholds are illustrated in Figure 107. These results indicate that 0.1 kg is the threshold level for the sea pen fields. The locations of the records which occur above this threshold provided in Table 40 and plotted in Figure 108. There are only 4 new records introduced by the spatial analyses although the threshold is considerably lower than the 1.0 kg identified from the quantile distribution.

The spatial analysis of the large gorgonian coral data used the interpolated density plots shown in Figure 109. The largest percent change in area occurs between the 0.5 and 0.1 kg thresholds where there is an increase of 891%, where the area increases from 366 km^2 to 3263 km^2 (Figure 110). The polygon areas for the 1 kg, 0.5 kg and 0.1 kg thresholds are illustrated in Figure 111. These results indicate that 0.5 kg is the threshold level for the large gorgonians. This threshold is very similar to that produced from the 90% quantile (Table 38) and there is no change in the number of records identifying significant concentrations. The location of the significant catches derived from spatial analyses is the same as that of Figure 104.

Sponges

Data Sources and Distribution

The data available for analysis of sponges in the Scotian Shelf Biogeographic Zone covers 7 years from 2001 to 2009 (Table 41). There were 388 records with sponge and 831 records of catches with no sponge from the same surveys. All surveys in this time series were conducted with Western IIA trawls with tow positions following a stratified random design (Kulka et al. 2006). A large area off southwest Nova Scotia is excluded from the survey area due to rough bottom. As for the corals, consistent reporting of invertebrate by-catch protocols were not practised until 2005 and so null data from before that year were not included (Tremblay et al. 2007). The data were extracted from the Maritimes Region Virtual Data Centre (VDC): http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.auth. In this Biogeographic Zone, the data are restricted to the shelf and upper slope with most of the area in deeper water extending out to the EEZ not surveyed (Figure 112). Within the surveyed area, the sponges have a scattered distribution but appear more frequently on Georges and Browns Banks.

Additional data from the Fisheries Observer Program was considered for this Biogeographic Zone (Table 41). Data from 1997 to 2007 on *Vazella pourtalesi* or “Russian Hats” locations were included as they provide more information on this unique population (see below). In total, 59 records of commercial sponge by-catch were available which ranged in weight from 5 kg to 8,994 kg (average 1,561 kg).

Species Composition

Research vessel survey data from the Maritimes Region of DFO distinguishes *Vazella pourtalesi* or "Russian Hats" from other Porifera. *Vazella pourtalesi* is a large, barrel-shaped shelf species which can form dense aggregations and is considered by NAFO/ICES to be one of the structure-forming species underpinning vulnerable marine ecosystems (ICES 2009). Fuller et al. (2008) describe the monospecific patch of *Vazella pourtalesi* in Emerald Basin on the Scotian Shelf as a significant and unique population. While these sponges are easy to distinguish from other sponges, it is not certain whether they were consistently recorded as Russian Hats on the surveys or whether they were sometimes recorded under general Porifera. *Geodia* spp. which form the sponge grounds in the NL-Labrador Biogeographic Zone are very rare in this zone and have only been reported as isolated individuals using other survey tools. Other species of sponge comprise the majority of the by-catch records and these have not yet been identified from the surveys. As for the Gulf Biogeographic Zone, they will include shallow water and shelf species that are not necessarily aggregating in nature.

Analyses

The cumulative frequency distribution of the sponge by-catch shows that there are a large number of small catches and few large catches but in contrast to the coral data, there are no large data gaps (Figure 113). The spatial analysis of the sponge data used the interpolated density plots shown in Figure 114. This analysis shows a high concentration of sponge on the Nova Scotian side of the mouth of the Bay of Fundy, with other concentrations in the vicinity of Emerald Basin. The largest percent change in polygon area occurs between the 2 and 1 kg thresholds where there is an increase of 250%, where the area increases from 15,315 km^2 to 38,260 km^2 (Figure 115). The polygon areas for the 3 kg, 2 kg and 1 kg thresholds are illustrated in Figure 116. This figure shows that the increase in area occurs mostly off of Cape Breton and southwest Nova Scotia, with the areas on Emerald Basin showing less change. These results indicate that 2 kg is the threshold level for the sponge grounds with this gear type in this area. This is between the 75% and 90% quantile of the catch distribution (Table 42) and approximates the point of maximum curvature in the cumulative frequency curve (Figure 113). There are a number of records that are at or above this threshold and their positions are indicated in Table 43 and mapped in Figure 117. The largest catch (56 kg) is larger than the largest catch reported from the southern Gulf with similar gear (Table 45 in the Overview Section), although it is uncertain whether there are differences in species composition that could account for this.

The *Vazella pourtalesi* sponge grounds are indicated in Figure 117; however, data from fisheries observers show that there is another important sponge ground for this species in Emerald Basin which is not sampled by the research vessel surveys (Figure 118). These sponge beds are located east of the areas detected in the research vessel survey data. The location of all of the commercial data recording *Vazella pourtalesi* from 1997-2007 is provided in Table 43.

OVERVIEW

Although the analyses reported here are particular to certain gear types and species composition, there is enough overlap in gears to allow comparisons of by-catch over broader geographic scales (Tables 44, 45).

The most common corals on the continental shelves of eastern Canada are the soft corals of the Family Nephtheidae. These corals are not considered to be vulnerable to fishing impacts (see pp. 19 and 20); however, knowledge of their distribution may be useful when considering components for representative networks of marine protected areas (COP Decision IX/20 Annex II) as they are replicated ecological benthic habitat features.

Sea pens are found in all of the biogeographic zones (Table 44, Figure 119) but are very rare in the Hudson Strait portion of the Hudson Bay Complex and are *exceptionally abundant* along the Laurentian Channel in the Gulf of St. Lawrence (Table 45). This area is unique in Eastern Canada and the sea pen fields should be investigated using underwater imagery *in situ* to evaluate this habitat further.

Small gorgonian corals have only been reported from the Eastern Arctic, NL-Labrador Shelves and Scotian Shelf Biogeographic Zones (Table 44, Figure 120), with the largest catches in the NL-Labrador Shelves (Table 45). They are never highly abundant (Table 45) and this may be because in some areas their preferred depth is deeper than the depths generally covered by the research vessel surveys (Cogswell et al. 2009).

The large gorgonian corals are prominent along the continental margins from the Scotian Shelf north to the Eastern Arctic with increasing biomass northwards (Figure 121). The large catches in the Eastern Arctic may be due to the relatively short history of bottom surveys there, in contrast to the NL-Labrador Shelves and Scotian Shelf Biogeographic Zones. The annual stock assessment surveys in those latter zones avoid areas of rough bottom where the gear could be lost. Those bottoms are often the same areas preferred by the large gorgonian coral. Consequently, the distribution of large gorgonians may be incomplete in those more southerly zones. In the north, the surveys are relatively new and the area relatively pristine, so the first encounters with these corals are in the data record. Wareham et al. (2010) further suggest that the relatively limited commercial fishing activity in the north, compared to southern locations, may account for there being more stands of high coral biomass. Alternatively, the oceanographic conditions may be more favourable in the north, promoting higher biomass.

Black coral are rare in the research vessel trawl data in the zones they occur in (Table 44) and are not found in the by-catch from the Hudson Strait portion of the Hudson Bay Complex, in the Gulf or on the Scotian Shelf. Species of black coral in Canadian waters are non-aggregating and NAFO used their presence to indicate suitable habitat for conservation.

Sponges are found in all of the biogeographic zones and very large by-catch has been reported from the continental slopes in the Eastern Arctic, the NL-Labrador Shelves and to some extent on the Scotian Shelf and in the Gulf Biogeographic Zones. Along the Eastern Arctic and NL-Labrador slopes large *Geodia* spp. and similar taxa dominate the large catches. As for the coral taxa, the Hudson Strait portion of the Hudson Bay complex has low densities of sponge (Table 45) and it appears that these are the same *Geodia* spp. which dominate the slope waters in the adjacent Eastern Arctic Biogeographic Zone.

In the Gulf, the shallower water hosts different sponge assemblages and the overall biomass is lower (Table 45). A similar situation is found on the Scotian Shelf, where most of the sponge catch is composed of a mixture of smaller biomass taxa. For these and other shallower shelf areas conservation strategies could focus on protection through representative networks of marine protected areas (COP Decision IX/20 Annex II) much as is suggested for the soft corals. However a *unique population* of the large barrel sponge *Vazella pourtalesi* is located on the muddy bottom of Emerald Basin and nearby areas. This is the only known population of this species in Eastern Canada and it qualifies as a sponge ground forming structural habitat (cf. Fuller et al. 2008).

Uncertainties

There are a number of uncertainties in the research vessel by-catch data that could not be addressed through the careful consideration of the data to use for the analyses. Taxonomic accuracy is not critical here since the analyses are based on species groups; however, there is an issue of the taxa remaining in the gear after sorting and being recorded in successive data records. This blending of catches undoubtedly occurs, particularly for the sea pens which get caught in the meshes. As noted in the text, at-sea technicians are careful to not weigh rotted material from a catch. Rotted material might be indicative of the specimens having been taken in earlier sets, they could represent specimens that were previously dumped and recaught, or specimens that were indirectly killed on the bottom and later caught. Despite these precautions, we consider that there is cross-contamination of sea pen catches between sets, particularly where large hauls have been made. This is noted in the text for the Gulf and Eastern Arctic Biogeographic Zones were it is most likely to occur. Consequently, the boundaries for delineating these taxa may be sharper than they appear in the spatial analyses. Other taxa may be similarly affected.

The NAFO approach makes use of data gaps to indirectly support the thresholds selected through spatial analyses of sponges. The rationale behind this is that these gaps represent natural breaks in abundance between the dense aggregations and the widespread occurrence of isolated individuals. In some cases, specimens are weighed to 0.0000 kg while in others they are estimated to the nearest 100 kg. When actual weights are recorded data discontinuities are likely to represent the intended spatial discontinuity; however, when data are estimated the gaps may be artificial and merely the product of rounding off numbers or estimating large catches. Consequently, the data distribution must be considered carefully when using this information as indirect evidence of a threshold value. Inaccuracies in weight measurements will also affect the cumulative catch frequency distributions and the quantiles derived from them. It is important that those analysing such data work with the data providers in order to determine at sea procedures that might affect interpretation of analyses.

Evaluation of the Spatial Analysis Method

The spatial analysis method (Kenchington et al. 2009) has proven to be useful in determining significant concentrations of sea pens, small gorgonians, large gorgonians and sponges. This report applies the method broadly to a wide range of environments with different species composition. It was particularly interesting to see that the model coped well when the data points were linearly constrained, as demonstrated for the analyses of the sponge along the NL and Labrador slope. The importance of separately analyzing the data by gear type has been demonstrated. Through these repeated applications we have gained confidence in interpreting how the analysis behaves under different situations. When large concentrations are not common, as for sponges in the Hudson Strait area, the analysis will build polygons around single data points and the polygon areas encompassing those points may increase dramatically due to addition of a single data point. Consideration of the number of points which cause the area to expand was an important aspect of the analyses that was not appreciated before we started.

CONCLUDING REMARKS

Spatial analysis as used here has identified dense aggregations of structure-forming corals and sponges in Eastern Canada and linked them to a biological property, that is, habitat area or patch size. Localization of these aggregations are based on research vessel surveys that are ideal for identifying these organisms within Canada's EEZ because of their large number of records, stratified random designs and extensive spatial coverage over a number of years. For species that form these dense aggregations this approach is well suited to identifying and quantifying their spatial footprint. In terms of ecological significance, large aggregations will be more important for population and species-level processes than interspecific interactions among isolated individuals. This does not mean that species which do not aggregate to the same degree are in anyway less important, rather it suggests that protection for those taxa may be better justified under other provisions and means, such as when considering components for representative networks of marine protected areas (COP Decision IX/20 Annex II) or if the species are rare or endangered, under the SARA.

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TABLES

***Table 1**. Timelines of NAFO science working group meetings and their relevant outcomes showing the development of practices used to identify significant concentrations of coral and sponges in the NAFO Regulatory Area.*

Working Group	Relevant Outcome	Reference
ICES/NAFO WGDEC, March 2008	▪ Detailed maps of occurrence of structural habitats in the North Atlantic specifically identifying major coral concentrations in the NW Atlantic (includes definition of structure-forming habitat) ▪ Identification of knowledge gaps for sponge ground distribution in NW Atlantic	ICES 2008
NAFO WGEAFM, May 2008	▪ Review of deep-water coral and sponge taxa of the NRA which meet the FAO guidelines for VMEs ▪ First maps of sponge distribution from the NRA and Canadian EEZ using data from the Canadian DFO Trawl Survey database (1995-2007) and DFO Scotia Fundy Fisheries Observer database (1977-2001)	Fuller et al. 2008; NAFO 2008a
NAFO WGEAFM, October 2008	▪ Determined that coral thresholds could be evaluated for groups of coral with similar morphology as opposed to individually for each species. Three groups recognized from NRA: Sea Pens, Large Gorgonians, Small Gorgonians. Black Corals treated separately as they were not gregarious. ▪ Determined significant concentrations for each coral group using the quantiles of the cumulative catch distribution ▪ Mapped location of the significant catches for each group and highlighted “key locations” where significant catches were close together	NAFO 2008b
ICES/NAFO WGDEC, March 2009	▪ More thorough review of sponge taxa of the NW Atlantic (200-2000 m) which meet the FAO guidelines for VMEs ▪ Identification of sponge grounds as the conservation unit as opposed to individual species of sponge ▪ Examined the types of damage that fishing operations can inflict on sponges and assessed their impact. These impacts were classified as due to mechanical damage, dislodgement and sedimentation ▪ Mapped location of sponge grounds in NW Atlantic using a 100kg weight threshold (expert opinion) to separate sponge grounds from the broader distribution of sponges mapped by Fuller et al. 2008 and NAFO 2008	ICES 2009
NAFO WGEAFM, May 2009	▪ Introduced the use of spatial analyses to delineate sponge grounds from trawl survey data ▪ Determined the catch threshold identifying significant concentrations for sponge grounds using spatial analyses, with support from the quantiles, estimated point of maximum curvature, and location of data breaks within the cumulative catch distribution ▪ Mapped the location of the significant sponge catches providing start and end positions for all tows above the threshold value	Kenchington et al. 2009; NAFO 2009a

Table 2. *Details of the data used for the analyses and description of coral distribution from the Eastern Arctic Biogeographic Zone.*

Year	NAFO Division	Mission	Gear Type	Number of Coral Records	Number of Null Coral Records	Data Provider*
Research Vessel Surveys						
1999	0A	PA1999-1	Alfredo	8		MT
2000	0B	PA2000-2	Alfredo	10		MT
2001	0B	PA2001-9	Alfredo	5[†]		MT
2001	0A	PA2001-6	Alfredo	5[††]		MT
2004	0A	PA2004-8	Alfredo	2		MT
2005	2G, 0B	BAL2005100	Campelen	49	112	VW
2006	2G, 0B	BAL2006101	Campelen	114	****65	VW
2006	0A	PA2006-5	Cosmos	41	62	MT/TS/VW
2006	0A	PA2006-8	Alfredo	67	18	MT/TS/VW
2007	2G, 0B	BAL2007102	Campelen	61	****84	VW
2007		PA2007-7	Cosmos	6	26	MT/TS/VW
2008	2G, 0B	BAL2008103***	Campelen	27	****81	VW
2008	0A	PA2008-7	Alfredo	81	52	MT/TS/VW
2008	0A	PA2008-7	Cosmos	74		MT/TS/VW
2009	0B	PA2009-7	Alfredo**	1		TS
Total				**541**	**500**	
Fisheries Observer Data						
2004	0AB, 2G			106		VW
2005	0AB, 2G			167		VW
2006	0AB, 2G			348		VW
2007	0AB, 2G			421		VW
Total				**1042**		

**TS = Tim Siferd, DFO- C&A; MT = Margaret Treble, DFO- C&A; VW = Vonda Wareham, DFO- NL.*
***Modified Alfredo with tagging box instead of normal cod end.*
****The SFA2EX study area (the majority of 0B) was sampled with a modified Campelen in 2008. The foot gear was increased to 21" (from 14") and the fishing line floated further extending the opening off bottom and may affect the catch of some species.*
*****Double null sets (zero coral in main trawl cod end and in Linney bag).*
[†] Three records from this survey in 2001 have no weights recorded but ID's were made and data were included in the distribution maps. 2 records had weights but were only identified as coral.
[††]All five records have no weights recorded but ID's were made and data were included in the distribution maps.

Table 3. *Species composition of the research vessel survey coral by-catch (Table 2) from the Eastern Arctic Biogeographic Zone.*

Order	Species/Taxon	No. Records (Trawl Sets)	NAFO Conservation Unit
	Anthozoa C.	7	
Alcyonacea	Nephtheidae F.	120	
	Gersemia rubiformis (Ehrenberg, 1834)	41	
	Capnella florida (Rathke, 1806)	90	
	Anthomastus grandiflorus Verrill, 1878	8	
Pennatulacea	*Anthoptilum grandiflorum* (Verrill, 1879)	4	Sea Pen
	Halipteris finmarchica (Sars, 1851)	11	Sea Pen
	Pennatula grandis Ehrenberg, 1834	16	Sea Pen
	Pennatulacea O.	99	Sea Pen
	Umbellula lindahli Kölliker, 1875	41	Sea Pen
Scleractinia	*Flabellum alabastrum* Moseley, 1876	10	
	Flabellum angulare Moseley, 1876	2	
Gorgonacea	*Acanella arbuscula* (Johnson, 1862)	54	Small Gorgonian
	Anthothela grandiflora (Sars, 1856)	3	Small Gorgonian
	Acanthogorgia armata Verrill, 1878	2	Large Gorgonian
	Paramuricea spp. Koelliker, 1865	2	Large Gorgonian
	Primnoa resedaeformis (Gunnerus, 1763)	20	Large Gorgonian
	Paragorgia arborea (Linnaeus, 1758)	18	Large Gorgonian
	Keratoisis ornata Verrill, 1878	1	Large Gorgonian
	Gorgonacea O. spp.	2	
Antipatharia	Antipatharia O. spp.	4	Black Coral

Table 4. *Quantile breakdown of sea pen research vessel catches in the Eastern Arctic Biogeographic Zone by gear type. [Bold type indicates quantiles considered by NAFO, * indicates quantiles used by NAFO.]*

Percentage of Data	Quantile	Alfredo II Gear Catch (kg) (N=89)	Cosmos Gear Catch (kg) (N=49)	Campelen Gear Catch (kg) (N=33)
100.0%	maximum	5.0000	0.78000	0.21000
99.5%		5.0000	0.78000	0.21000
97.5%		***2.7500**	***0.73575**	***0.21000**
90.0%		**0.7554**	**0.21700**	**0.13896**
75.0%	quartile	0.1200	0.10465	0.06990
50.0%	median	0.0285	0.04170	0.03000
25.0%	quartile	0.0080	0.01660	0.01000
10.0%		0.0020	0.00300	0.00022
2.5%		0.0007	0.00130	0.00010
0.5%		0.0003	0.00120	0.00010
0.0%	minimum	0.0003	0.00120	0.00010

Table 5. *Quantile breakdown of large and small gorgonian research vessel catches in the Eastern Arctic Biogeographic Zone. Both conservation units were sampled with Campelen trawl gear. [Bold type indicates quantiles considered by NAFO, * indicates quantiles used by NAFO.]*

Percentage of Data	Quantile	Large Gorgonians Catch (kg) (N=38)	Small Gorgonians Catch (kg) (N=43)
100.0%	maximum	500.0000	0.12240
99.5%		500.0000	0.12240
97.5%		**500.0000**	***0.11816**
90.0%		***27.5000**	**0.04000**
75.0%	quartile	0.6900	0.01300
50.0%	median	0.0830	0.00160
25.0%	quartile	0.0190	0.00020
10.0%		0.0020	0.00010
2.5%		0.0001	0.00010
0.5%		0.0001	0.00010
0.0%	minimum	0.0001	0.00010

Table 6. *Position of significant catches of coral from the Eastern Arctic Biogeographic Zone. Significant catches are drawn from the quantiles of the catch distribution (see Tables 4 and 5).*

Mission	**Year**	**Catch Weight (kg)**	**Start Latitude (Dec Deg)**	**Start Longitude (Dec Deg)**	**End Latitude (Dec Deg)**	**End Longitude (Dec Deg)**	**Depth (m)**
Sea Pens (Alfredo III Trawl Gear): 97.5% Quantile							
PA2000-2	2000	5.00	65.3800	-57.9500	65.3700	-57.9100	588
PA2000-2	2000	3.00	64.2800	-58.3200	64.2600	-58.3100	903
Sea Pens (Cosmos Trawl Gear): 97.5% Quantile							
PA2008-7	2008	0.78	67.4549	-62.4379	67.4473	-62.4177	147
Sea Pens (Campelen Trawl Gear): 97.5% Quantile							
BAL2005100	2005	0.21	65.5917	-58.8117	65.6020	-58.8350	488
Small Gorgonians (Campelen Trawl Gear): 97.5% Quantile							
BAL2006101	2006	0.1224	61.6717	-61.1617	61.6850	-61.1507	559
Large Gorgonians (Campelen Trawl Gear): 90% Quantile							
PA1999-1	1999	*2000.00	67.9800	-59.5100	67.9600	-59.4950	930
BAL2007102	2007	500.00	61.7275	-61.9593	61.7220	-61.9870	566
BAL2008103	2008	100.00	61.7668	-62.2748	61.7680	-62.2580	562
BAL2005100	2005	50.00	61.3850	-61.1850	61.3730	-61.1720	565
Black Corals (Antipatharians): All records							
BAL2008103	2008	2.000	63.9020	-59.6425	63.9012	-59.6708	600
PA2008-7	2008	0.213	66.4077	-58.7193	66.3955	-58.7159	680
PA2008-7	2008	0.013	66.6172	-58.0468	66.5953	-58.0358	649
PA2008-7	2008	0.002	68.6259	-59.4559	68.6465	-59.4227	692

**This catch was taken with Alfredo trawl gear but was so far above the other catches in weight that it was included as any catchability differences between these gears (the reason for excluding the few records from other gear types) would not discount for such a large haul as being classed as a significant catch.*

Table 7. *Position of significant catches of coral from the Eastern Arctic Biogeographic Zone as determined from the spatial analysis. Note: These include all of the catches in Table 6 plus additional ones provided by the lower threshold. All black coral records are provided.*

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)	Depth (m)
Sea Pens (Alfredo III Trawl Gear)							
PA2000-2	2000	5.00	65.3800	-57.9500	65.3700	-57.9100	588
PA2000-2	2000	3.00	64.2800	-58.3200	64.2600	-58.3100	903
PA2000-2	2000	2.00	63.9700	-58.7800	65.4700	-58.9100	868
PA2000-2	2000	2.00	65.4900	-58.9200	64.0000	-58.7600	483
PA2006-8	2006	1.79	68.5467	-59.3827	68.5703	-59.3676	565
PA2008-7	2008	1.78	68.4695	-59.4395	68.4935	-59.4237	553
PA2000-2	2000	1.50	65.3600	-58.2400	65.3500	-58.1900	550
PA2000-2	2000	1.50	65.4800	-58.7300	65.4800	-58.6600	489
PA2008-7	2008	0.75	68.6257	-59.4564	68.6465	-59.4227	692
PA2008-7	2008	0.44	67.5910	-63.5267	67.5669	-63.5382	586
PA1999-1	1999	0.33	68.4900	-59.9400	68.5100	-59.9420	1324
PA1999-1	1999	0.32	68.5300	-59.9400	68.5500	-59.9250	1341
PA2008-7	2008	0.29	66.2713	-59.1734	66.2491	-59.1790	697
PA1999-1	1999	0.28	68.4000	-59.4800	68.4200	-59.4680	551
PA1999-1	1999	0.28	71.2500	-68.1400	71.2600	-68.1480	866
PA2006-8	2006	0.25	66.4245	-59.8433	66.4463	-59.8512	675
Sea Pens (Cosmos Trawl Gear)							
PA2008-7	2008	0.78	67.4550	-62.4383	67.4473	-62.4177	147
PA2008-7	2008	0.60	68.3196	-65.2430	68.3131	-65.2690	252
PA2008-7	2008	0.38	68.5869	-59.4181	68.5972	-59.4095	618
PA2008-7	2008	0.36	67.5871	-63.5183	67.5975	-63.5137	572
PA2008-7	2008	0.22	67.1941	-62.0671	67.2003	-62.0901	263
PA2008-7	2008	0.18	68.3233	-65.2951	68.3255	-65.2681	109
PA2008-7	2008	0.14	67.7911	-62.8482	67.7827	-62.8317	497
PA2006-5	2006	0.13	70.5192	-66.5813	70.5126	-66.5624	335
PA2006-5	2006	0.12	69.0073	-65.0791	69.0146	-65.0978	538
PA2006-5	2006	0.12	69.0745	-65.6830	69.0670	-65.6990	474
PA2006-5	2006	0.11	68.7745	-64.5583	68.7833	-64.5468	352
PA2008-7	2008	0.11	66.5754	-57.7771	66.5836	-57.7626	584
PA2006-5	2006	0.10	71.5414	-69.6710	71.5389	-69.6391	727

Table 7. Continued.

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)	Depth (m)
Sea Pens (Campelen Trawl Gear)							
BAL2005100	2005	0.21	65.5917	-58.8117	65.6017	-58.8350	488
BAL2008103	2008	0.18	65.5305	-58.8020	65.5180	-58.7905	485
BAL2005100	2005	0.14	63.8083	-59.6167	63.8033	-59.5883	663
BAL2006101	2006	0.14	61.6717	-61.1617	61.6850	-61.1507	559
BAL2008103	2008	0.13	65.6547	-58.1173	65.6423	-58.0993	528
BAL2008103	2008	0.10	63.7708	-59.7217	63.7710	-59.7527	688
BAL2005100	2005	0.08	64.7717	-58.2450	64.7683	-58.2150	692
BAL2006101	2006	0.06	60.8450	-62.3617	60.8383	-62.3833	630
BAL2005100	2005	0.05	66.1733	-58.0467	66.1650	-58.0217	620
Small Gorgonians (Campelen Trawl Gear)							
BAL2006101	2006	0.12	61.6717	-61.1617	61.6850	-61.1507	559
BAL2008103	2008	0.08	65.4728	-57.9738	65.4587	-57.9727	556
Large Gorgonians (Campelen Trawl Gear)							
PA1999-1	1999	*2000.00	67.9800	-59.5100	67.9600	-59.4950	930
BAL2007102	2007	500.00	61.7275	-61.9593	61.7210	-61.9860	566
BAL2008103	2008	100.00	61.7668	-62.2748	61.7682	-62.2577	562
BAL2005100	2005	50.00	61.3850	-61.1850	61.3733	-61.1717	565
BAL2005100	2005	25.00	61.4383	-61.5383	61.4300	-61.5133	581
BAL2008103	2008	21.44	61.2005	-63.4782	61.1918	-63.4712	610
BAL2005100	2005	20.00	61.3433	-61.1600	61.3367	-61.1317	563
BAL2005100	2005	20.00	61.4633	-61.5100	61.4533	-61.5283	581
BAL2005100	2005	17.90	60.8917	-61.8000	60.8883	-61.8250	600
Black Corals (Antipatharians): All records							
BAL2008103	2008	2.000	63.9022	-59.6425	63.9012	-59.6708	600
PA2008-7	2008	0.213	66.4074	-58.7192	66.3955	-58.7159	680
PA2008-7	2008	0.013	66.6173	-58.0470	66.5953	-58.0358	649
PA2008-7	2008	0.002	68.6257	-59.4564	68.6465	-59.4226	692

**This catch was taken with Alfredo trawl gear but was so far above the other catches in weight that it was included as any catchability differences between these gears (the reason for excluding the few records from other gear types) would not discount for such a large haul as being classed as a significant catch.*

Table 8. *Details of the data used for the analyses of sponge distribution from the Eastern Arctic Biogeographic Zone.*

Year	NAFO Division	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records	Data Provider*
1996	2G	TEL1996037	Campelen	2		VW
1999	0A	PA1999-1	Alfredo	23		MT
2000	0B	PA2000-2	Alfredo	52		MT
2001	0B	PA2001-9	Alfredo	15		MT
2005	2G, 0B	BAL2005100	Campelen	48	111	TS
2006	2G, 0B	BAL2006101	Campelen	56	100	TS
2006	0A	PA2006-5	Cosmos	58	31	TS
2006	0A	PA2006-8	Alfredo	43	19	TS
2007	2G, 0B	BAL2007102	Campelen	67	85	TS
2007		PA2007-7	Cosmos	14	16	TS
2008	2G, 0B	BAL2008103**	Campelen	57	100	TS
2008	0A	PA2008-7	Alfredo	76	10	TS
2008	0A	PA2008-7	Cosmos	70	5	TS
Total				**581**	**477**	

**TS = Tim Siferd, DFO- C&A; MT = Margaret Treble, DFO- C&A; VW = Vonda Wareham, DFO- NL.*
***The SFA2EX study area (the majority of 0B) was sampled with a modified Campelen in 2008. The foot gear was increased to 21" (from 14") and the fishing line floated further extending the opening off bottom and may affect the catch of some species. Note: Linney bag data not available for sponges.*

Table 9. *Quantile breakdown of sponge research vessel catches (Table 8) in the Eastern Arctic Biogeographic Zone by gear type.*

Percentage of Data	Quantile	Weight (kg) of Sponge Corresponding to Quantile Value		
		Alfredo Trawl (N=209)	Cosmos Trawl (N=142)	Campelen Trawl (N=223)
100.0%	maximum	350.000	603.800	2000.00
99.5%		345.000	603.800	1940.00
97.5%		115.000	142.880	840.00
90.0%		52.400	6.980	153.10
75.0%	quartile	6.800	0.730	35.80
50.0%	median	1.390	0.140	5.60
25.0%	quartile	0.170	0.030	1.10
10.0%		0.020	0.005	0.33
2.5%		0.003	0.002	0.11
0.5%		0.001	0.001	0.04
0.0%	minimum	0.001	0.001	0.04

Table 10. *Start and end positions of significant concentrations of sponge in the Eastern Arctic Biogeographic Zone as determined from the spatial analyses.*

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)	Depth (m)	NAFO Division
Cosmos								
PA2006-5	2006	604	66.29000	-58.4235	66.29617	-58.4062	571	0A
PA2006-5	2006	196	66.41777	-59.2325	66.40853	-59.2223	767	0A
PA2008-7	2008	148	67.13375	-60.7104	67.12432	-60.6965	672	0A
PA2008-7	2008	139	66.61425	-58.8348	66.62427	-58.8273	777	0A
PA2008-7	2008	77	66.47082	-59.1279	66.45945	-59.1183	780	0A
PA2006-5	2006	70	66.43463	-59.5780	66.42828	-59.5577	771	0A
PA2006-5	2006	53	67.12583	-60.5648	67.11567	-60.5622	725	0A
PA2008-7	2008	41	66.40742	-58.7192	66.39547	-58.7159	680	0A
Alfredo								
PA2000-2	2000	350	61.79000	-60.5900	61.77000	-60.6000	839	0B
PA2008-7	2008	250	67.06180	-60.6479	67.03675	-60.6319	638	0A
PA2000-2	2000	150	61.94000	-61.2700	61.92000	-61.2500	529	0B
PA2006-8	2006	133	66.92167	-60.1857	66.94050	-60.2150	718	0A
PA2000-2	2000	120	62.33000	-61.0000	62.35000	-61.0000	654	0B
PA2008-7	2008	100	66.82815	-58.4712	-	-	868	0A
PA2000-2	2000	100	62.20000	-60.8600	62.23000	-60.8800	681	0B
PA2000-2	2000	100	62.11000	-60.8500	62.12000	-60.8600	619	0B
PA1999-1	1999	99	66.82000	-60.2800	66.84000	-60.2830	606	0A
PA1999-1	1999	91	66.29000	-59.3600	66.31000	-59.3620	714	0A
PA2000-2	2000	88	62.09000	-60.1000	62.06000	-60.1200	1404	0B
PA2006-8	2006	83	69.23160	-64.3578	69.24890	-64.3937	768	0A
PA2001-9	2001	75	62.84000	-58.7830	62.81700	-58.8100	1149	0B
PA2000-2	2000	75	61.80000	-62.9100	61.81000	-62.8600	500	0B
PA2008-7	2008	74	66.26855	-58.5341	66.26357	-58.4802	565	0A
Campelen								
BAL2006101	2006	2000	61.27300	-60.8720	61.27700	-60.8980	559	0B
BAL2005100	2005	1500	63.03700	-60.6030	62.02300	-60.6150	453	0B
BAL2008103	2008	1027	61.57200	-60.9600	61.56300	-60.9730	550	0B
BAL2008103	2008	1000	62.98200	-60.6130	62.97200	-60.6270	507	0B
BAL2007102	2007	900	63.02300	-60.6420	63.01500	-60.6670	434	0B
BAL2005100	2005	800	61.76300	-60.9930	61.76000	-60.9700	547	0B
BAL2007102	2007	551	61.64000	-61.3320	61.64200	-61.3600	570	0B
BAL2008103	2008	504	64.58500	-58.8980	64.57200	-58.9100	521	0B
BAL2008103	2008	500	61.76700	-62.2750	61.76800	-62.2580	562	0B
BAL2008103	2008	500	63.13800	-60.6630	63.15200	-60.6730	389	0B
BAL2007102	2007	500	61.63000	-63.3370	61.63300	-63.3100	542	0B
BAL2006101	2006	500	62.03000	-60.8620	62.04000	-60.8770	528	0B
BAL2007102	2007	300	62.91200	-61.0720	62.90300	-61.0930	471	0B
BAL2007102	2007	300	61.90200	-62.3720	61.89300	-62.3930	459	0B
BAL2006101	2006	300	61.76500	-62.3170	61.77200	-62.2900	562	0B
BAL2006101	2006	300	61.77000	-61.2270	61.78200	-61.2270	547	0B
BAL2008103	2008	226	61.65000	-60.8130	61.64300	-60.8250	537	0B
BAL2007102	2007	200	61.72800	-61.9600	61.72200	-61.9870	566	0B

Table 10. Continued.

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)	Depth (m)	NAFO Division
BAL2005100	2005	200	61.46300	-61.5100	61.45300	-61.5280	581	0B
BAL2005100	2005	200	61.89300	-61.2200	61.88200	-61.2020	531	0B
BAL2007102	2007	157	61.59800	-63.7280	61.60700	-63.7070	437	0B
BAL2007102	2007	155	64.59200	-58.7770	64.57800	-58.7930	559	0B
BAL2007102	2007	150	61.57700	-63.3000	61.58200	-63.2800	569	0B
BAL2006101	2006	150	61.95200	-61.2900	61.96300	-61.2780	518	0B
BAL2005100	2005	144	65.59200	-58.8120	65.60200	-58.8350	488	0B
BAL2008103	2008	120	65.47300	-57.9730	65.45800	-57.9730	556	0B
BAL2005100	2005	120	61.84800	-61.2300	61.83500	-61.2180	543	0B
BAL2007102	2007	117	64.25500	-59.1550	64.24000	-59.1520	544	0B
BAL2007102	2007	116	63.70700	-60.3180	63.69300	-60.3280	548	0B
BAL2005100	2005	109	61.92800	-62.8150	61.91300	-62.8150	488	0B
BAL2005100	2005	102	62.63300	-61.2080	62.62300	-61.1900	698	0B
BAL2008103	2008	101	66.15000	-59.8720	66.16300	-59.8770	576	0B
BAL2008103	2008	100	62.98700	-60.9500	63.00000	-60.9470	424	0B
BAL2007102	2007	100	64.20700	-59.0900	64.19500	-59.1070	584	0B
BAL2006101	2006	100	61.20200	-61.3880	61.21300	-61.3800	585	0B
BAL2006101	2006	100	61.37700	-61.3450	61.39000	-61.3380	570	0B
BAL2006101	2006	100	61.94200	-63.5800	61.95300	-63.5680	526	-
BAL2005100	2005	97	62.11300	-61.4520	62.10500	-61.4750	475	0B
BAL2008103	2008	90	64.96500	-58.5330	64.95300	-58.5480	535	0B
BAL2008103	2008	90	61.93800	-62.5850	61.93300	-62.5670	465	0B
BAL2005100	2005	65	65.70200	-59.0720	65.68800	-59.0620	481	0B
BAL2008103	2008	60	64.95200	-58.3180	64.94000	-58.3330	619	0B
BAL2006101	2006	60	61.70800	-63.1530	61.70000	-63.1320	520	-
BAL2007102	2007	53	61.92800	-63.4850	61.92700	-63.5130	511	0B
BAL2006101	2006	51	65.12500	-58.4600	65.13700	-58.4430	526	0B
BAL2007102	2007	50	61.90700	-63.5170	61.92000	-63.5230	506	0B
BAL2007102	2007	50	64.65500	-60.8670	64.64200	-60.8680	334	0B
BAL2006101	2006	48	65.09700	-58.1980	65.11000	-58.1870	605	0B
BAL2007102	2007	45	65.84200	-60.1650	65.82800	-60.1670	460	0B
BAL2007102	2007	40	65.46500	-57.7780	65.45500	-57.7850	582	0B
BAL2007102	2007	40	62.96800	-60.9180	62.95800	-60.9420	442	0B
BAL2006101	2006	40	61.48700	-61.8050	61.48800	-61.8330	608	0B

Table 11. *Details of the data used for the analyses and description of coral distribution from the Hudson Bay Complex Biogeographic Zone.*

Year	Mission	Gear Type	Depth Range (m)	Number of Coral Records	Number of Null Coral Records	Data Provider*
2006	BAL2006101	Campelen	383-660	3	8	VW
2007	PA2007-7	Cosmos	99-946	74	22	TS/MT
2009	PA2009-7	Cosmos	115-966	55	74	TS/MT
Total				**132**	**104**	

**TS = Tim Siferd, DFO- C&A; MT = Margaret Treble, DFO- C&A; VW = Vonda Wareham, DFO- NL.*

Table 12. *Species composition of the research vessel survey coral by-catch (Table 11) from the Hudson Bay Complex Biogeographic Zone.*

Order	Species/Taxon	No. Records	NAFO Conservation Unit
Alcyonacea	Nephtheidae F.	84	
	Gersemia rubiformis (Ehrenberg, 1834)	28	
	Capnella florida (Rathke, 1806)	19	
Pennatulacea	*Anthoptilum grandiflorum* (Verrill, 1879)	1	Sea Pen

Table 13. *Details of the data used for the analyses and description of sponge distribution from the Hudson Bay Complex Biogeographic Zone.*

Year	Mission	Gear Type	Depth Range (m)	Number of Sponge Records	Number of Null Sponge Records	Data Provider*
2006	BAL2006101	Campelen	326-660	3	9	VW
2007	BAL2007102	Campelen	244-252	2	9	VW
2007	PA2007-7	Cosmos	108-968	69	1	TS/MT
2008	BAL2008103	Campelen	261	1	10	VW
2009	PA2009-7	Cosmos	115-966	103	26	TS/MT
Total				**178**	**55**	

**TS = Tim Siferd, DFO- C&A; MT = Margaret Treble, DFO- C&A; VW = Vonda Wareham, DFO- NL.*

Table 14. *Quantiles of the sponge catch distribution from the Hudson Bay Complex Biogeographic Zone. Data are from DFO shrimp surveys in 2007 and 2009 using Cosmos shrimp trawl gear (Table 13).*

Percentage of Data	Quantile	Weight (kg) of Sponge Corresponding to Quantile Value
100.0%	maximum	4.6130
99.5%		4.6130
97.5%		3.0280
90.0%		1.3424
75.0%	quartile	0.5765
50.0%	median	0.2530
25.0%	quartile	0.0745
10.0%		0.0230
2.5%		0.0080
0.5%		0.0020
0.0%	minimum	0.0020

Table 15. *Position of catches of sponges ≥ 97.5% quantile of the catch distribution (3.028 kg) from the Hudson Bay Complex Biogeographic Zone. Data are from DFO shrimp surveys in 2007 and 2009 using Cosmos shrimp trawl gear (Table 13).*

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
PA2009-7	2009	4.6	62.97383	-77.9518	62.96467	-77.9517
PA2009-7	2009	4.2	61.64667	-66.2338	61.65683	-66.2355
PA2009-7	2009	3.3	60.63767	-68.6030	60.64683	-68.5902
PA2009-7	2009	3.2	63.29083	-73.0415	63.28367	-73.0245

Table 16. *Details of the data used for the analyses and description of coral distribution from the NL-Labrador Shelves Biogeographic Zone.*

Year	NAFO Division	Mission	Gear Type	Number of Coral Records	Number of Null Coral Records†	Data Provider*
2002	4V	NED2002040	Western IIA	7		AC
2003	2J	TEL2003509	Campelen	44	58	VW
2003	2J, 3K	TEL2003510	Campelen	1	34	VW
2003	3O	TEM2003485	Campelen	2	61	VW
2004	2H	TEL2004536	Campelen	11	21	VW
2004	2H, 2J	TEL2004537	Campelen	36	62	VW
2004	2J	TEL2004538	Campelen	4	44	VW
2004	2J, 3K	TEL2004539	Campelen	92	40	VW
2004	3K	TEL2004541	Campelen	25	22	VW
2004	3L, 3N	TEM2004548	Campelen	12	43	VW
2004	3L	TEM2004559	Campelen	7	45	VW
2004	3L	TEM2004587	Campelen	14	41	VW
2004	3O	TEM2004557	Campelen	14	63	VW
2004	3N	TEM2004558	Campelen	6	46	VW
2005	2G	BAL2005100	Campelen	41	46	VW
2005	3L	NED2005657	Campelen	16	57	VW
2005	3K	TEL2005542	Campelen	17	16	VW
2005		TEL2005546	Western IIA	1	4	AC
2005	3O	TEL2005608	Campelen	77		VW
2005	2J, 3K	TEL2005611	Campelen	24	43	VW
2005	2J	TEL2005612	Campelen	2	62	VW
2005		TEL2005633	Western IIA	7	2	AC
2005	3K	TEM2005588	Campelen	5	15	VW
2005	3P	TEM2005617	Campelen	17	97	VW
2005	3O	TEM2005618	Campelen	16	63	VW
2005	3O	TEM2005619	Western IIA	8	61	AC
2005	3L, 3N	TEM2005621	Campelen	62	71	VW
2005	3O	TEM2005627	Campelen	25	54	VW
2005	3N	TEM2005628	Campelen	5	29	VW
2005	3L	TEM2005629	Campelen	22	36	VW
2005	3L	TEM2005630	Campelen	13	43	VW
2005	3K	TEM2005631	Campelen	26	37	VW
2005	3K	TEM2005632	Campelen	10	33	VW
2006	2G	BAL2006101	Campelen	106	11	VW
2006		NED2006002	Western IIA	5	6	AC
2006		NED2006036	Western IIA	12	6	AC
2006	3K, 3L	TEL2006662	Campelen	39	10	VW
2006	2H	TEL2006679	Campelen	85	10	VW
2006	2H, 2J	TEL2006680	Campelen	38	29	VW
2006	2J, 3K	TEL2006681	Campelen	36	63	VW
2006	2J, 3K, 3L	TEL2006682	Campelen	127	17	VW
2006	3L	TEL2006683	Campelen	13		VW
2006	3K	TEL2006684	Campelen	31	30	VW
2006	4R	TEL2006003	Campelen	2	2	DB/DA/PA
2006	3K	TEM2006660	Campelen	23	38	VW
2006	3P, 3Q	TEM2006688	Campelen	23	31	VW
2006	3L	TEM2006692	Campelen	7	50	VW

Table 16. *Continued.*

Year	NAFO Division	Mission	Gear Type	Number of Coral Records	Number of Null Coral Records†	Data Provider*
2006	3L	TEM2006693	Campelen	50	33	VW
2006	3N	TEM2006705	Campelen	12	34	VW
2006	3L	TEM2006706	Campelen	29	30	VW
2006	3K, 3L	TEM2006707	Campelen	51	46	VW
2007	3P	722007782	Western IIA	12	33	AC
2007	2G	BAL2007102	Campelen	79	33	VW
2007	4R	TEL2007745	Western IIA	4	10	AC
2007	3O	TEL2007750	Campelen	60	7	VW
2007	2J	TEL2007753	Campelen	4	51	VW
2007	3K	TEL2007755	Campelen	30	56	VW
2007	3L	TEL2007799	Campelen	11	30	VW
2007	2J, 3K	TEL2007802	Campelen	49	30	VW
2007	3L	TEL2007803	Campelen	9	11	VW
2007	4R	TEL2007004	Campelen	1		DB/DA/PA
2007	4V	TEM2007686	Western IIA	18	7	AC
2007	3P	TEM2007757	Campelen	9	23	VW
2007	3P, 3Q	TEM2007758	Campelen	35	50	VW
2007	3P	TEM2007759	Campelen	23	86	VW
2007	3O	TEM2007760	Campelen	23	38	VW
2007	3N	TEM2007761	Campelen	6	26	VW
2007	3L	TEM2007762	Campelen	38	14	VW
2007	3O	TEM2007770	Campelen	4	25	VW
2007	3O	TEM2007771	Campelen	24	35	VW
2007	3L, 3N	TEM2007772	Campelen	12	55	VW
2007	3L	TEM2007773	Campelen	25	39	VW
2007	3K	TEM2007774	Campelen	13	35	VW
2007	3L	TEM2007800	Campelen	28	25	VW
2007	3L	TEM2007804	Campelen	6	2	VW
2007	3L	3LCANZEE07	Campelen	26		FJM
2008	2G	BAL2008103	Campelen	21	25	VW
2008	4V	TEM2008830	Western IIA	8		AC
2008	3L	3LCANZEE08	Campelen	30		FJM
2009		NED2009027	Western IIA	7		AC
2009	3L	3LCANZEE09	Campelen	37		FJM
Total				**2010**	**2541**	

**AC = Andrew Cogswell, DFO- Mar (BIO); VW = Vonda Wareham, DFO- NL; PA = Philippe Archambault, Université du Québec à Rimouski; DB = Denis Bernier, QC-DFO; DA = Diane Archambault, QC-DFO; FJM = F. Javier Murillo, Instituto Español de Oceanografía, Vigo, Spain.*

Table 17. *Species composition of the research vessel survey coral by-catch (Table 16) from the NL-Labrador Shelves Biogeographic Zone.*

Order	Species/Taxon	No. Records	NAFO Conservation Unit
	Anthozoa C.	8	
Alcyonacea	Alcyonacea O.	2	
	Nephtheidae F.	386	
	Gersemia rubiformis (Ehrenberg, 1834)	366	
	Gersemia sp. Marenzeller, 1877	4	
	Capnella florida (Rathke, 1806)	401	
	Anthomastus grandiflorus Verrill, 1878	77	
	Eunephthya rubiformis (Ehrenberg, 1834)	15	
	Duva sp. Koren & Danielssen, 1883	93	
Pennatulacea	*Anthoptilum grandiflorum* (Verrill, 1879)	88	Sea Pen
	Anthoptilum spp. Kölliker, 1880	35	Sea Pen
	Funiculina quadrangularis (Pallas, 1766)	26	Sea Pen
	Halipteris finmarchica (Sars, 1851)	42	Sea Pen
	Pennatula grandis Ehrenberg, 1834	51	Sea Pen
	Pennatula phosphorea Linnaeus, 1758	65	Sea Pen
	Pennatula aculeata Danielssen, 1860	38	Sea Pen
	Pennatulacea O.	48	Sea Pen
	Distichoptilum gracile Verrill, 1882	9	Sea Pen
	Kophobelemnon stelliferum (Müller, 1776)	1	Sea Pen
	Umbellula lindahli Kölliker, 1875	1	Sea Pen
Scleractinia	*Flabellum alabastrum* Moseley, 1876	76	
	Flabellum angulare Moseley, 1876	1	
	Flabellum spp. Lesson, 1832	3	
	Vaughanella margaritata (Jourdan, 1895)	1	
	Dasmosmilia lymani (Pourtalès, 1871)	1	
Gorgonacea	*Acanella arbuscula* (Johnson, 1862)	142	Small Gorgonian
	Anthothela grandiflora (Sars, 1856)	11	Small Gorgonian
	Acanthogorgia armata Verrill, 1878	52	Large Gorgonian
	Acanthogorgia spp. Gray, 1857	8	Large Gorgonian
	Paramuricea spp. Koelliker, 1865	42	Large Gorgonian
	Primnoa resedaeformis (Gunnerus, 1763)	34	Large Gorgonian
	Keratoisis ornata Verrill, 1878	13	Large Gorgonian
	Keratoisis spp. Wright, 1869	1	Large Gorgonian
	Paragorgia arborea (Linnaeus, 1758)	24	Large Gorgonian
	Radicipes gracilis (Verrill, 1884)	23	Large Gorgonian
	Gorgonacea O. spp.	1	
Antipatharia	Antipatharia O. spp.	12	Black Coral
	Stauropathes arctica (Lütken, 1871)	9	Black Coral

Table 18. *Quantile breakdown of coral research vessel catches (Table 16) in the NL-Labrador Shelves Biogeographic Zone by conservation unit. [Bold type indicates quantiles considered by NAFO, * indicates quantiles used by NAFO.]*

Percentage of Data	Quantile	Weight (kg) of Taxon Corresponding to Quantile Value		
		Sea Pens (N=403)	**Small Gorgonians (N= 152)**	**Large Gorgonians (N=199)**
100.0%	maximum	21.2200	1.1953	200.0000
99.5%		8.5900	1.1953	200.0000
97.5%		***2.4020**	***0.2796**	**45.7000**
90.0%		**0.2190**	**0.0848**	***1.5400**
75.0%	quartile	0.0600	0.0198	0.2000
50.0%	median	0.0150	0.0080	0.0510
25.0%	quartile	0.0040	0.0020	0.0120
10.0%		0.0010	0.0010	0.0040
2.5%		0.0001	0.0001	0.0010
0.5%		0.0001	0.0001	0.0001
0.0%	minimum	0.0001	0.0001	0.0001

Table 19. Position of significant catches of sea pens, small gorgonians and large gorgonians from the NL-Labrador Shelves Biogeographic Zone using quantiles of the catch distribution (Table 18). Positions of all black coral records are provided.

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Sea Pens: 97.5% Quantile						
NED2009027	2009	21.22	45.90567	-58.14283	45.88283	-58.11650
TEM2008830	2008	8.65	45.58317	-57.89633	45.56067	-57.87167
BAL2008103	2008	5.66	57.71917	-60.23500	57.72150	-60.20850
TEM2007686	2007	5.45	45.52283	-57.64250	45.51583	-57.68083
TEM2007686	2007	4.35	45.34950	-57.50700	45.36150	-57.54317
TEL2007745	2007	3.95	46.11767	-58.32483	46.14483	-58.34483
TEM2007759	2007	2.95	46.07167	-57.54833	46.06500	-57.51800
TEM2007686	2007	2.70	45.51600	-57.48517	45.54400	-57.48467
Small Gorgonians: 97.5% Quantile						
TEM2005619	2008	1.195	43.94000	-52.64200	43.93667	-52.62833
TEM2007760	2008	0.477	44.69500	-54.11333	44.69700	-54.10200
TEL2005542	2006	0.327	51.09667	-50.24333	51.08700	-50.25700
Large Gorgonians: 90% Quantile						
BAL2008103	2008	200.00	60.75817	-61.21017	60.74900	-61.21183
BAL2008103	2008	156.71	60.37483	-61.25067	60.39567	-61.24267
3LCANZEE07	2007	66.00	48.09950	-48.28670	48.09767	-48.24730
NED2006036	2006	54.20	44.38183	-57.34517	44.38483	-57.39633
TEM2005627	2005	45.70	43.54667	-52.05167	43.54700	-52.03300
3LCANZEE08	2008	19.00	48.15467	-48.55480	48.17267	-48.57880
BAL2006101	2006	17.22	60.49333	-61.39000	60.50333	-61.40000
TEL2006682	2006	10.00	50.44667	-50.59500	50.46000	-50.59700
3LCANZEE09	2009	6.00	48.34970	-49.06700	48.36133	-49.09267
3LCANZEE08	2008	4.80	48.11070	-48.23950	48.11350	-48.20350
BAL2005100	2005	3.75	60.18167	-61.72167	60.19333	-61.73833
TEL2007755	2007	2.63	51.94833	-50.71500	51.95800	-50.72800
BAL2008103	2008	2.25	60.77600	-62.12500	60.77533	-62.14283
TEM2005627	2005	2.02	44.73333	-54.28833	44.73300	-54.27200
TEL2004539	2004	1.70	52.37000	-51.18833	52.38000	-51.20200
3LCANZEE07	2007	1.54	48.14520	-48.42870	48.14133	-48.39350
Black Corals (All records)						
TEM2007760	2007	0.060	43.87167	-52.58833	43.88000	-52.60000
TEL2006683	2006	0.350	48.22000	-48.51333	48.23000	-48.52300
TEL2006682	2006	0.040	48.94833	-49.66000	48.93500	-49.65700

Table 19. Continued.

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Black Corals (All records)						
TEL2007755	2007	0.015	49.83500	-49.88333	49.84800	-49.88700
TEL2007755	2007	0.001	49.95167	-49.96667	49.96300	-49.97300
TEL2007755	2007	0.020	50.07167	-49.63667	50.08500	-49.64200
TEL2006682	2006	0.005	50.56667	-50.28167	50.55300	-50.28200
TEL2007755	2007	0.048	50.54000	-49.84833	50.55300	-49.84700
TEL2007802	2007	0.298	51.80333	-54.91500	51.79700	-54.89800
TEL2006682	2006	0.600	51.85167	-50.45167	51.86200	-50.47500
TEL2004539	2004	0.005	54.15167	-52.78000	54.14200	-52.76500
TEL2006680	2006	0.750	57.07167	-58.84500	57.06200	-58.83300
3LCANZEE08	2008	1.110	48.35267	-48.74300	48.36500	-48.77483
3LCANZEE09	2009	0.600	48.34400	-48.62450	48.33467	-48.59033
3LCANZEE07	2007	0.047	48.38383	-48.79083	48.36133	-48.77433
3LCANZEE07	2007	0.032	48.19450	-48.35600	48.20750	-48.38817
3LCANZEE08	2008	0.018	48.17533	-48.36150	48.18067	-48.39350
3LCANZEE08	2008	0.010	48.27600	-48.69333	48.28000	-48.72850
3LCANZEE07	2007	0.007	48.20400	-48.48617	48.17983	-48.48200
3LCANZEE08	2008	0.006	48.26833	-48.40950	48.28500	-48.43350
3LCANZEE07	2007	0.001	48.31283	-48.84483	48.29133	-48.83633

Table 20. *Position of significant catches of sea pens (≥ 0.4 kg/tow) from the NL-Labrador Shelves Biogeographic Zone as determined from spatial analyses.*

Mission	Year	Sea Pen Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
NED2009027	2009	21.22	45.90567	-58.14280	45.88283	-58.11650
TEM2008830	2008	8.65	45.58317	-57.89630	45.56067	-57.87170
BAL2008103	2008	5.66	57.71917	-60.23500	57.72150	-60.20850
TEM2007686	2007	5.45	45.52283	-57.64250	45.51583	-57.68080
TEM2007686	2007	4.35	45.34950	-57.50700	45.36150	-57.54320
TEL2007745	2007	3.95	46.11767	-58.32480	46.14483	-58.34480
TEM2007759	2007	2.95	46.07167	-57.54830	46.06500	-57.51800
TEM2007686	2007	2.70	45.51600	-57.48520	45.54400	-57.48470
BAL2008103	2008	2.49	57.99167	-59.71350	58.00050	-59.73050
BAL2008103	2008	2.43	57.86850	-59.70050	57.87167	-59.71970
TEM2007758	2007	2.15	47.52000	-57.81330	47.51300	-57.79800
TEM2005617	2005	1.90	46.81167	-58.35830	46.82500	-58.35700
TEM2007758	2007	1.87	46.92500	-58.70330	46.93300	-58.71300
TEM2005617	2005	0.94	46.29000	-57.69670	46.29800	-57.71200
TEM2007758	2007	0.91	46.49833	-57.75170	46.51200	-57.75200
TEM2005627	2005	0.90	43.54667	-52.05170	43.54700	-52.03300
TEM2007758	2007	0.89	46.47000	-58.32000	46.45800	-58.32200
TEM2007771	2007	0.85	43.62333	-52.20330	43.61700	-52.19500
TEL2005608	2005	0.69	43.79500	-52.63170	43.78500	-52.62000
TEM2007759	2007	0.68	45.61000	-56.67170	45.62000	-56.68200
TEL2007750	2007	0.61	43.61500	-52.24830	43.62000	-52.26300
TEM2005617	2005	0.58	46.65833	-57.69330	46.67000	-57.70200
TEL2005608	2005	0.50	43.60167	-52.22330	43.60000	-52.21700
TEM2007759	2007	0.48	45.40167	-56.61330	45.40000	-56.59700
TEL2007750	2007	0.47	43.84833	-52.61670	43.86200	-52.62200
BAL2006101	2006	0.43	58.95000	-60.03500	58.96167	-60.04330
TEM2007758	2007	0.41	46.37000	-57.62000	46.37300	-57.60300
TEM2007758	2007	0.40	46.67833	-57.72170	46.67000	-57.71000

Table 21. *Position of significant catches of small gorgonians (≥ 0.3 kg/tow) from the NL-Labrador Shelves Biogeographic Zone as determined by spatial analyses.*

Mission	Year	Small Gorgonian Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
TEM2005619	2008	1.195	43.94000	-52.64200	43.93667	-52.62833
TEM2007760	2008	0.477	44.69500	-54.11333	44.69700	-54.10200
TEL2005542	2006	0.327	51.09667	-50.24333	51.08700	-50.25700

Table 22. *Position of significant catches of large gorgonians (≥ 0.3 kg/tow) from the NL-Labrador Shelves Biogeographic Zone as determined from spatial analyses.*

Mission	Year	Large Gorgonian Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
BAL2008103	2008	200.00	60.75817	-61.21020	60.74900	-61.21180
BAL2008103	2008	156.71	60.37483	-61.25070	60.39567	-61.24270
3LCANZEE07	2007	66.00	48.09950	-48.28670	48.09767	-48.24730
NED2006036	2006	54.20	44.38183	-57.34520	44.38483	-57.39630
TEM2005627	2005	45.70	43.54667	-52.05170	43.54700	-52.03300
3LCANZEE08	2008	19.00	48.15467	-48.55480	48.17267	-48.57880
BAL2006101	2006	17.22	60.49333	-61.39000	60.50333	-61.40000
TEL2006682	2006	10.00	50.44667	-50.59500	50.46000	-50.59700
3LCANZEE09	2009	6.00	48.34970	-49.06700	48.36133	-49.09270
3LCANZEE08	2008	4.80	48.11070	-48.23950	48.11350	-48.20350
BAL2005100	2005	3.75	60.18167	-61.72170	60.19333	-61.73830
TEL2007755	2007	2.63	51.94833	-50.71500	51.95800	-50.72800
BAL2008103	2008	2.25	60.77600	-62.12500	60.77533	-62.14280
TEM2005627	2005	2.02	44.73333	-54.28830	44.73300	-54.27200
TEL2004539	2004	1.70	52.37000	-51.18830	52.38000	-51.20200
3LCANZEE07	2007	1.54	48.14520	-48.42870	48.14133	-48.39350
TEM2006707	2006	1.03	47.65000	-50.58170	47.64300	-50.56800
TEM2007760	2007	1.02	43.87167	-52.58830	43.88000	-52.60000
3LCANZEE08	2008	0.98	48.53230	-49.51470	48.54617	-49.54500
TEL2004539	2004	0.88	55.09167	-53.97000	55.08000	-53.97300
TEM2005588	2005	0.75	51.30833	-50.11670	51.30000	-50.11200
TEL2006679	2006	0.68	55.54333	-56.68330	55.55200	-56.69500
TEL2005542	2005	0.66	51.37833	-50.19170	51.39000	-50.19700
TEL2007755	2007	0.65	51.05167	-50.16500	51.05000	-50.14500
TEM2005618	2005	0.58	44.82667	-54.49170	44.83300	-54.47700
TEL2006681	2006	0.55	55.21667	-55.17330	55.22000	-55.19300
TEL2006682	2006	0.55	48.70333	-49.56830	48.71300	-49.57800
3LCANZEE08	2008	0.54	48.34280	-48.89570	48.36350	-48.91320
3LCANZEE08	2008	0.49	48.22400	-48.58280	48.24200	-48.60570
TEL2005611	2005	0.44	52.97667	-51.78330	52.96700	-51.77200
BAL2006101	2006	0.40	60.32667	-62.16000	60.31833	-62.13830
BAL2006101	2006	0.39	60.48333	-61.30000	60.49667	-61.30830
3LCANZEE07	2007	0.37	49.03570	-49.56350	49.01250	-49.57900
TEL2003509	2003	0.33	53.14667	-51.96500	53.13500	-51.95800
TEL2006683	2006	0.32	48.42000	-48.75330	48.42300	-48.76800
TEL2005611	2005	0.32	54.63833	-52.74500	54.62700	-52.75200

Table 23. *Details of the data used for the analyses and description of sponge distribution from the NL-Labrador Shelves Biogeographic Zone.*

Year	NAFO Division	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records†	Data Provider*
1995	2J, 3K	TEL1995020	Campelen	3		VW
1995	3N	TEM1995177	Campelen	2		VW
1995	3K	TEM1995180	Campelen	29		VW
1995	3K	TEM1995181	Campelen	13		VW
1996	3N	NED1996253	Campelen	2		VW
1996	2J, 3K, 3L	TEL1996023	Campelen	12		VW
1996	2H	TEL1996036	Campelen	18		VW
1996	2G, 2H	TEL1996037	Campelen	16		VW
1996	2J, 3K	TEL1996039	Campelen	43		VW
1996	3K	TEL1996040	Campelen	6		VW
1996	3L	TEL1996041	Campelen	3		VW
1996	3O	TEL1996042	Campelen	1		VW
1996	3P, 3Q	TEM1996186	Campelen	18		VW
1996	3O	TEM1996188	Campelen	1		VW
1996	3L	TEM1996197	Campelen	4		VW
1996	3K	TEM1996198	Campelen	5		VW
1997	2G	TEL1997053	Campelen	20		VW
1997	2H	TEL1997054	Campelen	14		VW
1997	2J, 3K	TEL1997055	Campelen	26		VW
1997	3K	TEL1997056	Campelen	65		VW
1997	3K, 3L	TEL1997057	Campelen	14		VW
1997	3L	TEL1997058	Campelen	2		VW
1997	3P	TEM1997202	Campelen	2		VW
1997	3N	TEM1997214	Campelen	2		VW
1997	3K	TEM1997217	Campelen	2		VW
1998	2G	TEL1998071	Campelen	5		VW
1998	2H, 2J	TEL1998072	Campelen	33		VW
1998	2J, 3K	TEL1998073	Campelen	14		VW
1998	3K	TEL1998074	Campelen	37		VW
1998	3K, 3L	TEL1998075	Campelen	12		VW
1998	3P	TEM1998219	Campelen	2		VW
1998	3O	TEM1998221	Campelen	1		VW
1998	3K	TEM1998227	Campelen	1		VW
1998	3O	TEM1998229	Campelen	4		VW
1998	3L, 3N	TEM1998230	Campelen	3		VW
1998	3L	TEM1998231	Campelen	1		VW
1998	3K, 3L	TEM1998232	Campelen	5		VW
1999	2G	TEL1999084	Campelen	5		VW
1999	2G, 2H	TEL1999085	Campelen	12		VW
1999	2H, 2J	TEL1999086	Campelen	40		VW
1999	3K	TEL1999087	Campelen	8		VW
1999	3K	TEL1999088	Campelen	8		VW
1999	3P	TEM1999236	Campelen	2		VW
1999	3N	TEM1999239	Campelen	2		VW
1999	3L	TEM1999241	Campelen	8		VW
1999	3L	TEM1999247	Campelen	2		VW
1999	3L	TEM1999248	Campelen	1		VW
2000	2J	TEL2000339	Campelen	3		VW
2000	2J, 3K	TEL2000340	Campelen	21		VW

Table 23. *Continued.*

Year	NAFO Division	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records†	Data Provider*
2000	3K	TEL2000340	Campelen	28		VW
2000	3P	TEM2000313	Campelen	2		VW
2000	3O	TEM2000316	Campelen	1		VW
2000	3L, 3N	TEM2000317	Campelen	2		VW
2000	3L	TEM2000318	Campelen	2		VW
2000	3O	TEM2000319	Campelen	1		VW
2000	3L	TEM2000321	Campelen	2		VW
2000	3N	TEM2000322	Campelen	2		VW
2000	3L	TEM2000323	Campelen	1		VW
2001	2J	NED2001399	Campelen	4		VW
2001	2H	NED2001400	Campelen	1		VW
2001	2J	TEL2001361	Campelen	14		VW
2001	2K	TEL2001362	Campelen	4		VW
2001	3K	TEL2001397	Campelen	6		VW
2001	3P, 3Q	TEM2001364	Campelen	4		VW
2001	3P	TEM2001365	Campelen	1		VW
2001	3L, 3N	TEM2001369	Campelen	2		VW
2001	3L	TEM2001370	Campelen	4		VW
2001	3N	TEM2001373	Campelen	1		VW
2001	3L	TEM2001375	Campelen	1		VW
2001	3K, 3L	TEM2001376	Campelen	5		VW
2001	3K	TEM2001398	Campelen	1		VW
2002	4V	NED2002040	Western IIA	1		AC
2002	3P, 4U	TEL2002409	Campelen	2		VW
2002	2J, 3K	TEL2002415	Campelen	12		VW
2002	3P, 3Q	TEM2002418	Campelen	3		VW
2002	3L	TEM2002423	Campelen	3		VW
2002	3L	TEM2002428	Campelen	2		VW
2002	3L	TEM2002430	Campelen	1		VW
2002	3K	TEM2002431	Campelen	12		VW
2002	2J	TEM2002455	Campelen	1		VW
2003	2J, 3K	TEL2003457	Campelen	9		VW
2003	2J	TEL2003509	Campelen	27	62	VW
2003	2J, 3K	TEL2003510	Campelen	13	22	VW
2003	3K	TEM2003456	Campelen	1		VW
2003	3P, 3Q	TEM2003476	Campelen	2	57	VW
2003	3L	TEM2003481	Campelen	1	48	VW
2003	3L	TEM2003482	Campelen	3	97	VW
2003	3N	TEM2003486	Campelen	2	25	VW
2003	3K, 3L	TEM2003511	Campelen	5	33	VW
2004	3K, 3L	TEL2004513	Campelen	4	47	VW
2004	3K	TEL2004514	Campelen	2	78	VW
2004	3P	TEL2004522	Campelen	2	62	VW
2004	2H	TEL2004536	Campelen	7	17	VW
2004	2H, 2J	TEL2004537	Campelen	15	69	VW
2004	2J	TEL2004538	Campelen	3	44	VW
2004	2J, 3K	TEL2004539	Campelen	21	72	VW
2004	3K	TEL2004540	Campelen	1	37	VW
2004	3K	TEL2004541	Campelen	7	40	VW
2004	3P, 3Q	TEM2004546	Campelen	3	60	VW

Table 23. *Continued.*

Year	NAFO Division	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records†	Data Provider*
2004	3L, 3N	TEM2004548	Campelen	5	47	VW
2004	3L	TEM2004549	Campelen	3	112	VW
2004	3L	TEM2004587	Campelen	7	48	VW
2005	2G	BAL2005100	Campelen	15	64	VW
2005	3L	NED2005657	Campelen	3	67	VW
2005	3L	NED2005658	Campelen	3	12	VW
2005	3K	TEL2005542	Campelen	12	9	VW
2005	2J, 3K	TEL2005611	Campelen	25	30	VW
2005	2J	TEL2005612	Campelen	18	41	VW
2005	3K	TEM2005588	Campelen	5	12	VW
2005	3P	TEM2005617	Campelen	2	110	VW
2005	3P	TEM2005618	Campelen	4	65	VW
2005	3O	TEM2005619	Campelen	2	66	VW
2005	3L	TEM2005621	Campelen	11	114	VW
2005	3O	TEM2005627	Campelen	2	61	VW
2005	3N	TEM2005628	Campelen	2	32	VW
2005	3L	TEM2005629	Campelen	3	50	VW
2005	3L	TEM2005630	Campelen	1	51	VW
2005	3K	TEM2005631	Campelen	11	47	VW
2005	3K	TEM2005632	Campelen	5	38	VW
2006	2G	BAL2006101	Campelen	13	77	VW
2006	3N	NED2006729	Campelen	1	38	VW
2006	3K	TEL2006662	Campelen	5	21	VW
2006	2H	TEL2006679	Campelen	7	44	VW
2006	2H, 2J	TEL2006680	Campelen	12	40	VW
2006	2J, 3K	TEL2006681	Campelen	27	60	VW
2006	2J, 3K, 3L	TEL2006682	Campelen	28	39	VW
2006	3L	TEL2006683	Campelen	1	5	VW
2006	3K	TEL2006684	Campelen	15	37	VW
2006	3K	TEL2006733	Campelen	3	9	VW
2006	4R	TEL2006003	Campelen	3	1	DB/DA/PA
2006	3K	TEM2006660	Campelen	39	22	VW
2006	3P, 3Q	TEM2006688	Campelen	8	41	VW
2006	3L	TEM2006692	Campelen	1	56	VW
2006	3L	TEM2006693	Campelen	14	59	VW
2006	3O	TEM2006704	Campelen	1	65	VW
2006	3N	TEM2006705	Campelen	1	43	VW
2006	3L	TEM2006706	Campelen	3	48	VW
2006	3K, 3L	TEM2006707	Campelen	26	56	VW
2006	3K	TEM2006708	Campelen	15	43	VW
2007	2G	BAL2007102	Campelen	15	71	VW
2007	4R	TEL2007745	Western IIA	3		AC
2007	2J, 3L	TEL2007752	Campelen	21	16	VW
2007	2J	TEL2007753	Campelen	31	21	VW
2007	3K	TEL2007755	Campelen	35	35	VW
2007	3L	TEL2007799	Campelen	2	39	VW
2007	2J, 3K	TEL2007802	Campelen	31	32	VW
2007	3L	TEL2007803	Campelen	2	16	VW
2007	4V	TEM2007686	Western IIA	4		AC
2007	3P	TEM2007757	Campelen	2	28	VW

***Table 23**. Continued.*

Year	NAFO Division	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records†	Data Provider*
2007	3P, 3Q	TEM2007758	Campelen	17	59	VW
2007	3P	TEM2007759	Campelen	1	96	VW
2007	3O	TEM2007760	Campelen	3	41	VW
2007	3N	TEM2007761	Campelen	3	28	VW
2007	3L	TEM2007762	Campelen	2	39	VW
2007	3L, 3N	TEM2007772	Campelen	2	63	VW
2007	3L	TEM2007773	Campelen	14	44	VW
2007	3K	TEM2007774	Campelen	19	24	VW
2007	3L	TEM2007800	Campelen	14	29	VW
2007	3L	TEM2007804	Campelen	3	3	VW
2008	2G	BAL2008103	Campelen	26	49	VW
2008	3L	NED2008867	Campelen	1		VW
2008	3K, 3L	NED2008868	Campelen	20		VW
2008	3K	NED2008869	Campelen	28		VW
2008	4V	TEL2008805	Western IIA	3		AC
2008	2H	TEL2008817	Campelen	20		VW
2008	2H	TEL2008818	Campelen	18		VW
2008	2J	TEL2008820	Campelen	20		VW
2008	3K	TEL2008821	Campelen	3		VW
2008	3L	TEL2008864	Campelen	12		VW
2008	3P	TEM2008824	Campelen	12		VW
2008	3P	TEM2008826	Campelen	6		VW
2008	3O	TEM2008827	Campelen	3		VW
2008	3N	TEM2008828	Campelen	4		VW
2008	3L	TEM2008829	Campelen	6		VW
2008	4V	TEM2008830	Western IIA	4		AC
2008	3N	TEM2008833	Campelen	2		VW
2008	3O	TEM2008835	Campelen	4		VW
2008	3O	TEM2008836	Campelen	3		VW
2008	3L, 3N	TEM2008837	Campelen	9		VW
2008	3K, 3L	TEM2008838	Campelen	32		VW
2008	2J, 3K	TEM2008839	Campelen	46		VW
2008	2J, 3K	TEM2008840	Campelen	26		VW
2008	3K	TEM2008841	Campelen	13		VW
2009		NED2009027	Western IIA	7		AC
Total				**1721**	**3403**	

**AC = Andrew Cogswell, DFO- Mar (BIO); VW = Vonda Wareham, DFO- NL; PA = Philippe Archambault, Université du Québec à Rimouski, DB = Denis Bernier, QC-DFO; DA = Diane Archambault, QC-DFO.*
†There are 216 null records that are found in the NAFO Zone 2G and can not be associated with a single mission but are from two or three possible missions. These have been included in plots.

Table 24. *A preliminary list of sponge taxa identified by S.D. Fuller (unpub. MS) from research vessel surveys of the NL-Labrador Shelves Biogeographic Zone.*

Order	**Family**	**Taxon**
Class Demospongiae		
Hadromerida	Polymastiidae	*Tentorium semisuberites* (Schmidt, 1870)
		Weberella bursa (Muller, 1806)
	Suberitidae	*Suberites ficus* (Esper, 1794)
Halichondrida	Halichondriidae	*Halichondria* spp.
	Axinellidae	*Phakellia* spp.
		Axinella spp.
	Haliclonidae	*Haliclona* spp.
Astrophorida	Astrophoridae	Astrophoridae
	Geodidae	*Geodia macandrewi* Bowerbank, 1858
		Geodia barretti Bowerbank, 1858
	Pachastrellidae	*Thenea muricata* (Bowerbank, 1858)
Poecilosclerida	Mycalidae	*Mycale lingua* (Bowerbank, 1866)
	Myxillidae	*Melonanchora elliptica* Carter, 1874
	Desmacellidae	*Biemna* cf. *variantia* (Bowerbank, 1866)
	Cladorhizidae	*Cladorhiza abyssicola* Sars, 1872
		Chondrocladia gigantea (Hansen, 1885)
		Asbestopluma spp.
	Clathriidae	*Antho dichotoma* (Linnaeus, 1767)
	Coelospheridae	*Lissondendoryx* spp.
	Desmacellidae	*Biemna* cf. *variantia* (Bowerbank, 1866)
	Esperiopsidae	*Amphilectus* spp.*?*
Spirophorida	Tetillidae	*Tetilla* spp.
Class Hexactinellida		
Hexactinosida	Aphrocallistidae	*Aphrocallistes beatrix* (?) Gray, 1858
Lyssancinosida	Euplectellidae	*Euplectella aspergillum* (?*)*Owen, 1841
Hexactinellida	Rossellidae	*Asconema foliata*

Table 25. *Quantile breakdown of sponge research vessel catches using a Campelen trawl (Table 23) in the NL-Labrador Shelves Biogeographic Zone by conservation unit.*

Percentage of Data	Quantile	Weight (kg) of Sponge Corresponding to Quantile Value
100.0%	maximum	1200.00
99.5%		561.40
97.5%		207.30
90.0%		40.00
75.0%	quartile	8.00
50.0%	median	2.40
25.0%	quartile	0.80
10.0%		0.25
2.5%		0.09
0.5%		0.03
0.0%	minimum	0.01

Table 26. *Start and end positions of significant concentrations of sponge in the NL-Labrador Shelves Biogeographic Zone as determined from spatial analyses of research vessel survey by-catch using Campelen trawls (Table 23).*

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)	Depth (m)	NAFO Division
BAL2008103	2008	1200.0	60.758	-61.210	60.748	-61.212	555	2G
BAL2008103	2008	1043.2	60.375	-61.250	60.395	-61.243	468	2G
TEL1997053	1997	1000.0	60.812	-61.195	60.812	-61.195	548	2G
BAL2006101	2006	800.0	60.643	-61.433	60.650	-61.457	468	2G
TEL2007753	2007	602.8	55.033	-53.658	55.022	-53.657	1494	2J
TEL2001361	2001	591.8	54.722	-52.777	54.712	-52.790	1357	2J
TEL2007753	2007	580.9	55.082	-53.988	55.070	-53.978	1043	2J
BAL2007102	2007	579.7	60.025	-60.992	60.035	-61.002	315	2G
TEL1996039	1996	550.0	54.782	-52.957	54.790	-52.973	1122	2J
TEL2004539	2004	521.2	55.092	-53.970	55.080	-53.973	1211	2J
TEL2004539	2004	519.1	52.000	-50.660	52.010	-50.672	1064	3K
TEL2005611	2005	514.0	53.935	-52.545	53.925	-52.537	1313	2J
TEL2005542	2005	500.0	51.577	-50.100	51.567	-50.092	1408	3K
TEL2001361	2001	500.0	54.112	-52.747	54.100	-52.738	1101	2J
TEL2006681	2006	500.0	54.727	-52.915	54.715	-52.928	1095	2J
TEL2001361	2001	500.0	54.412	-53.170	54.398	-53.162	838	2J
TEL1999084	1999	500.0	60.400	-61.257	60.412	-61.262	423	2G
BAL2006101	2006	500.0	60.483	-61.300	60.497	-61.308	413	2G
TEL1997053	1997	500.0	60.637	-61.297	60.652	-61.297	471	2G
TEL2005611	2005	487.6	54.638	-52.745	54.627	-52.752	1427	2J
TEL2001361	2001	446.7	54.157	-52.708	54.170	-52.713	1306	2J
TEL2007753	2007	436.7	54.947	-53.535	54.948	-53.548	1252	2J
TEL2006681	2006	400.0	54.760	-52.927	54.767	-52.943	1086	2J
TEL2001361	2001	400.0	54.780	-52.915	54.772	-52.900	1159	2J
TEL2001361	2001	400.0	54.683	-53.083	54.672	-53.097	878	2J
TEL1996023	1996	368.4	54.542	-53.132	54.547	-53.110	948	2J
TEL1996039	1996	360.0	54.663	-53.105	54.675	-53.113	863	2J
TEL2004539	2004	350.0	55.068	-54.028	55.055	-54.033	875	2J
TEL2004539	2004	320.0	51.857	-50.465	51.868	-50.475	1132	3K
TEM1996188	1996	275.9	45.860	-53.957	45.865	-53.975	137	3O
TEL2005611	2005	265.7	54.627	-52.960	54.617	-52.960	1205	2J
TEL1998072	1998	257.6	55.448	-55.803	55.445	-55.818	1473	2H
TEL2003509	2003	256.0	53.233	-52.000	53.245	-52.012	1035	2J
TEL1998073	1998	250.0	54.348	-52.967	54.362	-52.968	1212	2J
TEL2006681	2006	250.0	54.455	-53.002	54.443	-53.008	1443	2J
TEL1996037	1996	239.5	60.583	-60.783	60.585	-60.808	1436	2G
TEL2007753	2007	235.7	55.238	-54.947	55.238	-54.932	1150	2J
TEL2003457	2003	230.8	54.580	-53.270	54.593	-53.268	656	2J
TEL2008820	2008	215.5	53.387	-52.063	53.398	-52.072	1165	2J
TEL2001362	2001	215.2	51.890	-50.457	51.878	-50.445	1422	3K
TEL2002415	2002	214.6	53.502	-52.140	53.490	-52.130	1177	2J
TEL2008820	2008	210.4	53.078	-51.797	53.092	-51.807	1422	2J

__Table 26.__ Continued.

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)	Depth (m)	NAFO Division
TEL2007753	2007	207.9	53.035	-51.750	53.043	-51.755	1371	2J
TEL2000340	2000	200.0	53.087	-51.807	53.095	-51.818	1388	2J
TEL2003509	2003	200.0	53.348	-51.957	53.337	-51.948	1404	2J
TEL1999086	1999	200.0	54.108	-52.683	54.122	-52.690	1282	2J
TEL2000340	2000	200.0	54.192	-52.802	54.202	-52.827	1147	2J
TEL2006681	2006	200.0	54.733	-53.125	54.723	-53.113	786	2J
TEL2000340	2000	200.0	54.525	-53.115	54.513	-53.118	1141	2J
TEL1999085	1999	200.0	56.950	-58.247	56.960	-58.258	1454	2H
BAL2007102	2007	200.0	60.612	-61.270	60.625	-61.275	462	2G

Table 27. *Details of the data used for the analyses and description of coral distribution from the Gulf Biogeographic Zone. All data are from research vessel surveys.*

Year	Survey Area	Mission	Gear Type	Number of Coral Records	Number of Null Coral Records**	Data Provider*
1990	Southern Gulf	HAM1990219	Western IIA	3		HB
1991	Southern Gulf	HAM1991232	Western IIA	14		HB
1992	Southern Gulf	NED1992178	Western IIA	6		HB
1993	Southern Gulf	NED1993192	Western IIA	11		HB
1994	Southern Gulf	NED1994210	Western IIA	3		HB
1995	Southern Gulf	NED1995230	Western IIA	7		HB
1996	Southern Gulf	NED1996249	Western IIA	14		HB
1997	Southern Gulf	NED1997746	Western IIA	15		HB
1998	Southern Gulf	NED1998846	Western IIA	8		HB
1999	Southern Gulf	NED1999941	Western IIA	12		HB
2000	Southern Gulf	NED2000045	Western IIA	16		HB
2001	Southern Gulf	NED2001150	Western IIA	15	134	HB
2001	Northern Gulf	NED2001012	URI Shrimp	27	230	DB/DA
2002	Southern Gulf	NED2002251	Western IIA	11	174	HB
2002	Northern Gulf	NED2002013	URI Shrimp	46	165	DB/DA
2003	Southern Gulf	TEM2003352	Western IIA	57	29	HB
2003	Southern Gulf	NED2003042	Western IIA	4		AC
2003	Northern Gulf	NED2003014	URI Shrimp	1	198	DB/DA
2004	Southern Gulf	NED2004446	Western IIA	17	31	HB
2004	Southern Gulf	TEL2004434	Western IIA	69	99	HB
2004	Northern Gulf	NED2004015	URI Shrimp	2	8	DB/DA
2004	Northern Gulf	TEL2004001	Campelen	2	140	DB/DA
2005	Southern Gulf	NED2005542	Western IIA	52	67	HB
2005	Southern Gulf	TEL2005507	Western IIA	72	52	HB
2005	Southern Gulf	TEL2005633	Western IIA	10	3	AC
2005	Northern Gulf	NED2005016	URI Shrimp	4	176	DB/DA
2006	Northern Gulf	TEL2006003	Campelen	151	100	DB/DA/PA
2006	Southern Gulf	TEL2006678	Western IIA	95	84	HB
2006	Southern Gulf	TEM2006688	Campelen	3	1	VW
2006	Southern Gulf	NED2006036	Western IIA	4	4	AC
2007	Northern Gulf	TEL2007004	Campelen	176	74	DB/DA/PA
2007	Southern Gulf	TEL2007749	Western IIA	91	78	HB
2007	Southern Gulf	TEL2007745	Western IIA	4	8	AC
2007	Southern Gulf	TEM2007758	Campelen	12		VW
2008	Southern Gulf	TEL2008815	Western IIA	86	92	HB
2008	Southern Gulf	TEM2008830	Western IIA	5		AC
2008	Northern Gulf	TEL2008005	Campelen	219	73	DB
2009	Southern Gulf	NED2009027	Western IIA	5		AC
2009	Northern Gulf	TEL2009006	Campelen	189	46	DB
Total				**1538**	**2066**	

**HB = Hugues Benoit, DFO-Gulf; AC = Andrew Cogswell, DFO- Mar (BIO); VW = Vonda Wareham, DFO-NL; PA = Philippe Archambault, Université du Québec à Rimouski, DB = Denis Bernier, QC-DFO; DA = Diane Archambault, QC-DFO.*
***Null records prior to 2001 are not considered to be reliable as coral were not routinely recorded then.*

Table 28. *Species composition of the 2003 research vessel survey coral by-catch from the Gulf Biogeographic Zone.*

Order (NAFO Conservation Unit)	**Species/Taxon**	**No. Records**	**Region**
	Anthozoa C.	4	Southern Gulf
Alcyonacea	Alcyonacea O.	108	Northern Gulf
	Gersemia rubiformis (Ehrenberg, 1834)	604	Southern Gulf, Northern Gulf 3Pn, 4S, 4R, 4T
	Capnella florida (Rathke, 1806)	4	Northern Gulf 3Pn, 4S, 4R
	Duva sp. Koren & Danielssen, 1883	28	Northern Gulf 4S, 4T, 4Vn, 3Pn
	Eunephthya rubiformis (Ehrenberg, 1834)	18	Southern Gulf 4Vn
	Anthomastus grandiflorus Verrill, 1878	4	Northern Gulf 4T, 4S
Pennatulacea (Sea Pens)	*Anthoptilum grandiflorum* (Verrill, 1879)	3	Northern Gulf 3Pn
	Funiculina quadrangularis (Pallas, 1766)	1	Northern Gulf 3Pn
	Halipteris finmarchica (Sars, 1851)	1	Northern Gulf 3Pn
	Pennatula borealis M. Sars, 1846	264	Southern Gulf
	Pennatula grandis Ehrenberg, 1834	2	Northern Gulf 3Pn
	Pennatula aculeata Danielssen, 1860	12	Northern Gulf 4R, 4S, 4T
	Pennatulacea O.	442	Northern Gulf Southern Gulf 4Vn, 4R, 4S, 4T, 3Pn
Scleractinia	*Flabellum alabastrum* Moseley, 1876	18	Northern Gulf 3Pn, 4S, 4R
	Scleractinia O.	21	Northern Gulf 4S, 4T, 4R
Gorgonacea (Large Gorgonians)	*Paramuricea* spp. Koelliker, 1865	4	Northern Gulf 4R
	Primnoa resedaeformis (Gunnerus, 1763)	1	Southern Gulf 4Vn

Table 29. *Quantile breakdown of sea pen (Pennatulacea O. spp.) research vessel catches (Table 27) from the Gulf Biogeographic Zone by gear type. [Bold type indicates quantiles considered by NAFO, * indicates quantiles used by NAFO.]*

Percentage of Data	Quantile	Weight (kg) of Sea Pens Corresponding to Quantile Value	
		Western IIA Trawl (Southern Gulf)	**Campelen Trawl (Northern Gulf)**
100.0%	maximum	193.210	93.1000
99.5%		159.450	43.8150
97.5%		***46.450**	***15.9900**
90.0%		**8.650**	**3.8050**
75.0%	quartile	1.410	1.0660
50.0%	median	0.270	0.0970
25.0%	quartile	0.044	0.0110
10.0%		0.015	0.0030
2.5%		0.005	0.0010
0.5%		0.002	0.0002
0.0%	minimum	0.002	0.0001

Table 30. *Start and end positions of significant concentrations of sea pens in the Gulf Biogeographic Zone by gear type as determined from the 97.5% quantile of the catch distribution (Table 29).*

Mission	Year	Sea Pen* Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Western IIA Trawl (Southern Gulf)						
NED1998846	1998	193.2	47.7280	-60.4855	47.7545	-60.5022
TEL2008815	2008	99.4	47.9827	-60.8882	47.9672	-60.8520
NED1996249	1996	85.3	47.8697	-60.6370	47.8492	-60.6070
NED1998846	1998	81.6	47.7230	-60.4780	47.7462	-60.5025
NED1998846	1998	72.6	47.8920	-60.7042	47.9128	-60.7355
TEL2004434	2004	48.2	47.8447	-60.6468	47.8670	-60.6750
Campelen Trawl (Northern Gulf)						
TEL2008005	2008	93.10	49.33050	-64.2745	49.31733	-64.2763
TEL2009006	2009	49.45	49.45500	-64.7817	49.45517	-64.7628
TEL2007004	2007	30.35	47.83667	-60.6050	47.82800	-60.5915
TEL2008005	2008	27.96	48.54283	-62.7862	48.55067	-62.8015
TEL2009006	2009	24.40	48.75767	-62.7922	48.76317	-62.8105
TEL2004001	2004	24.10	48.39500	-62.0912	48.39750	-62.1080
TEL2006003	2006	20.85	49.19483	-63.9722	49.18967	-63.9555
TEL2008005	2008	20.05	49.16467	-64.0998	49.16100	-64.0820
TEL2006003	2006	19.85	49.54733	-64.9745	49.54917	-64.9558
TEL2008005	2008	17.24	48.55183	-62.4913	48.55900	-62.5068
TEL2008005	2008	16.75	47.78283	-60.5528	47.79283	-60.5655

**All significant catches were reported as Pennatula borealis or Pennatulacea O. spp.*

Table 31. *Start and end positions of significant concentrations of sea pens in the Gulf Biogeographic Zone by gear type as determined from spatial analyses of research vessel survey by-catch (Table 27).*

Mission	Year	Sea Pen* Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Western IIA Trawl (Southern Gulf)						
NED1998846	1998	193.20	47.7280	-60.4855	47.7545	-60.5022
TEL2008815	2008	99.4	47.9827	-60.8882	47.9672	-60.8520
NED1996249	1996	85.3	47.8697	-60.6370	47.8492	-60.6070
NED1998846	1998	81.6	47.7230	-60.4780	47.7462	-60.5025
NED1998846	1998	72. 6	47.8920	-60.7042	47.9128	-60.7355
TEL2004434	2004	48.2	47.8447	-60.6468	47.8670	-60.6750
TEL2006678	2006	46.0	48.6785	-63.4545	48.7035	-63.4787
TEL2007749	2007	42.5	47.9362	-60.8255	47.9552	-60.8588
HAM1991232	1991	40.1	47.7167	-60.4667	-	-
NED2001150	2001	37.2	47.9208	-60.7230	47.9003	-60.6912
HAM1991232	1991	31.9	49.1000	-63.8833	-	-
TEL2006678	2006	24.2	49.1322	-63.9753	49.1607	-63.9732
TEL2006678	2006	20.6	47.9100	-60.6710	47.9015	-60.6440
TEL2003352	2003	19.8	48.7732	-63.2023	48.7933	-63.2328
TEL2007749	2007	19.3	48.2750	-61.8828	48.2630	-61.8435
NED1998846	1998	17.6	47.8903	-60.7058	47.9122	-60.7345
TEL2007749	2007	17.4	48.6973	-63.2172	48.6753	-63.1917
TEL2008815	2008	17.3	48.7977	-63.2955	48.7807	-63.2617
TEL2005507	2005	15.8	48.7640	-63.2078	48.7420	-63.1788
Campelen Trawl (Northern Gulf)						
TEL2008005	2008	93.10	49.33050	-64.2745	49.31733	-64.2763
TEL2009006	2009	49.45	49.45500	-64.7817	49.45517	-64.7628
TEL2007004	2007	30.35	47.83667	-60.6050	47.82800	-60.5915
TEL2008005	2008	27.96	48.54283	-62.7862	48.55067	-62.8015
TEL2009006	2009	24.40	48.75767	-62.7922	48.76317	-62.8105
TEL2004001	2004	24.10	48.39500	-62.0912	48.39750	-62.1080
TEL2006003	2006	20.85	49.19483	-63.9722	49.18967	-63.9555
TEL2008005	2008	20.05	49.16467	-64.0998	49.16100	-64.0820
TEL2006003	2006	19.85	49.54733	-64.9745	49.54917	-64.9558
TEL2008005	2008	17.24	48.55183	-62.4913	48.55900	-62.5068
TEL2008005	2008	16.75	47.78283	-60.5528	47.79283	-60.5655
TEL2006003	2006	15.15	49.22467	-63.9092	49.21150	-63.9052
TEL2004001	2004	13.80	48.01433	-60.9085	48.00650	-60.8935
TEL2007004	2007	12.55	47.75233	-60.3902	47.75833	-60.4047
TEL2009006	2009	11.55	49.33000	-64.2033	49.33333	-64.2233
TEL2007004	2007	11.20	49.44217	-64.8053	49.43217	-64.7938
TEL2009006	2009	11.00	48.74367	-63.1578	48.73617	-63.1420

Table 31. Continued.

Mission	Year	Sea Pen* Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Campelen Trawl (Northern Gulf)						
TEL2006003	2006	11.00	47.73967	-59.5865	47.7520	-59.5895
TEL2006003	2006	10.60	49.51683	-66.0410	49.5215	-66.0242
TEL2009006	2009	10.00	48.28017	-60.4312	48.2795	-60.4125
TEL2007004	2007	9.95	49.34083	-64.4903	49.3475	-64.5077
TEL2008005	2008	7.97	48.61833	-62.6233	48.6113	-62.6087
TEL2008005	2008	7.70	49.33800	-66.2898	49.3345	-66.3085
TEL2009006	2009	7.50	49.18367	-66.6577	49.1863	-66.6395
TEL2006003	2006	7.05	48.40933	-61.3452	48.4178	-61.3580

**All catches were reported as Pennatula borealis or Pennatulacea O. spp.*

Table 32. *Details of the data used for the analyses and description of sponge distribution from the Gulf Biogeographic Zone.*

Year	Survey Area	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records	Data Provider*
1990	Southern Gulf	HAM1990219	Western IIA	10	137	HB
1991	Southern Gulf	HAM1991232	Western IIA	29	163	HB
1991	Northern Gulf	NED1991002	URI Shrimp	1		DB/DA
1992	Southern Gulf	NED1992178	Western IIA	24	145	HB
1993	Southern Gulf	NED1993192	Western IIA	39	150	HB
1994	Southern Gulf	NED1994210	Western IIA	48	112	HB
1994	Northern Gulf	NED1994005	URI Shrimp	4		DB/DA
1995	Southern Gulf	NED1995230	Western IIA	46	136	HB
1995	Northern Gulf	NED1995006	URI Shrimp	3		DB/DA
1996	Southern Gulf	NED1996249	Western IIA	36	172	HB
1996	Northern Gulf	NED1996007	URI Shrimp	2		DB/DA
1997	Southern Gulf	NED1997746	Western IIA	64	150	HB
1998	Southern Gulf	NED1998846	Western IIA	60	146	HB
1999	Southern Gulf	NED1999941	Western IIA	75	118	HB
1999	Northern Gulf	NED1999010	URI Shrimp	1		DB/DA
1999	Northern Gulf	1999012	Rock Hopper	1		DB/DA
2000	Southern Gulf	NED2000045	Western IIA	63	135	HB
2000	Northern Gulf	NED2000011	URI Shrimp	1		DB/DA
2001	Southern Gulf	NED2001150	Western IIA	70	79	HB
2001	Northern Gulf	2001016	Rock Hopper	1		DB/DA
2002	Southern Gulf	NED2002251	Western IIA	75	110	HB
2002	Southern Gulf	NED2002040	Western IIA	1		AC
2002	Northern Gulf	NED2002013	URI Shrimp	2		DB/DA
2002	Northern Gulf	2002021	Rock Hopper	1		DB/DA
2002	Northern Gulf	2002020	Rock Hopper	4		DB/DA
2003	Southern Gulf	TEM2003352	Western IIA	55	28	HB
2004	Southern Gulf	NED2004446	Western IIA	26	25	HB
2004	Southern Gulf	TEL2004434	Western IIA	107	68	HB
2004	Northern Gulf	2004025	Rock Hopper	1		DB/DA
2005	Southern Gulf	NED2005542	Western IIA	55	62	HB
2005	Southern Gulf	TEL2005507	Western IIA	77	50	HB
2005	Northern Gulf	NED2005016	URI Shrimp	6		DB/DA
2006	Northern Gulf	TEL2006003	Campelen	93	135	DB/DA/PA
2006	Northern Gulf	2006032	Rock Hopper	4	159	DB/DA
2006	Southern Gulf	TEL2006678	Western IIA	124	52	HB
2007	Northern Gulf	TEL2007004	Campelen	95	124	DB/DA/PA
2007	Southern Gulf	TEL2007749	Western IIA	108	66	HB
2007	Southern Gulf	TEL2007745	Western IIA	8		AC
2007	Northern Gulf	2007034	Rock Hopper	19	82	DB/DA

Table 32. Continued.

Year	Survey Area	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records	Data Provider*
2008	Southern Gulf	TEL2008815	Western IIA	110	79	HB
2008	Southern Gulf	TEM2008830	Western IIA	6		AC
2008	Northern Gulf	TEL2008005	Campelen	142	111	DB/DA
2008	Northern Gulf	2008036	Rock Hopper	10	112	DB/DA
2009	Southern Gulf	NED2009027	Western IIA	7		AC
2009	Northern Gulf	TEL2009006	Campelen	117	91	DB/DA
2009	Northern Gulf	2009038	Rock Hopper	3	123	DB/DA
Total				**1834**	**3120**	

**HB = Hugues Benoit, DFO-Gulf; AC = Andrew Cogswell, DFO- Mar (BIO); VW = Vonda Wareham, DFO-NL; PA = Philippe Archambault, Université du Québec à Rimouski, DB = Denis Bernier, QC-DFO; DA = Diane Archambault, QC-DFO.*

***Table 33**. Sponge taxa** identified by Susanna Fuller (unpub. MS) from the 2003 research vessel surveys of the southern Gulf of St. Lawrence using a Western IIA trawl.*

Order	**Family**	**Taxon**	**Typical Morphology**
Hadromerida	Polymastiidae	*Polymastia robusta* (Bowerbank, 1861)	Cushion, 5 cm height
		Polymastia mamillaris (Mueller, 1806)*†	Encrusting, 30 cm diameter, 11 cm height
		*Polymastia infrapilosa (*Topsent, 1927)	Cushion, 5 cm diameter, 2 cm height
		Trachyteleia hispida (Bowerbank, 1864) (taxon updated from *Polymastia hispida* reported by Fuller, unpub. MS)	Cushion, 4 cm diameter, 2.5 cm height
		Tentorium semisuberites (Schmidt, 1870)	Globular, 2.5 cm diameter, 3 cm height
		Weberella bursa (Muller, 1806)	Globular, 2-10 cm diameter
	Suberitidae	*Suberites ficus* (Esper, 1794)*	Massive, Lobed, 20 cm diameter
		Suberites hispidus (Bowerbank, 1864)	
		Suberitidae undetermined	
Poecilosclerida	Acarnidae	*Iophon* sp.	Encrusting
	Mycalidae	*Mycale lingua* (Bowerbank, 1866)* †	Massive, 30 cm height
		Mycale sp.	
		Mycalidae undetermined	
	Desmacellidae	*Biemna* cf. *variantia* (Bowerbank, 1866)	Encrusting, Cushion, 5+ cm height
Halichondrida	Halichondriidae	*Halichondria (Halichondria) panacea* (Pallas, 1766) *	Massive, Branching, 20+ cm height
		Halichondria (Halichondria) bowerbankii (Burton, 1930)	Branching, Massive, 25 cm height
		Halichondria (Halichondria) colossea (Lundbeck, 1902)	Massive
		Halichondria (Eumastia) sitiens (Schmidt, 1870)	Cushion, 2-3 cm height
		Halichondria sp.	
	Axinellidae	*Phakellia ventilabrum (*Linnaeus, 1767)* †	Funnel, 20 cm height
Haplosclerida	Chalinidae	*Haliclona (Haliclona) oculata* (Pallas, 1766)*	Branching, 30+ cm height
		Haliclona sp.	

**Indicates common species reaching 20-30 cm height or diameter.*
***All taxa belong to the Class Demospongiae. Typical morphologies and maximum dimensions (h=height, d=diameter) are extracted from Fuller (unpub. MS).*
† Indicates taxa identified by ICES (2009) as large, structure-forming sponges typical of sponge grounds in the North Atlantic.

Table 34. *Quantile breakdown of recent sponge research vessel catches in the Gulf Biogeographic Zone by gear type.*

Percentage of Data	Quantile	Weight (kg) of Sponge Corresponding to Quantile Value	
		Western IIA Trawl Gear Southern Gulf (2003-2009)	**Campelen Trawl Gear Northern Gulf (2006-2009)**
100.0%	maximum	23.202	43.9100
99.5%		18.036	24.5920
97.5%		6.911	11.9000
90.0%		1.699	3.6700
75.0%	quartile	0.552	1.0940
50.0%	median	0.146	0.2350
25.0%	quartile	0.041	0.0500
10.0%		0.014	0.0080
2.5%		0.005	0.0020
0.5%		0.002	0.0004
0.0%	minimum	0.001	0.0002

Table 35. *Start and end positions of significant concentrations of sponge in the Gulf Biogeographic Zone as determined from spatial analyses by gear type (2003-2009).*

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Campelen (Northern Gulf) 2006-2009						
TEL2006003	2006	43.91	49.70117	-65.59417	49.70333	-65.57550
TEL2007004	2007	25.30	48.63867	-68.90083	48.64617	-68.88600
TEL2008005	2008	22.35	48.85317	-60.47033	48.86517	-60.46817
TEL2008005	2008	20.60	49.81883	-65.39083	49.82400	-65.40850
TEL2008005	2008	18.20	49.92367	-63.60450	49.91800	-63.58717
TEL2006003	2006	17.99	49.81733	-61.07583	49.81783	-61.09550
TEL2007004	2007	17.10	50.12100	-64.61000	50.11617	-64.59067
TEL2008005	2008	15.60	48.67850	-61.46333	48.67617	-61.44550
TEL2007004	2007	13.64	49.11500	-63.39967	49.10783	-63.38433
TEL2007004	2007	12.75	48.76467	-61.86250	48.76617	-61.88083
TEL2006003	2006	12.10	48.21767	-59.45800	48.22967	-59.46400
TEL2007004	2007	11.10	49.27033	-66.53917	49.27433	-66.52117
TEL2008005	2008	10.40	49.96083	-63.74633	49.96367	-63.76617
TEL2008005	2008	9.45	50.66300	-57.91983	50.67517	-57.92367
TEL2006003	2006	8.35	49.14600	-63.28767	49.14617	-63.26883
TEL2006003	2006	8.16	49.80533	-64.97317	49.80533	-64.95383
TEL2006003	2006	7.91	49.08050	-59.38900	49.08550	-59.37183
TEL2008005	2008	7.65	50.00933	-63.36500	50.00267	-63.34833
TEL2008005	2008	7.40	48.79917	-59.78450	48.81167	-59.78867
TEL2008005	2008	7.05	49.43150	-61.21967	49.41967	-61.21283
TEL2008005	2008	6.29	49.74450	-62.49300	49.75567	-62.48583
TEL2006003	2006	6.22	48.66200	-60.51967	48.66933	-60.50317
TEL2006003	2006	6.02	49.77500	-60.46317	49.78183	-60.46933
TEL2008005	2008	5.70	49.72917	-62.53317	49.71667	-62.53000
TEL2006003	2006	5.17	48.80250	-60.48167	48.81417	-60.47617
TEL2007004	2007	5.10	49.12200	-63.13367	49.13167	-63.14550
TEL2007004	2007	5.05	48.93450	-61.19883	48.93367	-61.17983
TEL2007004	2007	4.82	48.56483	-59.62850	48.55250	-59.62917
TEL2009006	2009	4.80	49.84917	-59.17783	49.85067	-59.19100
TEL2008005	2008	4.75	49.09533	-63.24883	49.09967	-63.26283
TEL2008005	2008	4.60	49.71183	-62.48700	49.72400	-62.48133
TEL2008005	2008	4.58	48.59717	-68.91133	48.58817	-68.92533
TEL2006003	2006	4.50	48.75767	-59.79083	48.76933	-59.78450
TEL2007004	2007	4.48	49.39367	-67.12450	49.40233	-67.11100
TEL2009006	2009	4.40	48.32717	-60.81800	48.31583	-60.82367
TEL2007004	2007	4.40	48.74383	-61.02883	48.73750	-61.01150
TEL2009006	2009	4.40	49.10817	-60.93283	49.10267	-60.94500
TEL2007004	2007	4.33	48.91867	-60.62267	48.92900	-60.60883
TEL2009006	2009	4.15	49.18367	-66.65767	49.18633	-66.63950
TEL2006003	2006	4.10	50.13067	-64.62250	50.11850	-64.61517
TEL2009006	2009	3.95	49.67900	-58.55167	49.66783	-58.56283
TEL2009006	2009	3.95	49.62117	-63.97400	49.62567	-63.99350

Table 35. *Continued.*

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
TEL2007004	2007	3.76	48.96433	-60.43467	48.97683	-60.43317
TEL2009006	2009	3.75	50.14083	-64.86200	50.15317	-64.86500
TEL2006003	2006	3.65	49.80333	-65.51633	49.80117	-65.49750
TEL2008005	2008	3.65	48.98350	-60.93017	48.98500	-60.91167
TEL2006003	2006	3.56	49.74600	-64.88317	49.74800	-64.89750
TEL2008005	2008	3.50	50.04833	-58.57500	50.04217	-58.59333
TEL2008005	2008	3.45	50.01983	-64.21733	50.02367	-64.19933
TEL2007004	2007	3.03	49.84267	-58.56233	49.85267	-58.57767
TEL2007004	2007	3.00	49.62183	-60.08417	49.62200	-60.06467
TEL2008005	2008	2.90	49.63233	-59.83517	49.64517	-59.83433
TEL2006003	2006	2.90	50.08100	-65.26133	50.08117	-65.24583
TEL2007004	2007	2.88	48.47150	-69.01883	48.47950	-69.00350
TEL2007004	2007	2.74	51.76500	-55.99517	51.75900	-56.01517
TEL2006003	2006	2.71	48.92600	-60.89517	48.92983	-60.87983
TEL2008005	2008	2.70	51.24067	-57.22417	51.25317	-57.21933
TEL2006003	2006	2.68	49.89817	-61.48833	49.89817	-61.47183
TEL2006003	2006	2.64	48.97967	-60.85600	48.97283	-60.87200
TEL2007004	2007	2.50	51.63733	-56.40533	51.64800	-56.39733
TEL2008005	2008	2.30	48.04867	-60.78450	48.04183	-60.76867
TEL2006003	2006	2.30	49.04300	-61.09617	49.05567	-61.09800
TEL2007004	2007	2.26	51.06100	-57.26967	51.04767	-57.27683
TEL2009006	2009	2.25	48.98267	-59.22017	48.97217	-59.23300
TEL2009006	2009	2.25	50.56067	-58.03900	50.56683	-58.02150
TEL2008005	2008	2.20	48.40600	-61.22217	48.41450	-61.20883
TEL2007004	2007	2.20	49.21550	-59.81050	49.20450	-59.81833
TEL2009006	2009	2.15	49.43783	-59.06967	49.42750	-59.08333
TEL2009006	2009	2.05	49.89183	-60.17033	49.89317	-60.15100
TEL2008005	2008	2.00	49.93800	-58.19167	49.95000	-58.18467
TEL2008005	2008	2.00	49.33800	-66.28983	49.33450	-66.30850
Western IIA (Southern Gulf) 2003-2009						
TEL2005507	2005	23.2	47.93220	-63.59120	47.93030	-63.63480
TEL2006678	2006	21.0	47.41130	-60.35780	47.42800	-60.38570
TEM2003352	2003	18.9	47.15580	-61.92430	47.13330	-61.91020
NED2005542	2005	16.8	47.93970	-63.60180	47.93430	-63.64330
TEL2006678	2006	13.7	48.49900	-63.12730	48.51070	-63.15300
TEL2005507	2005	13.5	47.97870	-61.36330	47.97520	-61.33300
TEM2003352	2003	13.2	47.13570	-60.86070	47.13780	-60.90170
TEL2006678	2006	11.9	48.66370	-63.58030	48.64170	-63.55170
TEM2003352	2003	10.2	46.97250	-63.06820	46.98280	-63.02820
TEL2007745	2007	9.7	46.39016	-59.88216	46.40550	-60.00000
TEL2008815	2008	9.6	47.19070	-61.45580	47.16300	-61.47230
TEL2007749	2007	9.4	46.59280	-62.30870	46.58430	-62.28080
NED2005542	2005	8.2	47.74180	-60.70870	47.76900	-60.70630
TEM2003352	2003	7.6	47.02100	-62.73970	47.02250	-62.69680

Table 35. *Continued.*

Mission	Year	Sponge Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
TEM2008830	2008	7.3	46.43016	-59.86483	46.45000	-60.0000
TEL2005507	2005	7.1	47.37680	-64.37530	47.38870	-64.3505
TEL2008815	2008	6.9	46.97680	-62.42750	46.94780	-62.4163
NED2005542	2005	6.8	48.00120	-64.24250	48.02030	-64.2503
NED2004446	2004	6.3	46.99120	-62.70530	46.98770	-62.6625
TEL2004434	2004	6.2	47.12550	-61.81270	47.09880	-61.8297
TEL2008815	2008	6.0	47.03330	-62.74400	47.00720	-62.7667
TEL2007749	2007	5.5	48.26700	-62.51830	48.25720	-62.5462
TEL2004434	2004	5.3	47.85320	-63.02720	47.83700	-63.0615
TEL2007749	2007	5.0	48.63770	-63.66700	48.65700	-63.6780
TEL2005507	2005	4.4	48.22230	-62.02030	48.22120	-61.9745
TEL2004434	2004	4.1	47.75120	-63.61900	47.74200	-63.6612
TEL2005507	2005	4.1	45.92870	-62.54580	45.93150	-62.5885
TEL2004434	2004	4.0	47.30220	-63.95030	47.33220	-63.9427
TEL2007745	2007	3.8	46.66000	-60.00133	46.68867	-60.0000
TEL2004434	2004	3.8	48.64030	-63.53220	48.64670	-63.5762
TEM2003352	2003	3.8	47.31830	-62.81550	47.29900	-62.8475
TEL2005507	2005	3.5	47.48450	-63.61500	47.50450	-63.6135
TEM2003352	2003	3.2	45.94170	-62.48650	45.91250	-62.4870
TEL2008815	2008	3.1	48.53020	-63.27150	48.53450	-63.2405

Table 36. *Details of the data used for the analyses and description of coral distribution from the Scotian Shelf Biogeographic Zone. All data are from research vessel surveys.*

Year	Mission	Gear Type	Number of Coral Records	Number of Null Coral Records**	Data Source*
2002	NED2002037	Western IIA	3		VDC
2002	NED2002040	Western IIA	3		VDC
2003	NED2003036	Western IIA	4		VDC
2003	NED2003042	Western IIA	14		VDC
2004	TEL2004529	Western IIA	2		VDC
2004	TEL2004530	Western IIA	1		VDC
2005	NED2005002	Western IIA	1	70	VDC
2005	NED2005027	Western IIA	2	109	VDC
2005	NED2005034	Western IIA	13	91	VDC
2005	NED2005050	Western IIA	2	72	VDC
2005	TEL2005546	Western IIA	3	37	VDC
2005	TEL2005605	Western IIA	2	83	VDC
2005	TEL2005633	Western IIA	36	69	VDC
2006	NED2006002	Western IIA	8	61	VDC
2006	NED2006030	Western IIA	7	109	VDC
2006	NED2006036	Western IIA	28	67	VDC
2007	TEL2006615	Western IIA	10	81	VDC
2007	TEL2007745	Western IIA	23	152	VDC
2008	TEM2007686	Western IIA	12	61	VDC
2008	TEL2008805	Western IIA	21	41	VDC
2008	TEM2008775	Western IIA	2	59	VDC
2009	TEM2008830	Western IIA	16	138	VDC
2009	NED2009002	Western IIA	1	45	VDC
2009	NED2009027	Western IIA	48	141	VDC
Total			**262**	**1486**	

**VDC = Maritimes Region Virtual Data Centre (VDC).*
***Null records prior to 2005 are not considered to be reliable as coral were not routinely recorded then.*

Table 37. *Species composition of the research vessel survey coral by-catch (Table 36) from the Scotian Shelf Biogeographic Zone.*

Order	Species/Taxon	No. Records	NAFO Conservation Unit
	Anthozoa C.	40	
Alcyonacea	*Anthomastus grandiflorus* Verrill, 1878	1	
	Eunephthya rubiformis (Ehrenberg, 1834)	98	
Pennatulacea	*Anthoptilum grandiflorum* (Verrill, 1879)	1	Sea Pen
	Pennatulacea O.	45	Sea Pen
Scleractinia	*Flabellum* spp. Lesson, 1832	20	
	Lophelia pertusa (Linnaeus, 1758)	4	
Gorgonacea	*Acanella arbuscula* (Johnson, 1862)	7	Small Gorgonian
	Chrysogorgia agassizii (Verrill, 1883)	2	Small Gorgonian
	Acanthogorgia armata Verrill, 1878	5	Large Gorgonian
	Primnoa resedaeformis (Gunnerus, 1763)	9	Large Gorgonian
	Keratoisis ornata Verrill, 1878	12	Large Gorgonian
	Paragorgia arborea (Linnaeus, 1758)	7	Large Gorgonian
	Radicipes gracilis (Verrill, 1884)	11	Large Gorgonian

Table 38. *Quantile breakdown of sea pen and large gorgonian research vessel catches in the Scotian Shelf Biogeographic Zone. Both conservation units were sampled with Western IIA trawl gear. [Bold type indicates quantiles considered by NAFO, * indicates quantiles used by NAFO.]*

Percentage of Data	Quantile	Sea Pens Catch (kg) (N=46)	Large Gorgonians Catch (kg) (N=40)
100.0%	maximum	1.0000	27.076
99.5%		1.0000	27.076
97.5%		***1.0000**	**26.549**
90.0%		**0.1698**	***0.559**
75.0%	quartile	0.0530	0.109
50.0%	median	0.0150	0.026
25.0%	quartile	0.0040	0.006
10.0%		0.0010	0.004
2.5%		0.0010	0.001
0.5%		0.0010	0.001
0.0%	minimum	0.0010	0.001

Table 39. *Start and end positions of significant concentrations of sea pens and large gorgonians in the Scotian Shelf Biogeographic Zone as determined from the quantiles of the catch distribution (see Table 38).*

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Sea Pens: 97.5% Quantile						
NED1998846	1998	1.00	44.1322	-61.4705	44.1120	-62.0000
TEL2008815	2008	1.00	44.3633	-61.3178	44.3348	-61.0000
Large Gorgonians: 90% Quantile						
TEL2007745	2007	27.08	-65.6605	42.1348	-65.6605	42.1405
NED2002040	2002	6.00	-57.8353	44.2238	-57.8353	44.2387
NED2006036	2006	2.17	-58.6072	43.9630	-58.6072	43.9490
TEL2005633	2005	0.57	-57.7317	44.3053	-57.7317	44.2835

Table 40. *Start and end positions of significant concentrations of sea pens and large gorgonians in the Scotian Shelf Biogeographic Zone as determined from the spatial analyses.*

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Sea Pens						
NED1998846	1998	1.00	44.1322	-61.4705	44.1120	-62.0000
TEL2008815	2008	1.00	44.3633	-61.3178	44.3348	-61.0000
TEL2007745	2007	0.50	46.0853	-58.7368	46.1035	-59.0000
NED2009027	2009	0.29	45.8457	-59.0187	45.8425	-59.0000
TEM2007686	2007	0.12	45.6302	-58.5587	45.6560	-59.0000
NED2006036	2006	0.11	44.6245	-62.3723	44.6393	-62.0000
Large Gorgonians						
TEL2007745	2007	27.08	-65.6605	42.1348	-65.6605	42.1405
NED2002040	2002	6.00	-57.8353	44.2238	-57.8353	44.2387
NED2006036	2006	2.17	-58.6072	43.9630	-58.6072	43.9490
TEL2005633	2005	0.57	-57.7317	44.3053	-57.7317	44.2835

Table 41. *Details of the data used for the analyses of sponge distribution from the Scotian Shelf Biogeographic Zone.*

Year	Mission	Gear Type	Number of Sponge Records	Number of Null Sponge Records**	Data Source*
Research Vessel Surveys					
2001	NED2001032	Western IIA	1		VDC
2002	NED2002037	Western IIA	32		VDC
2002	NED2002040	Western IIA	23		VDC
2002	NED2002062	Western IIA	1		VDC
2005	NED2005002	Western IIA	1	71	VDC
2005	TEL2005545	Western IIA	15	36	VDC
2005	TEL2005605	Western IIA	5	82	VDC
2006	NED2006030	Western IIA	6	110	VDC
2007	TEL2007745	Western IIA	65	116	VDC
2007	TEM2007685	Western IIA	19	30	VDC
2007	TEM2007686	Western IIA	8	67	VDC
2008	TEL2008805	Western IIA	22	39	VDC
2008	TEM2008775	Western IIA	6	55	VDC
2008	TEM2008830	Western IIA	74	81	VDC
2009	NED2009002	Western IIA	7	39	VDC
2009	NED2009027	Western IIA	92	91	VDC
2009	NED2009841	Western IIA	11	14	VDC
Total			**388**	**831**	
Fisheries Observer Data* **					
1997-07			59		SF
Total			**59**		

**VDC = Maritimes Region Virtual Data Centre (VDC); SF = Susanna Fuller, Dalhousie University*
***Null records prior to 2007 are not considered to be reliable as sponges were not routinely recorded then.*
****Records are for Vazella pourtalesi “Russian Hat Sponges” only.*

Table 42. *Quantile breakdown of sponge research vessel catches (Table 41) in the Scotian Shelf Biogeographic Zone.*

Percentage of Data	Quantile	Sponge Catch Weight (kg)
100.0%	maximum	56.000
99.5%		31.903
97.5%		8.591
90.0%		2.806
75.0%	quartile	1.136
50.0%	median	0.274
25.0%	quartile	0.076
10.0%		0.030
2.5%		0.009
0.5%		0.001
0.0%	minimum	0.001

Table 43. *Start and end positions of significant concentrations of sponges in the Scotian Shelf Biogeographic Zone as determined from the spatial analyses.* Indicates Vazella pourtalesi sponge.*

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
Research Vessel Surveys: Spatial Analyses						
TEM2008830	2008	56.00	43.91683	-66.42050	43.93383	-66.45367
NED2002037	2002	30.50	43.98917	-63.21050	43.96683	-63.18483
NED2009027	2009	27.41	44.31217	-62.77817	44.31500	-62.73833
NED2009027	2009	24.80	43.96833	-66.43217	43.94883	-66.43317
NED2002037	2002	23.63	43.57433	-63.41150	43.59717	-63.38750
TEL2005605	2005	15.85	43.13517	-63.46150	43.14550	-63.42283
NED2009027	2009	12.42	42.58783	-65.62533	42.58917	-65.66450
NED2002040	2002	11.76	44.22383	-57.83533	44.23867	-57.86467
TEM2008830	2008	*10.15	42.80617	-63.19967	42.80700	-63.16333
NED2009027	2009	8.00	44.38950	-66.47750	44.41550	-66.45700
NED2002037	2002	7.96	43.20967	-63.53100	43.23367	-63.50700
NED2002040	2002	7.66	46.14550	-59.02533	46.13917	-58.98400
TEM2008830	2008	7.17	42.61817	-65.39367	42.63500	-65.42650
TEM2008830	2008	7.10	42.80150	-65.66717	42.77783	-65.68583
NED2009027	2009	7.04	44.07083	-66.41117	44.05133	-66.41117
TEM2008830	2008	6.55	46.31767	-59.49067	46.33050	-59.45233
NED2002037	2002	6.53	43.83617	-66.35067	43.86583	-66.34567
TEL2008805	2008	6.10	44.05033	-59.97933	44.05267	-59.93967
TEM2008830	2008	6.05	45.98867	-59.40467	45.96383	-59.41567
NED2009027	2009	5.74	46.19417	-59.08733	46.17750	-59.05267
TEL2008805	2008	5.20	44.26983	-62.08433	44.26800	-62.04383
TEL2007745	2007	4.99	44.17983	-66.57283	44.19250	-66.55133
TEL2007745	2007	*4.65	42.97783	-63.43167	42.97683	-63.39267
TEL2007745	2007	*4.35	43.05600	-63.37300	43.08517	-63.37000
NED2006030	2006	4.32	42.80267	-63.20167	42.80733	-63.16200
TEM2008830	2008	*3.95	42.83067	-63.56183	42.82750	-63.52383
TEM2007686	2007	3.85	44.30617	-59.11133	44.33483	-59.10267
NED2002040	2002	3.84	45.31683	-60.04567	45.29200	-60.02333
TEL2007745	2007	3.70	44.06217	-60.05633	44.06550	-60.09667
NED2002040	2002	3.67	46.23167	-59.19667	46.24933	-59.23117
TEM2007686	2007	3.50	42.80517	-63.07400	42.80383	-63.11350
TEL2007745	2007	3.20	44.84883	-59.78833	44.82033	-59.78950
TEL2005605	2005	3.10	43.91250	-63.72250	43.93467	-63.69300
NED2009002	2009	3.04	44.53950	-60.02250	44.56867	-60.01667
NED2002040	2002	2.91	45.90167	-59.01733	45.89000	-59.05617
TEM2007685	2007	2.89	41.75833	-66.37283	41.77833	-66.40000
TEM2008830	2008	2.86	43.59467	-66.67850	43.61983	-66.69917

Table 43. Continued.

Mission	Year	Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	End Latitude (Dec Deg)	End Longitude (Dec Deg)
TEM2008830	2008	2.82	42.67900	-66.40083	42.66050	-66.37300
NED2009027	2009	2.80	43.03883	-64.74617	43.06483	-64.72883
NED2001032	2001	2.73	43.22267	-63.39783	43.23567	-63.36150
NED2009027	2009	2.71	42.94283	-64.82217	42.96450	-64.79633
NED2009027	2009	2.70	44.14567	-63.23850	44.14000	-63.21200
TEM2008830	2008	2.66	45.01950	-66.15750	44.99033	-66.15333
NED2002037	2002	2.51	43.82483	-66.44033	43.84550	-66.41667
TEM2008830	2008	2.50	42.47233	-65.30350	42.44500	-65.31950
NED2009027	2009	2.49	42.83983	-65.58000	42.83850	-65.61933
TEL2007745	2007	2.40	44.81717	-60.14783	44.79100	-60.16650
TEM2007685	2007	2.34	41.68367	-66.23133	41.68883	-66.26867
TEM2008830	2008	2.30	44.50450	-66.50550	44.53050	-66.52383
TEM2008830	2008	*2.26	43.71867	-63.15450	43.69600	-63.17650
NED2002037	2002	2.24	42.61150	-65.80683	42.63633	-65.83117
NED2009027	2009	2.24	45.84567	-59.01867	45.84250	-59.05333
TEM2007685	2007	2.23	42.10233	-67.04767	42.11200	-67.08533
NED2009002	2009	2.20	44.60950	-60.06883	44.60600	-60.10933
TEL2007745	2007	2.17	42.86983	-65.61983	42.89217	-65.58967
NED2006030	2006	2.10	43.08900	-63.16983	43.11633	-63.18667
TEM2007685	2007	2.05	41.55983	-66.36967	41.58200	-66.39367

Fisheries Observer Data: All Records of *Vazella pourtalesi* > 20 kg from 1997-2007

Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	Depth (m)
8994.00	44.250	-62.533	153
5900.00	44.333	-62.250	138
4013.00	44.233	-62.650	192
3900.00	44.200	-62.633	201
3750.00	44.283	-62.600	179
3605.00	44.217	-62.550	163
3500.00	44.300	-62.617	207
3231.00	44.250	-62.633	183
3200.00	44.233	-62.633	183
3100.00	44.300	-62.617	209
3000.00	44.267	-62.633	183
2120.00	44.167	-62.483	119
2000.00	44.250	-62.583	179
2000.00	44.267	-62.467	187
1880.00	44.233	-62.600	172
1500.00	44.267	-62.600	157
1500.00	44.283	-62.617	174

Table 43. *Continued.*

Catch Weight (kg)	Start Latitude (Dec Deg)	Start Longitude (Dec Deg)	Depth (m)
1500.00	44.250	-62.467	166
1500.00	44.283	-62.683	170
1500.00	44.183	-62.583	162
1500.00	44.200	-62.600	
1480.00	44.267	-62.617	180
1469.00	44.267	-62.633	177
1460.00	44.233	-62.617	169
1435.00	44.067	-63.200	135
1400.00	44.317	-62.617	194
1375.00	44.233	-62.633	183
1370.00	44.217	-62.617	175
1195.00	44.283	-62.600	165
1166.00	44.267	-62.617	175
1000.00	44.217	-62.583	95
1000.00	44.267	-62.617	165
1000.00	44.250	-62.633	154
1000.00	44.167	-62.533	143
1000.00	44.250	-62.600	174
1000.00	44.300	-62.617	187
896.00	44.217	-62.617	183
830.00	43.567	-63.483	170
756.00	44.267	-62.600	160
750.00	44.117	-63.167	195
745.00	44.233	-62.600	176
701.00	44.233	-62.617	176
700.00	44.217	-62.600	177
600.00	44.217	-62.617	176
550.00	44.233	-62.667	210
500.00	43.583	-63.467	86
500.00	44.183	-62.567	157
500.00	44.183	-62.583	154
400.00	44.217	-62.533	154
400.00	44.300	-62.600	200
400.00	44.250	-62.783	159
300.00	44.233	-62.600	172
250.00	44.217	-62.617	177
200.00	44.183	-62.567	216
200.00	44.200	-62.350	128
200.00	44.083	-63.150	165
180.00	44.117	-63.167	170

Table 44. *A comparison of coral taxa from research vessel surveys across biogeographic zones. Orders assessed by NAFO are in bold. Light grey shading indicates NAFO conservation unit not quantitatively assessed in this report. Dark grey shading indicates conservation unit not present in research vessel data from the Biogeographic Zone.*

Order	Species/Taxon	Biogeographic Zone				
		EA	HBC	NLS	G	SS
	Anthozoa C.	X		X	X	X
Alcyonacea	Alcyonacea O.			X	X	
	Nephtheidae F.	X	X	X		
	Gersemia rubiformis (Ehrenberg, 1834)	X	X	X	X	
	Gersemia sp. Marenzeller, 1877			X		
	Capnella florida (Rathke, 1806)	X	X	X	X	
	Duva sp. Koren & Danielssen, 1883			X	X	
	Anthomastus grandiflorus Verrill, 1878	X		X	X	X
	Eunephthya rubiformis (Ehrenberg, 1834)			X	X	X
Pennatulacea	*Anthoptilum grandiflorum* (Verrill, 1879)	X	X	X	X	X
	Funiculina quadrangularis (Pallas, 1766)			X	X	
	Halipteris finmarchica (Sars, 1851)	X		X	X	
	Pennatula grandis Ehrenberg, 1834	X		X	X	
	Pennatula phosphorea Linnaeus, 1758			X		
	Pennatula borealis M. Sars, 1846				X	
	Pennatula aculeata Danielssen, 1860			X	X	
	Pennatula sp. Linnaeus, 1758				X	
	Pennatulacea O.	X		X	X	X
	Distichoptilum gracile Verrill, 1882			X		
	Kophobelemnon stelliferum (Müller, 1776)			X		
	Umbellula lindahli Kölliker, 1875	X		X		
Scleractinia	*Flabellum alabastrum* Moseley, 1876	X		X	X	
	Flabellum angulare Moseley, 1876	X		X		
	Flabellum sp. Lesson, 1832			X		X
	Vaughanella margaritata (Jourdan, 1895)			X		
	Dasmosmilia lymani (Pourtalès, 1871)			X		
	Lophelia pertusa (Linnaeus, 1758)					X
Gorgonacea	*Acanella arbuscula* (Johnson, 1862)	X		X		X
	Anthothela grandiflora (Sars, 1856)	X		X		
	Acanthogorgia armata Verrill, 1878	X		X		X
	Paramuricea spp. Koelliker, 1865	X		X	X	
	Chrysogorgia agassizii (Verrill, 1883)					X
	Primnoa resedaeformis (Gunnerus, 1763)	X		X	X	X
	Keratoisis ornata Verrill, 1878	X		X		X
	Paragorgia arborea (Linnaeus, 1758)	X		X		X
	Radicipes gracilis (Verrill, 1884)			X		X
	Gorgonacea O. spp.	X		X		
Antipatharia	Antipatharia O. spp.	X		X		
	Stauropathes arctica (Lütken, 1871)			X		

Table 45. *Comparison of weight thresholds and maximum catch for the coral and sponge conservation units by biogeographic zone/gear type.*

	97.5% Quantile (kg)	90% Quantile (kg)	Spatial Analysis Catch (kg)	Maximum Catch (kg)
Sea Pens				
Eastern Arctic (Alfredo)	2.750	0.755	0.250	5.000
Eastern Arctic (Cosmos)	0.736	0.217	0.100	0.780
Eastern Arctic (Campelen)	0.210	0.139	0.050	0.210
NL-Labrador Shelves (Campelen)	2.402	0.219	0.400	21.220
Gulf (Northern-Campelen)	15.990	3.805	7.000	93.100
Gulf (Southern- WIIA)	46.450	8.650	15.000	193.210
Scotian Shelf (WIIA)	1.000	0.170	0.100	1.000
Small Gorgonians				
Eastern Arctic (Campelen)	0.118	0.040	0.050	0.120
NL-Labrador Shelves (Campelen)	0.280	0.085	0.300	1.195
Large Gorgonians				
Eastern Arctic (Alfredo)	-	-	-	2000.000
Eastern Arctic (Campelen)	500.000	27.500	15.000	500.000
NL-Labrador Shelves (Campelen)	45.700	1.540	0.300	200.000
Scotian Shelf (WIIA)	26.549	0.559	0.500	27.080
Sponges				
Eastern Arctic (Alfredo)	115.000	52.400	70.000	350.000
Eastern Arctic (Cosmos)	142.880	6.980	40.000	603.800
Hudson Bay Complex (Cosmos)	3.028	1.342	-	4.610
Eastern Arctic (Campelen)	840.000	153.100	40.000	2000.000
NL-Labrador Shelves (Campelen)	207.300	40.000	200.000	1200.000
Gulf (Northern-Campelen)	11.900	3.670	2.000	43.910
Gulf (Southern- WIIA)	6.911	1.699	3.000	23.200
Scotian Shelf (WIIA)	8.591	2.806	2.000	56.000

FIGURES

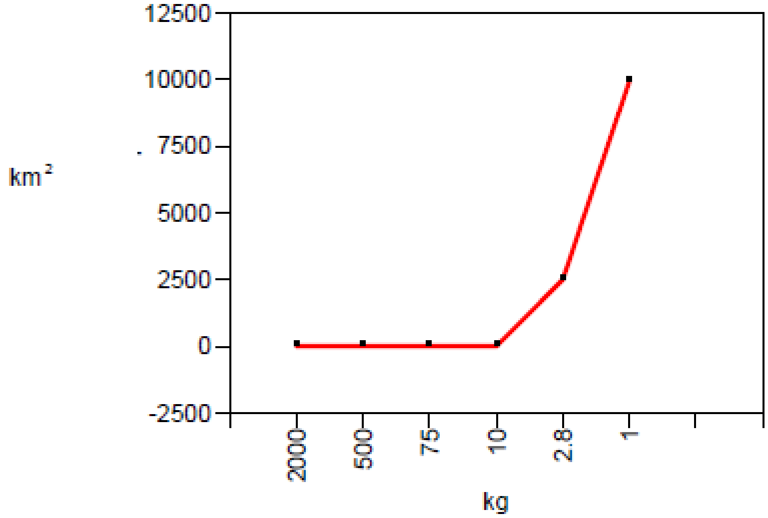
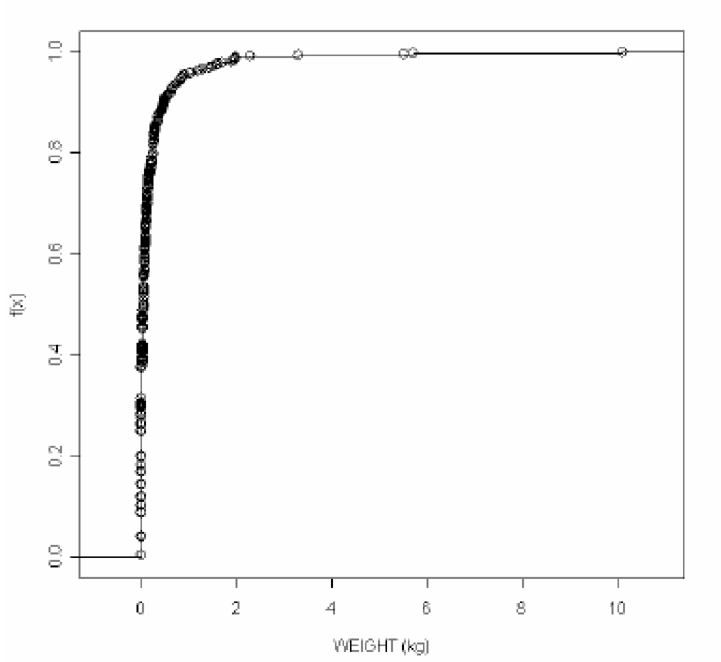


Figure 1. *A hypothetical graph showing the constant area occupied by catches greater than 10 kg with an exponential increase at smaller weight categories. In this example, 10 kg would be the catch weight threshold used to identify significant concentrations of the organisms (from Kenchington et al. 2009).*

Figure 2. *A large catch of Geodia sponges from the continental slope off Norway at about 350 m depth. Photo courtesy of H.T. Rapp and extracted from ICES (2009). Similar sponges are found in the NRA particularly along Sackville Spur and along the slope waters off Labrador and the Eastern Arctic.*



Weight Quantiles

100.0 %	maximum	10.116000
99.5 %		4.718880
97.5 %		1.602200
90.0 %		0.484600
75.0 %	quartile	0.170000
50.0 %	median	0.049000
25.0 %	quartile	0.010500
10.0 %		0.003094
2.5 %		0.001000
0.5 %		0.001000
0.0 %	minimum	0.000100

Figure 3. *Cumulative catch distribution of sea pens collected in research vessel surveys in the NRA with associated weight quantiles (extracted from NAFO 2008b).*

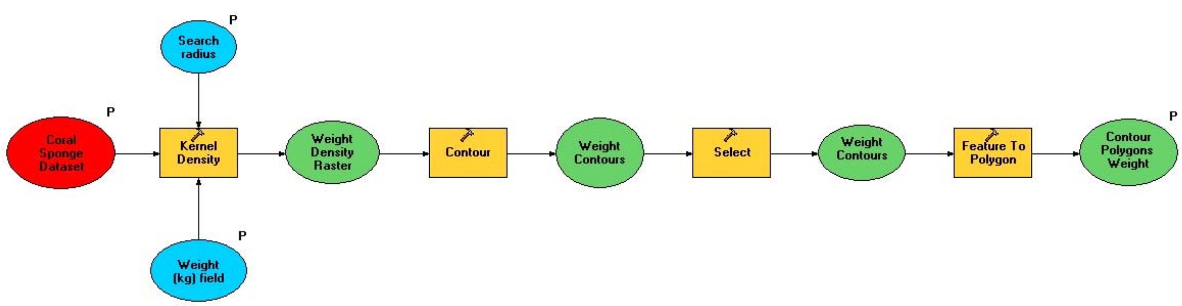


Figure 4. *The original model taken from Kenchington et al. (2009) used to describe sponge density in the NRA. This model created "donut" polygons (Figure 6A) from the Kernel Density rasters.*

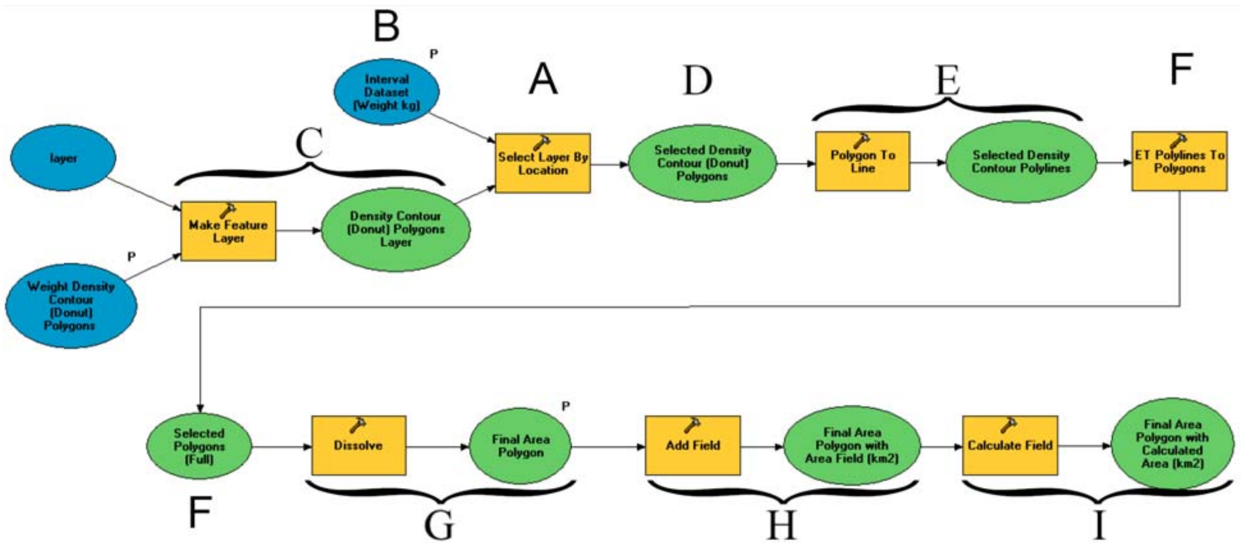


Figure 5. *This model replaces the manual steps performed at the completion of the original model detailed in Figure 4 and in Kenchington et al. (2009). Those steps are described in detail in the text.*

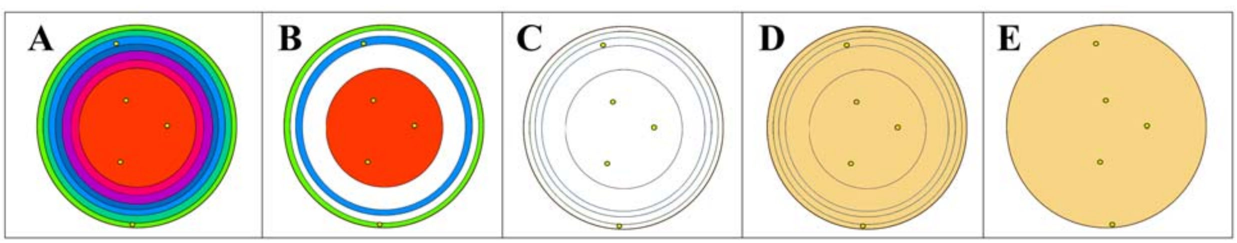


Figure 6. *A schematic showing the output derived from running the second model. This model takes the "donut" polygon output from the original model (A), selects only the polygons that contain data points from the weight threshold (B), converts the "donut" polygons to lines (C), converts the lines to "full" polygons (D) and then "dissolves" these polygons into a single polygon representing the minimum area required to encompass the points from a particular weight threshold.*

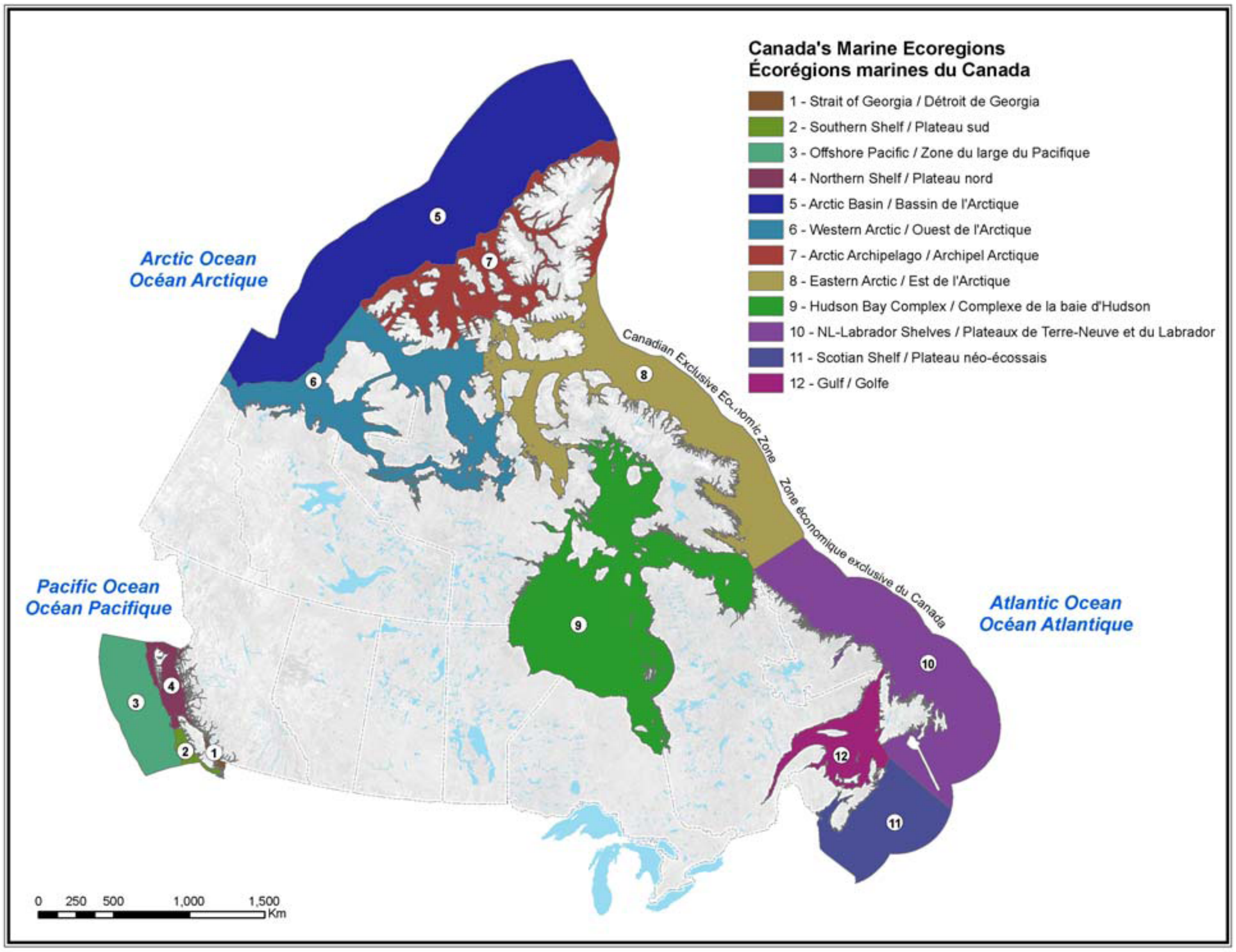


Figure. 7. *Canadian marine biogeographic zones recommended by the June 2009 National Workshop on Biogeographic Classification (DFO 2009).*

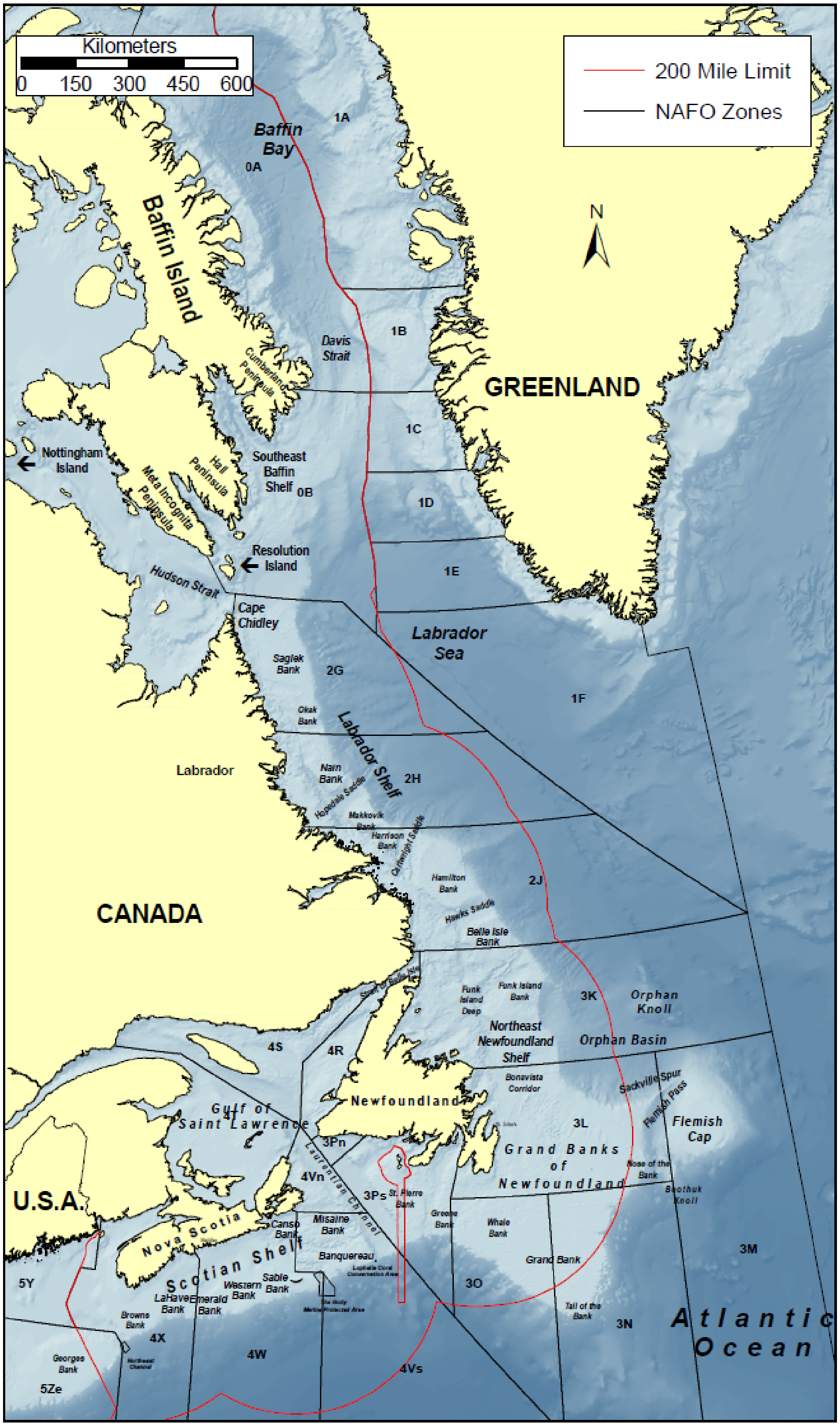


Figure 8. *Place names associated with offshore banks and other features referred to in this report. NAFO Divisions and Subdivisions are indicated in black and the Canadian Exclusive Economic Zone in red.*

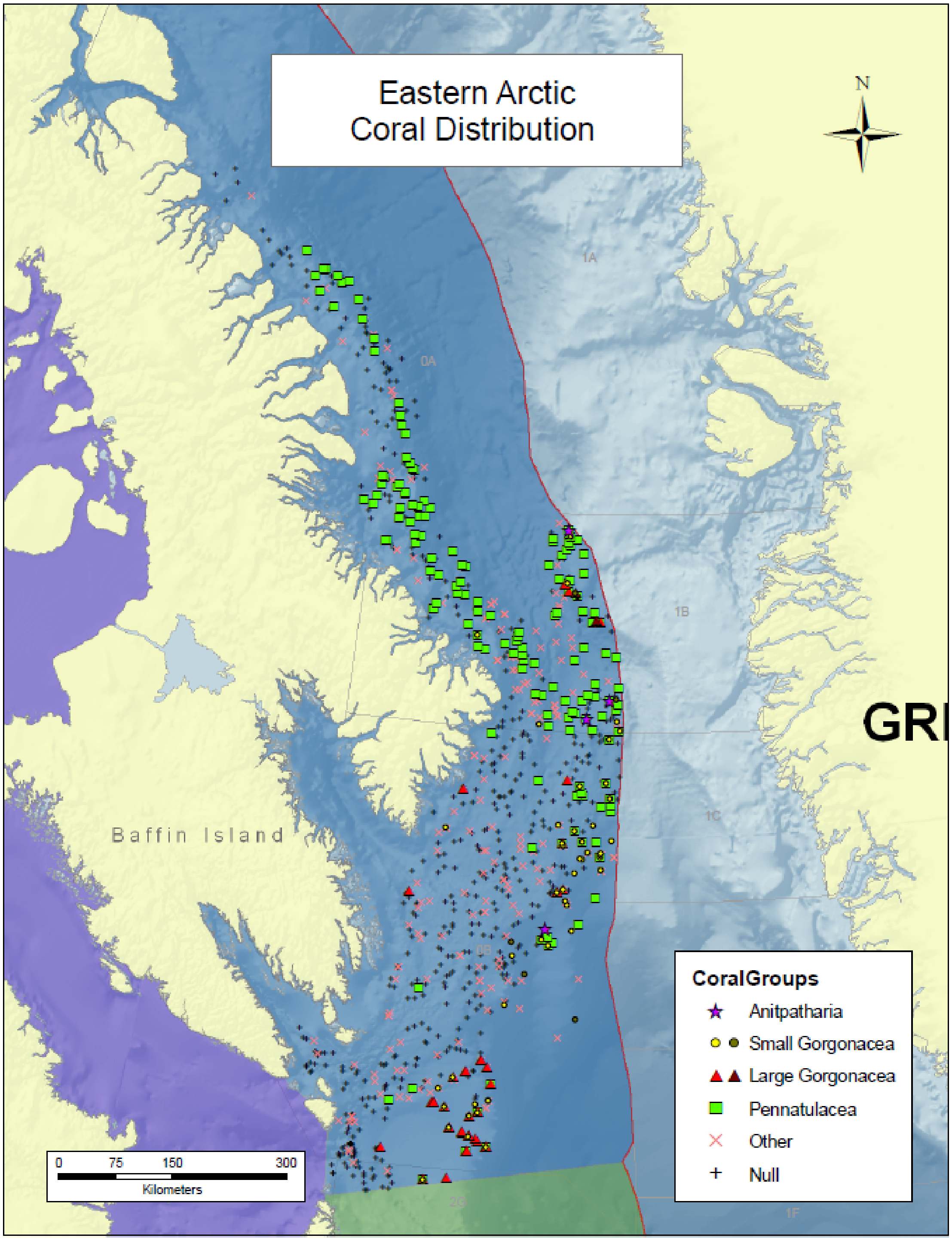


Figure 9. *Distribution of the coral conservation units (sea pens, small gorgonians, large gorgonians and black corals), as well as other corals (soft corals and cup corals) in the Eastern Arctic Biogeographic Zone. Null records (no coral species caught) are indicated by a cross. Darker symbols for small and large gorgonians indicate the position of the catches without weights (research vessel survey data only).*

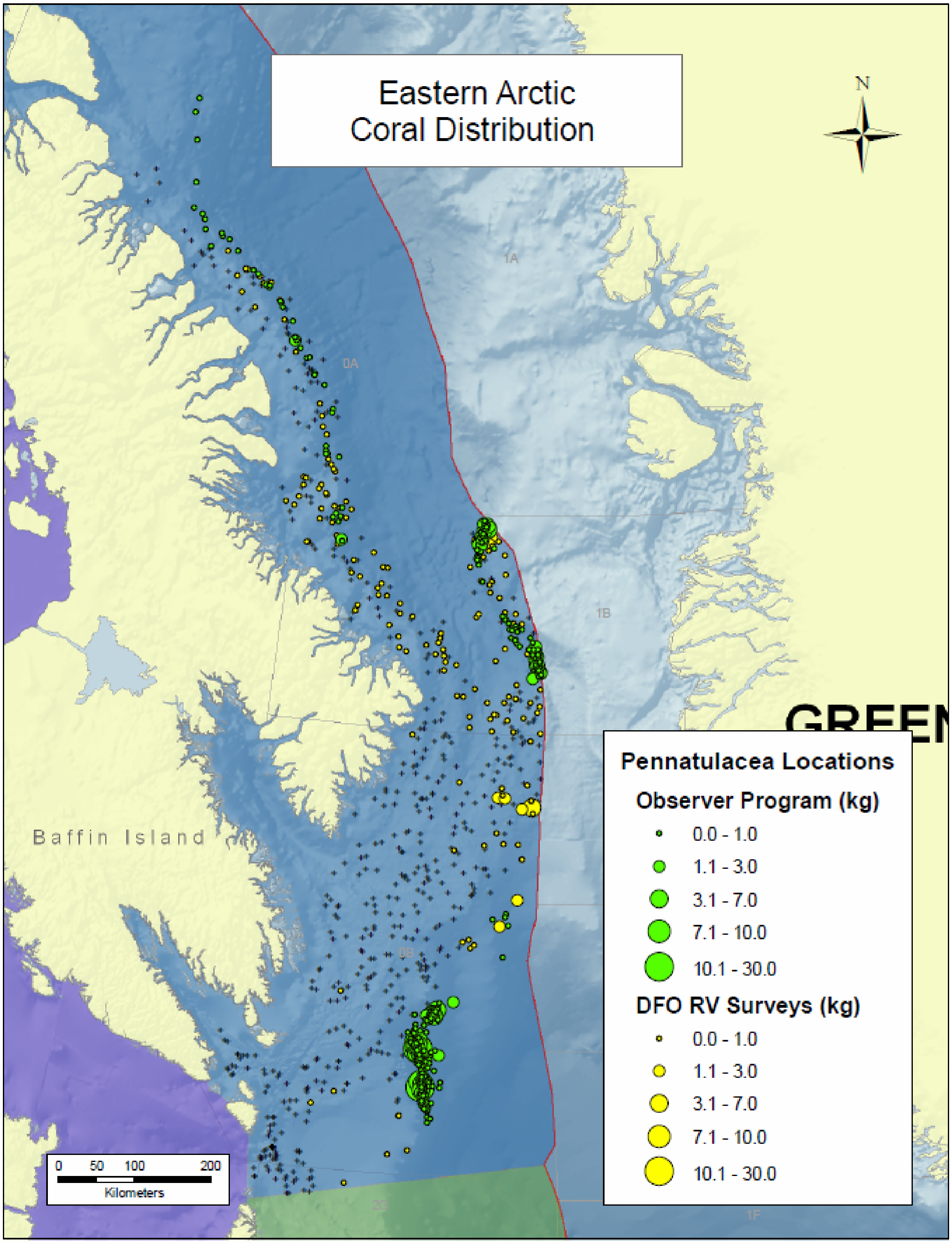


Figure 10. *Distribution of sea pens from the research vessel surveys and Fisheries Observer Program (Table 2). Due to differences in gear types and fishing duration quantitative comparisons between data sets in this map should not be made. The combined data do provide greater spatial coverage of the Eastern Arctic Biogeographic Zone. Further assessment of these data is provided in Wareham et al. (2010).*

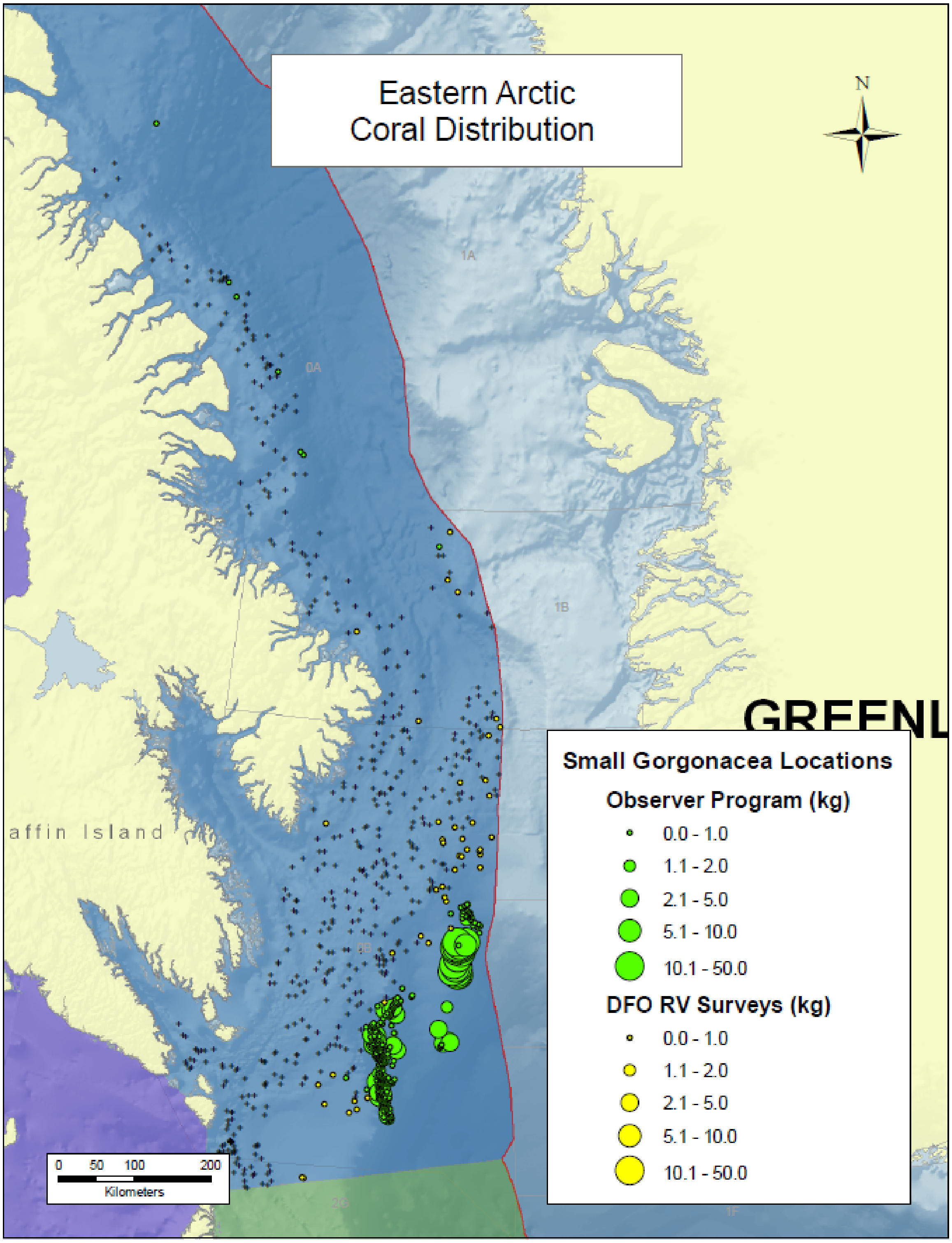


Figure 11. *Distribution of small gorgonian corals from the research vessel surveys and Fisheries Observer Program. Due to differences in gear types and fishing duration quantitative comparisons between data sets in this map should not be made. The combined data do provide greater spatial coverage of the Eastern Arctic Biogeographic Zone. Further assessment of these data is provided in Wareham et al. (2010).*

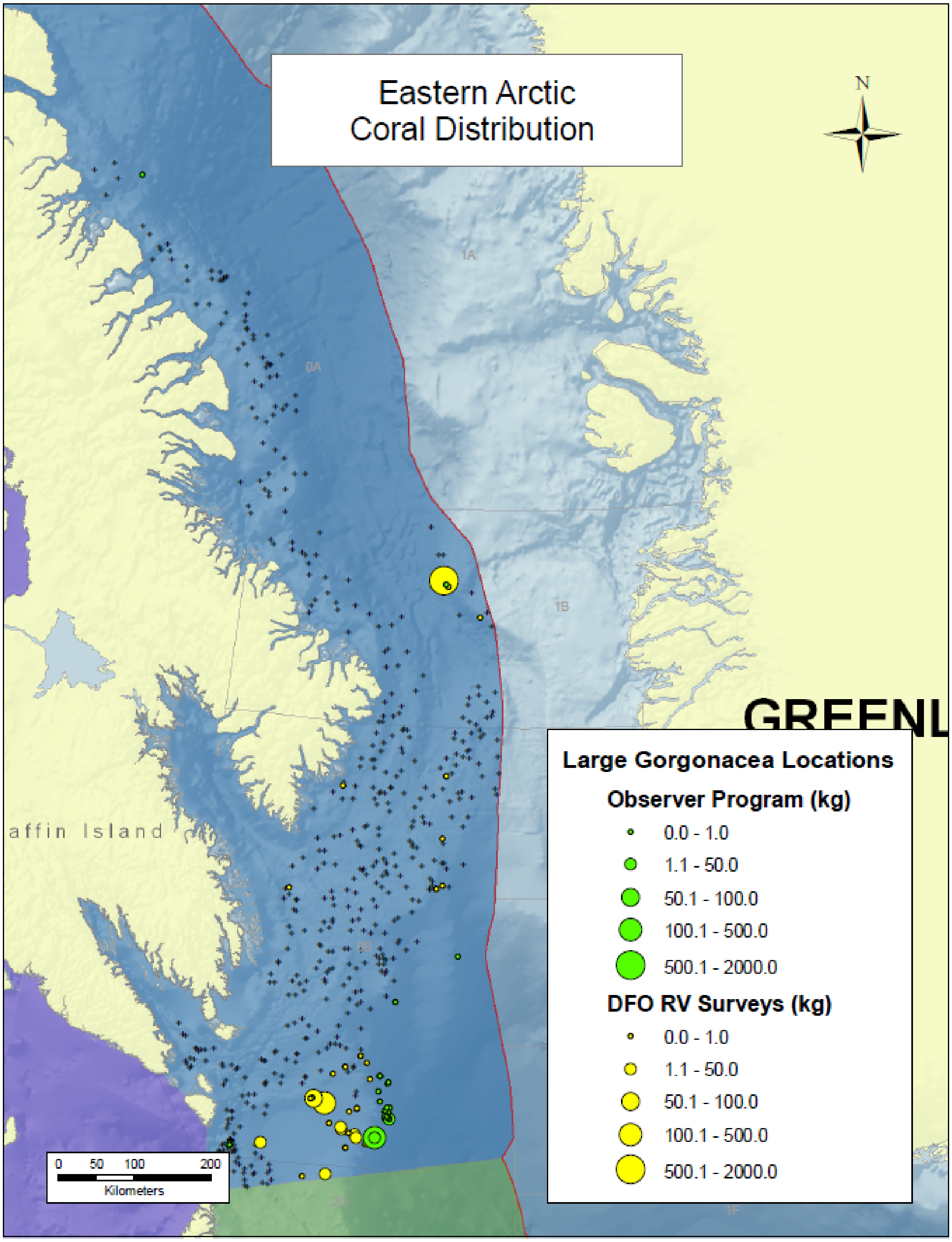


Figure 12. *Distribution of large gorgonian corals from the research vessel surveys and Fisheries Observer Program. Due to differences in gear types and fishing duration quantitative comparisons between data sets in this map should not be made. The combined data do provide greater spatial coverage of the Eastern Arctic Biogeographic Zone. Further assessment of these data is provided in Wareham et al. (2010).*

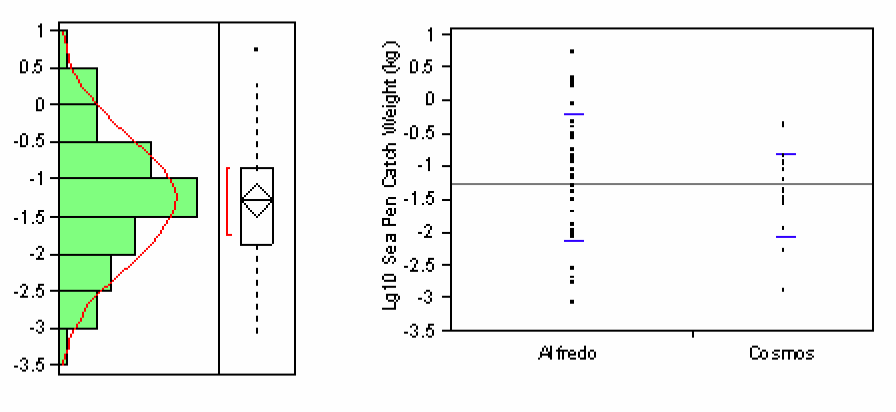


Figure 13. *Distribution of sea pen catch weight data after log10 transformation. Data are from a common area and depth (400-800 m) in NAFO Division OA where both Alfredo and Cosmos trawl gear were used. The left panel shows the distribution of the transformed data with associated box plot indicating the median (line across the middle), the sample mean and 95% confidence interval (means diamond), the 25th and 75th quantiles (ends of box) and outlying points (whiskers). The red bracket along the edge of the box identifies the shortest half, which is the densest 50% of the observations. The red curve represents the fitted normal distribution against which the data distribution was tested. The right panel shows the distribution of the log10 transformed data by gear type with the dashed lines representing one standard deviation and the solid line across the data representing the grand mean.*

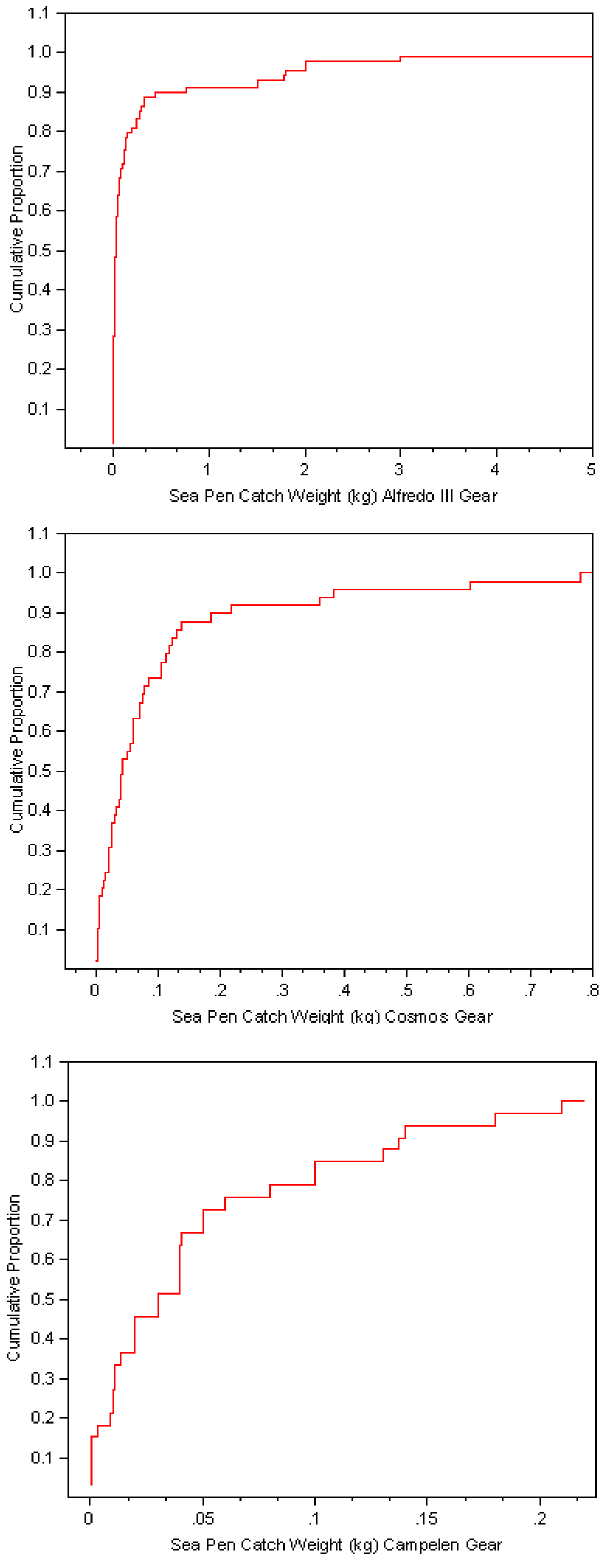


Figure 14. *Cumulative frequency distribution plots for sea pen catches by gear type from the Eastern Arctic Biogeographic Zone.*

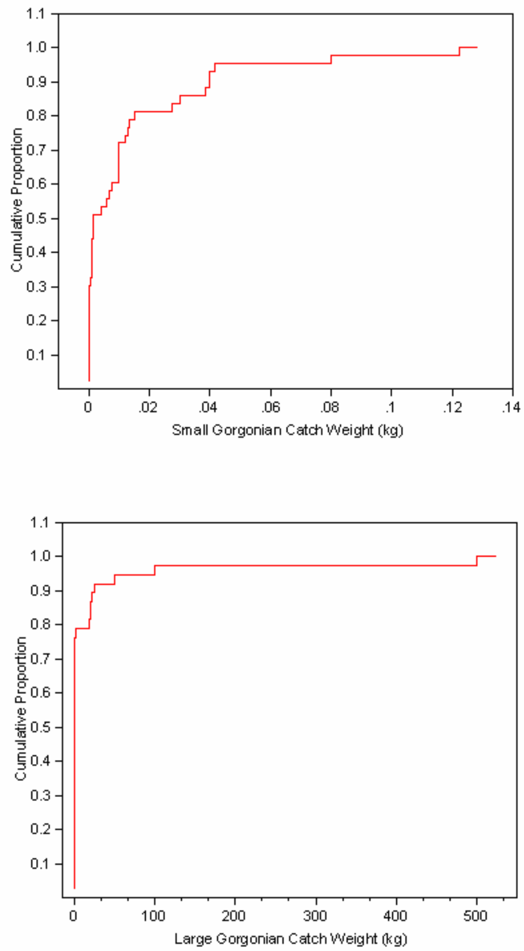


Figure 15. *Cumulative frequency distribution plots for Campelen trawl catches of small gorgonian corals and large gorgonian corals (top to bottom) from the Eastern Arctic Biogeographic Zone.*

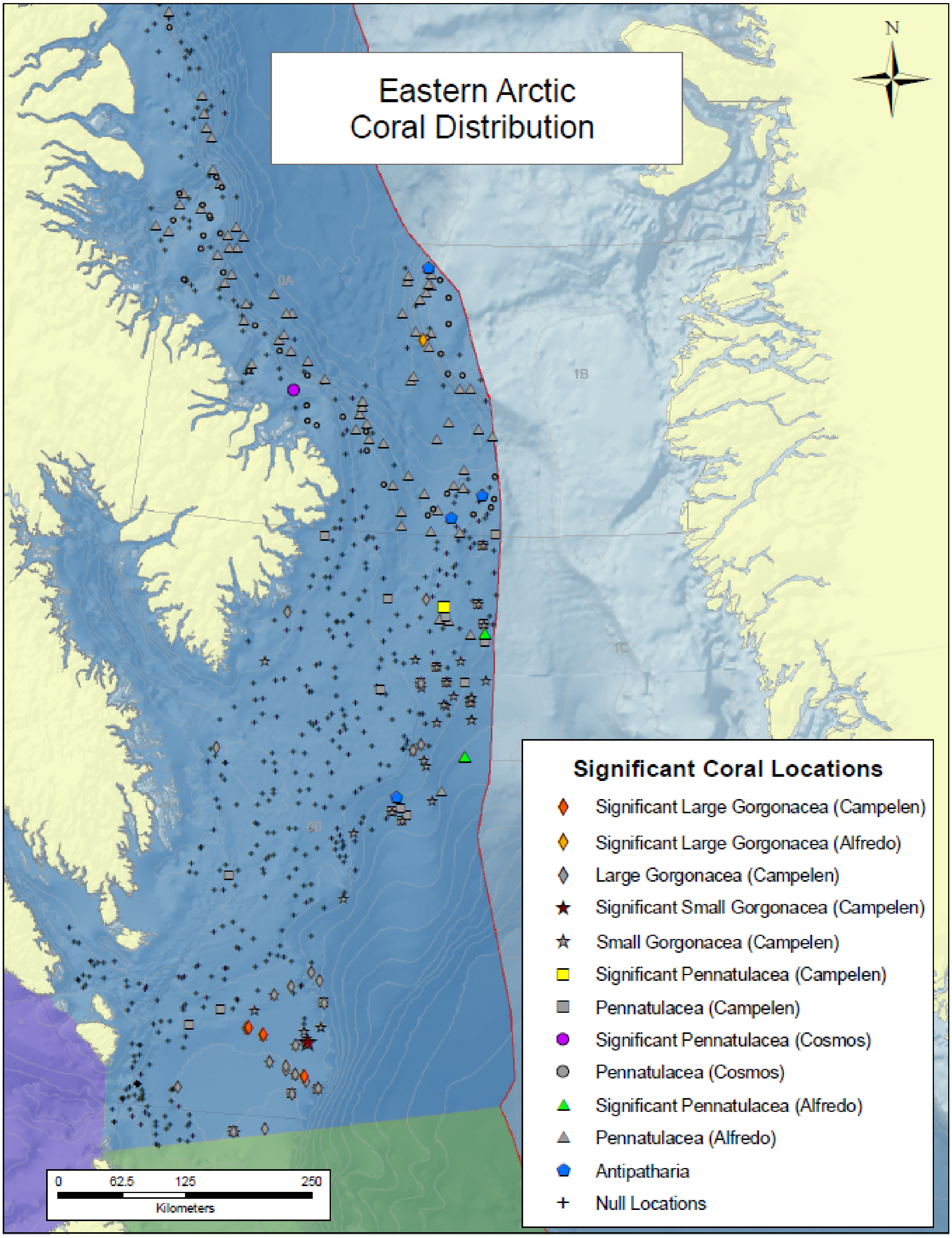


Figure 16. *Location of significant concentrations of corals in the Eastern Arctic Biogeographic Zone using thresholds established from the quantile distribution. Non-significant catches of coral (grey) and null catches are also indicated. (see Table 6). All black coral (Antipatharia) locations are indicated.*

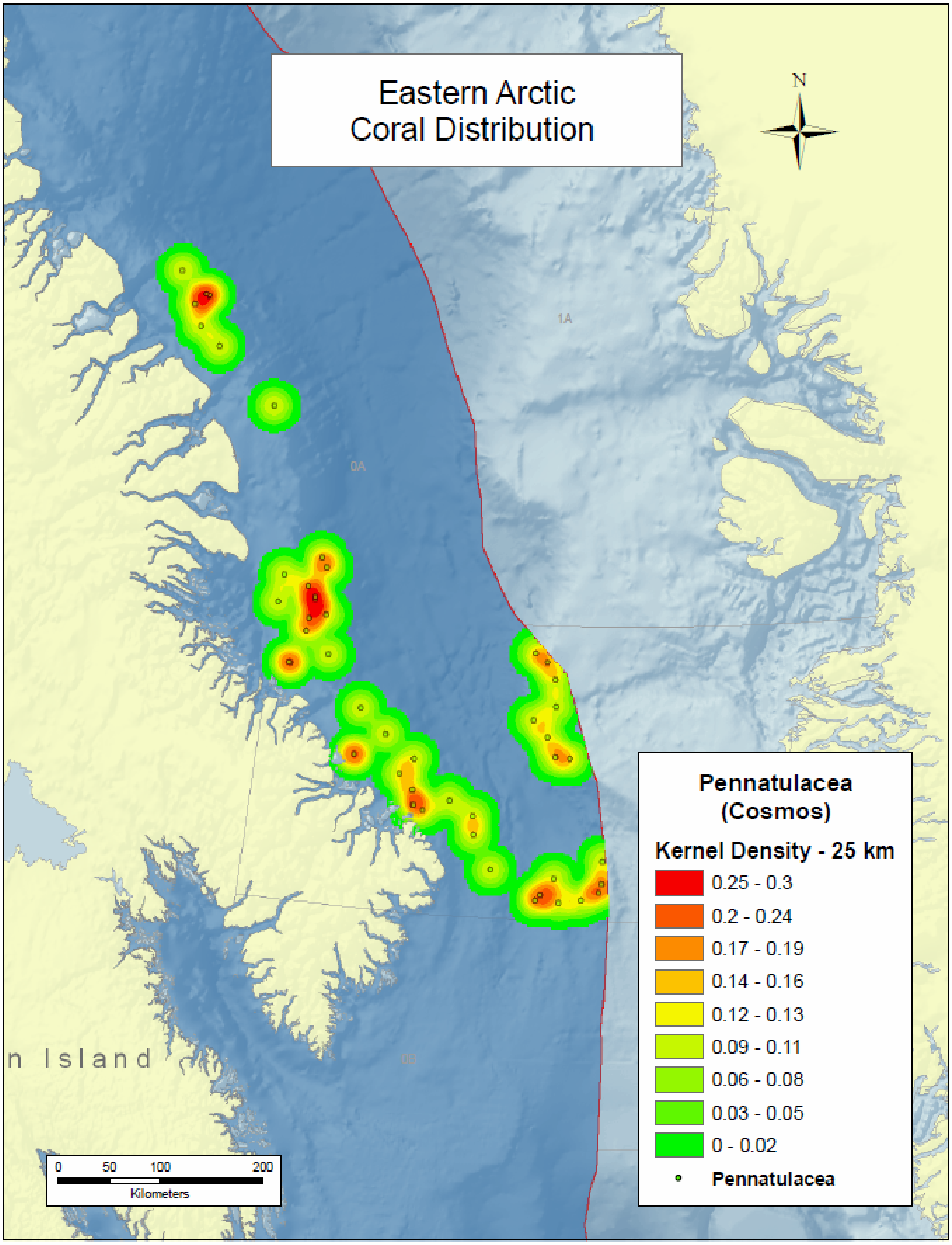


Figure 17. *Interpolated density distribution (kg/km^2) of sea pen catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Cosmos trawl gear (see Table 2).*

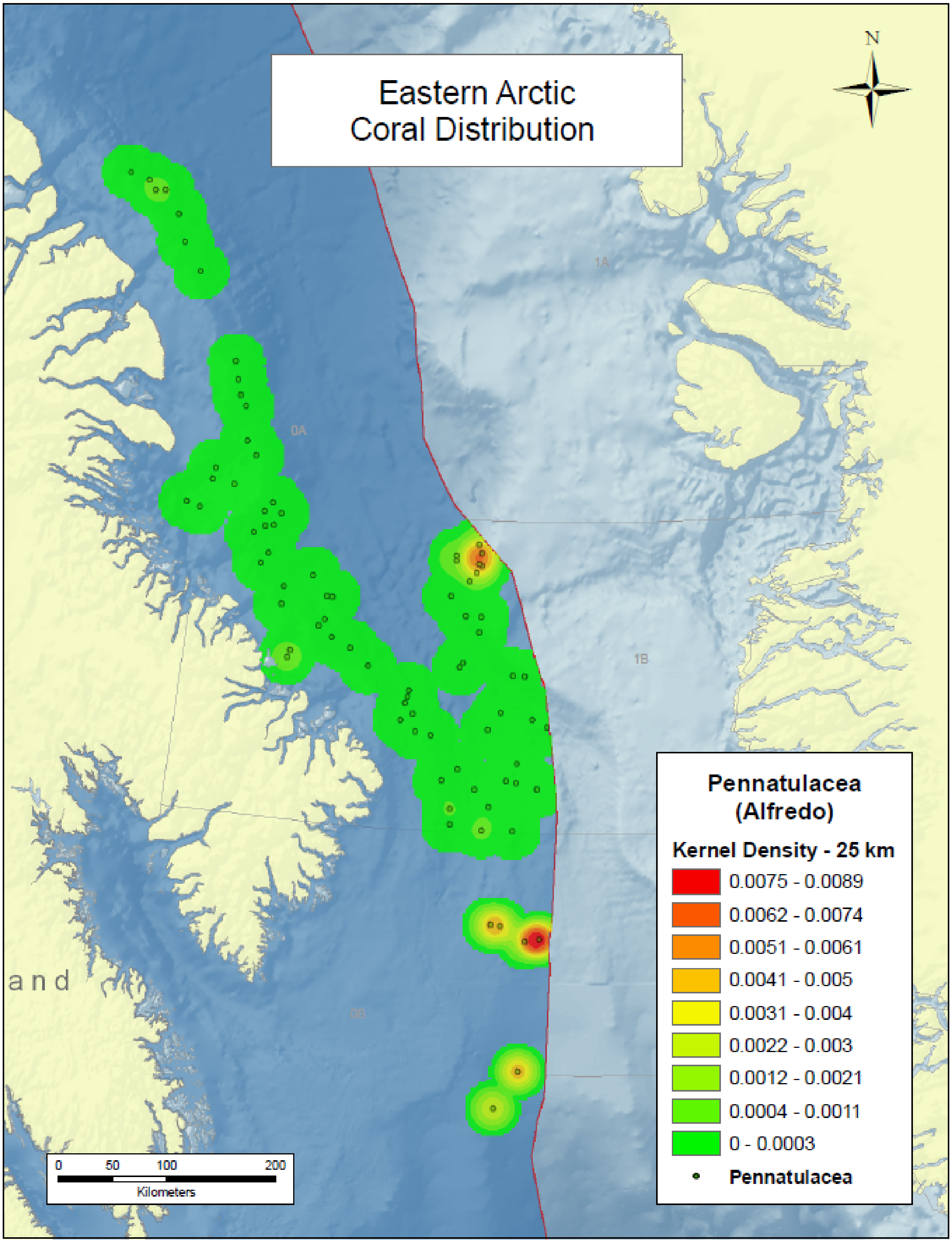


Figure 18. *Interpolated density distribution (kg/km^2) of sea pen catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Alfredo trawl gear (see Table 2).*

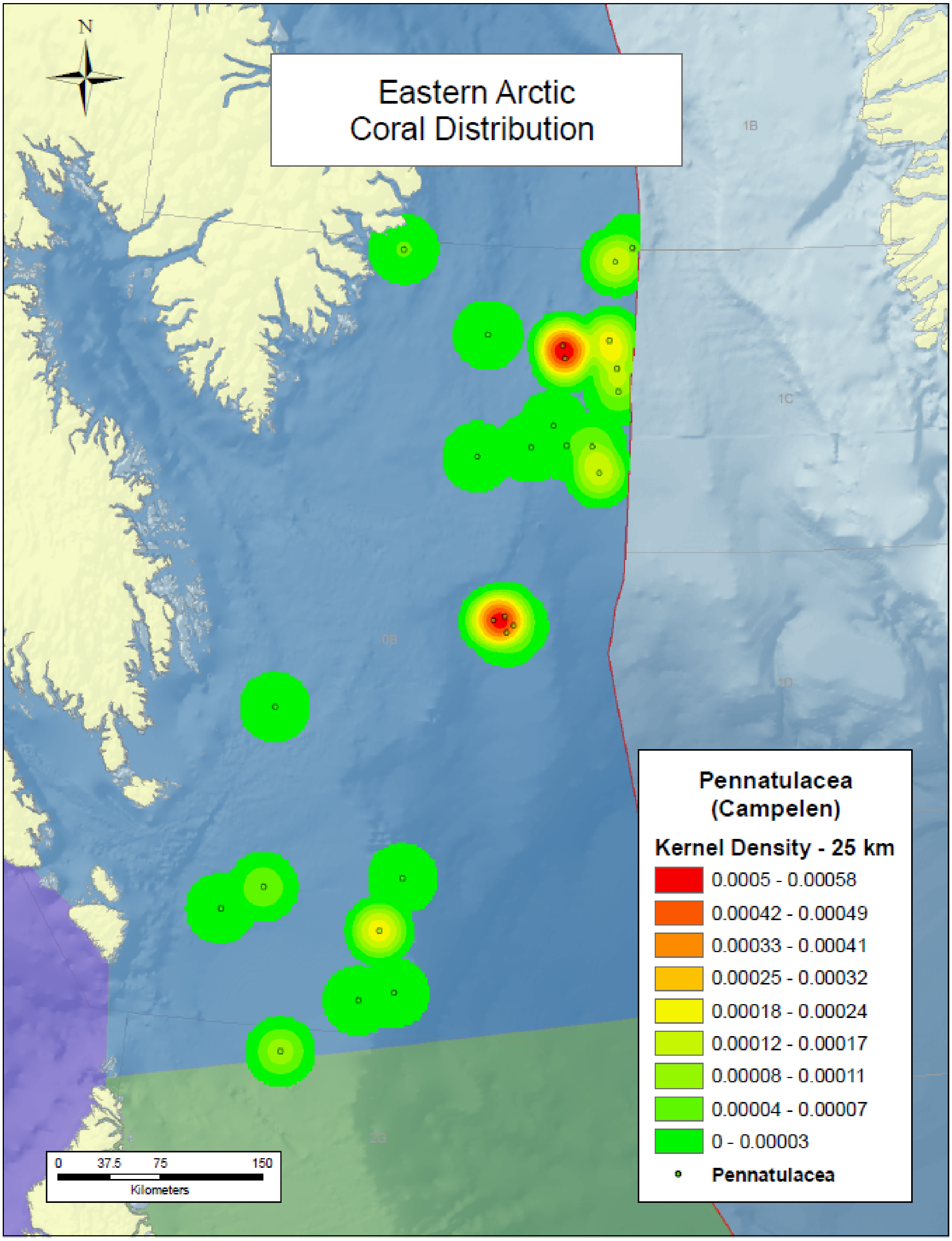


Figure 19. *Interpolated density distribution (kg/km^2) of sea pen catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 2).*

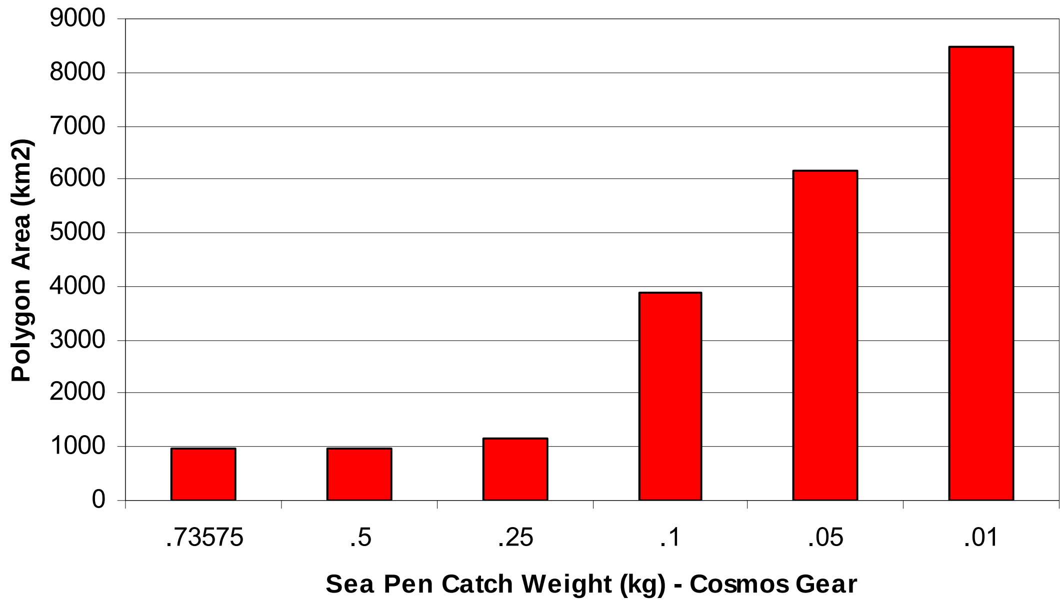


Figure 20. *The area occupied by polygons encompassing specific weight thresholds of sea pen catch (all catches ≥ the threshold level) from research vessel surveys using a Cosmos trawl in the Eastern Arctic Biogeographic Zone.*

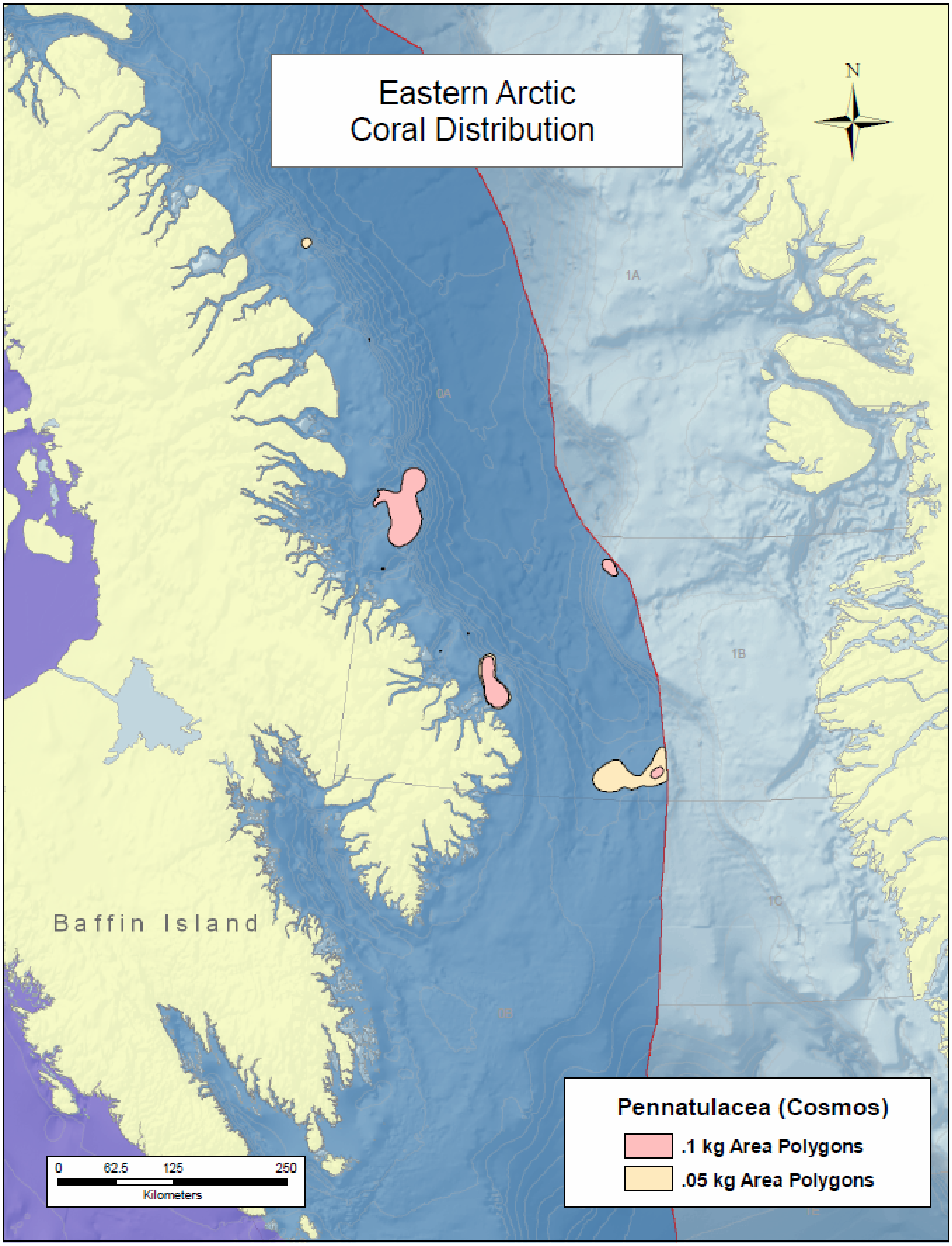


Figure 21. *Polygon areas encompassing sea pen catches of greater than 0.05 kg and 0.1 kg using a Cosmos trawl, illustrating the large increase in area achieved through moving below the 0.1 kg threshold.*

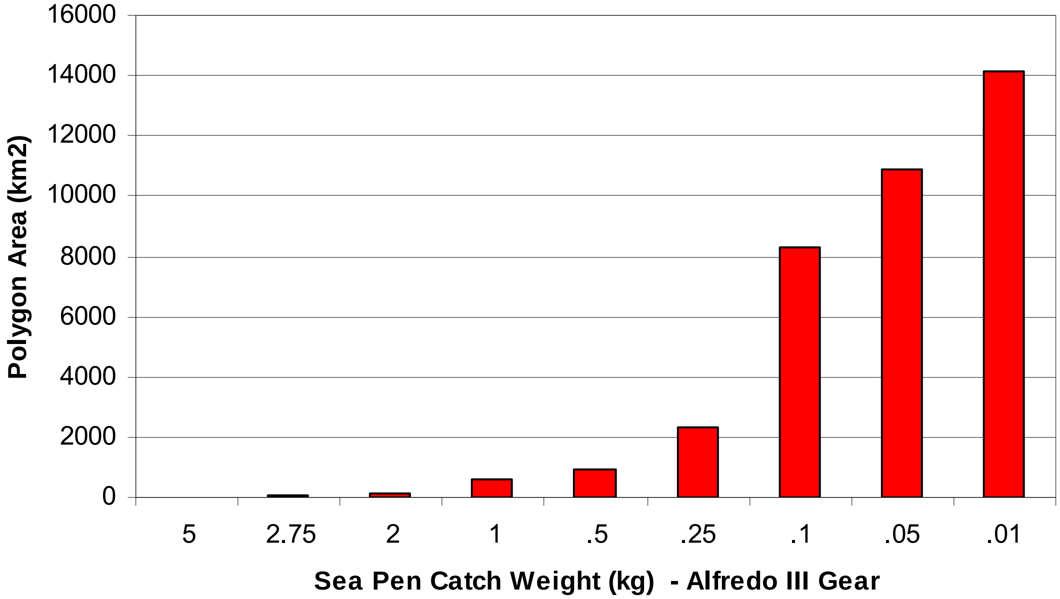


Figure 22. *The area occupied by polygons encompassing specific weight thresholds (all catches ≥ the threshold level) of sea pen catch from research vessel surveys using an Alfredo III trawl in the Eastern Arctic Biogeographic Zone.*

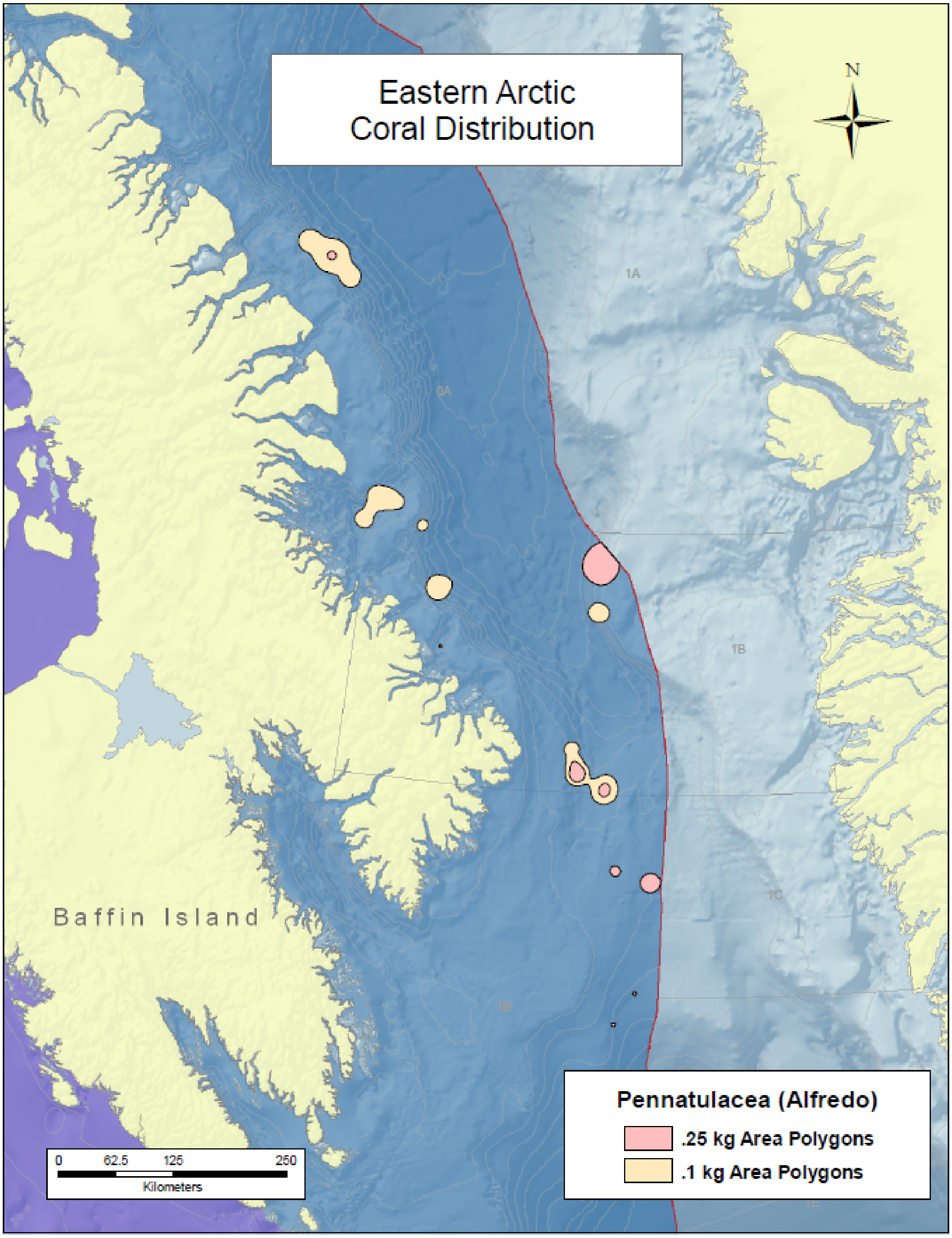


Figure 23. *Polygon areas encompassing sea pen catches of greater than 0.25 kg and 0.1 kg using an Alfredo III trawl, illustrating the large increase in area achieved through moving below the 0.25 kg threshold.*

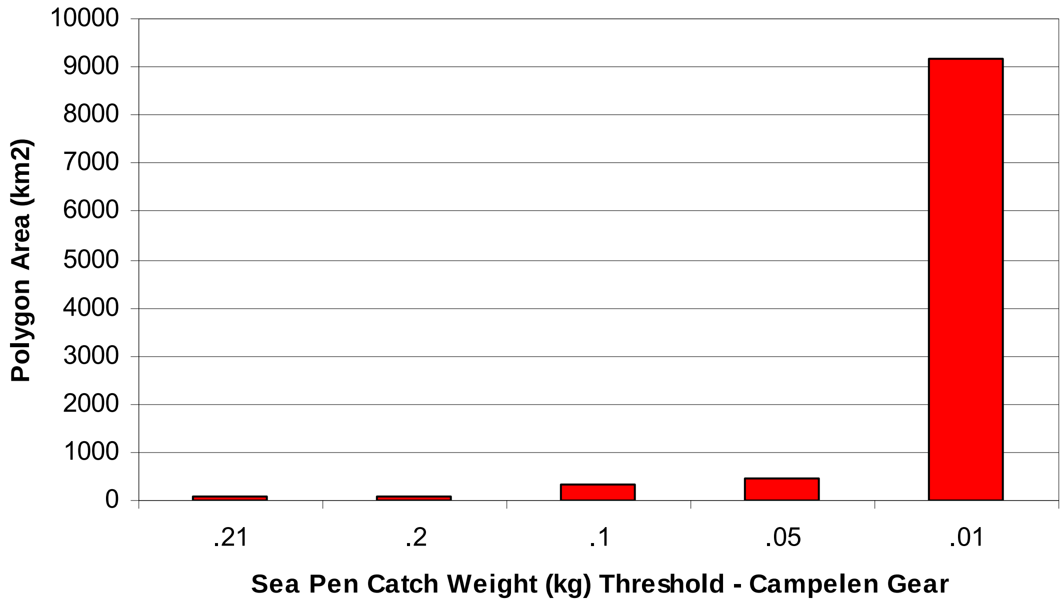


Figure 24. *The area occupied by polygons encompassing specific weight thresholds (all catches ≥ the threshold level) of sea pen catch from research vessel surveys using a Campelen trawl in the Eastern Arctic Biogeographic Zone.*

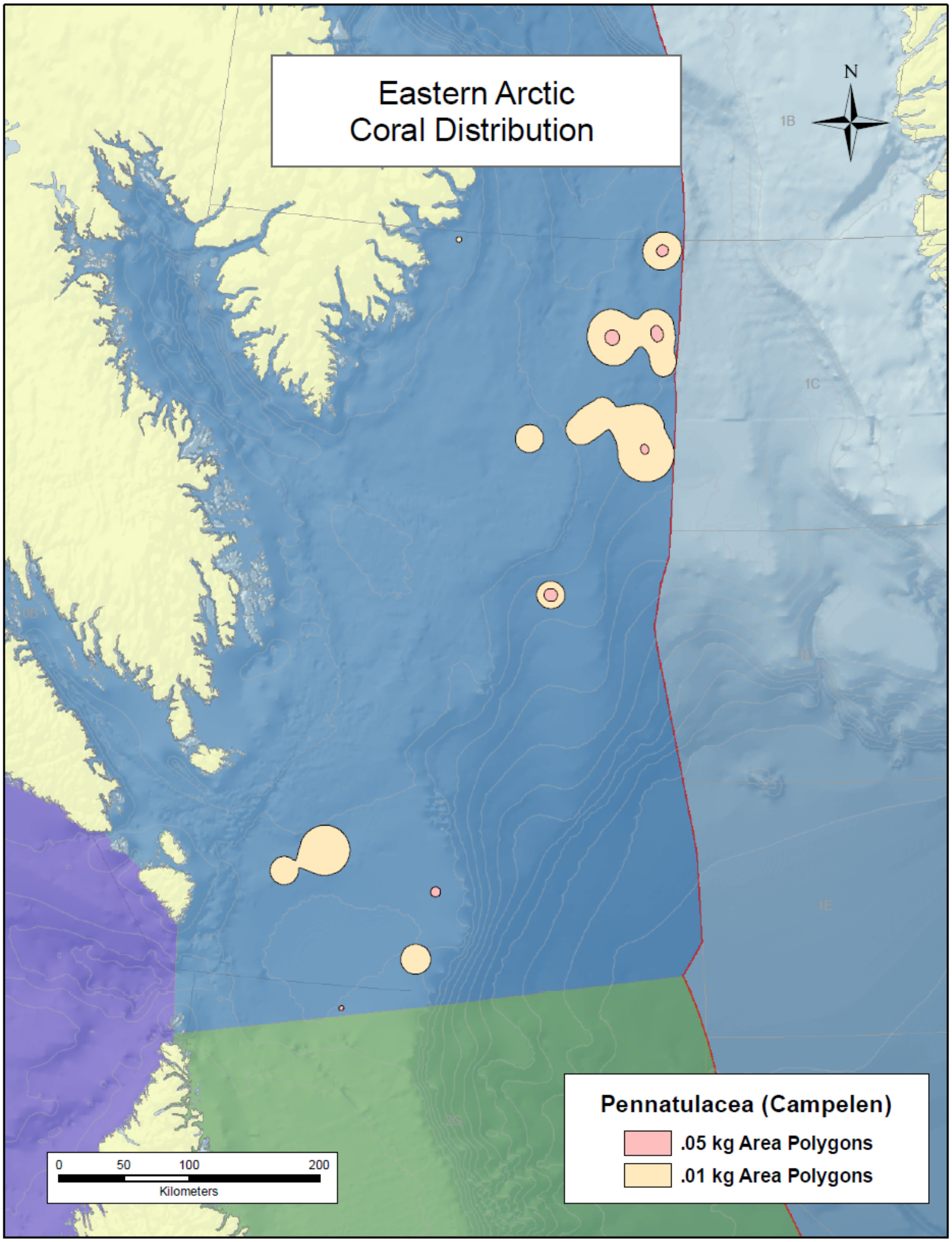


Figure 25. *Polygon areas encompassing sea pen catches of greater than 0.01 kg and 0.05 kg using a Campelen trawl, illustrating the large increase in area achieved through moving below the 0.05 kg threshold.*

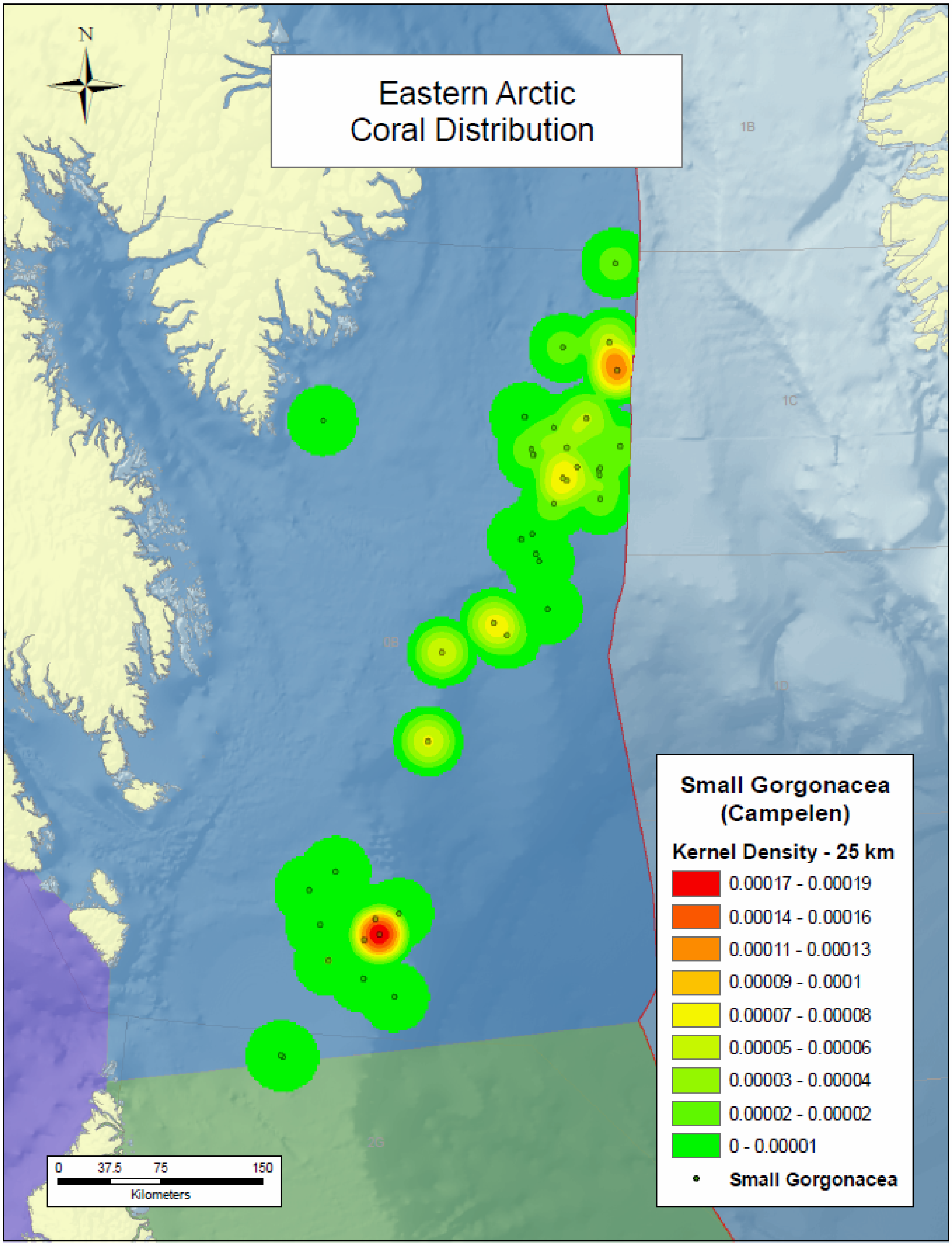


Figure 26. *Interpolated density distribution (kg/km²) of small gorgonian catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 2).*

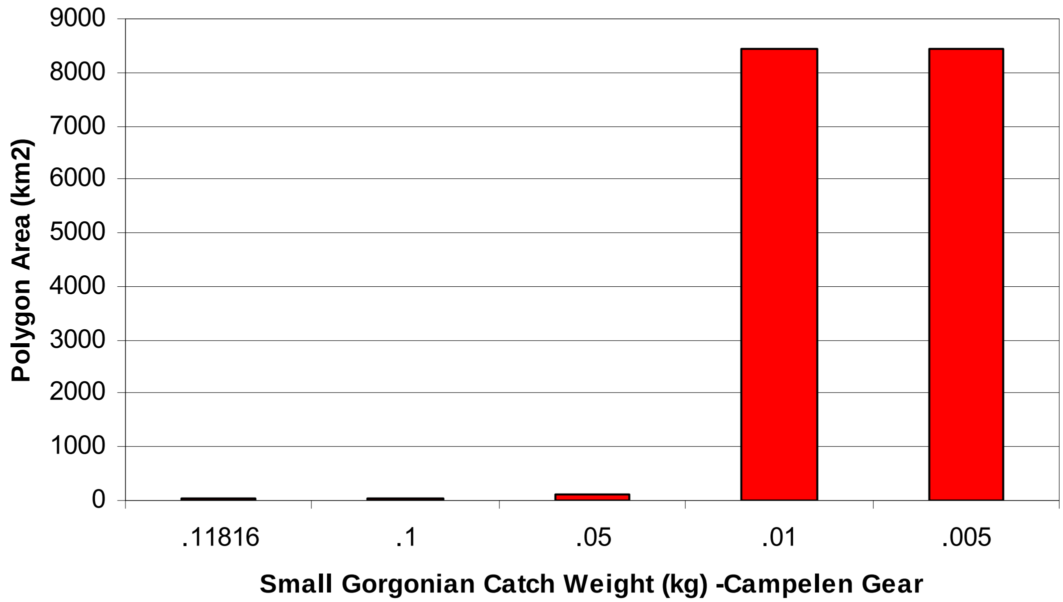


Figure 27. *The area occupied by polygons encompassing specific weight thresholds (all catches ≥ the threshold level) of small gorgonian catch from research vessel surveys using a Campelen trawl in the Eastern Arctic Biogeographic Zone.*

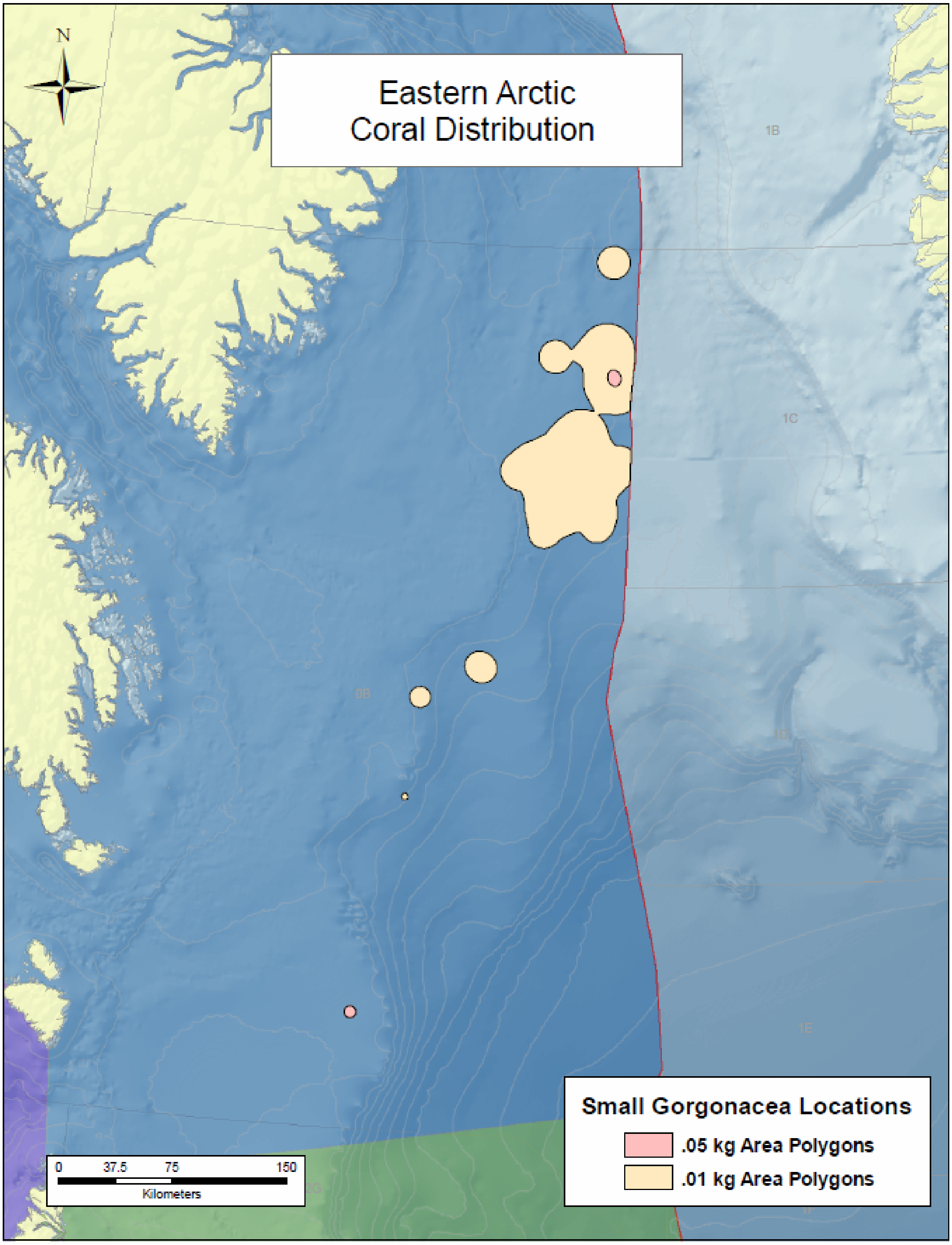


Figure 28. *Polygon areas encompassing small gorgonian catches of greater than 0.01 kg and 0.05 kg using a Campelen trawl, illustrating the large increase in area achieved through moving below the 0.05 kg threshold.*

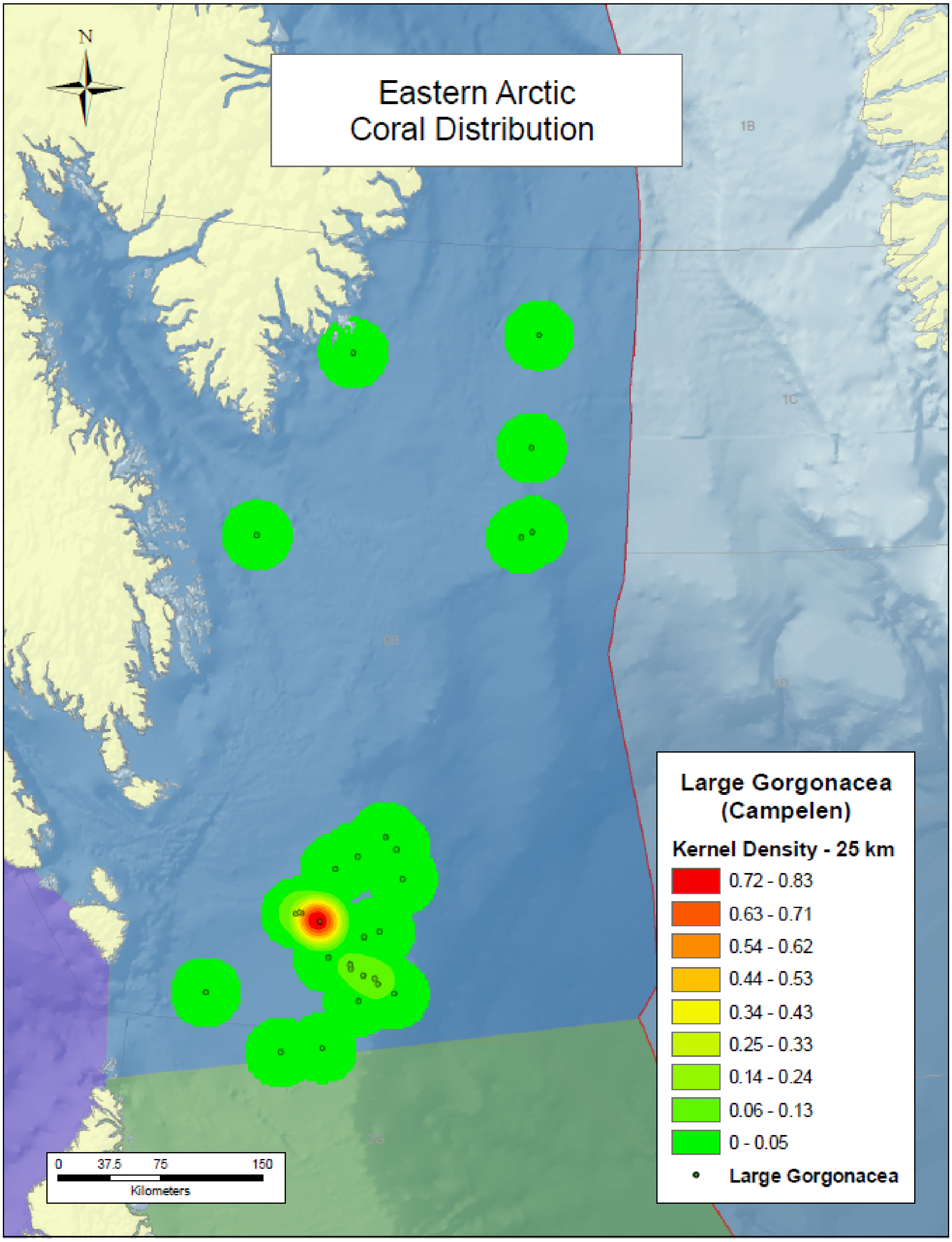


Figure 29. *Interpolated density distribution (kg/km^2) of large gorgonian catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 2).*

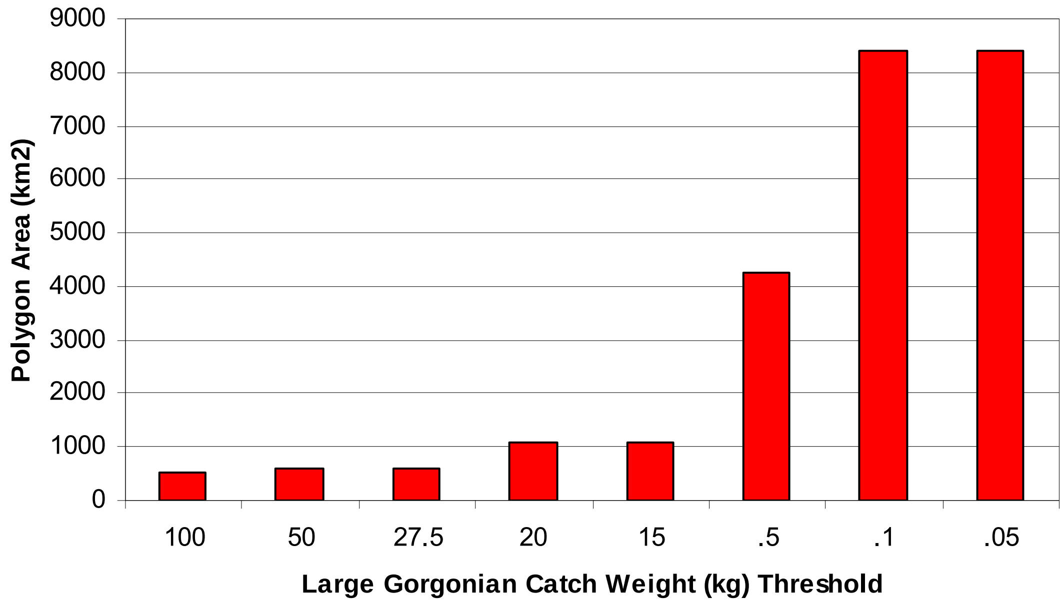


Figure 30. *The area occupied by polygons encompassing specific weight thresholds (all catches ≥ the threshold level) of large gorgonian catch from research vessel surveys using a Campelen trawl in the Eastern Arctic Biogeographic Zone.*

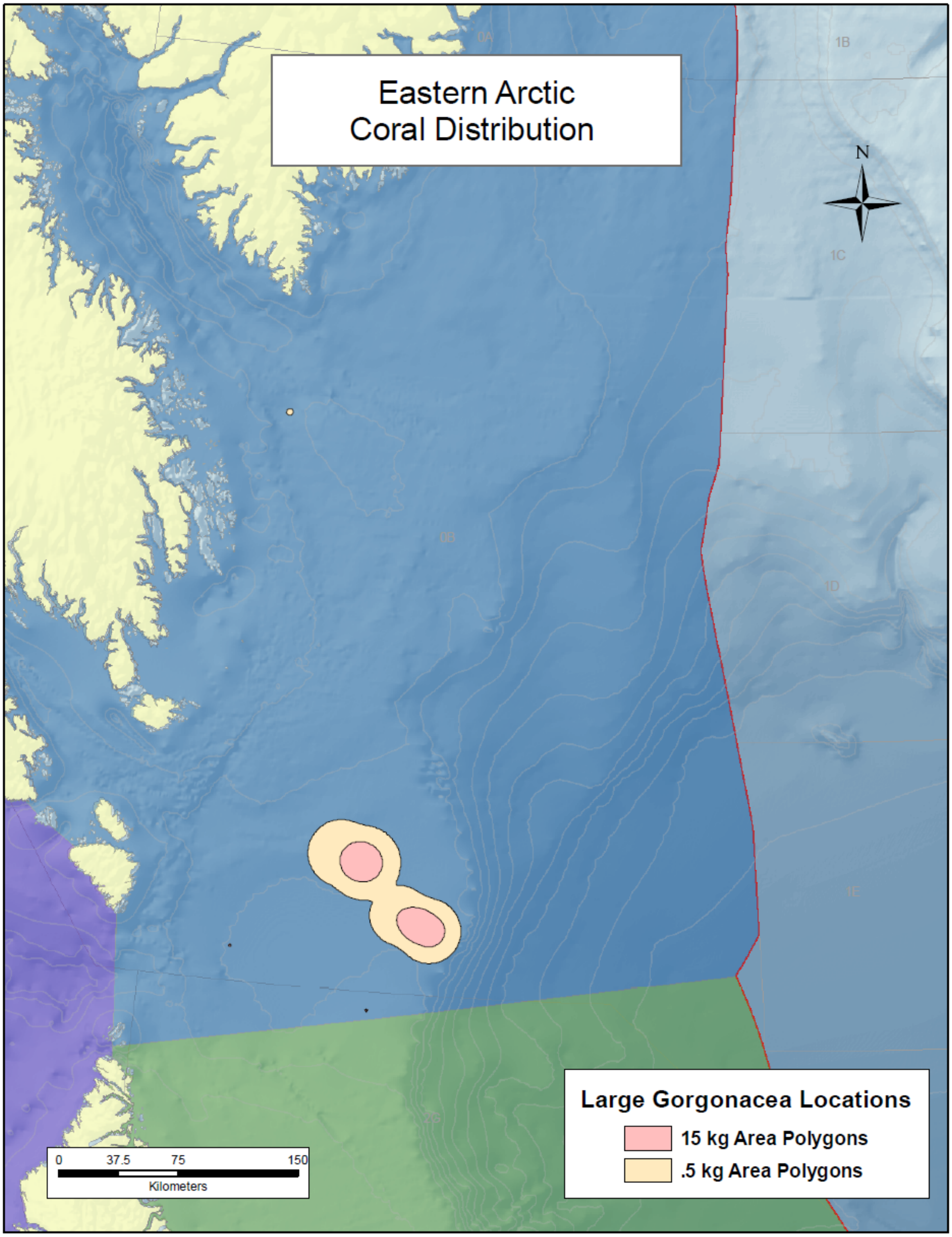


Figure 31. *Polygon areas encompassing large gorgonian catches of greater than 0.5 kg and 15 kg using a Campelen trawl in the Eastern Arctic Biogeographic Zone.*

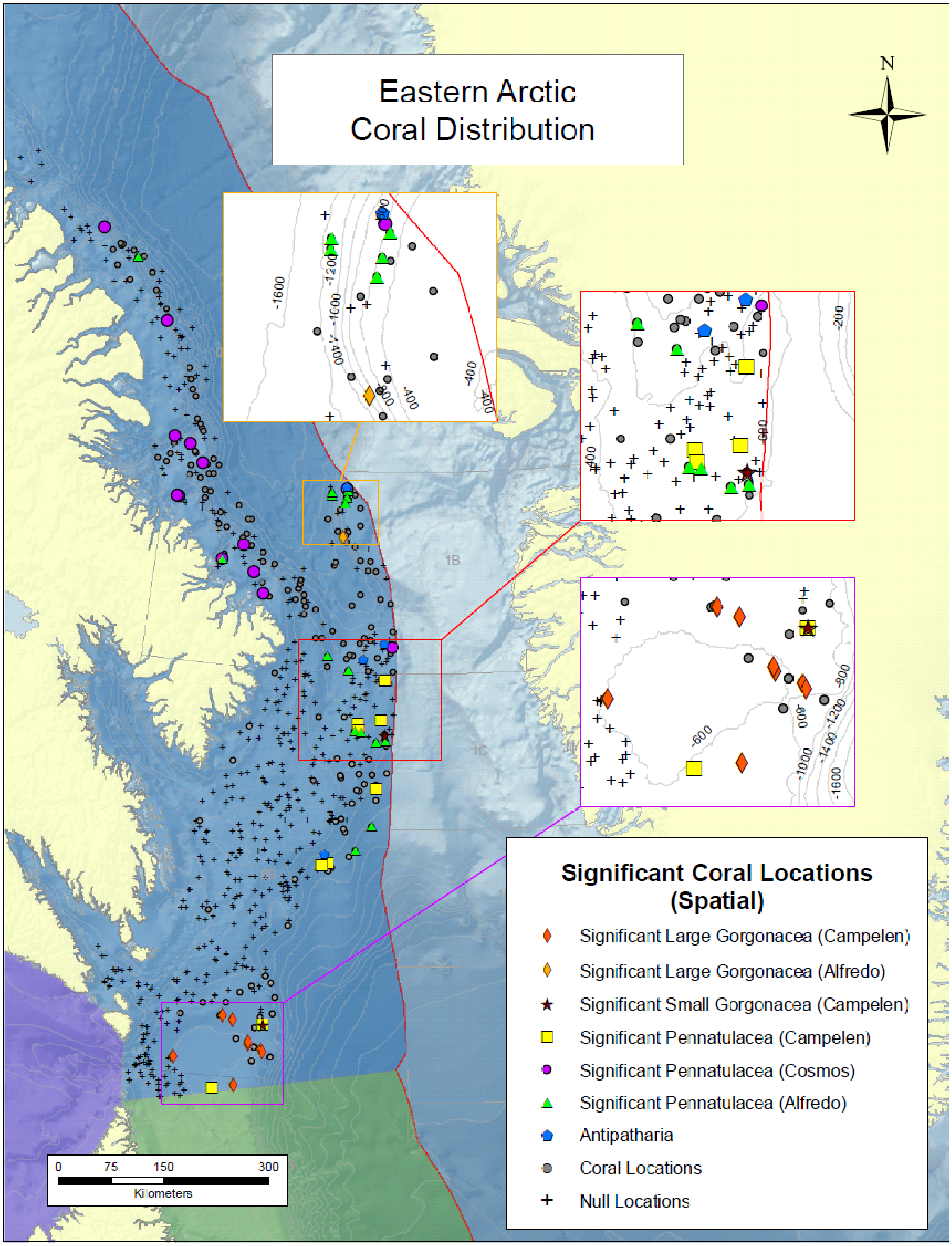


Figure 32. *Location of significant catches of coral in the Eastern Arctic Biogeographic Zone as determined from the spatial analyses. All black coral (Antipatharia) locations are indicated (see Table 7).*

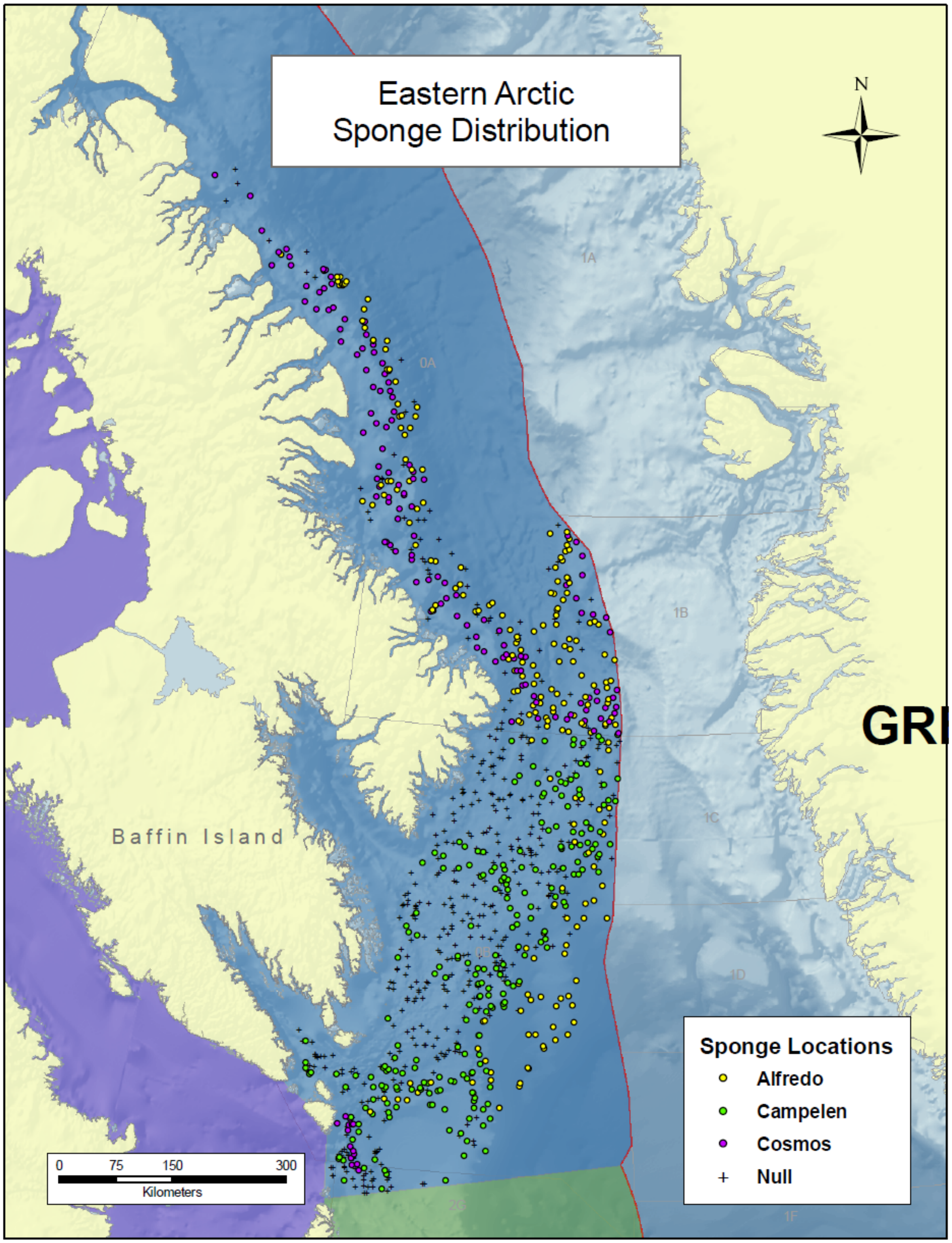


Figure 33. *Distribution of sponges in the Eastern Arctic Biogeographic Zone by gear type. Null records are indicated by a cross (see Table 8) for details of the missions.*

Figure 34. *Coral and sponge by-catch from the Eastern Arctic Biogeographic Zone confirming the presence of the large Geodia spp. sponges. Photo courtesy of V. Wareham (DFO-NL).*

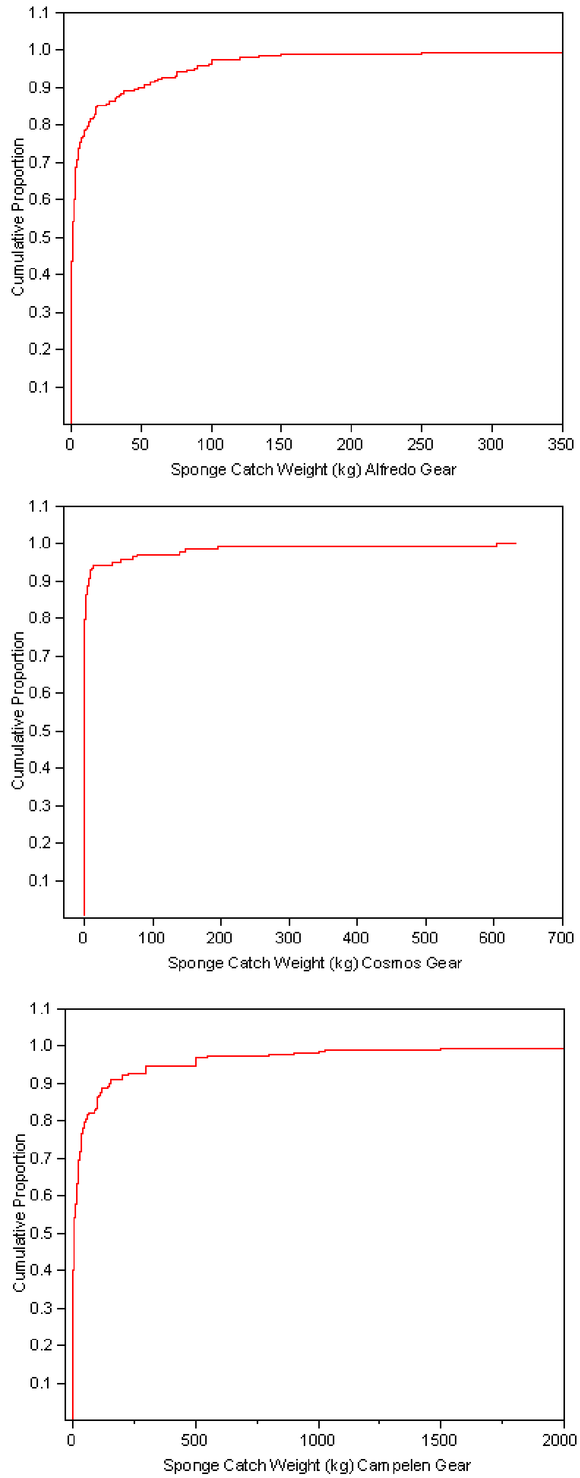


Figure 35. *Cumulative frequency distribution plots for catches of sponges using Alfredo, Cosmos and Campelen trawl gear (top to bottom) in the Eastern Arctic Biogeographic Zone.*

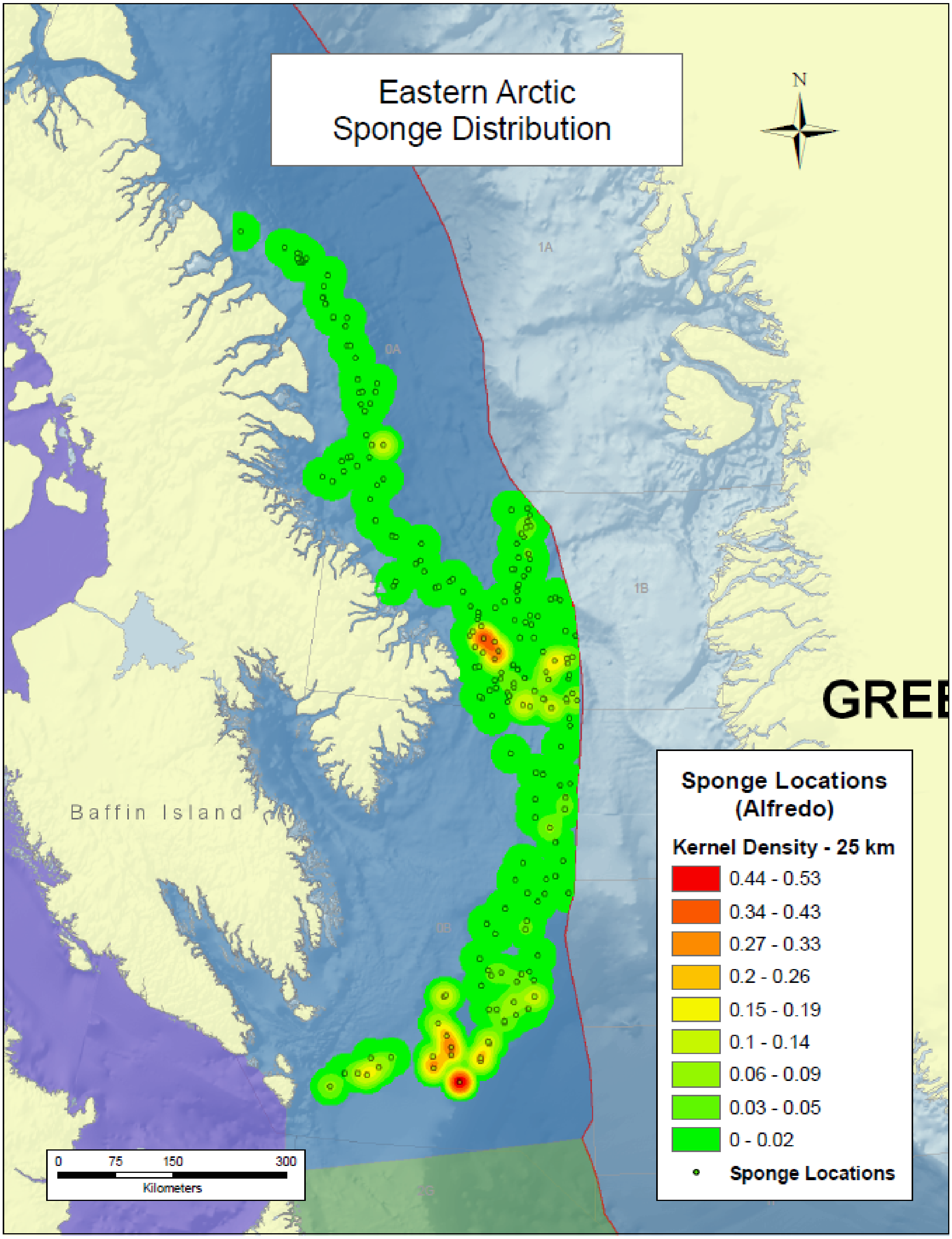


Figure 36. *Interpolated density distribution (kg/km^2) of sponge catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Alfredo trawl gear (see Table 8).*

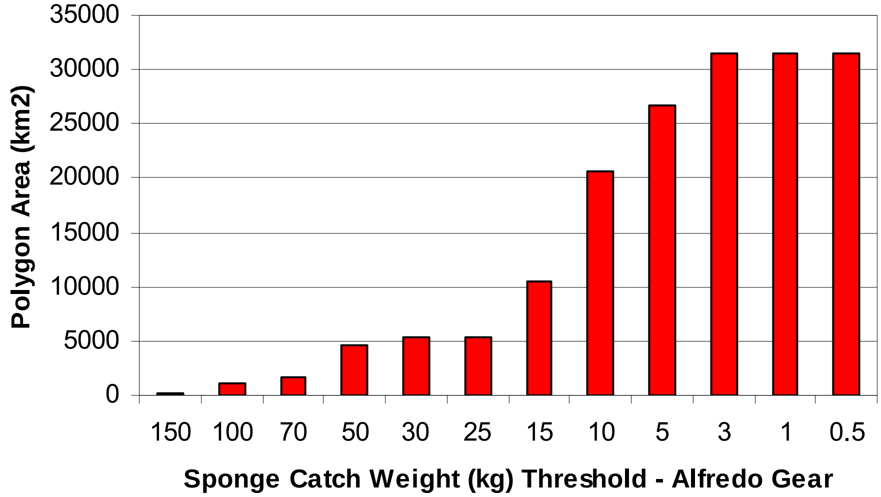


Figure 37. *The area occupied by polygons encompassing specific weight thresholds (all catches ≥ the threshold level) of sponge catch from research vessel surveys using an Alfredo III trawl in the Eastern Arctic Biogeographic Zone.*

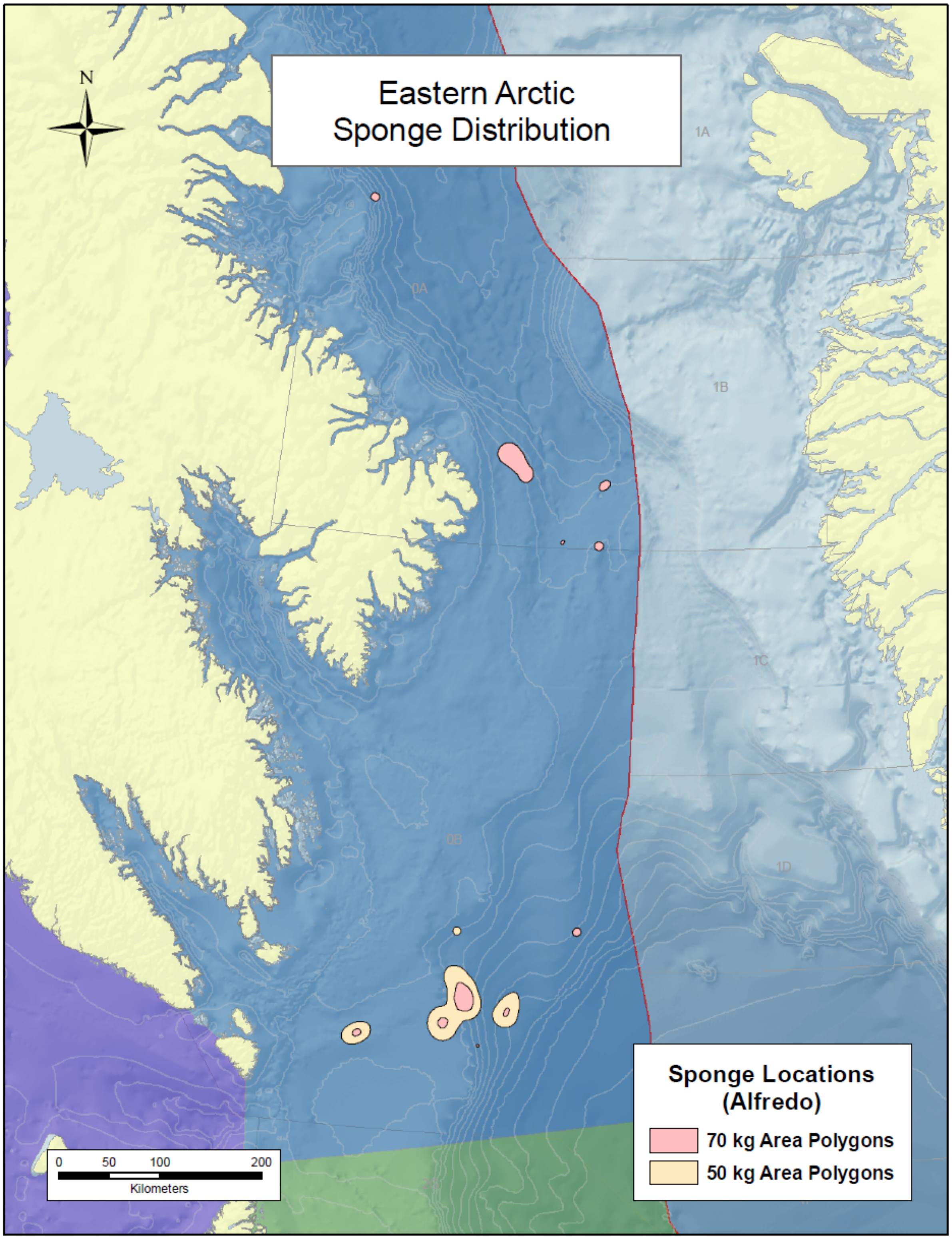


Figure 38. *Polygon areas created by 50 kg and 70 kg and greater sponge catches with Alfredo III trawl gear in the Eastern Arctic Biogeographic Zone.*

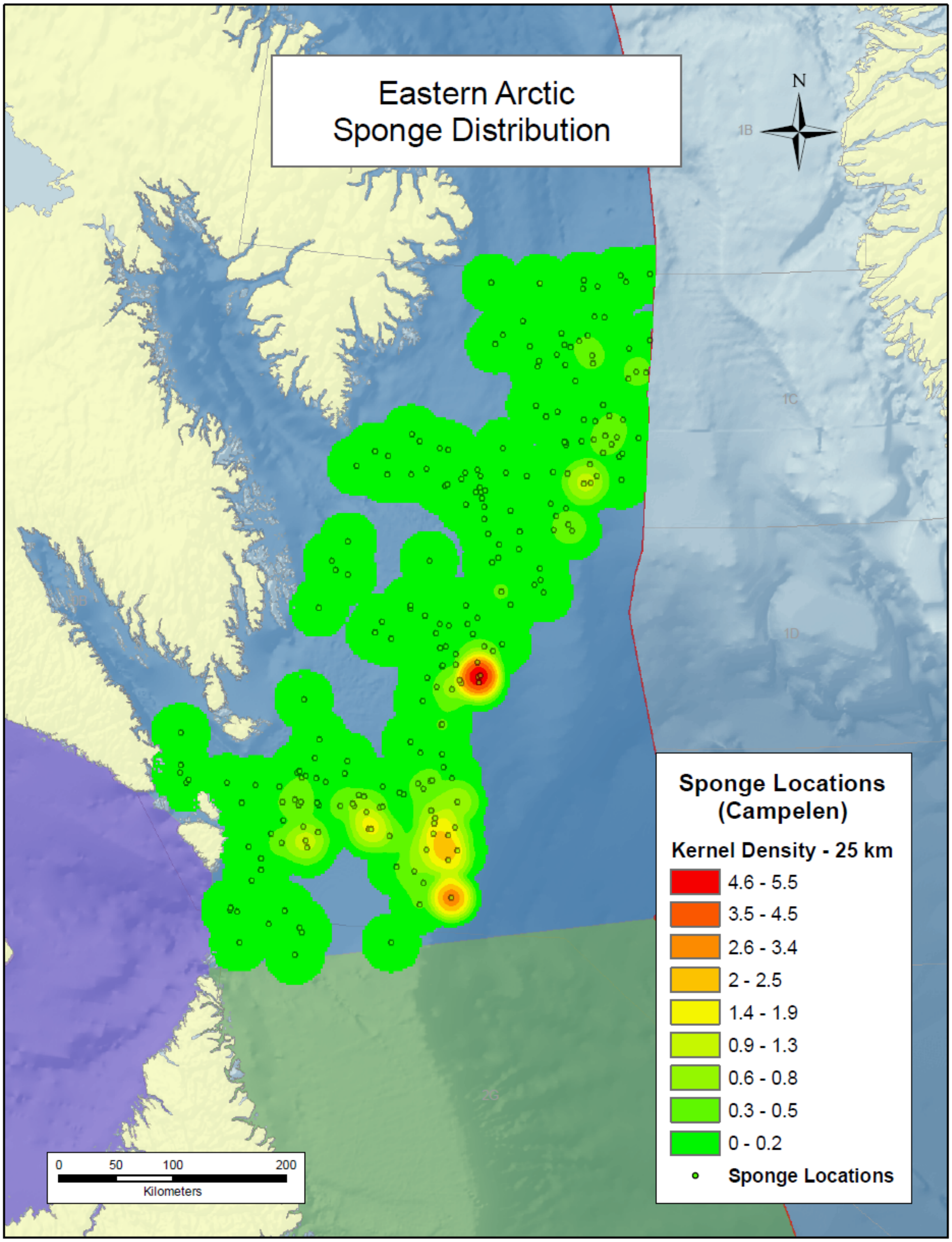


Figure 39. *Interpolated density distribution (kg/km^2) of sponge catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 8).*

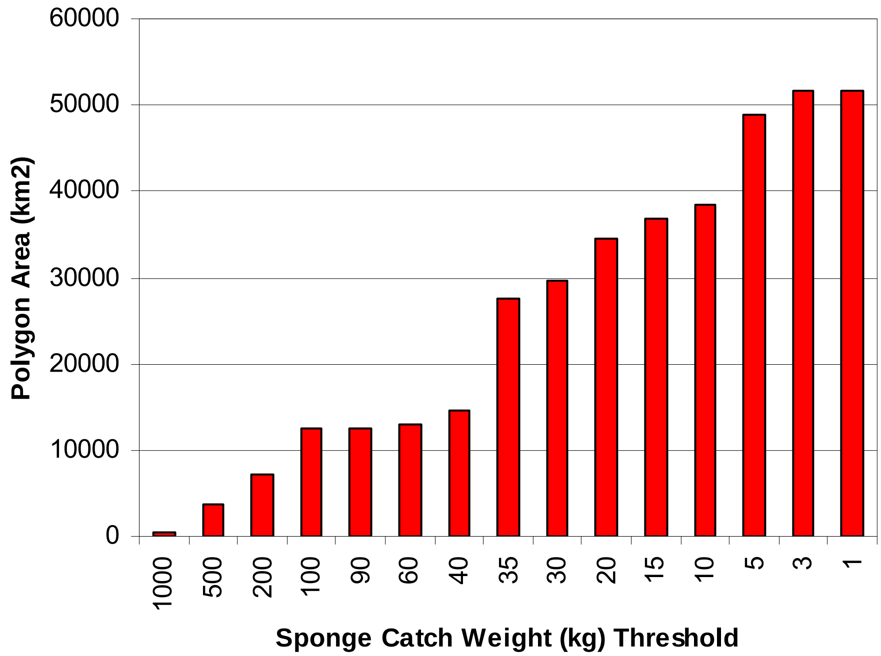


Figure 40. *The area occupied by polygons encompassing specific weight thresholds of sponge catch (all catches ≥ the threshold level) from research vessel surveys using a Campelen trawl in the Eastern Arctic Biogeographic Zone.*

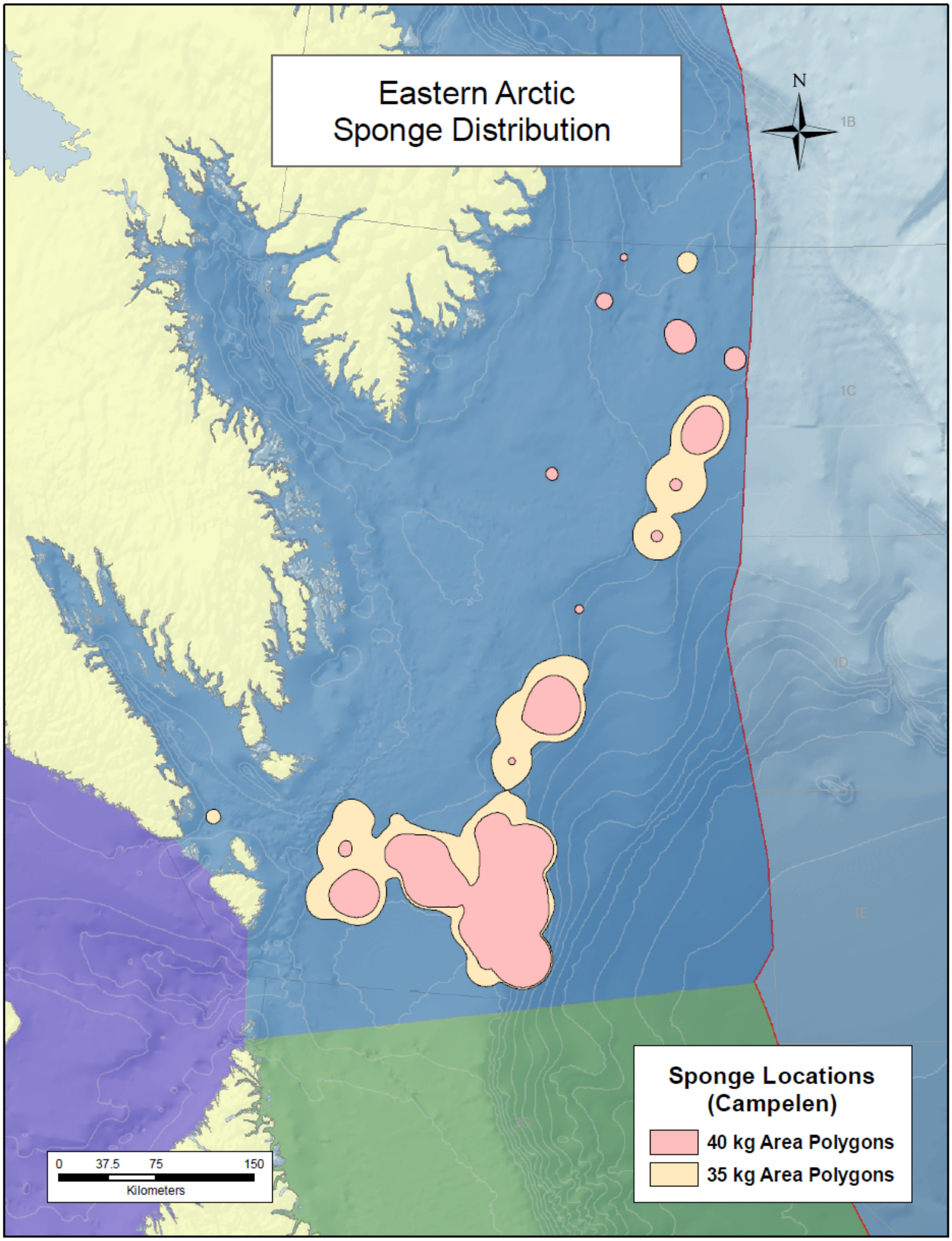


Figure 41. *Polygon areas created by 35 kg and 40 kg and greater sponge catches with Campelen trawl gear in the Eastern Arctic Biogeographic Zone.*

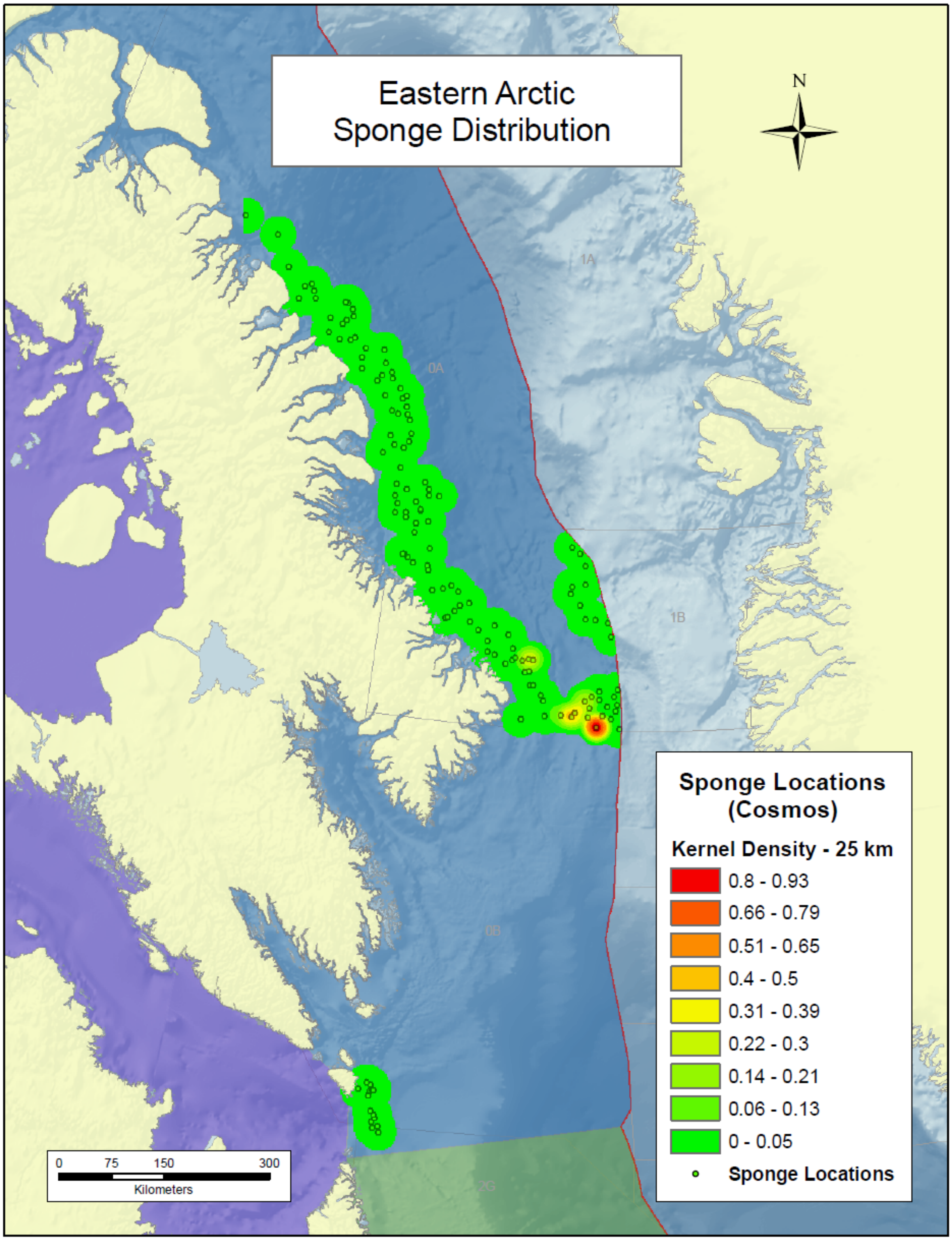


Figure 42. *Interpolated density distribution (kg/km^2) of sponge catches in the Eastern Arctic Biogeographic Zone as determined from research vessel surveys using Cosmos trawl gear (see Table 8).*

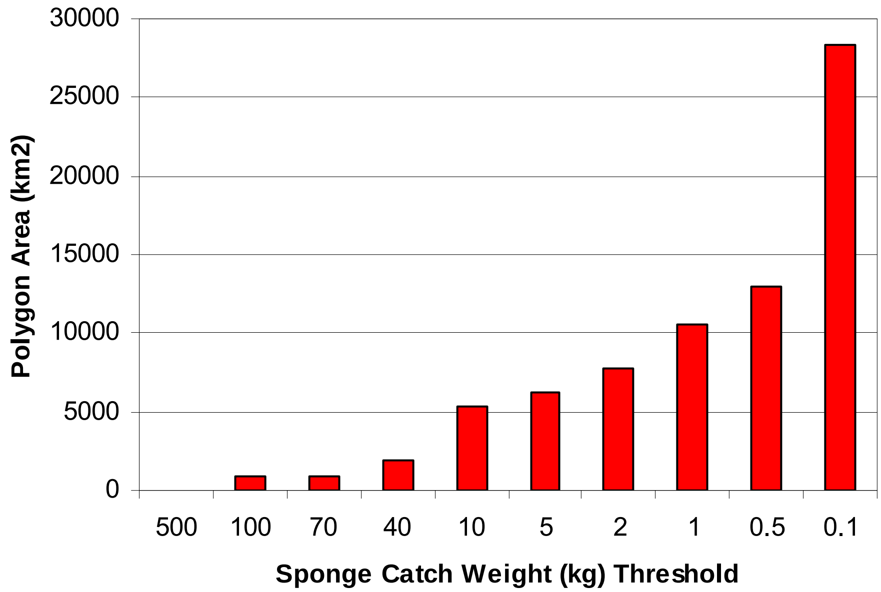


Figure 43. *The area occupied by polygons encompassing specific weight thresholds of sponge catch (all catches ≥ the threshold level) from research vessel surveys using a Cosmos trawl in the Eastern Arctic Biogeographic Zone.*

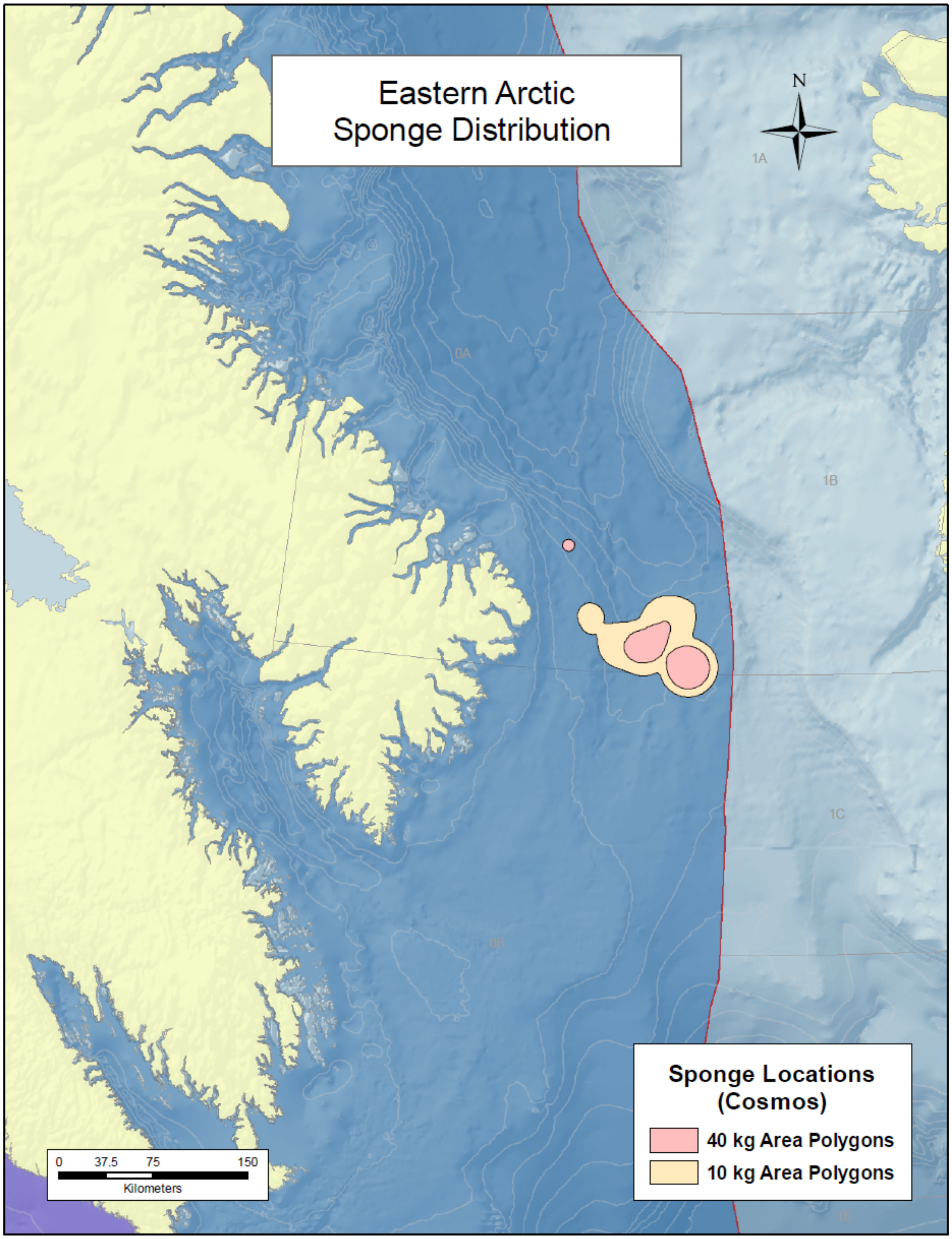


Figure 44. *Polygon areas created by 10 kg and 40 kg and greater sponge catches with Cosmos trawl gear in the Eastern Arctic Biogeographic Zone.*

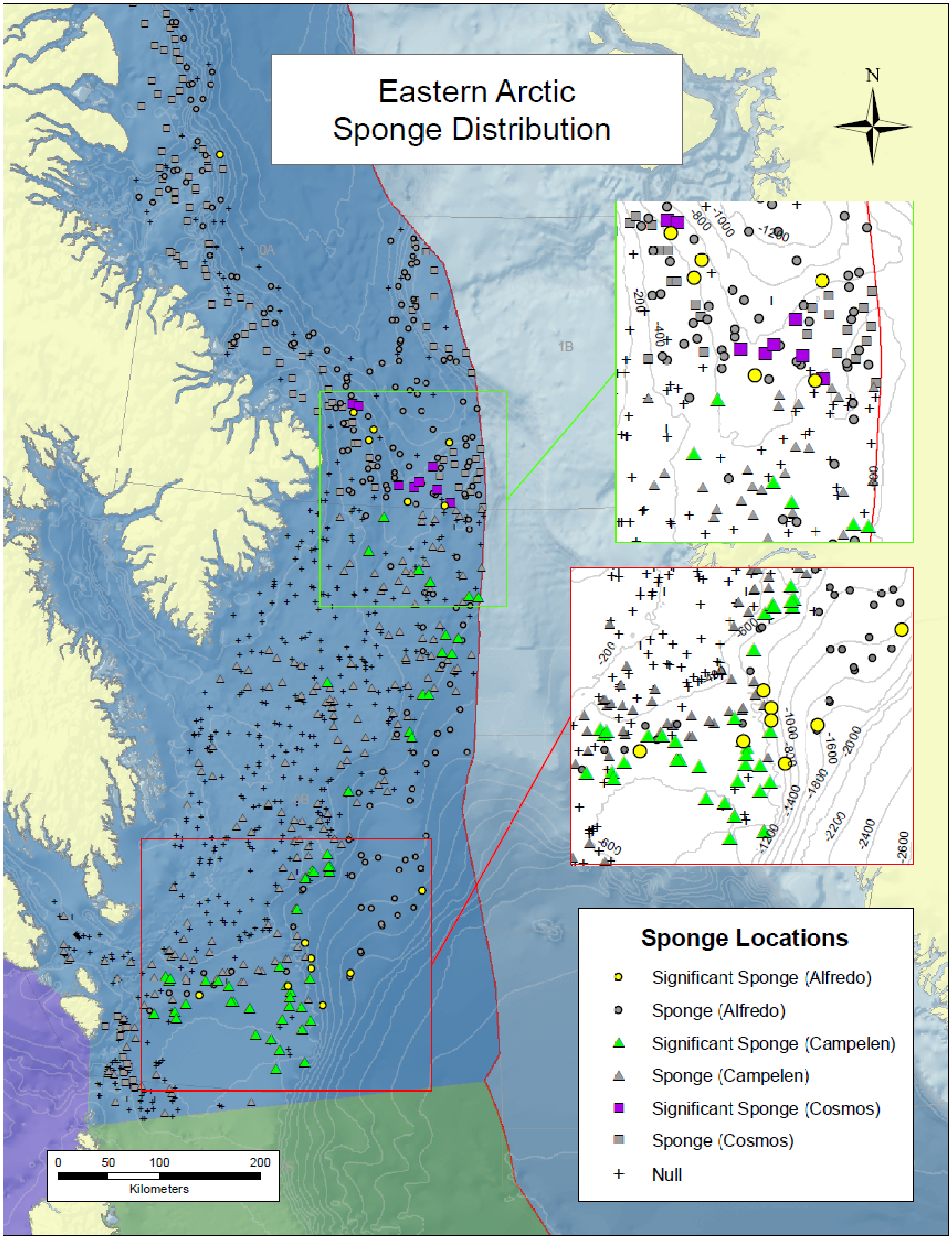


Figure 45. *Location of significant concentrations of sponge in the Eastern Arctic Biogeographic Zone as determined by spatial analyses.*

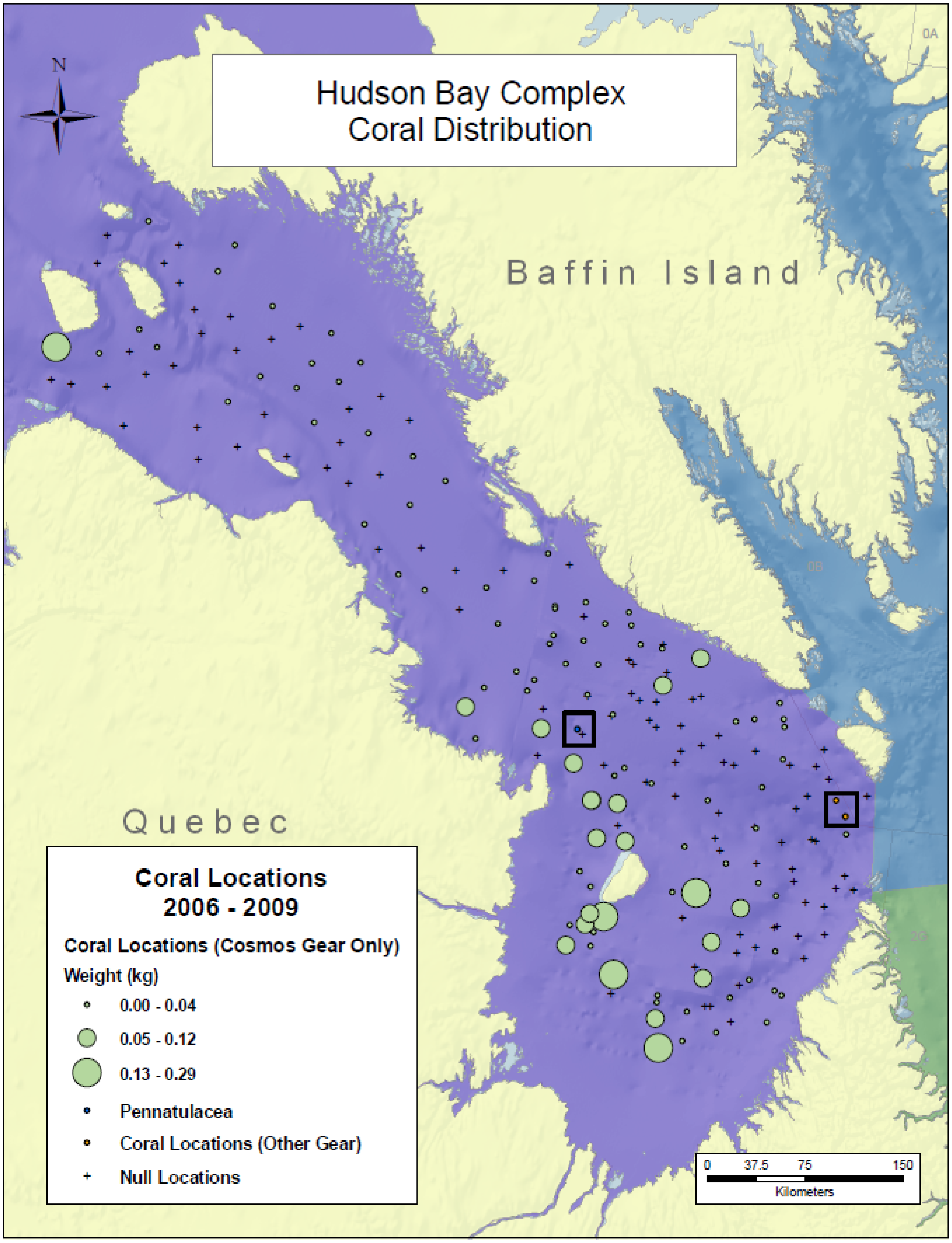


Figure 46. *Distribution of corals in the eastern portion of the Hudson Bay Complex Biogeographic Zone. Coral catches using the Cosmos shrimp trawl are shown as proportional circles according to catch weight (kg). The single record of a sea pen is indicated in blue and boxed. The location of the coral catches made with Campelen trawl gear are in orange and also boxed.*

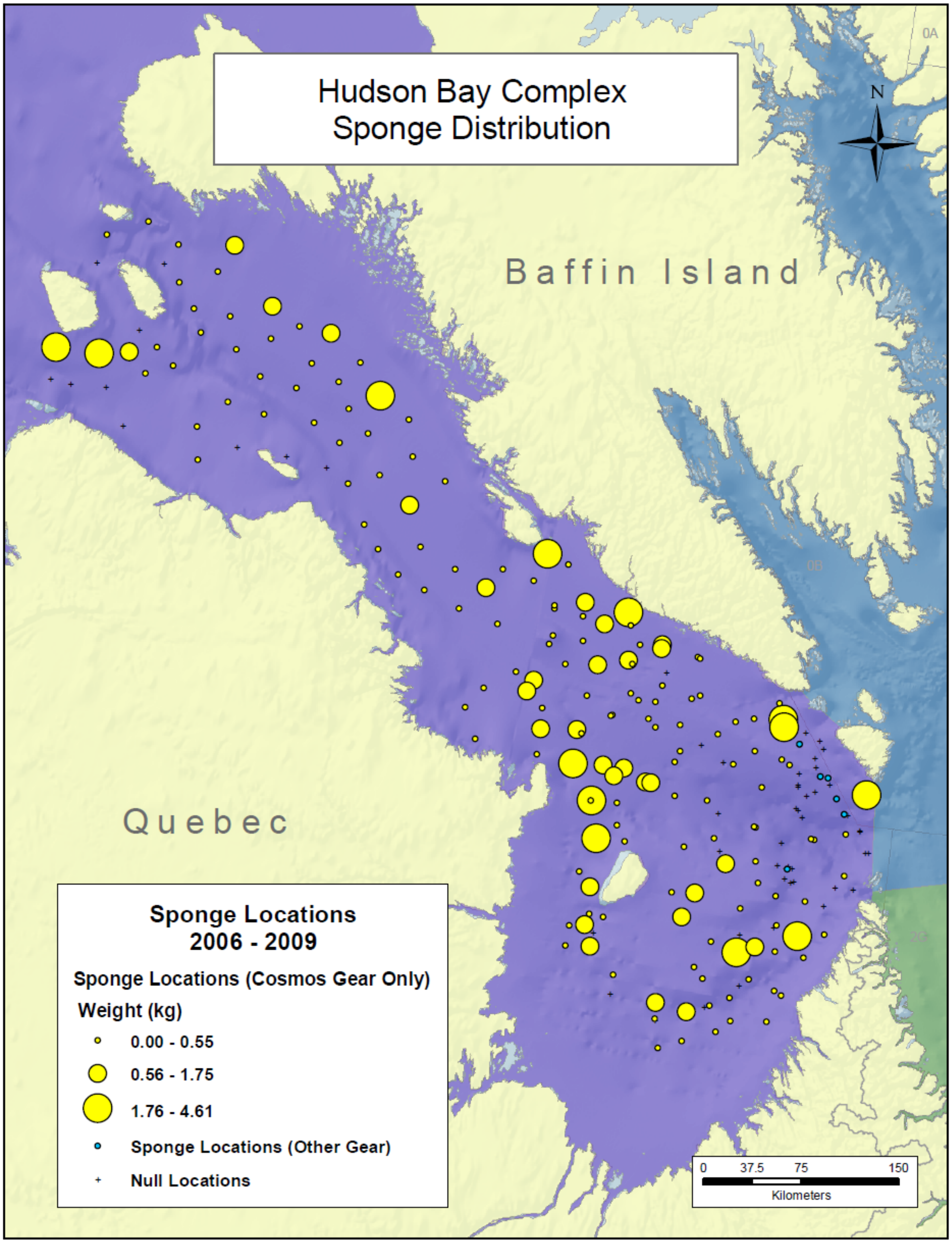


Figure 47. *Distribution of sponges in the eastern portion of the Hudson Bay Complex Biogeographic Zone. Sponge catch weight (kg) using Cosmos shrimp trawl gear is indicated by proportional circles. The few sponge catches taken using Campelen trawl gear are indicated in blue to the west of Resolution Island. Null records are indicated by a cross.*

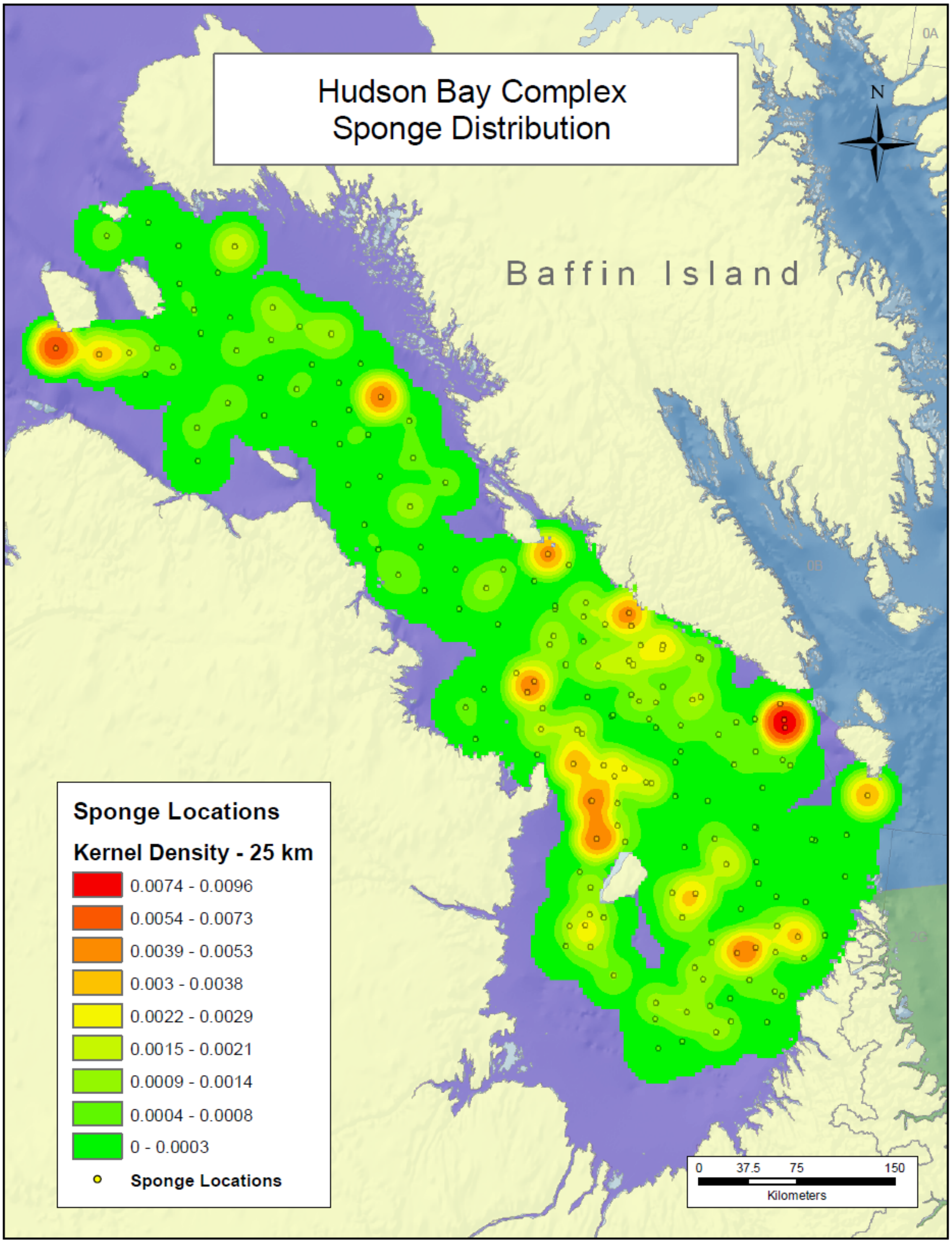


Figure 48. *Interpolated density distribution (kg/km^2) of sponge catches in the Hudson Strait and Ungava Bay portion of the Hudson Bay Complex Biogeographic Zone as determined from research vessel surveys using Cosmos shrimp trawl gear (see Table 13).*

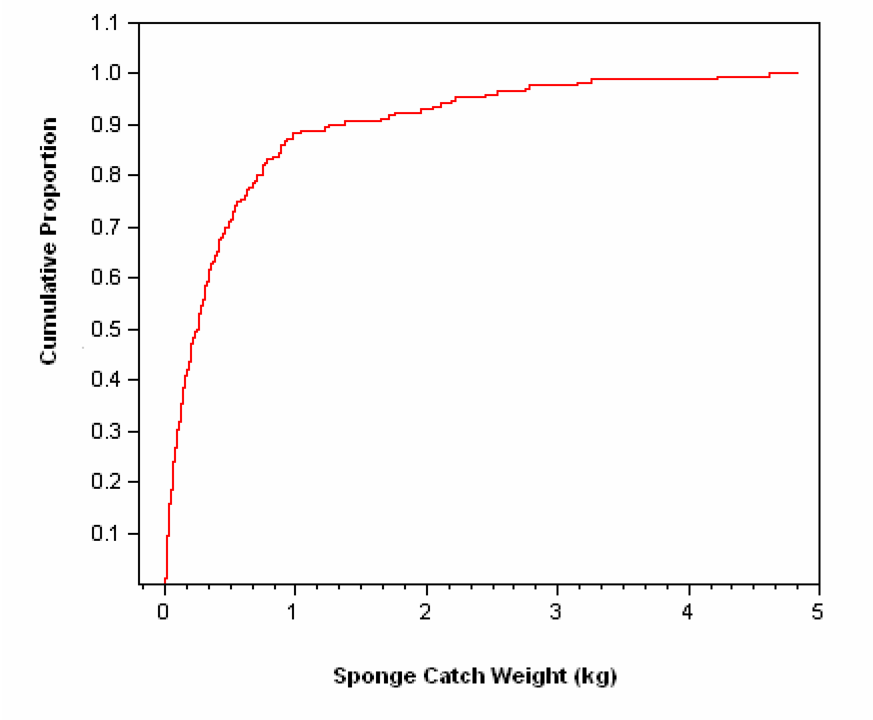


Figure 49. *Cumulative frequency distribution of sponge catches in the Hudson Bay Complex Biogeographic Zone.*

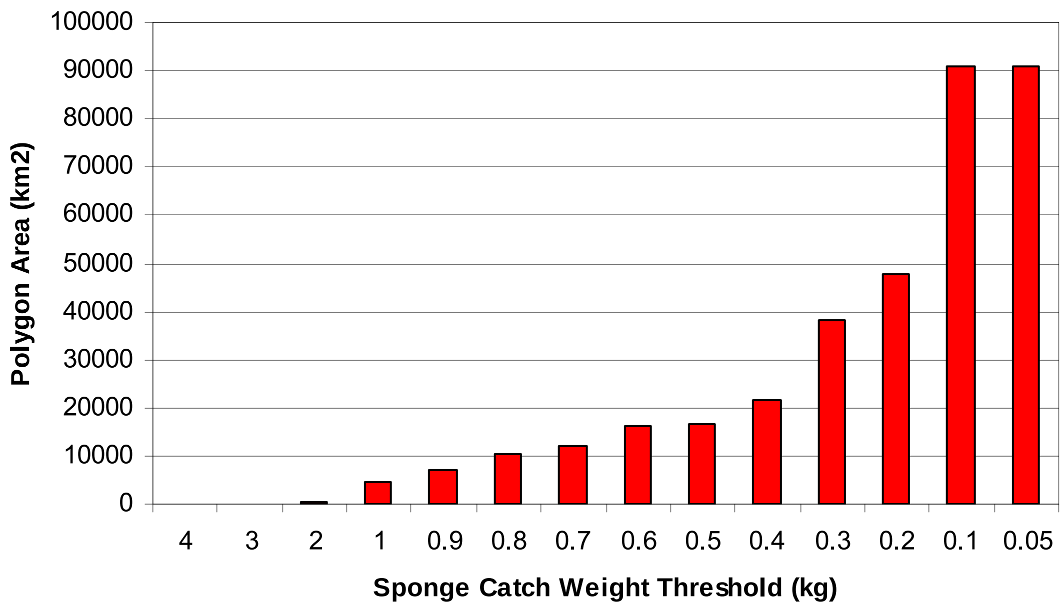


Figure 50. *The area occupied by polygons encompassing specific weight thresholds of sponge catch (all catches ≥ the threshold level) from research vessel surveys with Cosmos shrimp trawls in the Hudson Bay Complex Biogeographic Zone.*

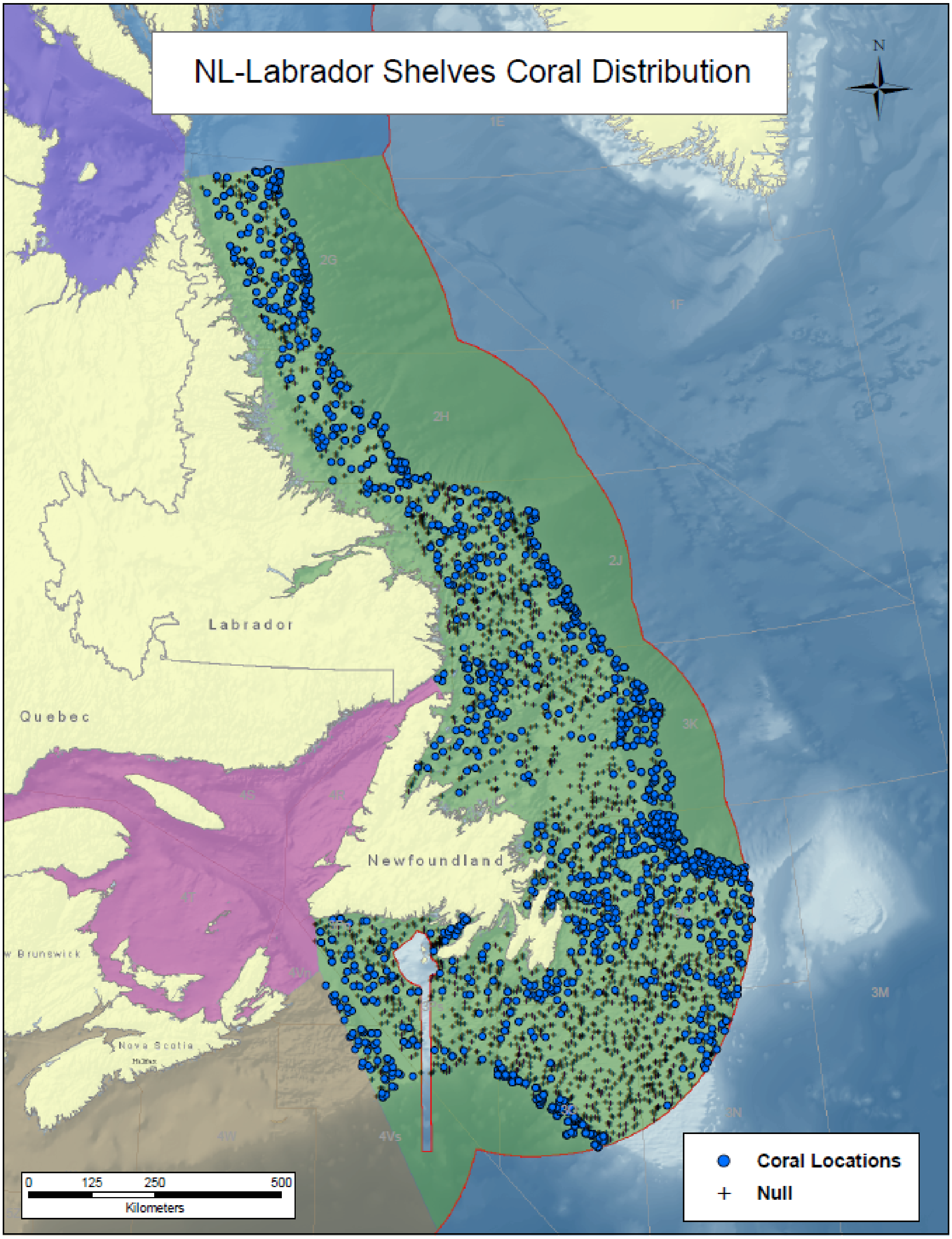


__Figure 51.__ Distribution of catches containing coral (all taxa) from research vessel surveys in the NL-Labrador Biogeographic Zone.

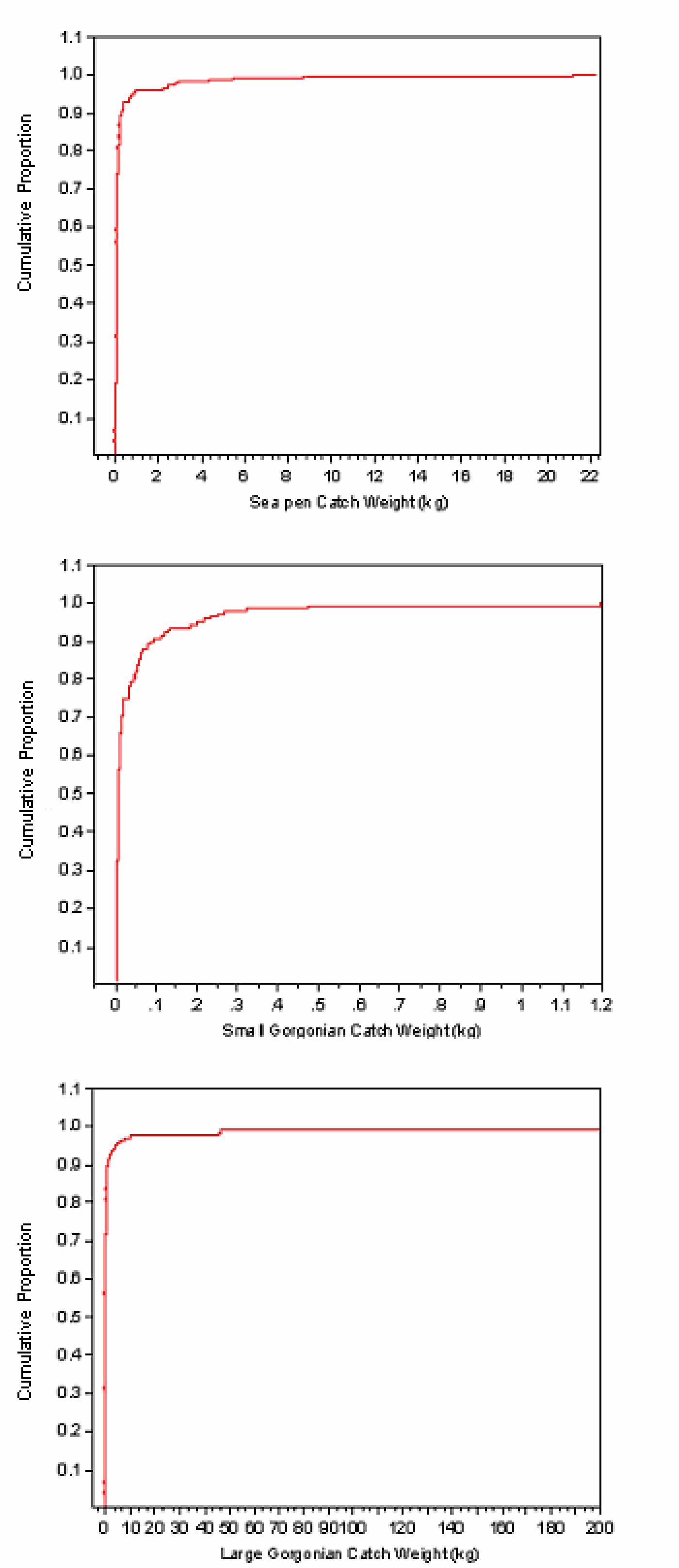


Figure 52. *Cumulative frequency distribution plots for sea pens, small gorgonian corals and large gorgonian corals (top to bottom) from the NL-Labrador Shelves Biogeographic Zone.*

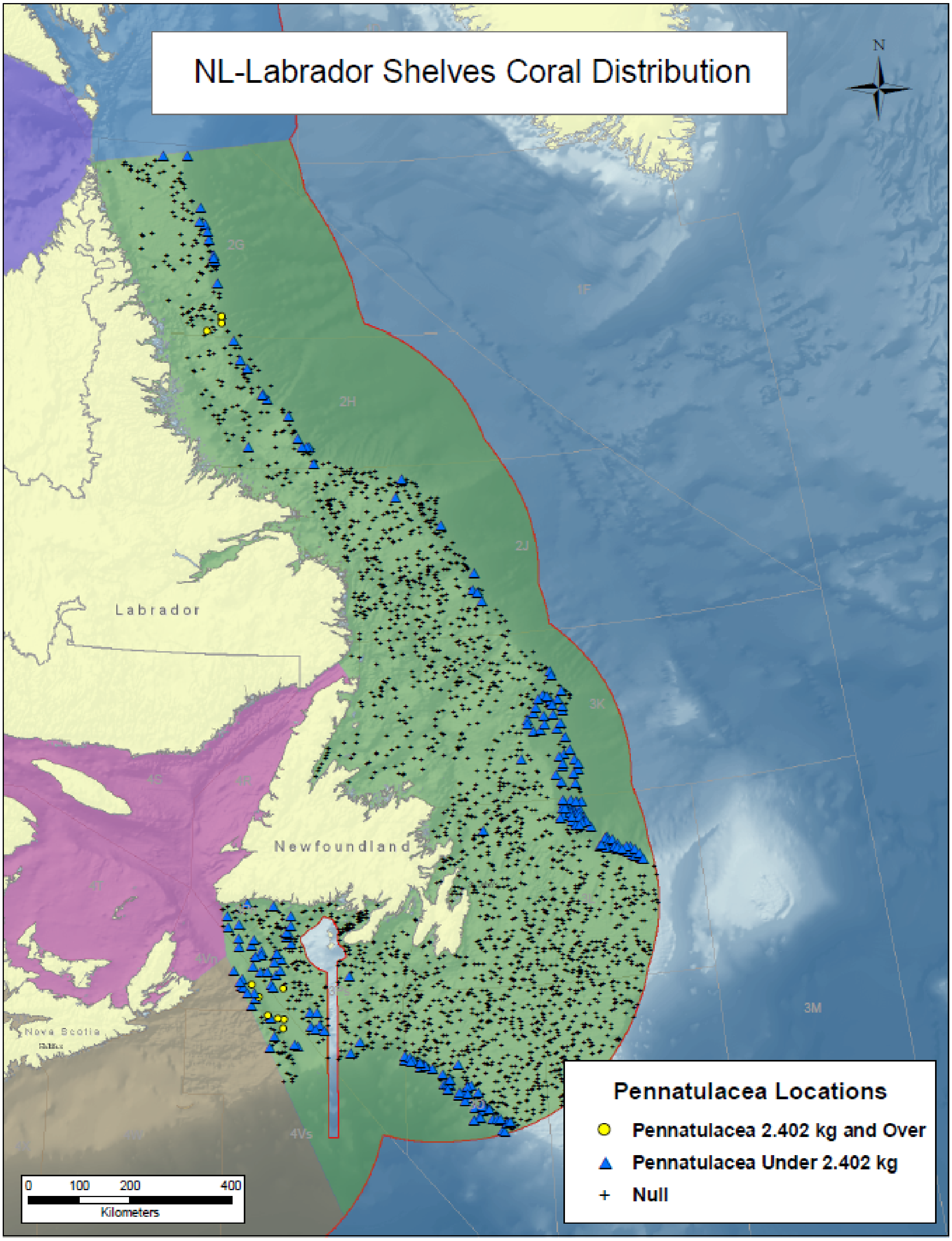


Figure 53. *Location of significant concentrations of sea pens (Pennatualcea) in the NL-Labrador Shelves Biogeographic Zone. Smaller catches of sea pens and null catches (no sea pens) are also indicated (underlain).*

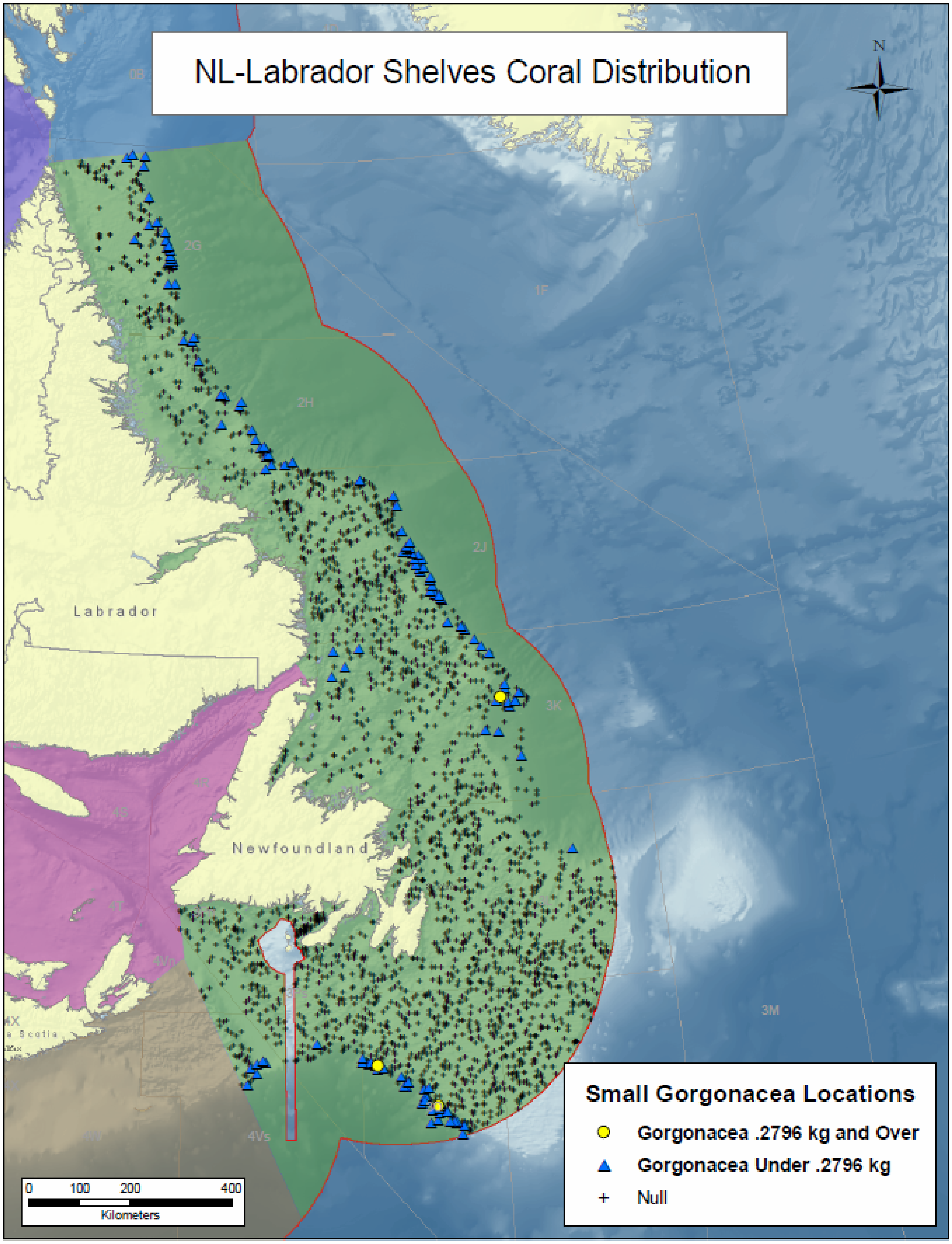


Figure 54. *Location of significant concentrations of small gorgonians (species of Acanella and Anthothela) in the NL-Labrador Shelves Biogeographic Zone. Smaller catches of small gorgonians and null catches (no small gorgonians) are also indicated (underlain).*

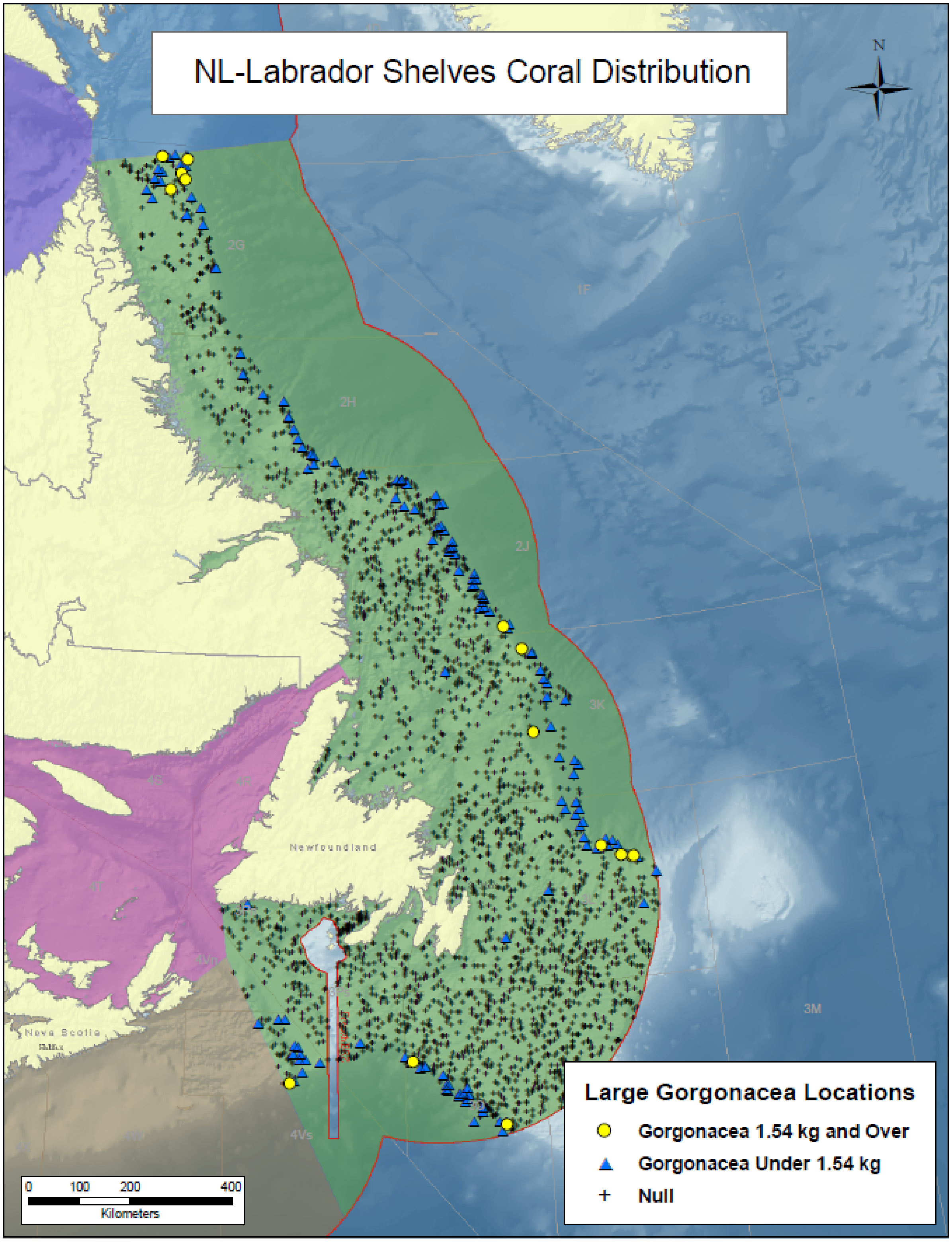


Figure 55. *Location of significant concentrations of large gorgonian corals in the NL-Labrador Shelves Biogeographic Zone. Smaller catches of large gorgonians and null catches (no large gorgonians) are also indicated (underlain).*

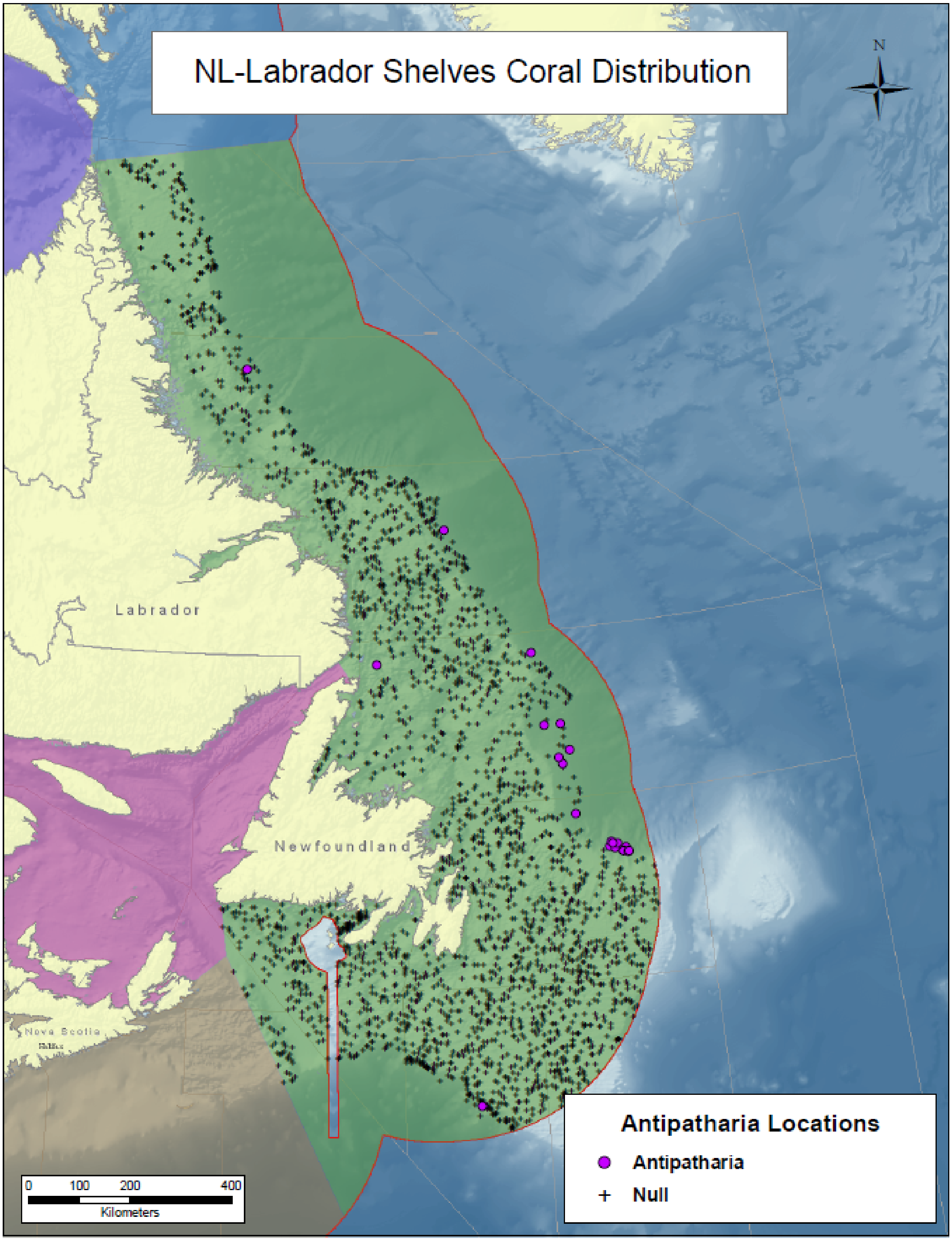


Figure 56. *Location of black coral catches (Antipatharia O. spp.) in the NL-Labrador Shelves Biogeographic Zone. Null catches (no black coral) are also indicated.*

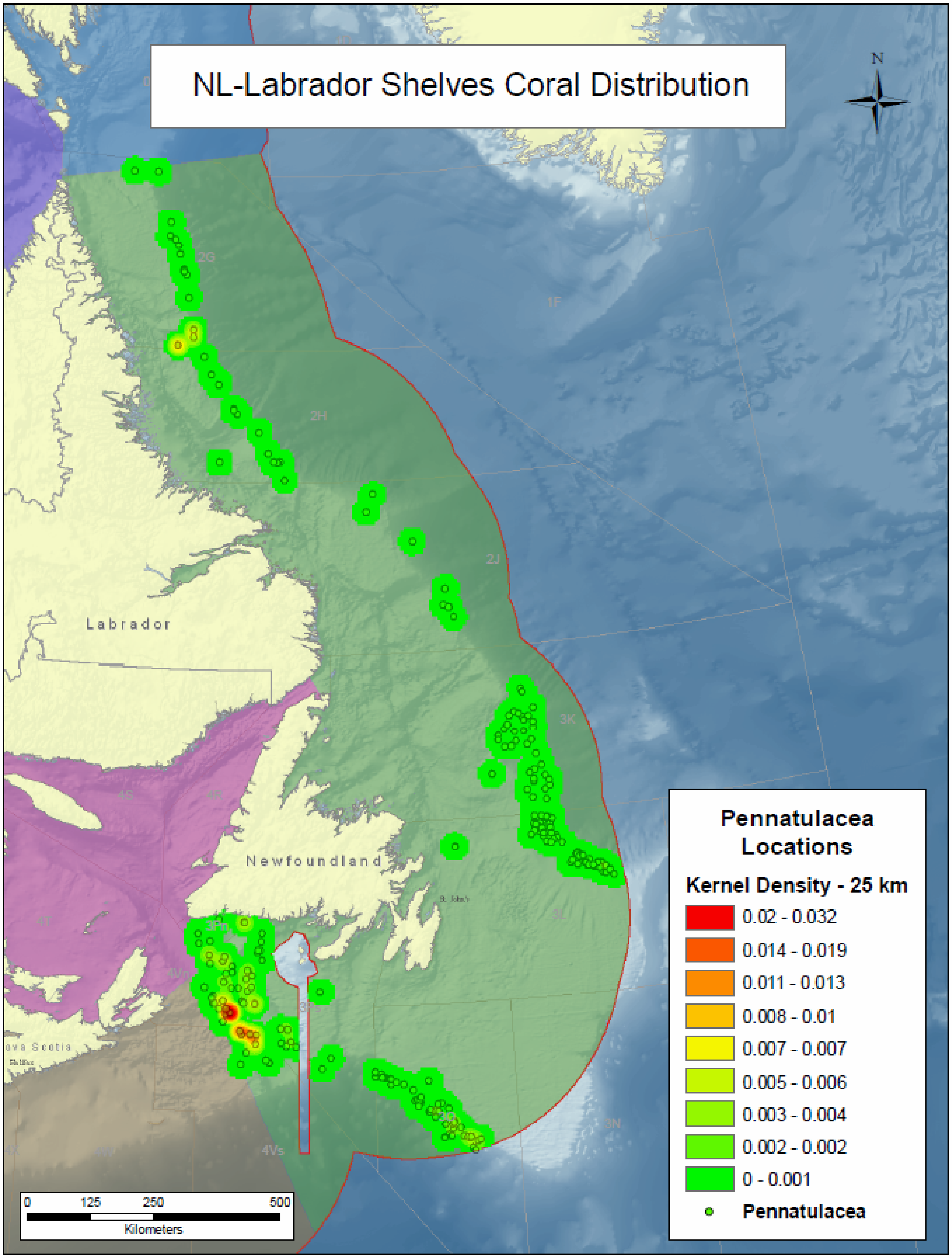


Figure 57. *Interpolated density distribution (kg/km²) of sea pen (Pennatulacea) catch weights (kg) in the NL-Labrador Shelves Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 16).*

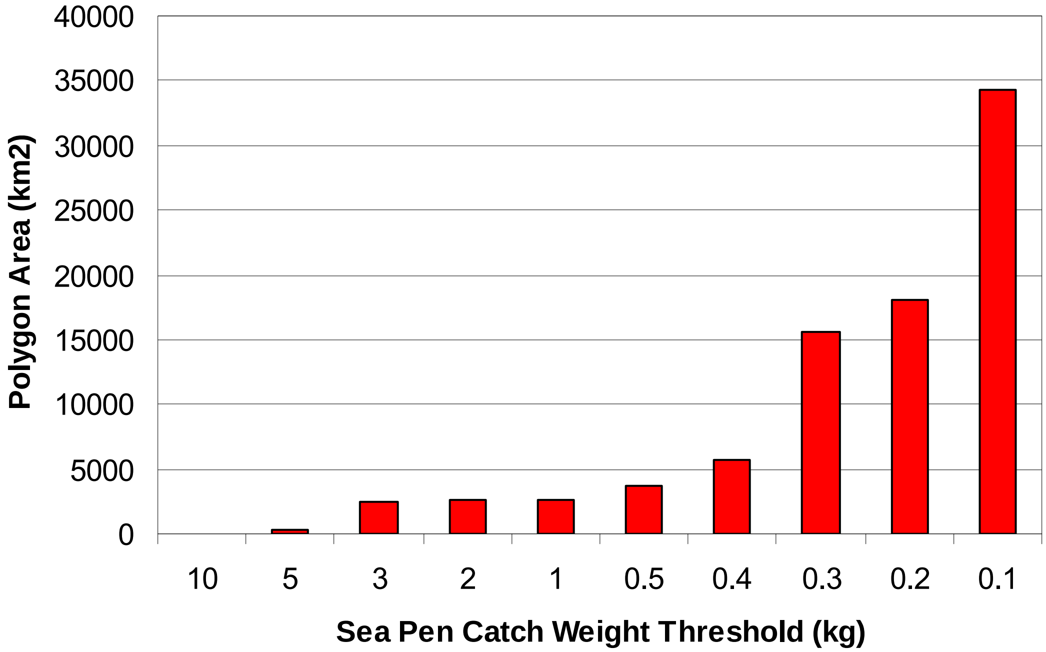


Figure 58. *The area occupied by polygons encompassing specific weight thresholds of sea pen catch (all catches ≥ the threshold level) from research vessel surveys in the NL-Labrador Shelves Biogeographic Zone.*

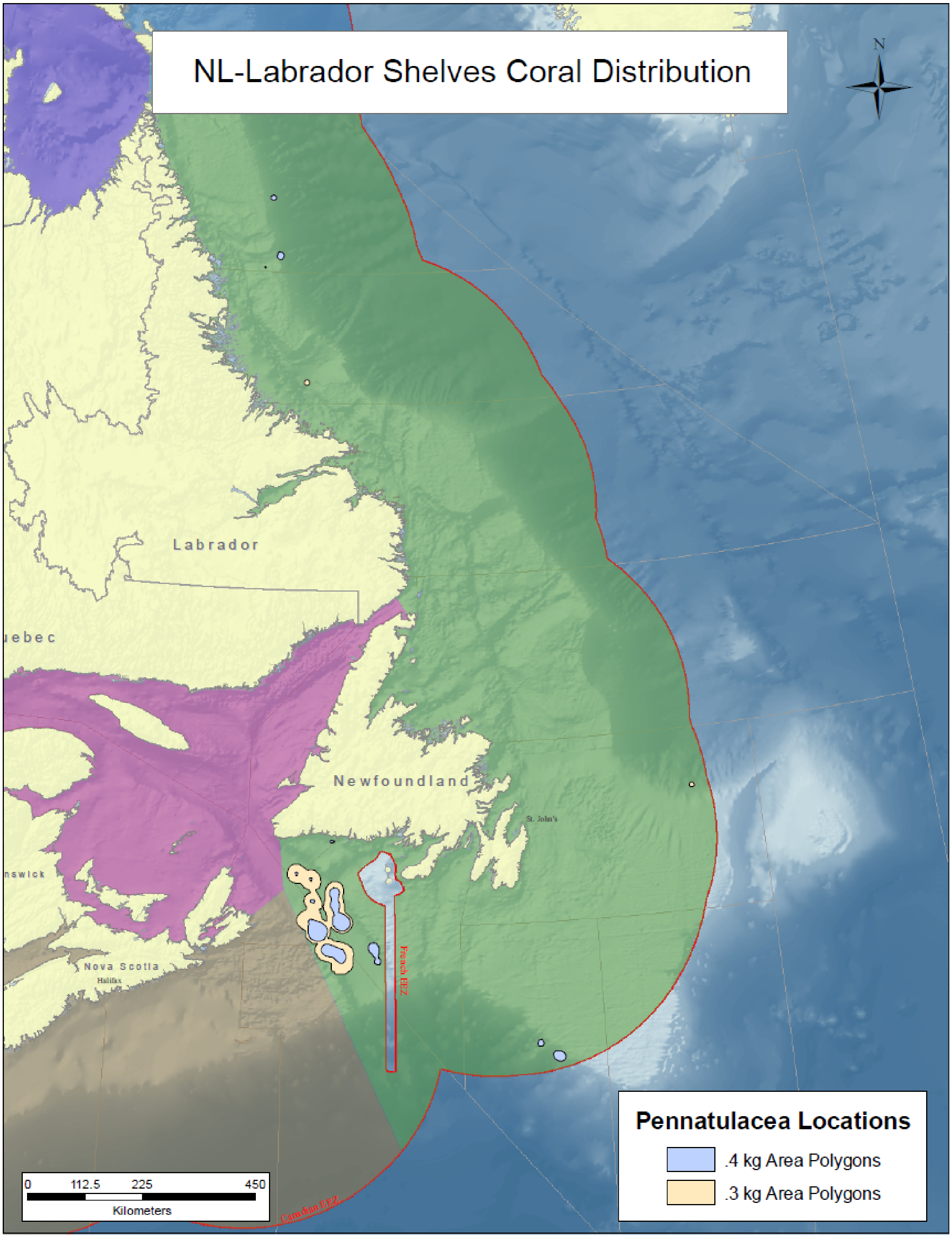


Figure 59. *Polygon areas established by using 0.3 kg and 0.4 kg sea pen (Pennatulacea) catch weight thresholds.*

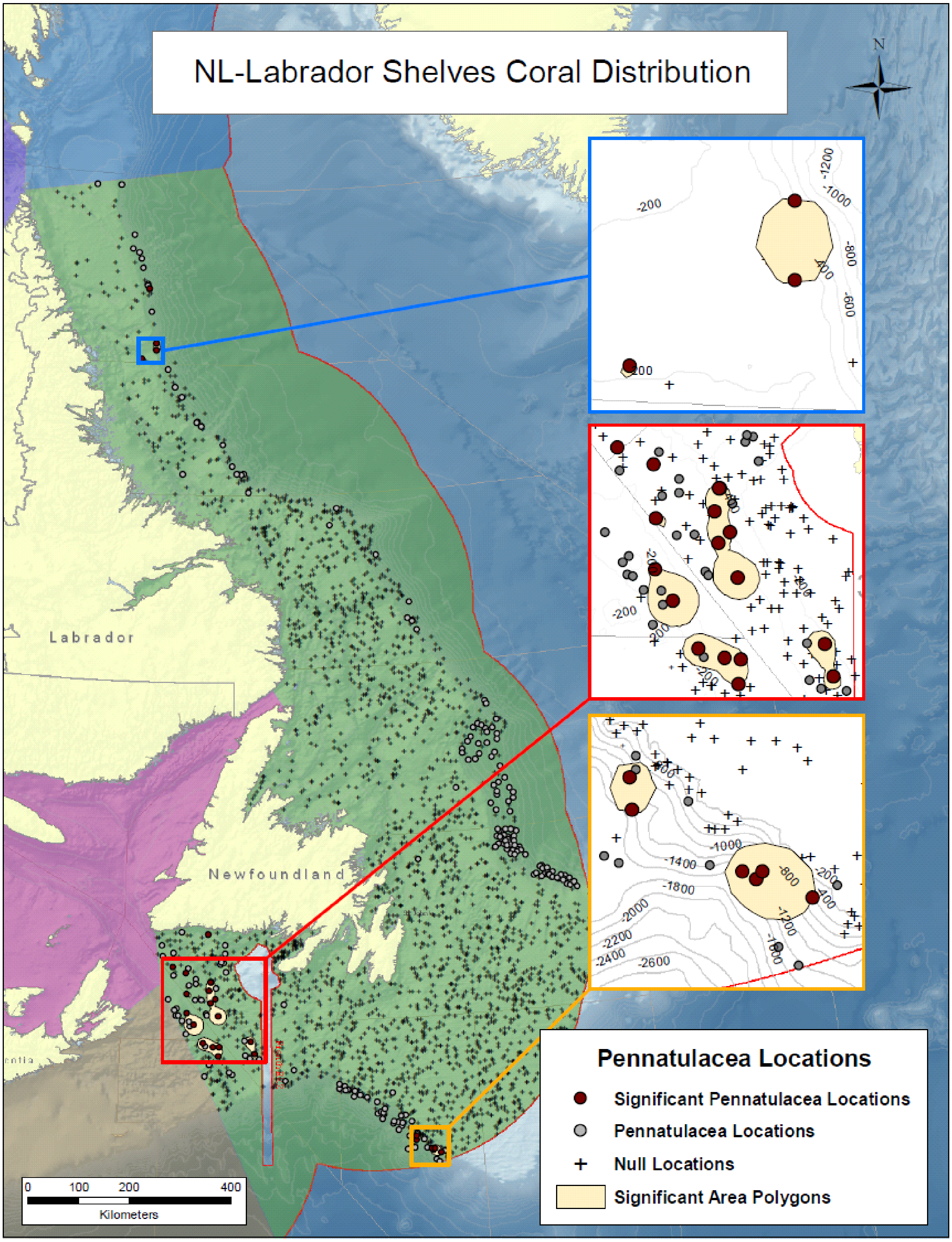


Figure 60. *Location of significant catches of sea pens (Pennatulacea) in the NL-Labrador Shelves Biogeographic Zone determined using spatial analysis methods.*

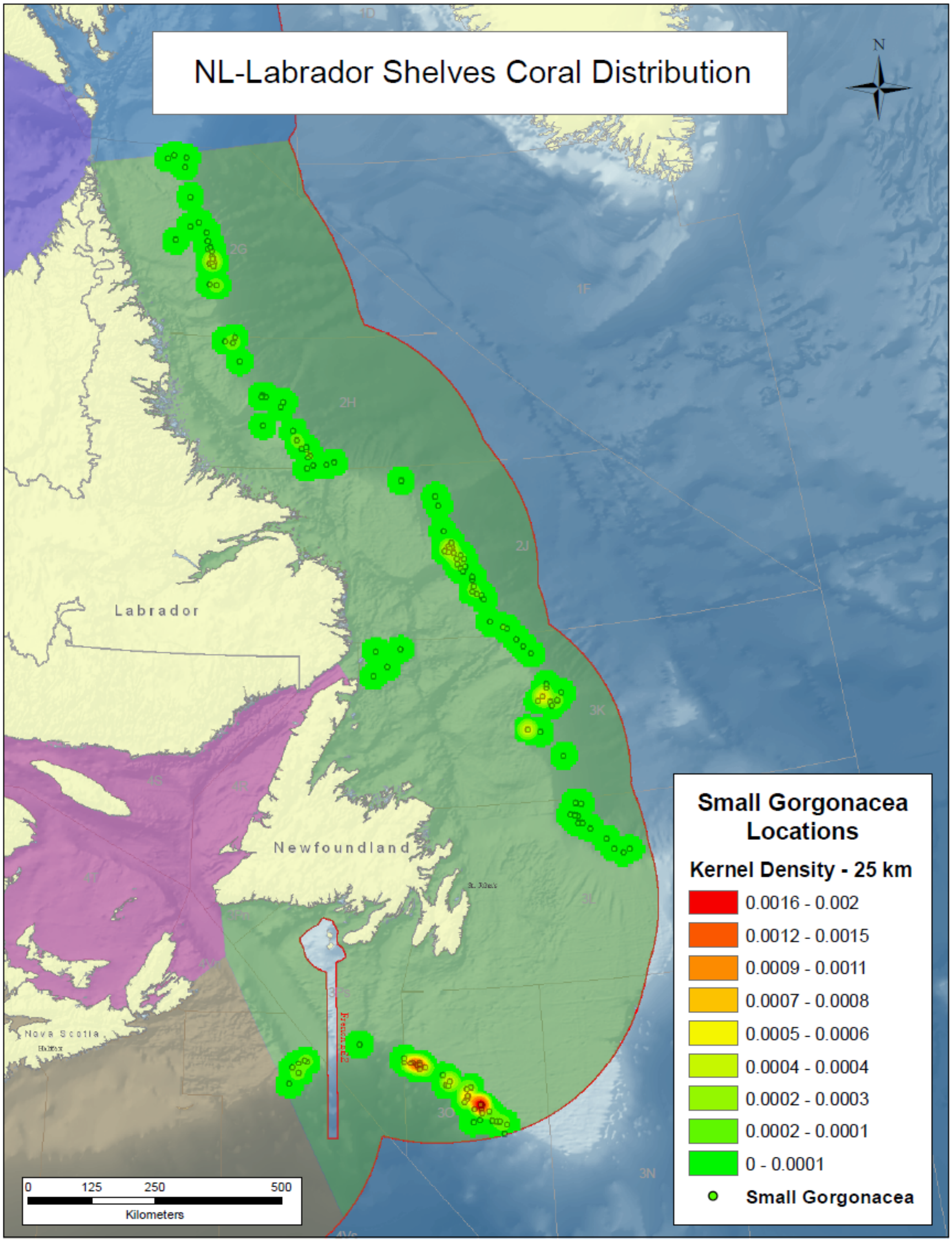


Figure 61. *Interpolated density distribution (kg/km²) of small gorgonian catches (kg) in the NL-Labrador Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 16).*

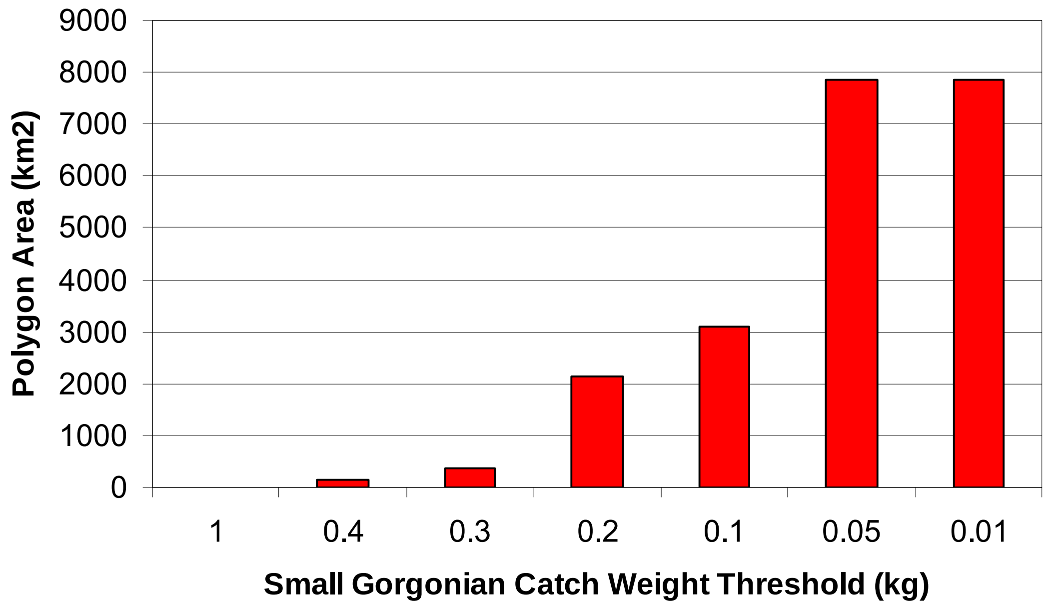


Figure 62. *The area occupied by polygons encompassing specific weight thresholds of small gorgonian catch (all catches ≥ the threshold level) from research vessel surveys in the NL-Labrador Shelves Biogeographic Zone.*

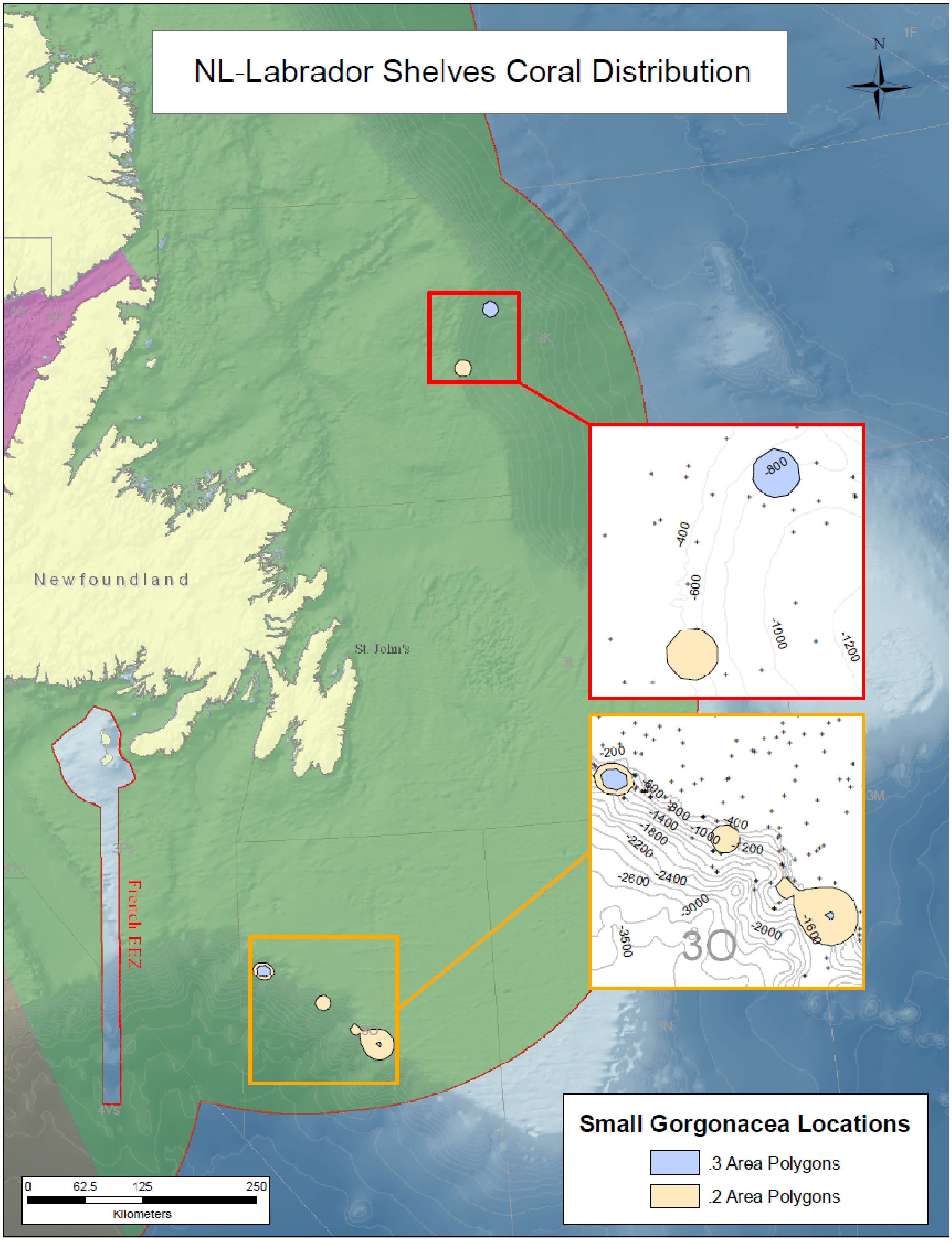


__Figure 63.__ Comparison of polygon areas produced from using 0.2 kg and 0.3 kg catch weight thresholds for small gorgonian corals.

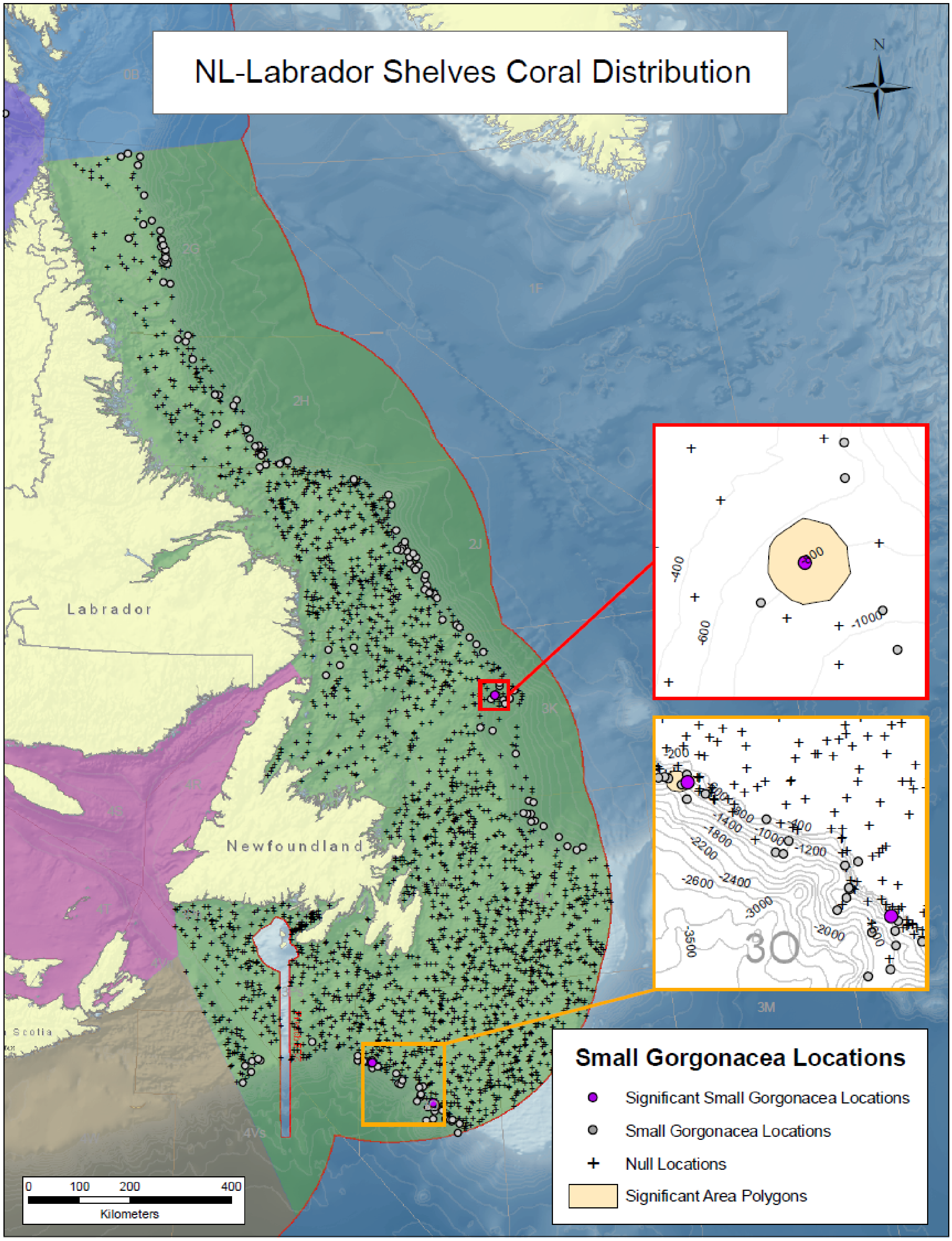


Figure 64. *Location of significant catches of small gorgonians identified using spatial analysis methods.*

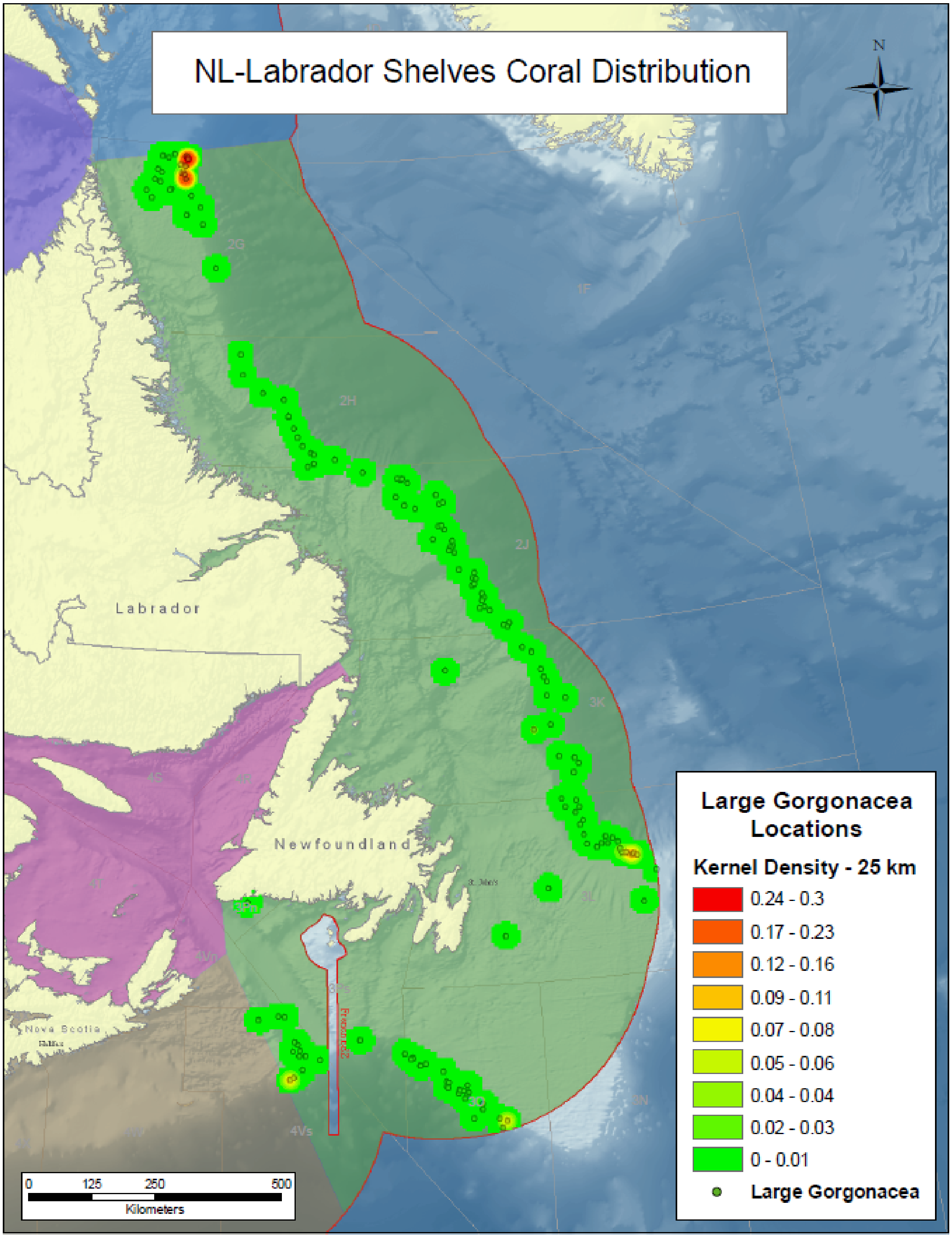


Figure 65. *Interpolated density distribution (kg/km^2) of large gorgonian catches (kg) in the NL-Labrador Shelves Biogeographic Zone as determined from research vessel surveys using Campelen trawl gear (see Table 16).*

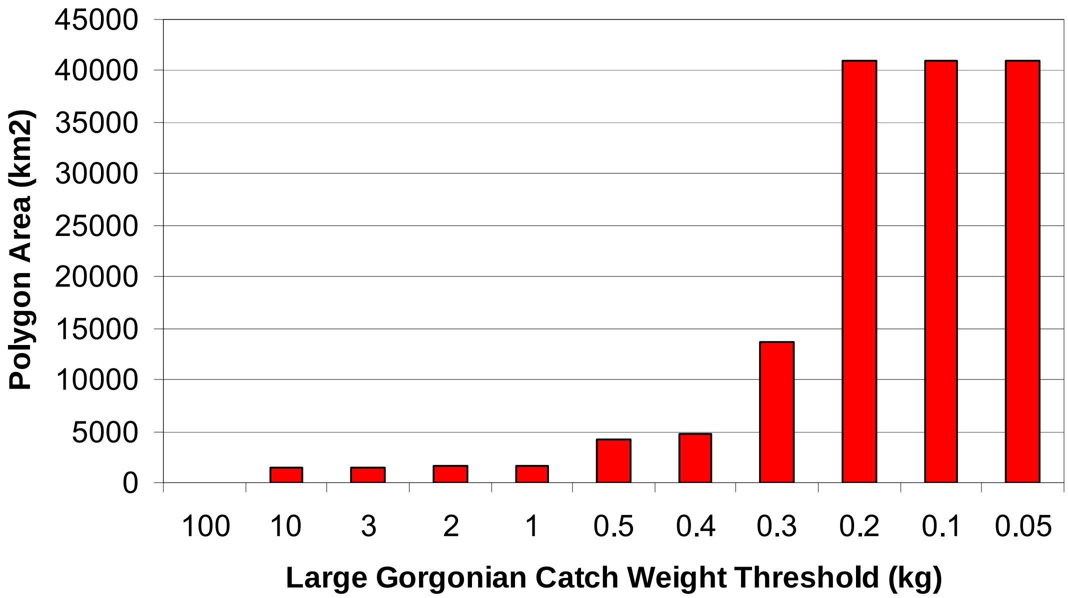


Figure 66. *The area occupied by polygons encompassing specific weight thresholds of large gorgonian catch (all catches ≥ the threshold level) from research vessel surveys in the NL-Labrador Shelves Biogeographic Zone.*

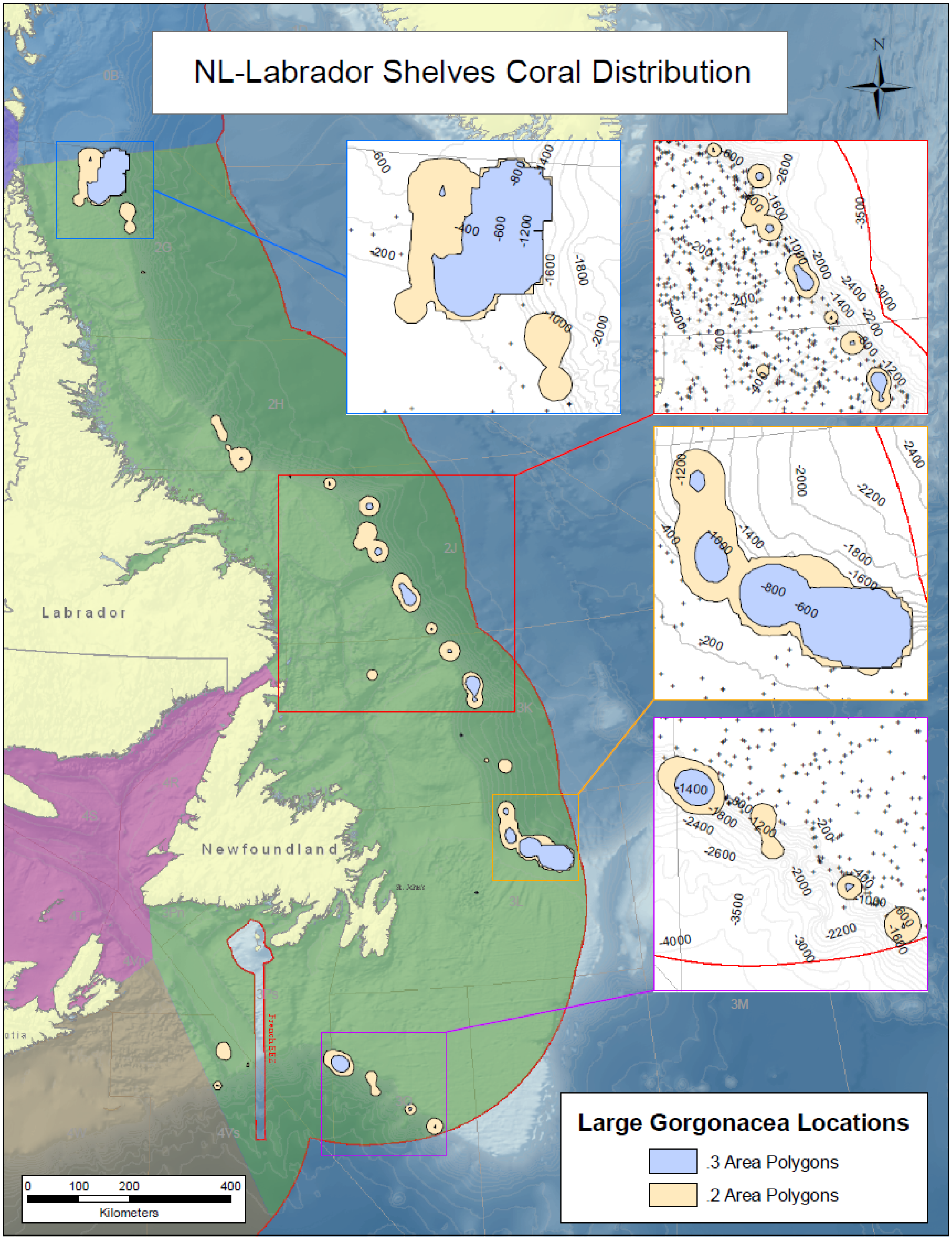


Figure 67. *Detailed location of the polygon areas produced using the 0.2 kg and 0.3 kg weight thresholds for large gorgonians.*

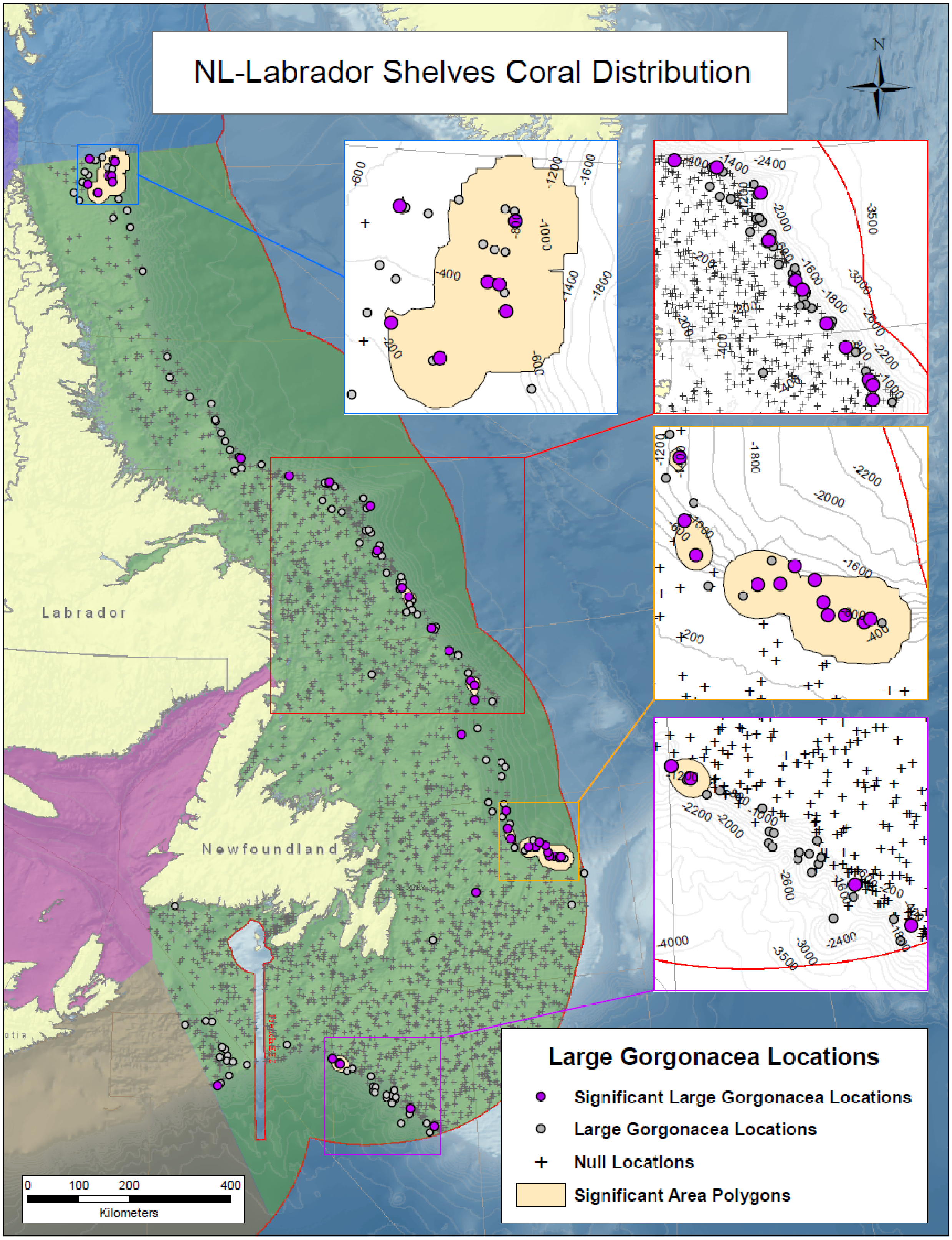


Figure 68. *Location of significant concentrations of large gorgonian corals determined using the spatial analysis method.*

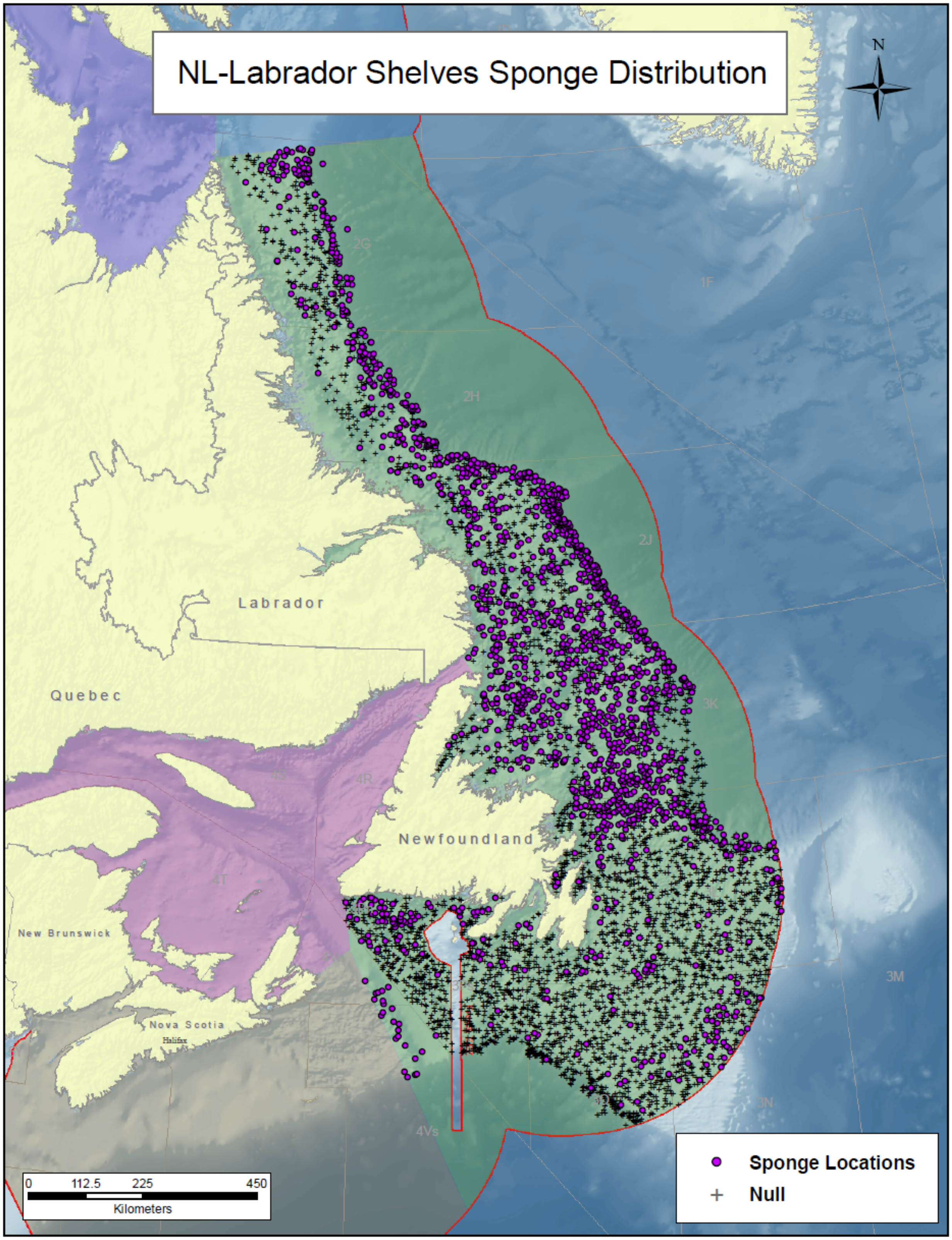


Figure 69. *Location of research vessel survey tows listed in Table 23. Presence and absence of sponge by-catch are indicated.*

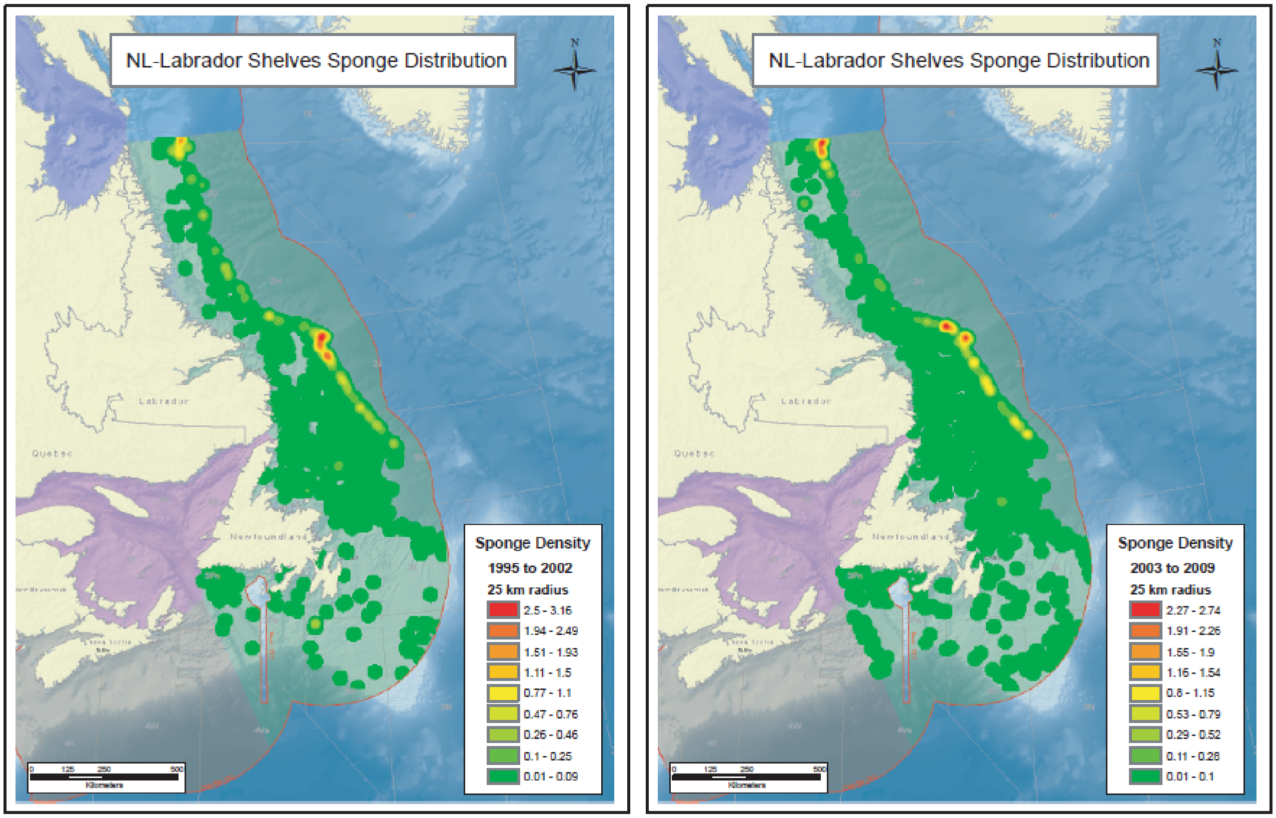


Figure 70. *Interpolated density distribution (kg/km²) of sponges in the NL-Labrador Shelves Biogeographic Zone for two time periods, 1995-2002 (left) and from 2003-2009 (right) as determined from research vessel surveys using a Campelen trawl. Note similar scales between time periods (see Table 23 for details).*

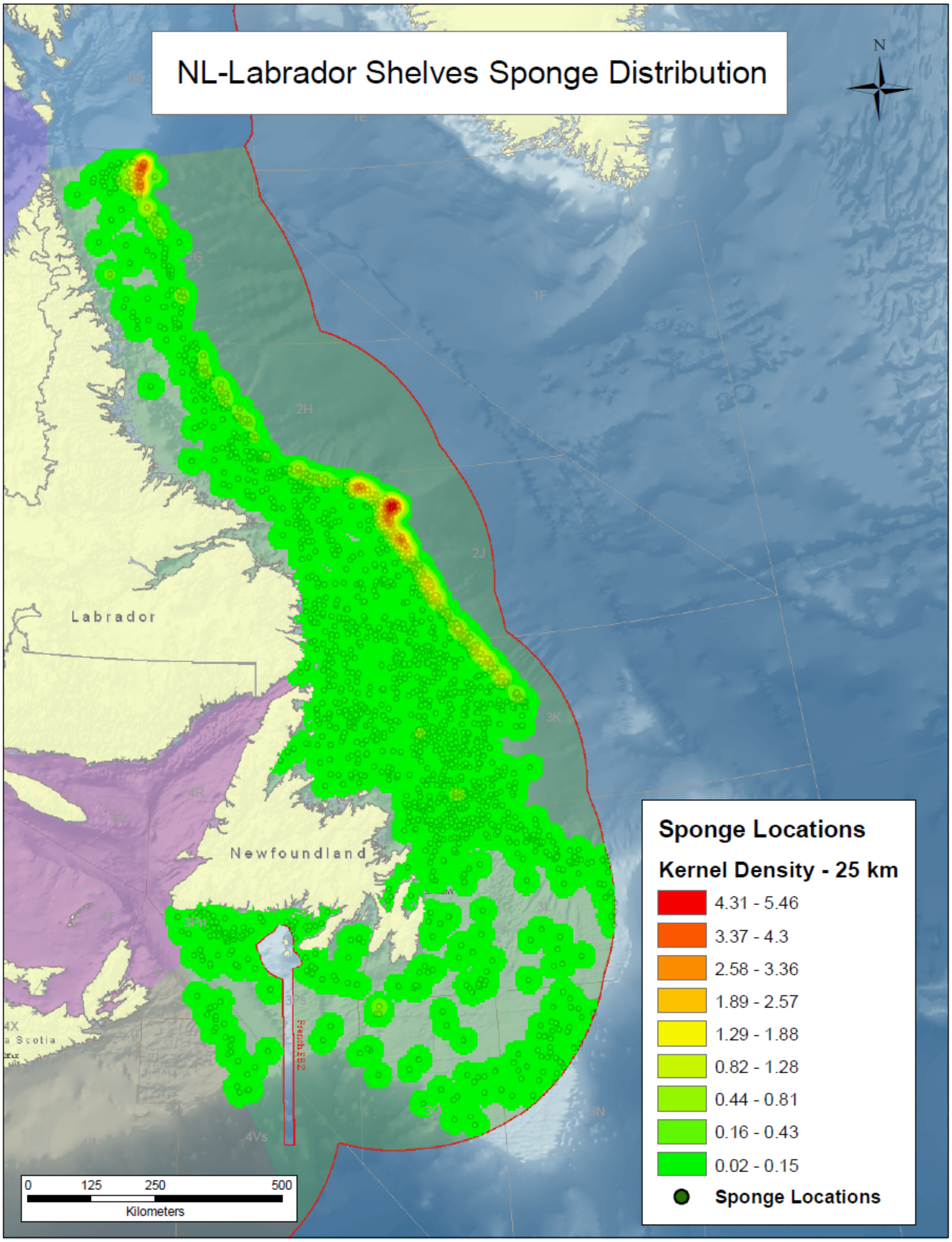


Figure 71. *Interpolated density distribution (kg/km^2) of sponges in the NL-Labrador Shelves Biogeographic Zone as determined from research vessel surveys using a Campelen trawl.*

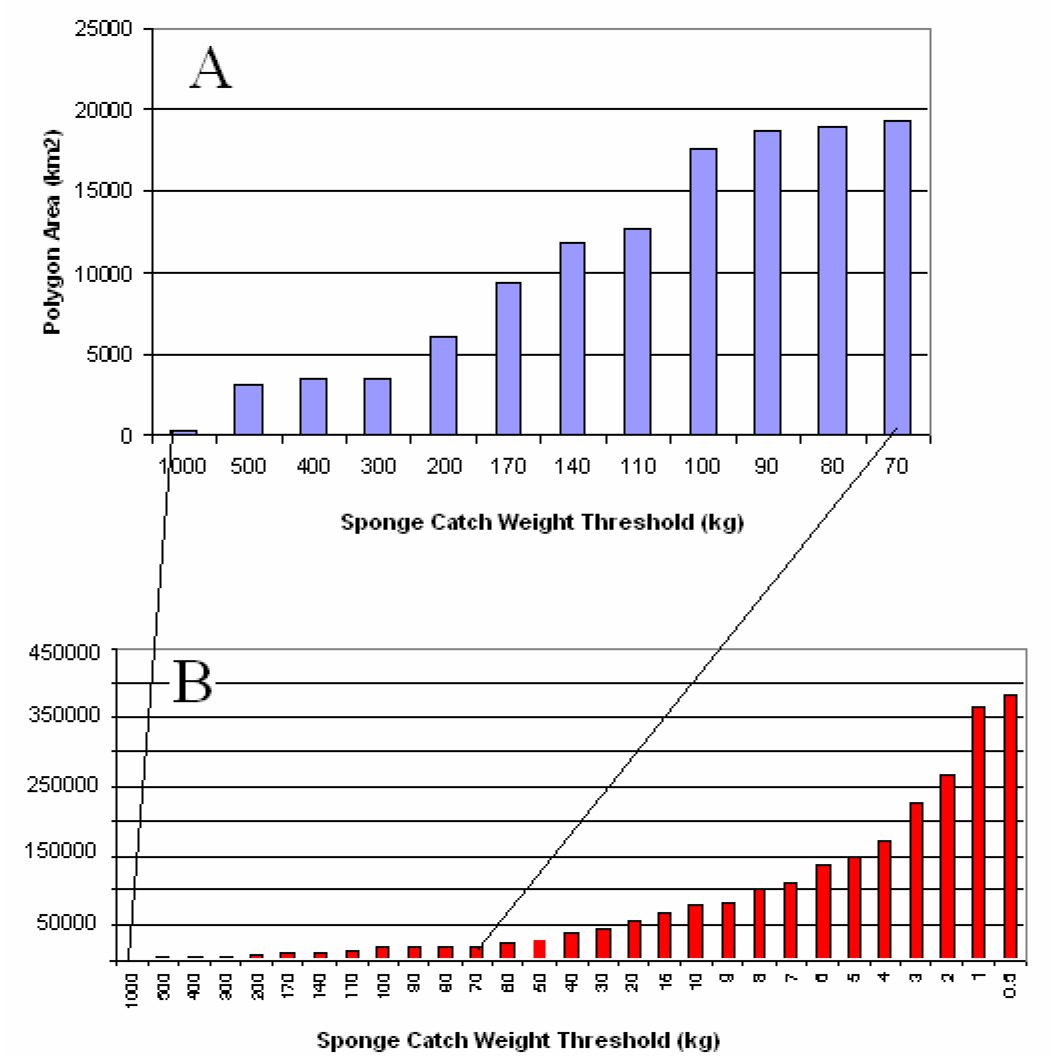


Figure 72. *The area occupied by polygons encompassing specific weight thresholds of sponge catch (all catches ≥ the threshold level) from research vessel surveys in the NL-Labrador Shelves Biogeographic Zone (see Table 23). A: Close up of changes occurring in the polygon area between 1000 and 70 kg. B: The full suite of polygon areas considered in this analysis. The 20 kg threshold is the level at which the areas extend from the slopes onto the shelves. The 200 kg threshold indicates the significant concentrations of sponge along the continental slope.*

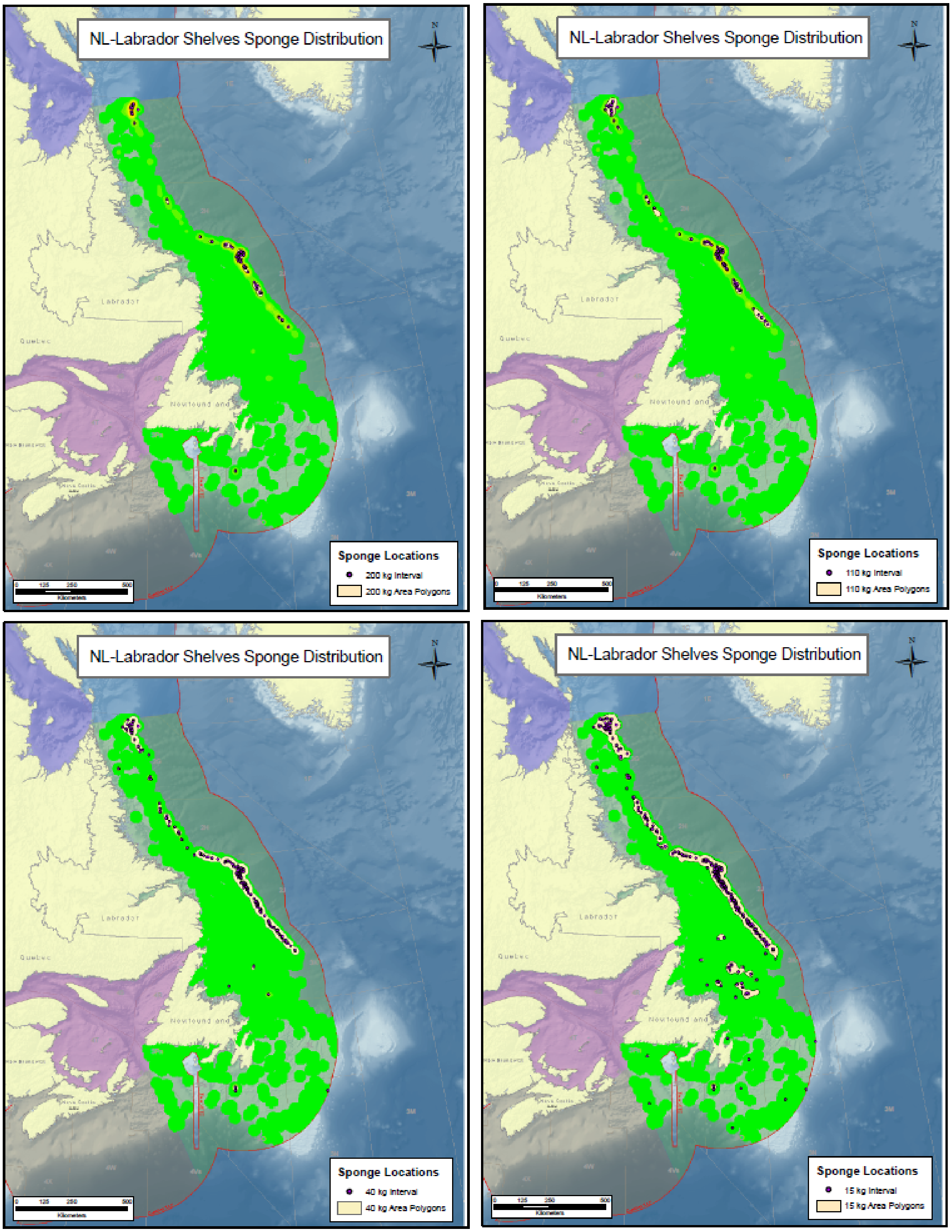


Figure 73. *Polygon areas encompassing sponge catches of greater than 200 kg (upper left), 100 kg (upper right), 40 kg (lower left) and 15 kg (lower right).*

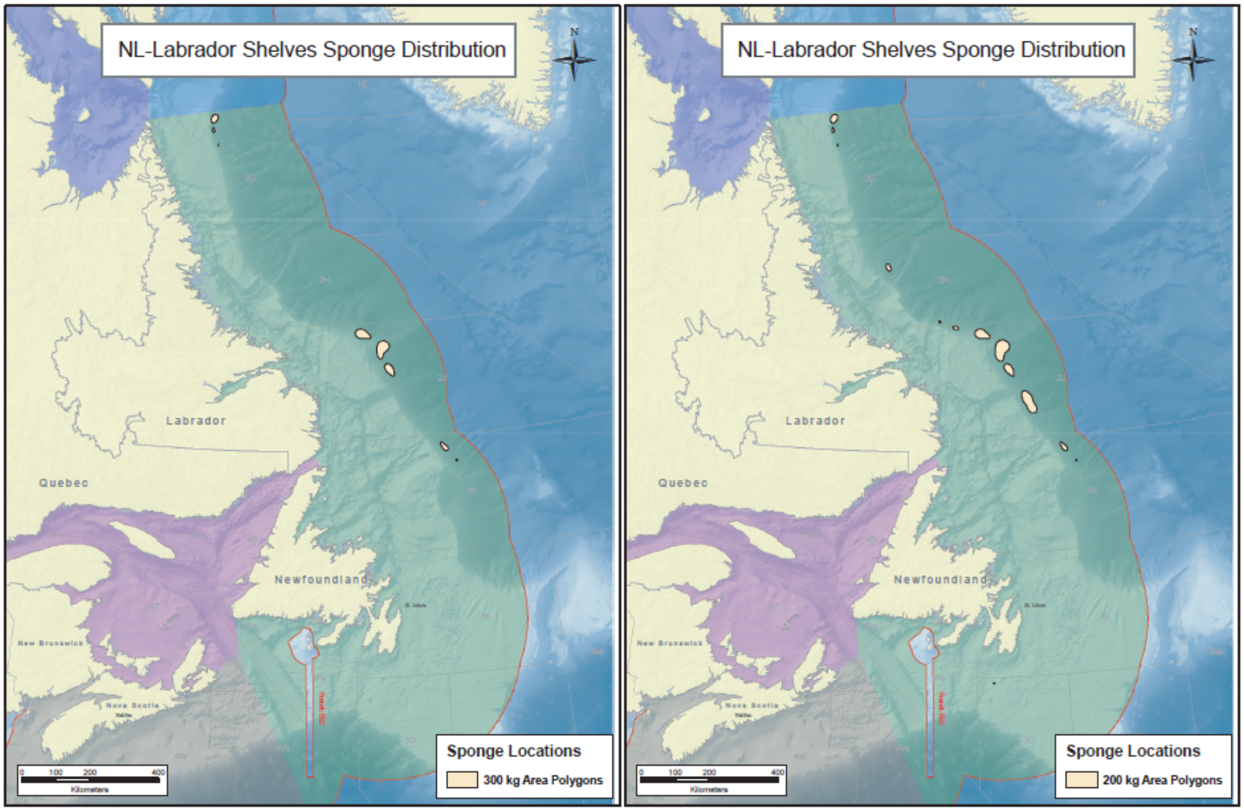


Figure 74. *Polygon areas calculated using a 300 kg (left) and a 200 kg (right) sponge weight threshold. Note the new polygons added by lowering the threshold to 200 kg.*

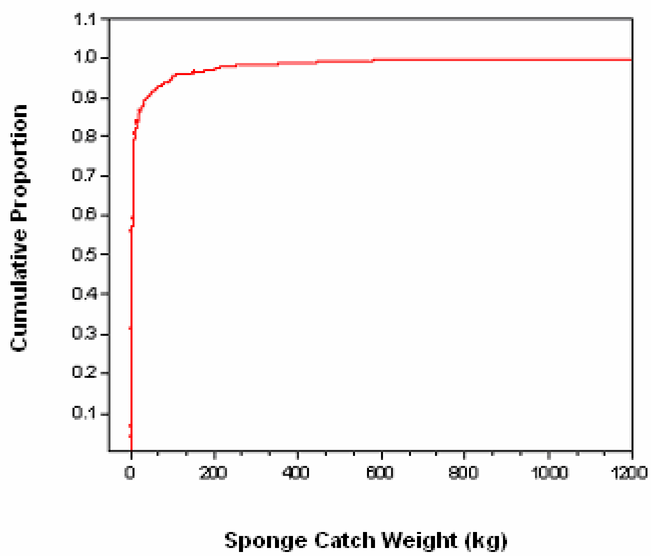


Figure 75. *Cumulative frequency distribution of sponge catches in the NL-Labrador Shelves Biogeographic Zone.*

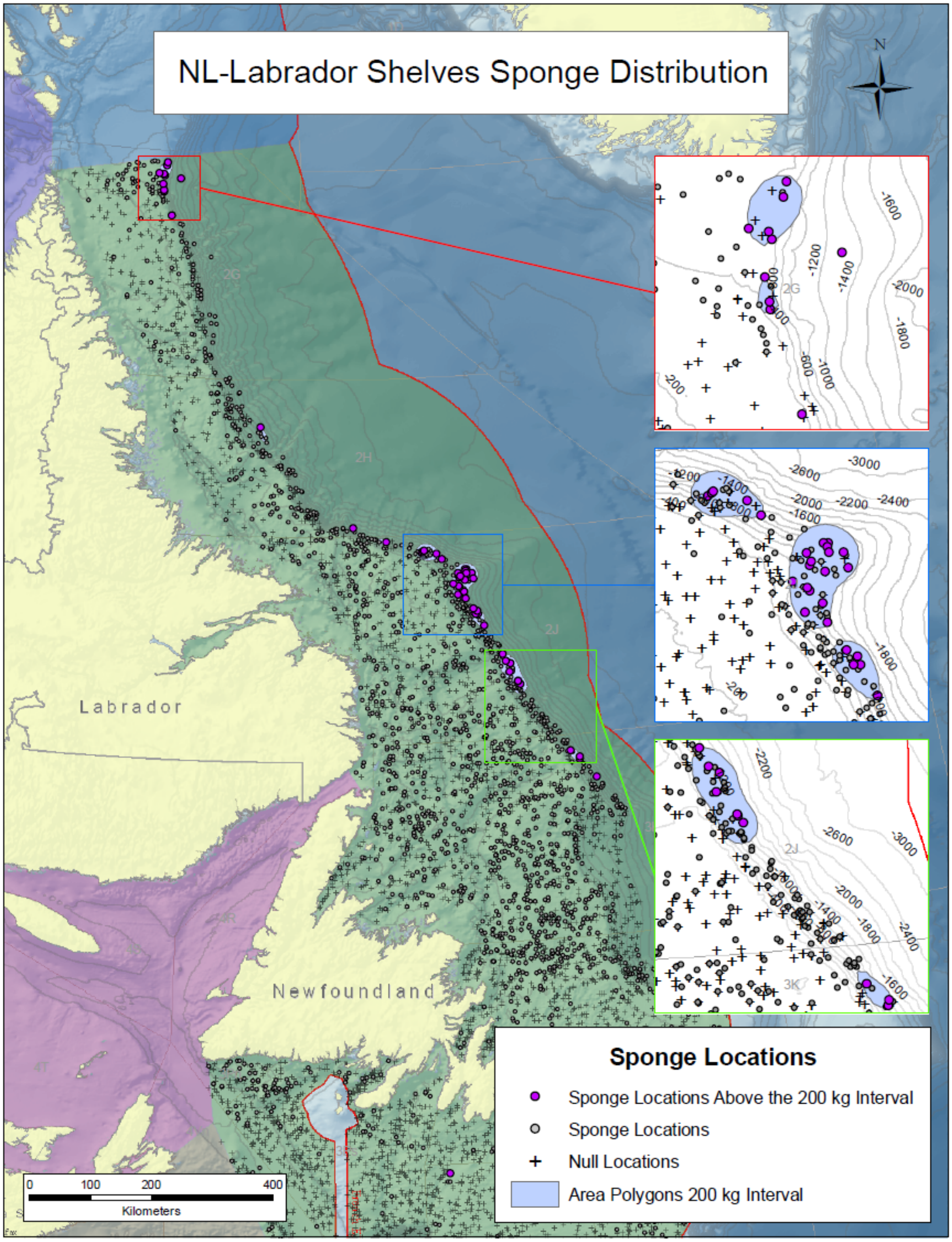


Figure 76. *Location of significant catches of sponge from research vessel surveys in the NL-Labrador Shelves Biogeographic Zone. (see Table 23).*

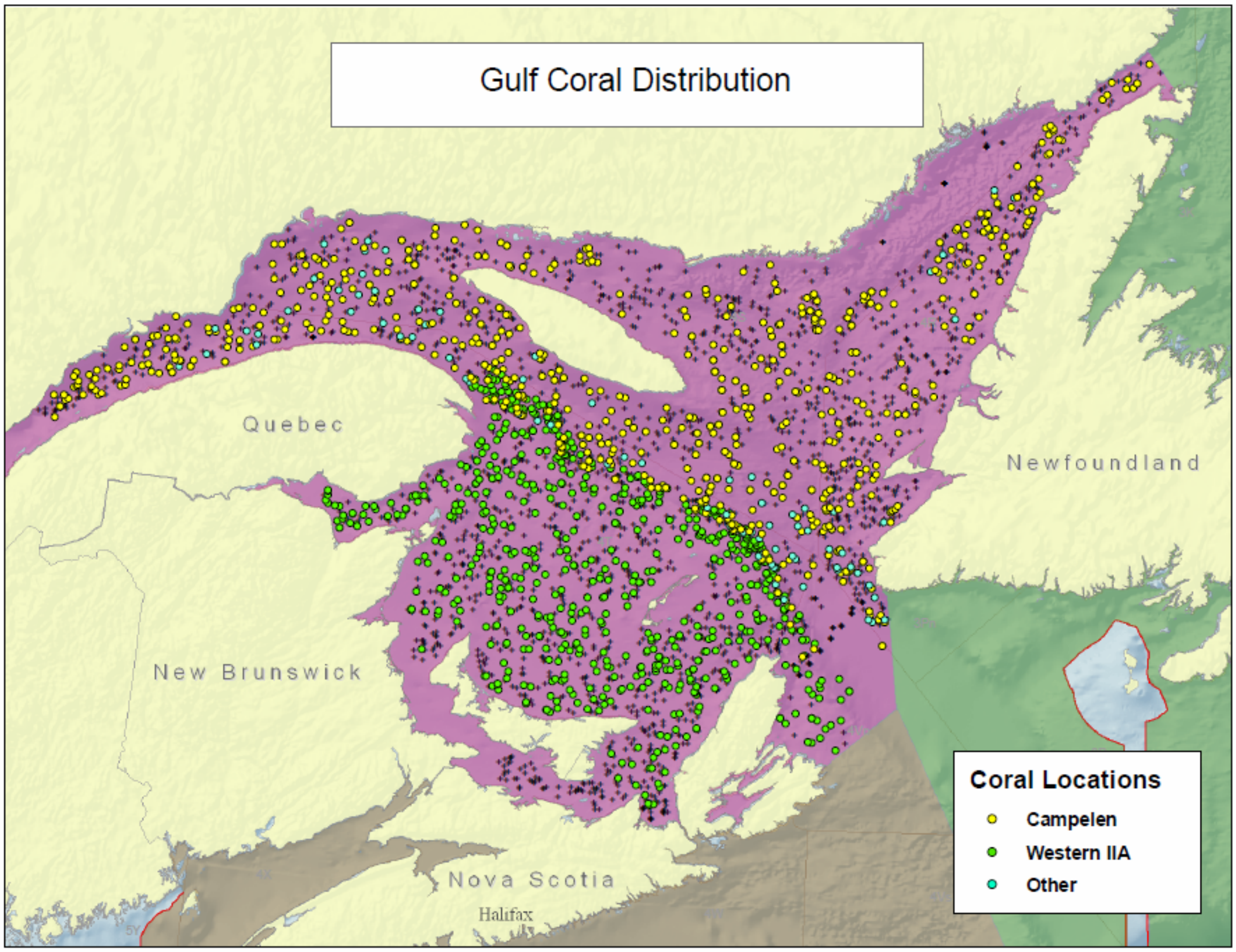


Figure 77. *Location of research vessel survey tows showing the distribution of coral (presence and absence) listed in Table 27. Tows are coded by gear type with Western IIA trawl sets in green and Campelen trawl sets in yellow. Null sets are indicated by a cross.*

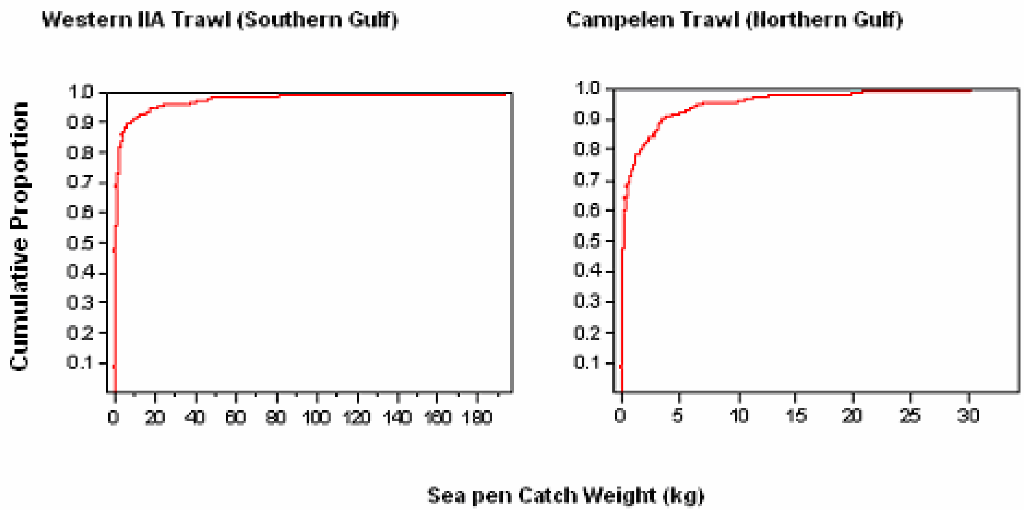


Figure 78. *Cumulative frequency distribution of the sea pen (Pennatulacea O. spp.) trawl catch in the Gulf Biogeographic Zone by gear type.*

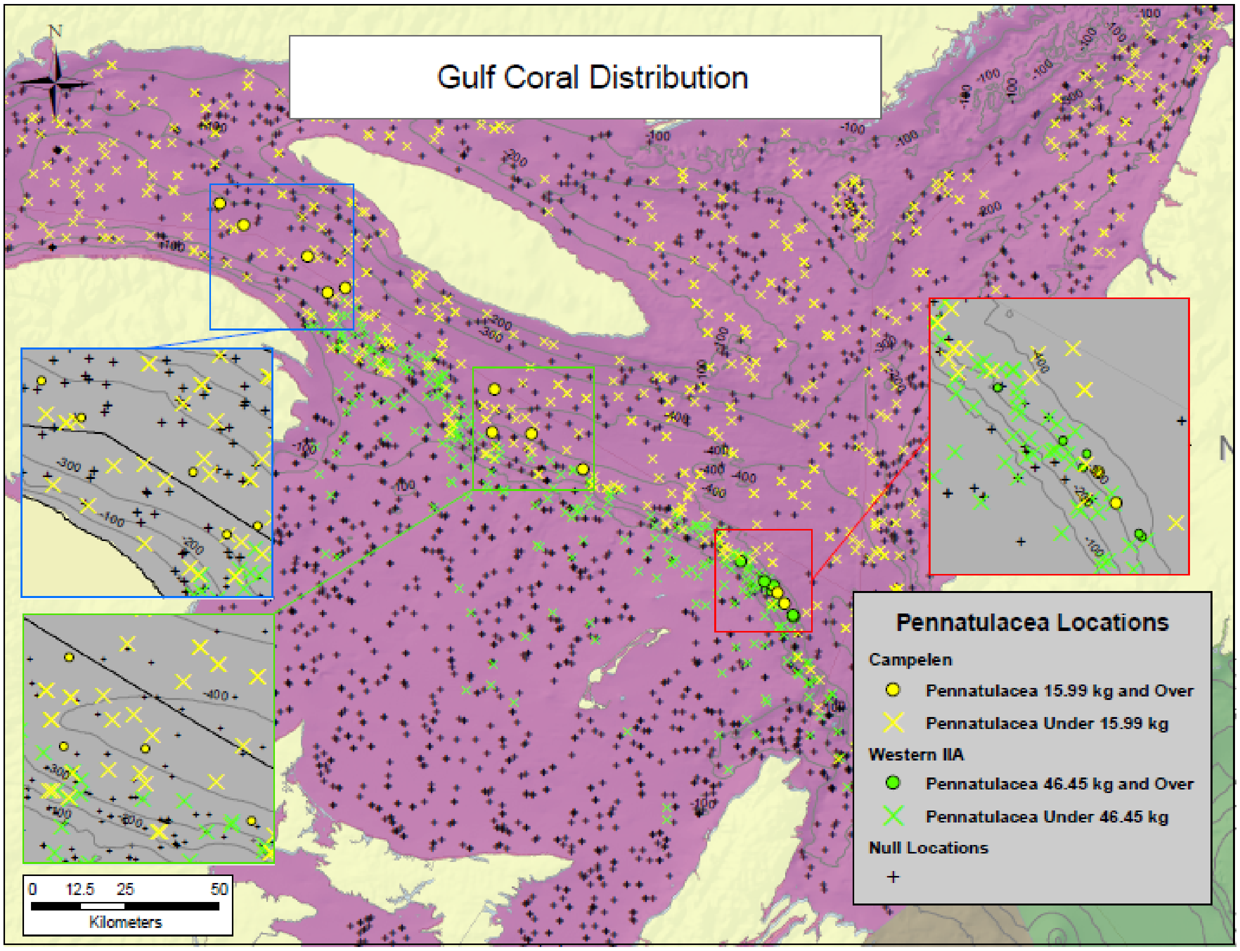


Figure 79. *Location of significant catches of sea pens in the Gulf Biogeographic Zone as determined from the 97.5% quantiles of the distributions produced for the Campelen and Western IIA trawl sets. Data from the Western IIA trawls are from 2003-2009. Insets show close-ups of the catch positions relative to depth contours. The locations of other sea pens catches by gear type and null catches are indicated.*

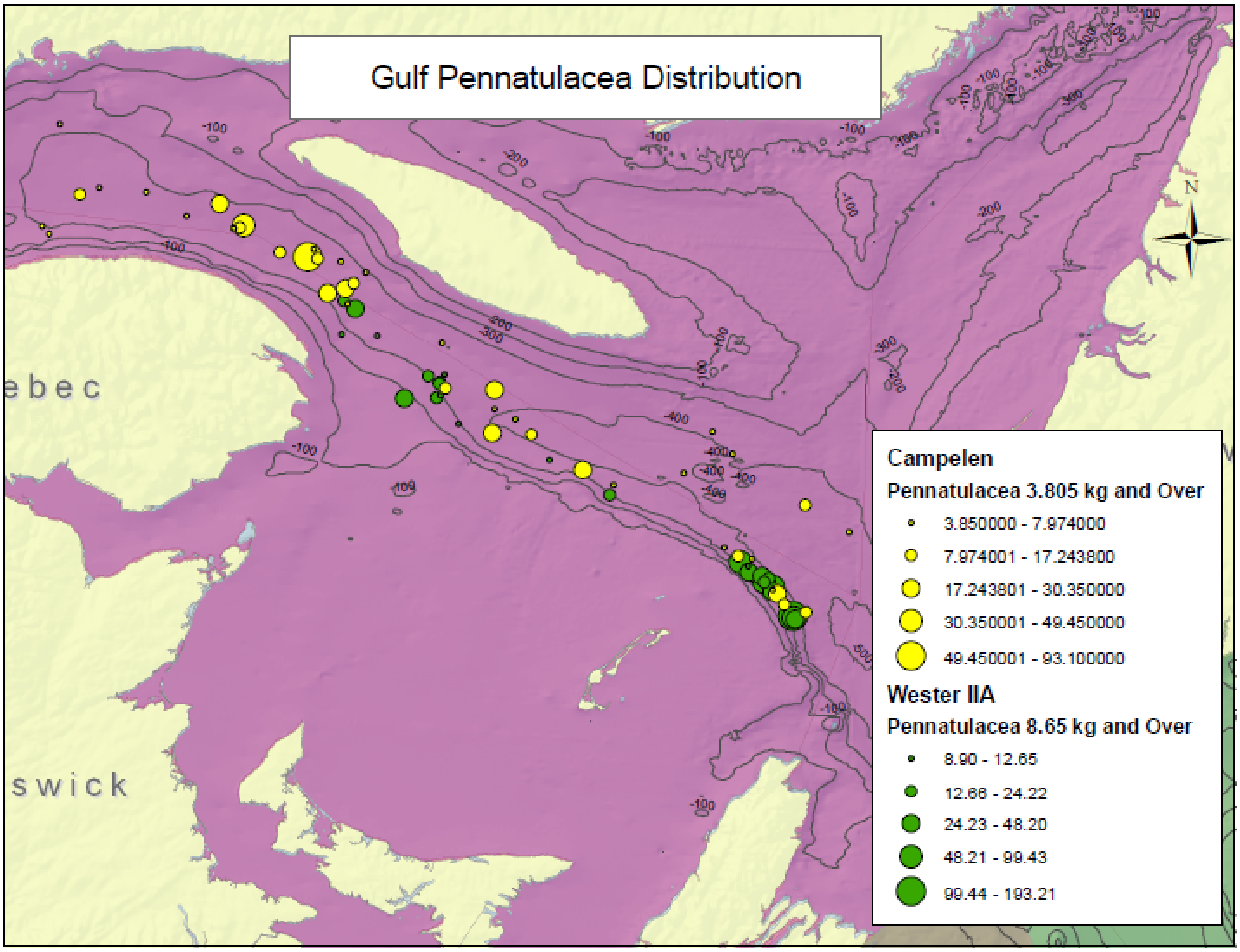


Figure 80. *Location of large catches of sea pens above the 90% weight quantile for each gear type (Campelen and Western IIA trawl) in the Gulf Biogeographic Zone. Only data for the period 2003-2009 were used for the Western IIA trawl gear.*

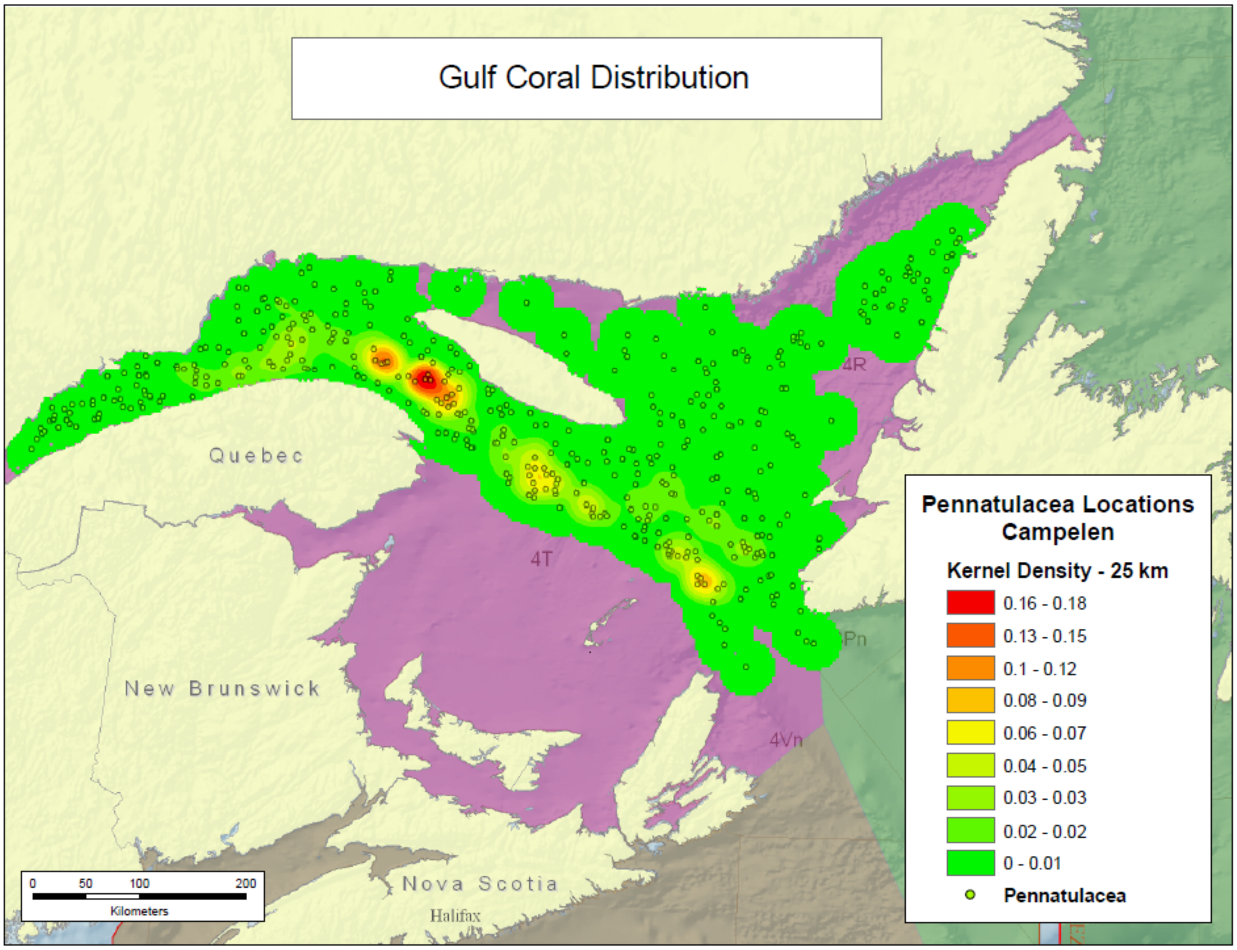


Figure 81. *Interpolated density distribution (kg/km^2) of sea pens (Pennatulacea) in the northern Gulf of St. Lawrence. Data are from research vessel surveys using Campelen trawl gear (2004-2009, see Table 27).*

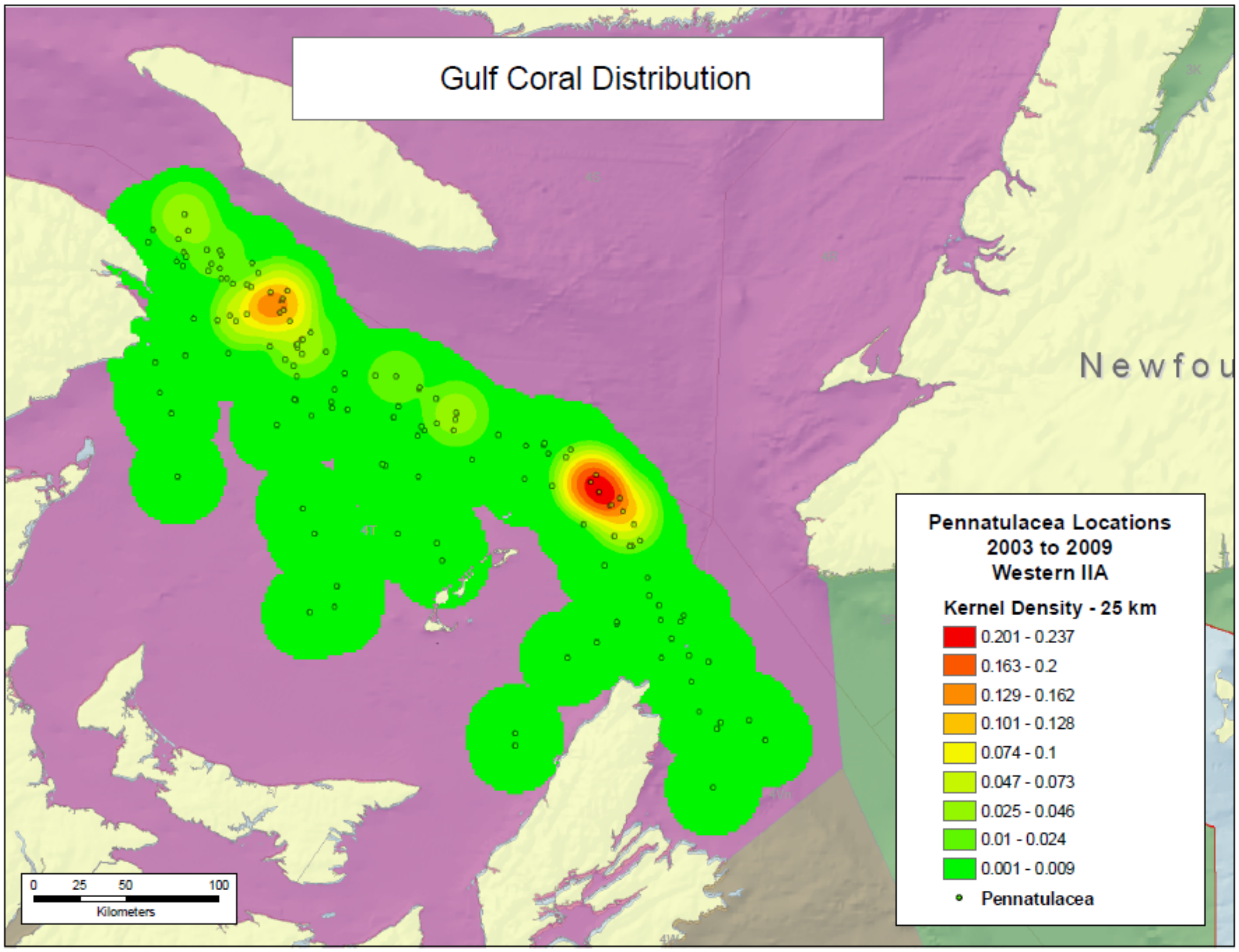
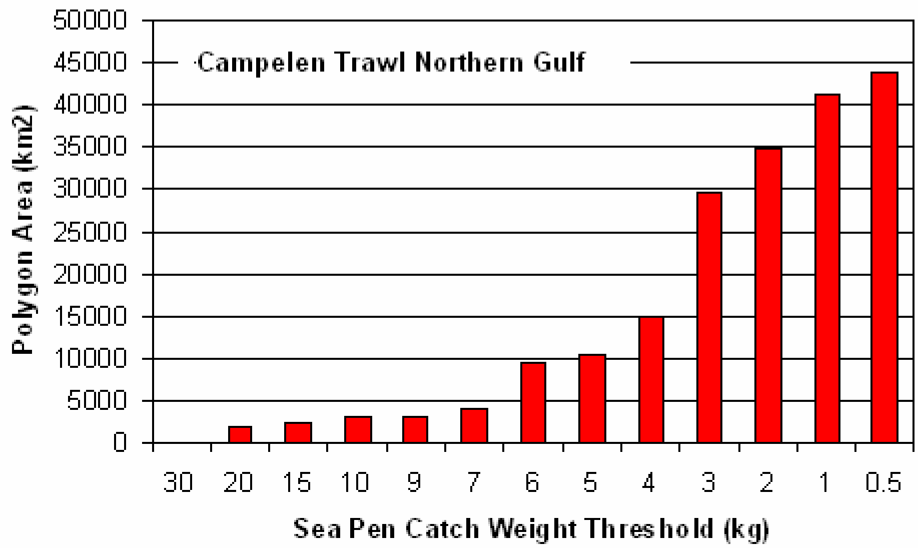


Figure 82. *Interpolated density distribution (kg/km²) of sea pens (Pennatulacea) in the southern Gulf of St. Lawrence. Data are from research vessel surveys from 2003 to 2009 using Western IIA trawl gear (see Table 27).*



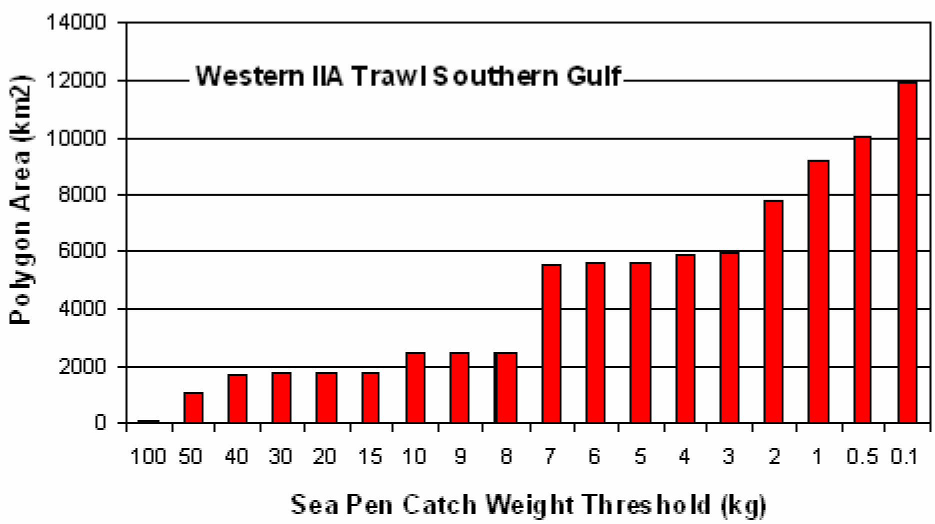


Figure 83. *The area occupied by polygons encompassing specific weight thresholds of sea pen (Pennatulacea) catch (all catches ≥ the threshold level) from research vessel surveys using Campelen and Western IIA trawl gear in the northern and southern Gulf Biogeographic Zone, respectively.*

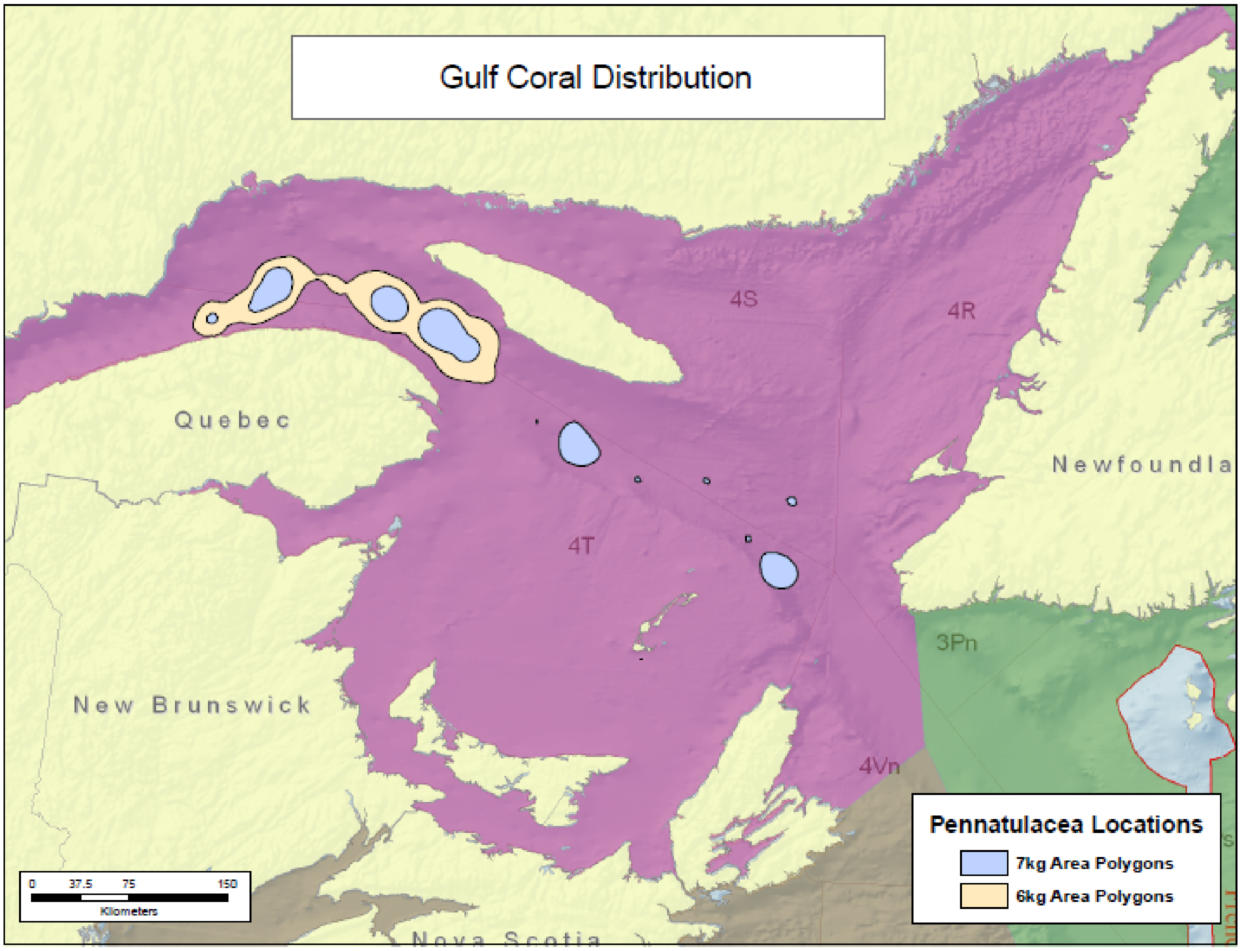


Figure 84. *Polygon areas encompassing sea pen catches of greater than or equal to 7 kg and 6 kg sampled with a Campelen trawl from the northern Gulf of St. Lawrence.*

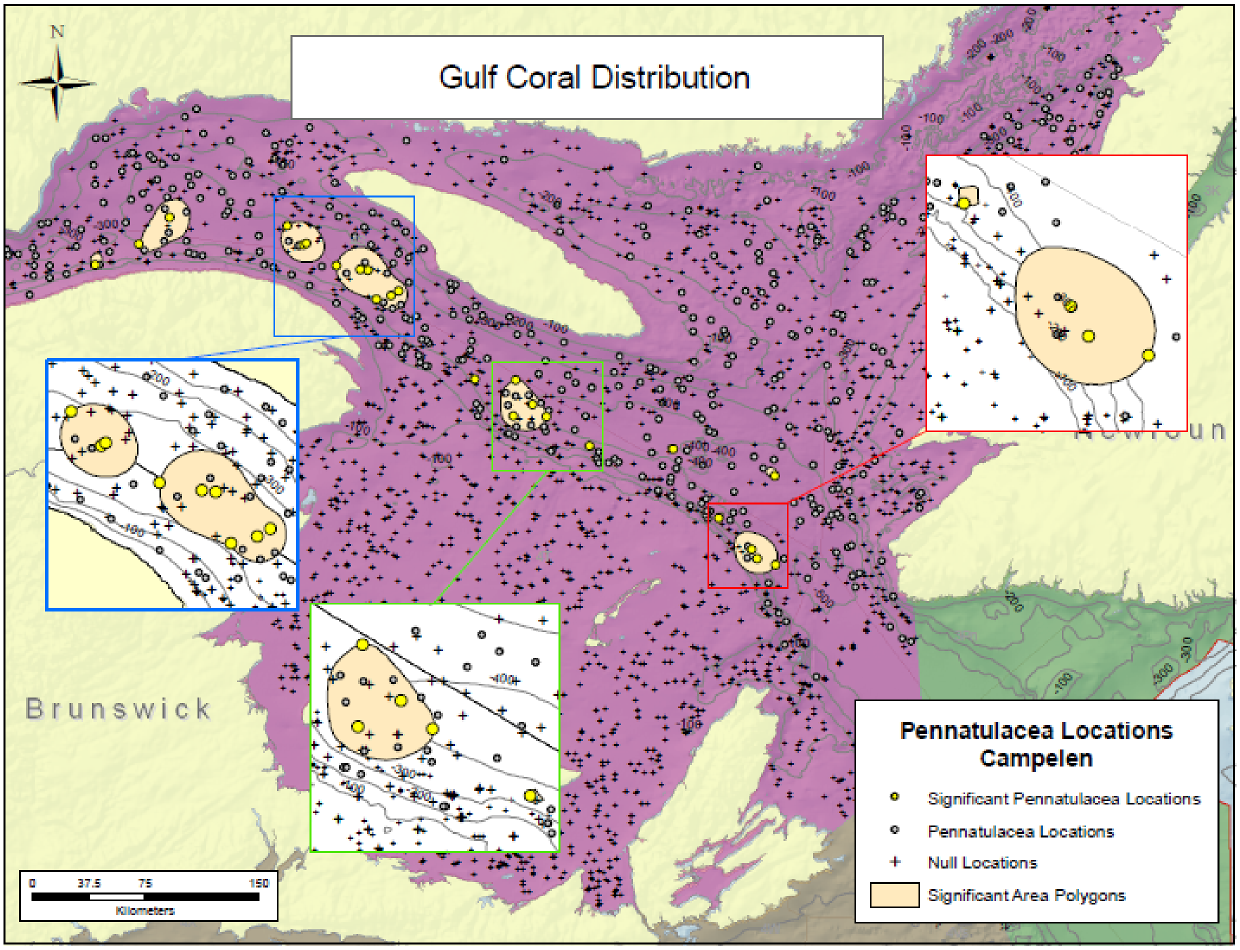
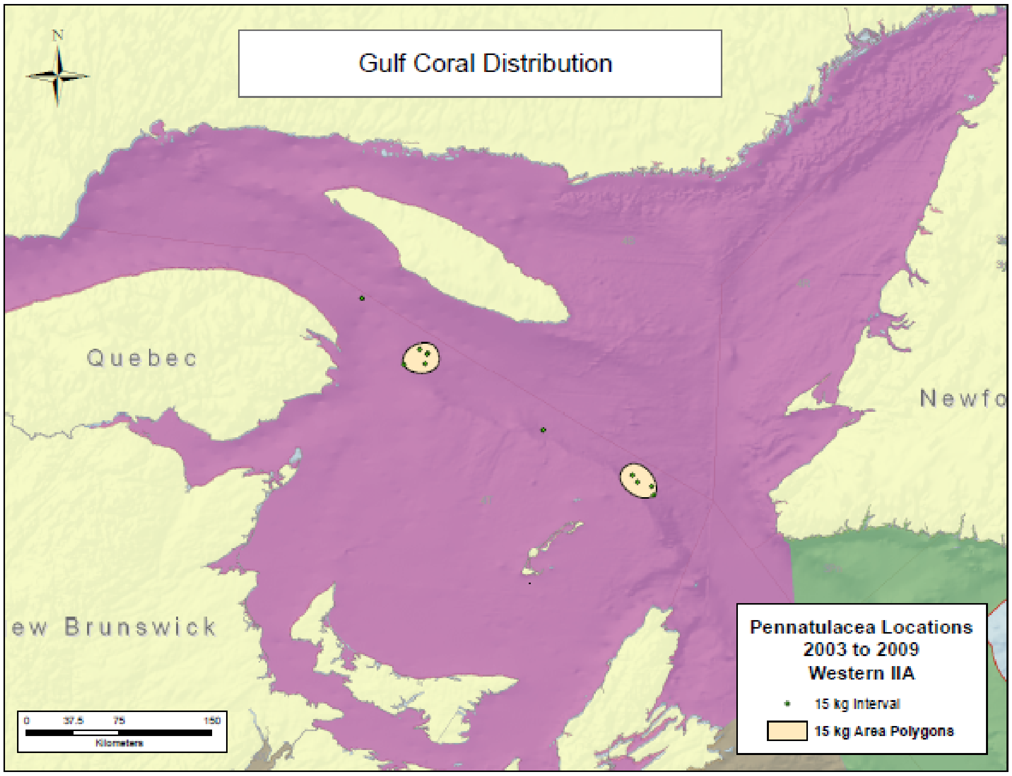


Figure 85. *Location of significant concentrations of sea pens and associated polygon areas, as identified from the spatial analyses using data from the northern Gulf of St. Lawrence collected with Campelen trawl gear.*



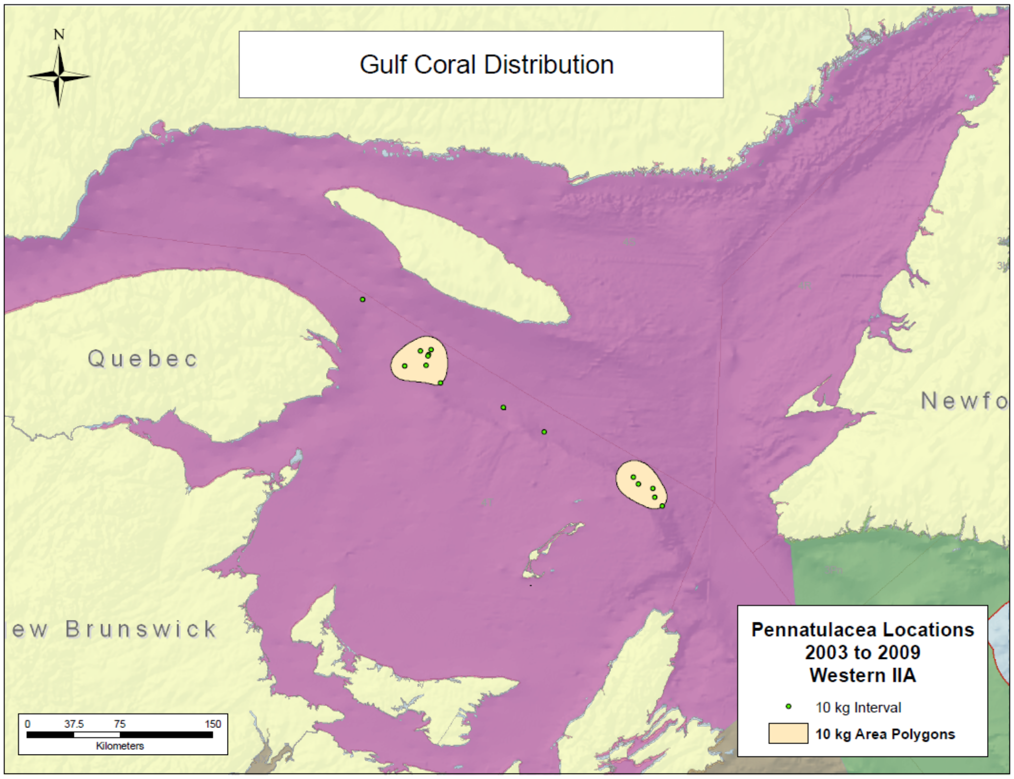


Figure 86. *Polygon areas encompassing sea pen catches of greater than or equal to 15 kg and 10 kg sampled with a Western IIA trawl from the southern Gulf of St. Lawrence using data from 2003-2009 only.*

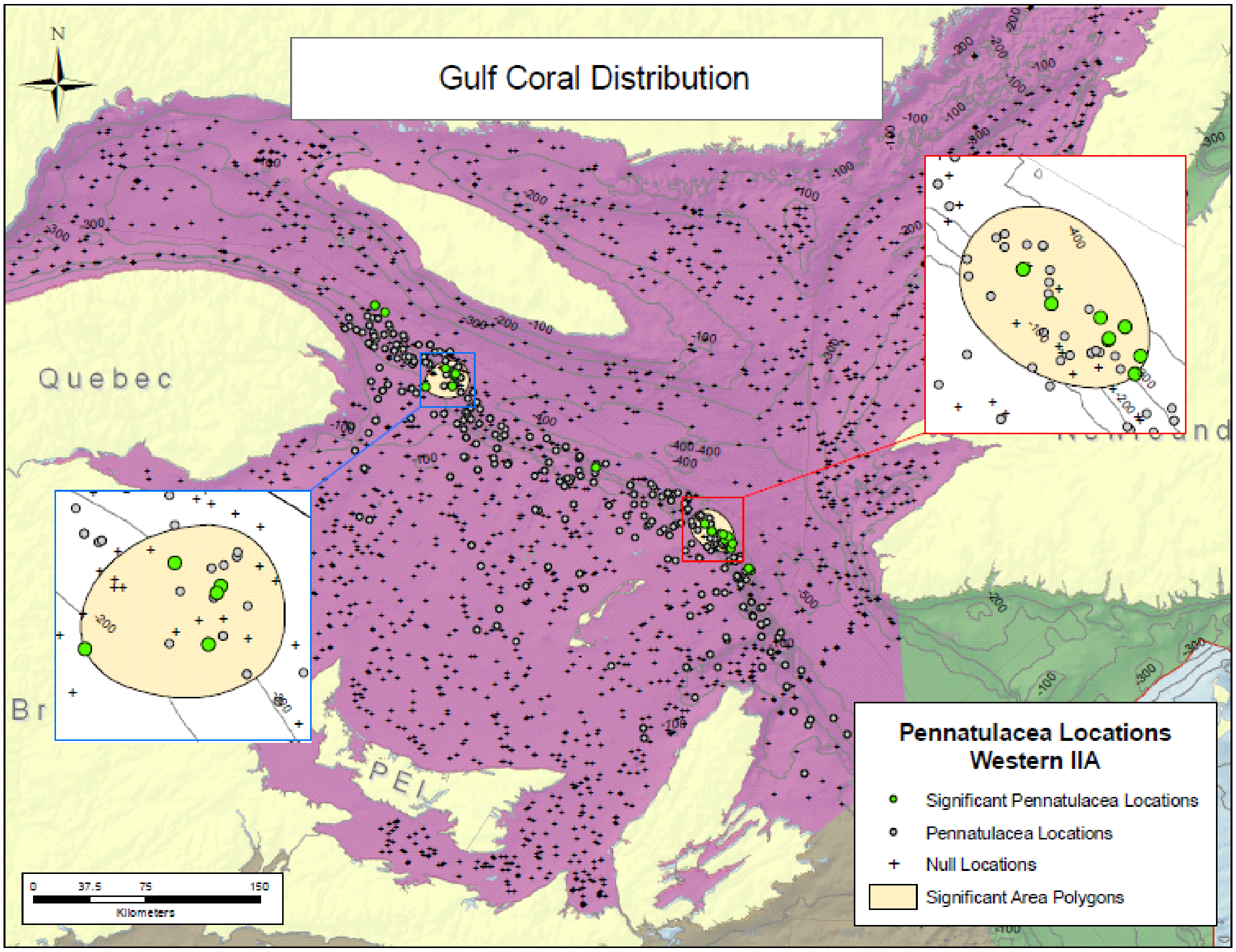


Figure 87. *Location of significant concentrations of sea pens (≥ 15 kg per tow) and the associated polygon areas, as identified from the spatial analyses using data from the southern Gulf of St. Lawrence collected with Western IIA trawl gear.*

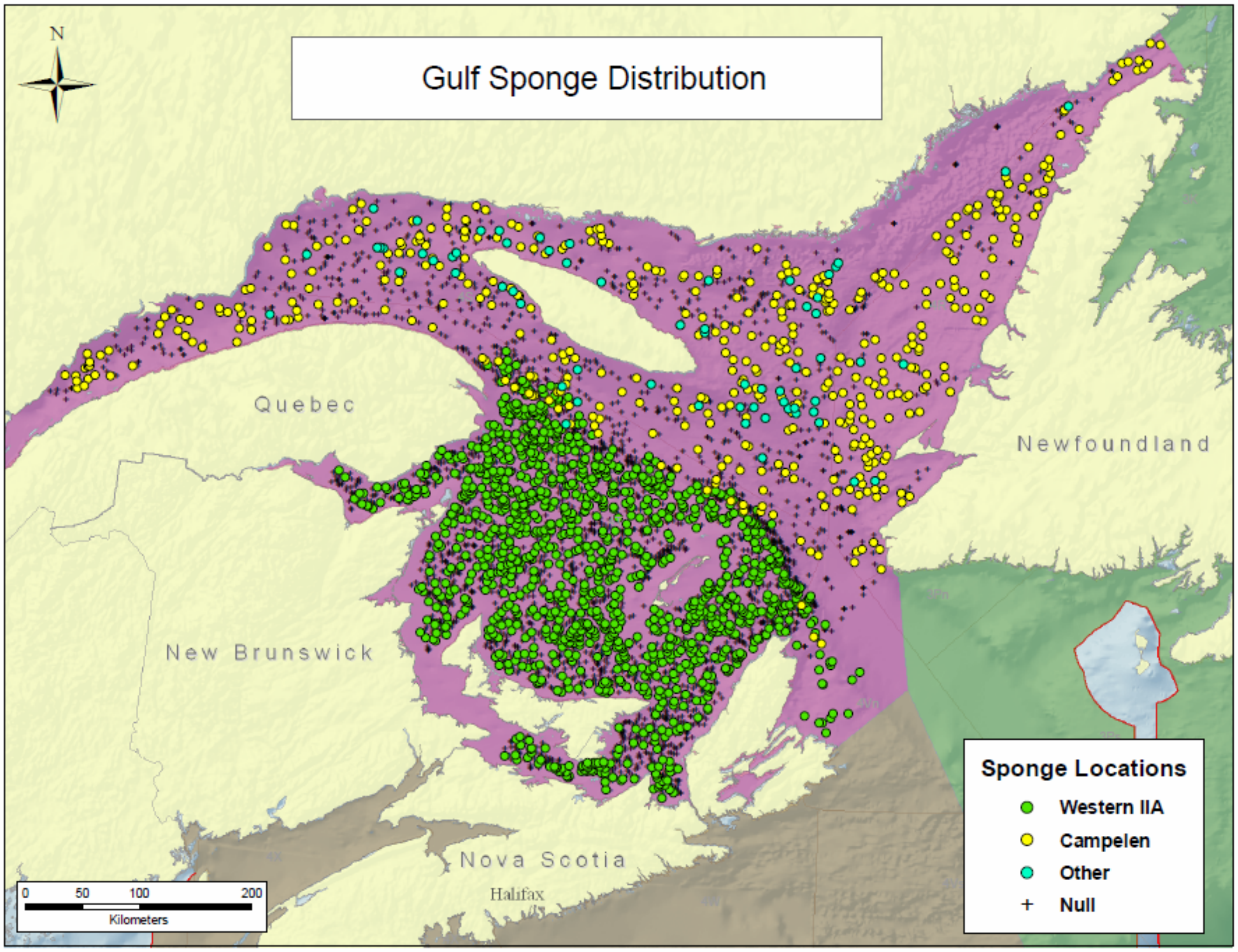


Figure 88. *Distribution of sponge (presence and absence) from the research vessel surveys listed in Table 32. Tows are coded by gear type with Western IIA trawl sets in green and Campelen trawl sets in yellow. Null data is indicated by a cross.*

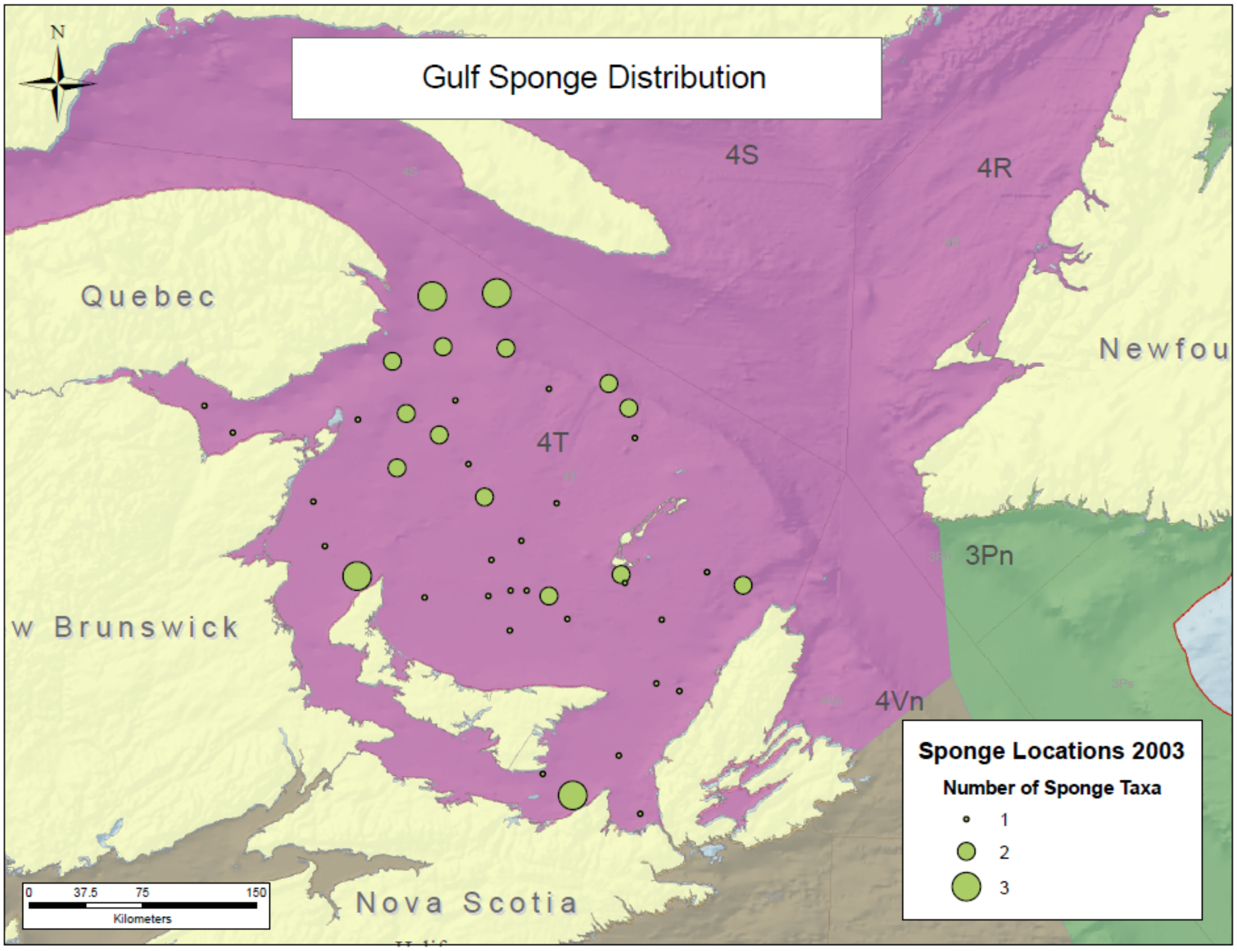


Figure 89. *The number of sponge taxa (a measure of sponge diversity) collected per research vessel tow using a Western IIA trawl from the southern Gulf of St. Lawrence in 2003 (TEM2003352, Table 32).*

Figure 90. *Haliclona oculata specimen (from Fuller, unpub. MS). This species of branching sponge is common in the Gulf of St. Lawrence to depths of about 100 m. It reaches heights of 30 cm.*

Figure 91. *Weberella bursa specimen (from Fuller, unpub. MS). This species is compact and globular and generally 2-10 cm in diameter with a slightly flattened upper surface. It is common in the Gulf of St. Lawrence to depths of about 900 m (grid in background is 1 cm).*

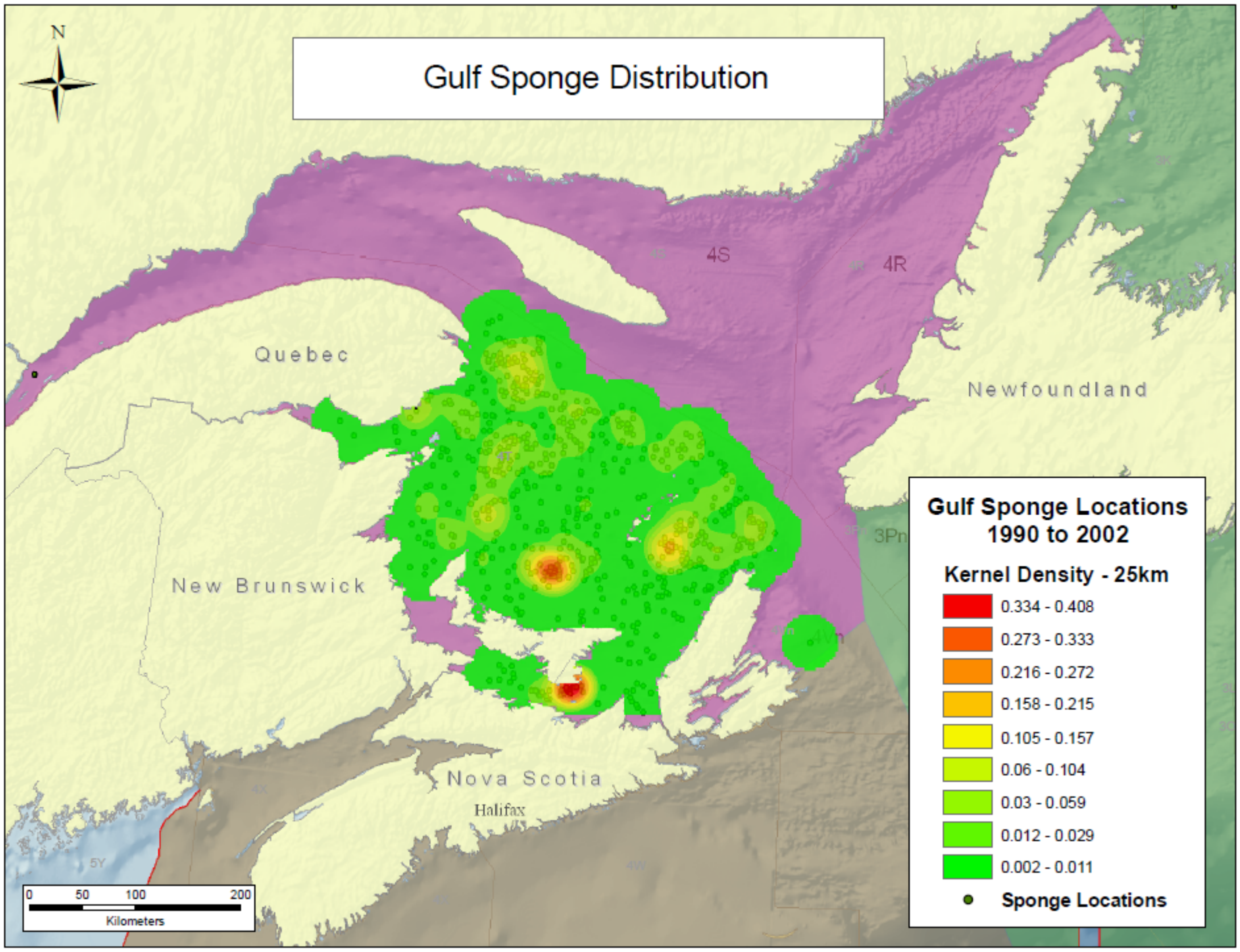
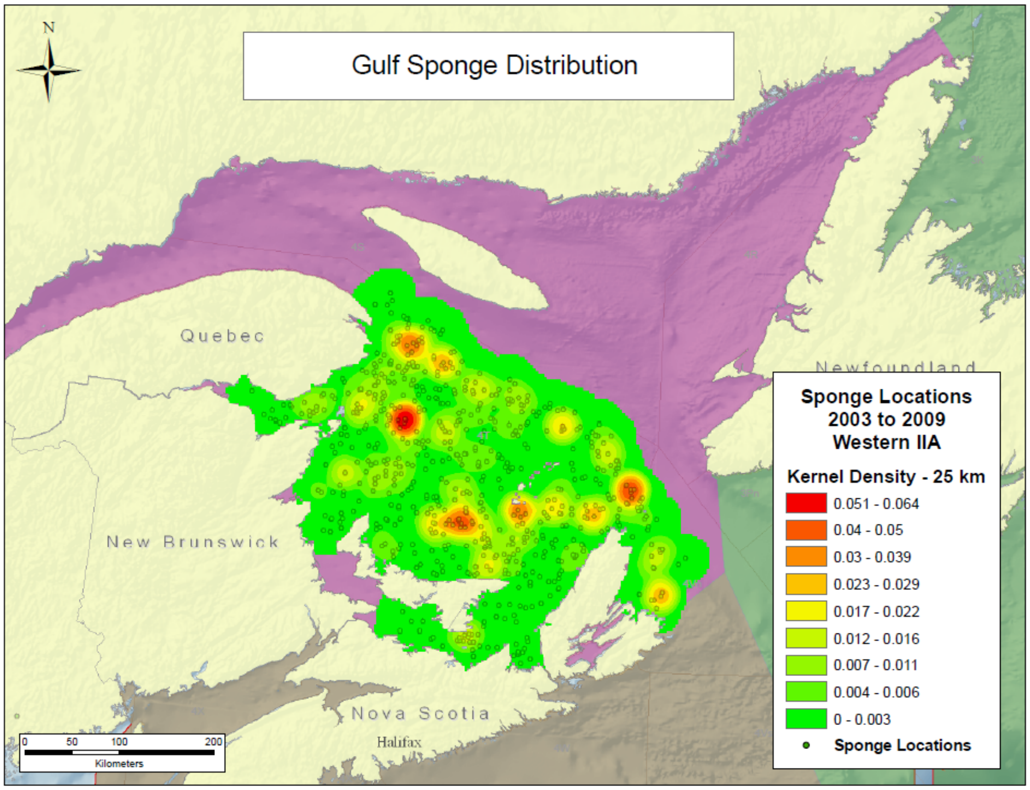


Figure 92. *Interpolated density distribution (kg/km^2) of sponges in the southern Gulf of St. Lawrence using data from research vessel surveys using Western IIA trawls. Data are from 1990-2002 (see Table 32).*



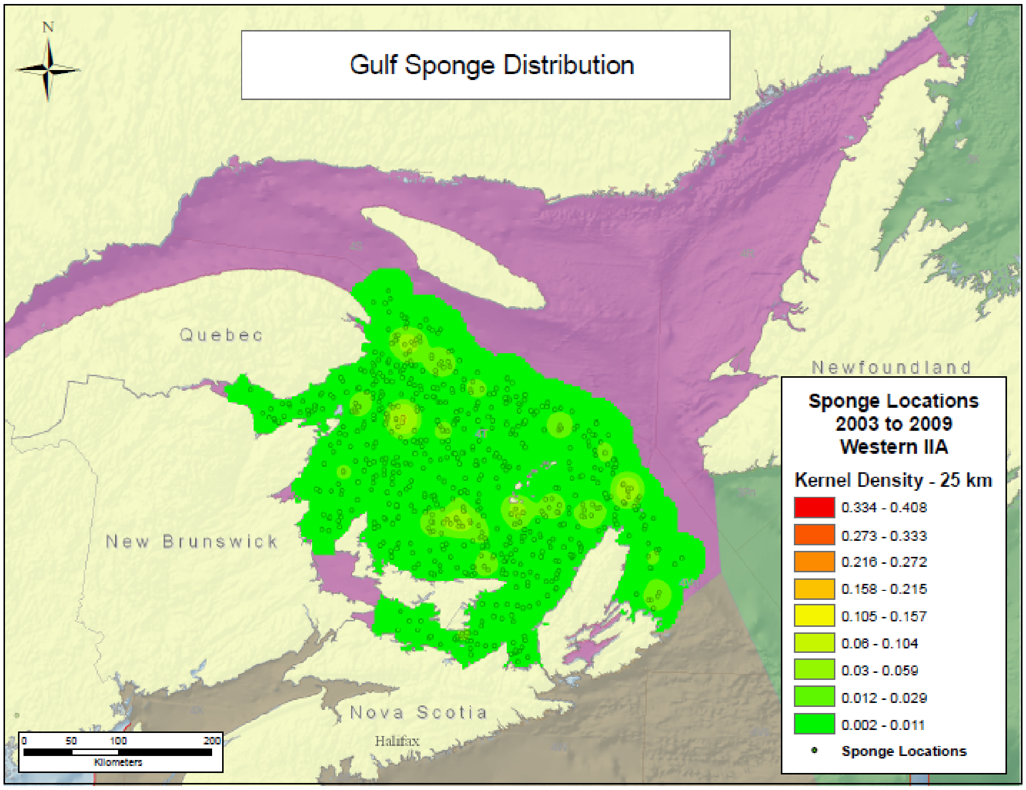


Figure 93. *Interpolated density distribution (kg/km^2) of sponges in the southern Gulf caught with Western IIA trawl gear. Data are from 2003-2009 (see Table 32). Upper panel is scaled to match data range; lower panel is scaled to match distribution from 1990-2002 in Figure 92 to better illustrate the loss of the sponges.*

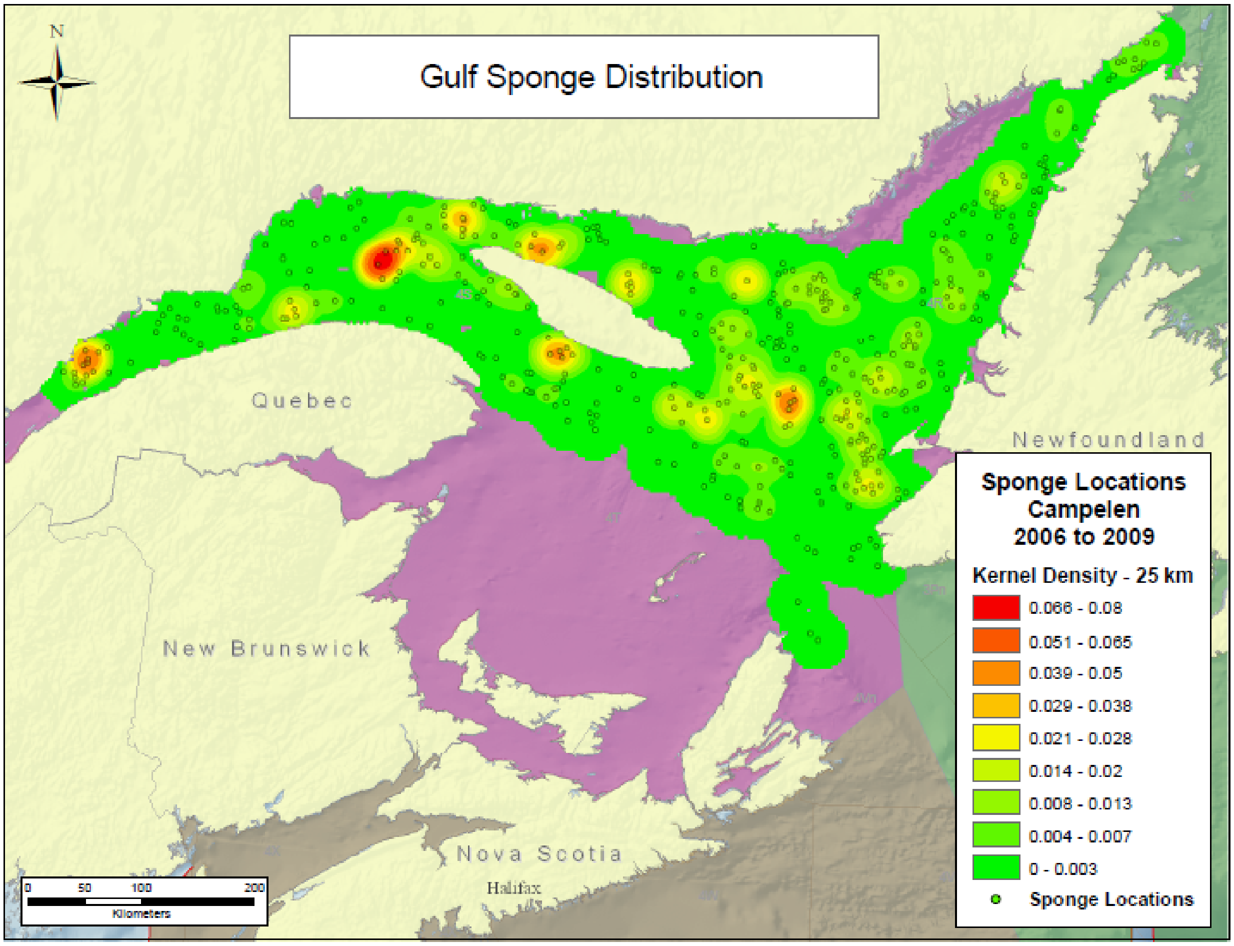


Figure 94. *Interpolated density distribution (kg/km^2) of sponges in the northern Gulf of St. Lawrence sampled with a Campelen trawl. Data are from the 2006-2009 period (see Table 32).*

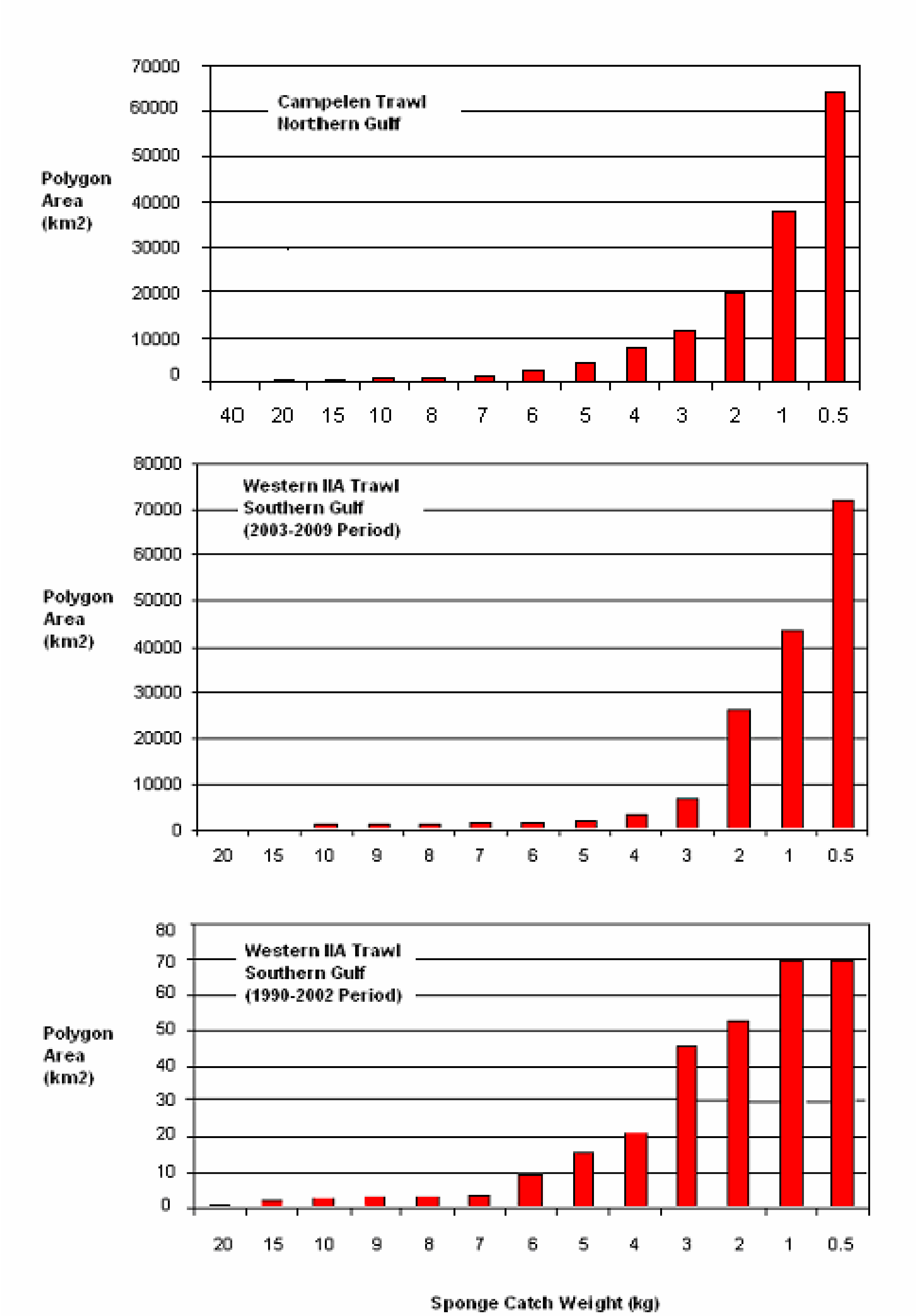


Figure 95. *The area occupied by polygons encompassing specific weight thresholds of sponge catch (all catches ≥ the threshold level) from research vessel surveys using Campelen (2006-2009) and Western IIA trawl gear (2003-2009) in the northern and southern Gulf Biogeographic Zone and from research vessel surveys using Western IIA trawl gear in the southern Gulf Biogeographic Zone for the 1990-2002 time period.*

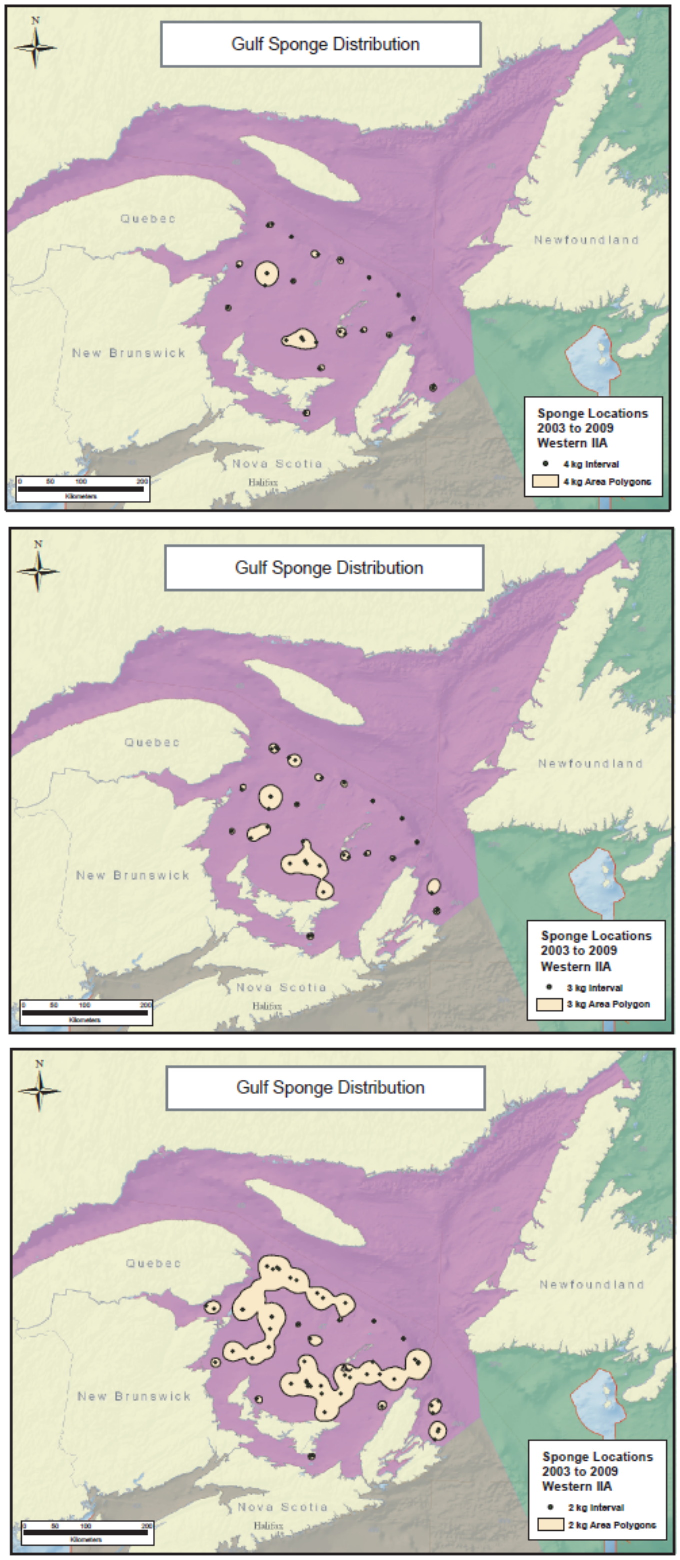


Figure 96. *Polygon areas encompassing sponge catches from the southern Gulf caught with Western IIA trawl gear (2003-2009) of greater than 4 kg (upper), 3 kg (middle), and 2 kg (lower). Note the increasing polygon area between 3 and 2 kg weight thresholds.*

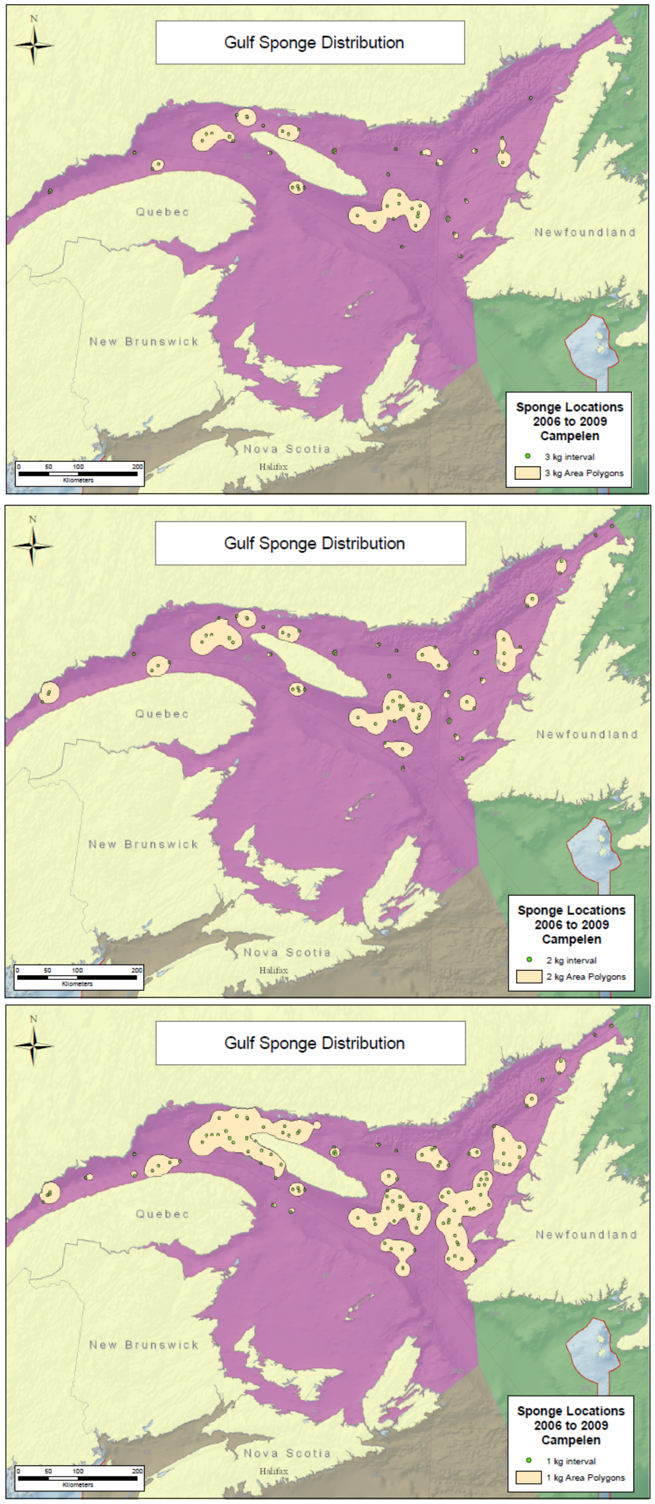


Figure 97. *Polygon areas encompassing sponge catches from the northern Gulf caught with Campelen trawl gear (2007-2009) of greater than 3 kg (upper), 2 kg (middle) and 1 kg (lower). Note the increasing polygon area between 2 and 1 kg weight thresholds.*

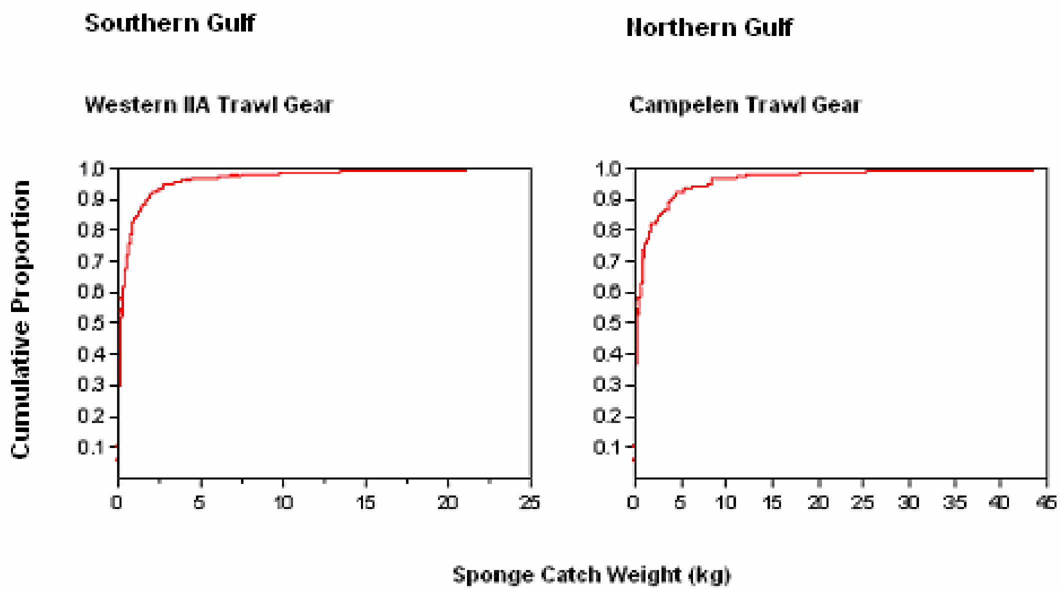


Figure 98. *Cumulative frequency sponge catch curves from the Gulf Biogeographic Zone by gear type (Western IIA: 2003-2009; Campelen 2006-2009).*

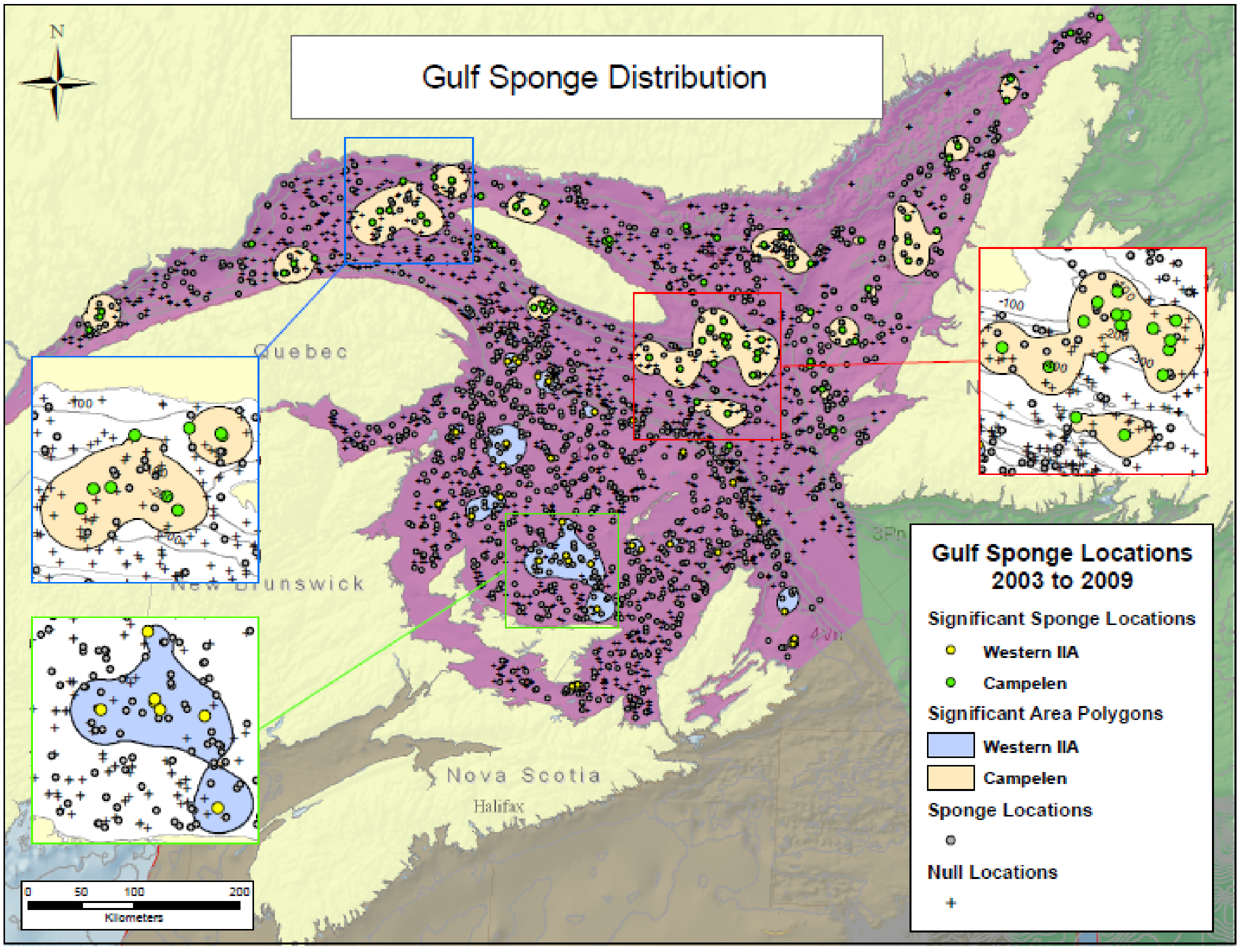


Figure 99. *Locations of significant sponge by-catch using thresholds calculated separately for each gear type with smaller sponge by-catch and null by-catch depicted, along with the associated area polygons. Data collected with the Western IIA trawl are from 2003-2009. Data collected with the Campelen trawl are from 2006-2009.*

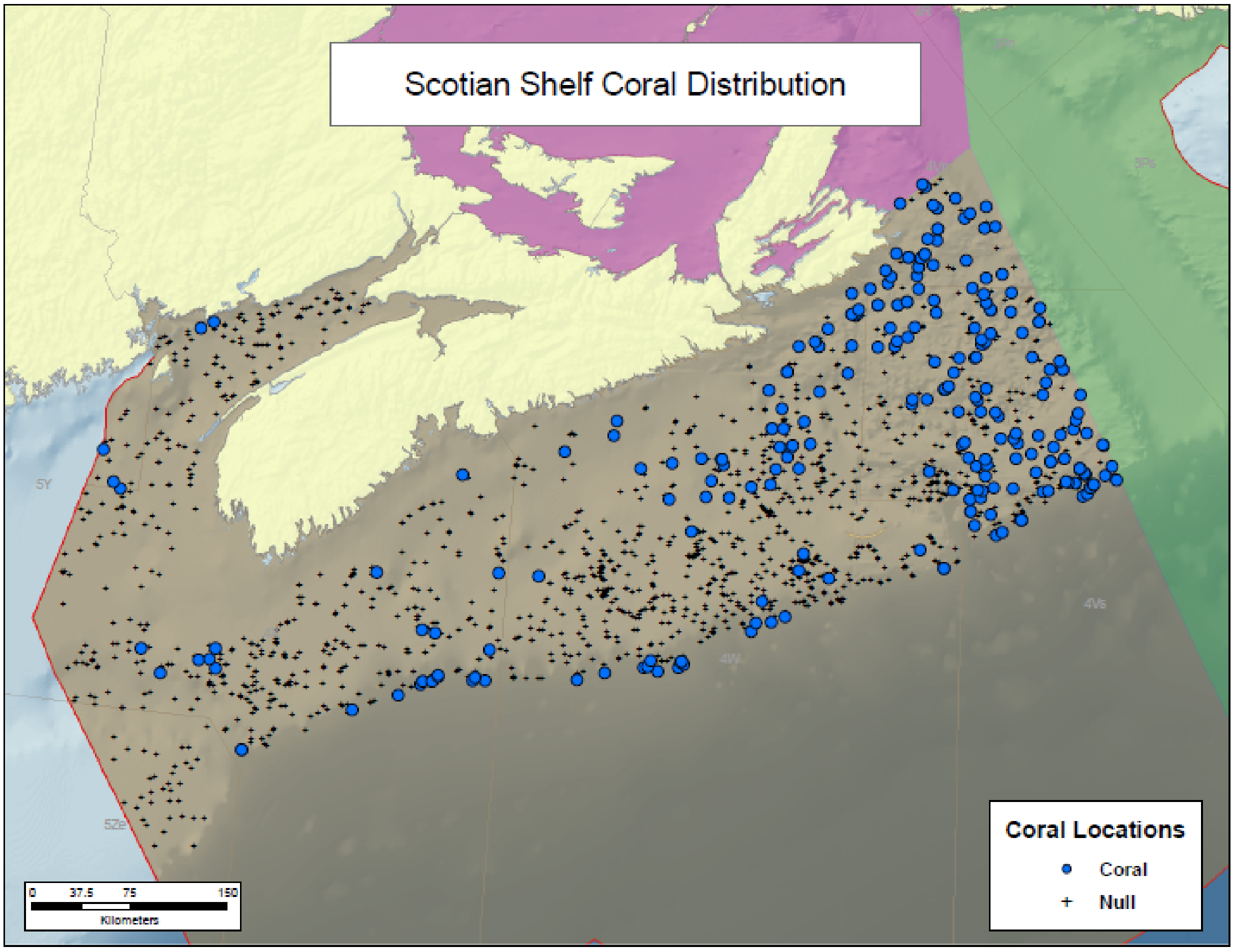


Figure 100. *Location of research vessel survey trawls showing the presence and absence (null) of coral by-catch in the Scotian Shelf Biogeographic Zone. All trawls were fitted with Western IIA gear.*

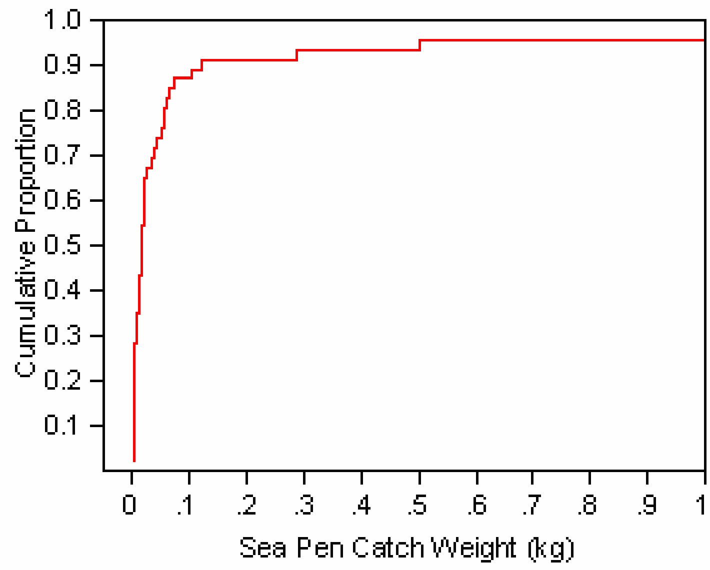


Figure 101. *Cumulative frequency distribution of sea pen by-catch from research vessel surveys in the Scotian Shelf Biogeographic Zone. All trawls were fitted with Western IIA gear.*

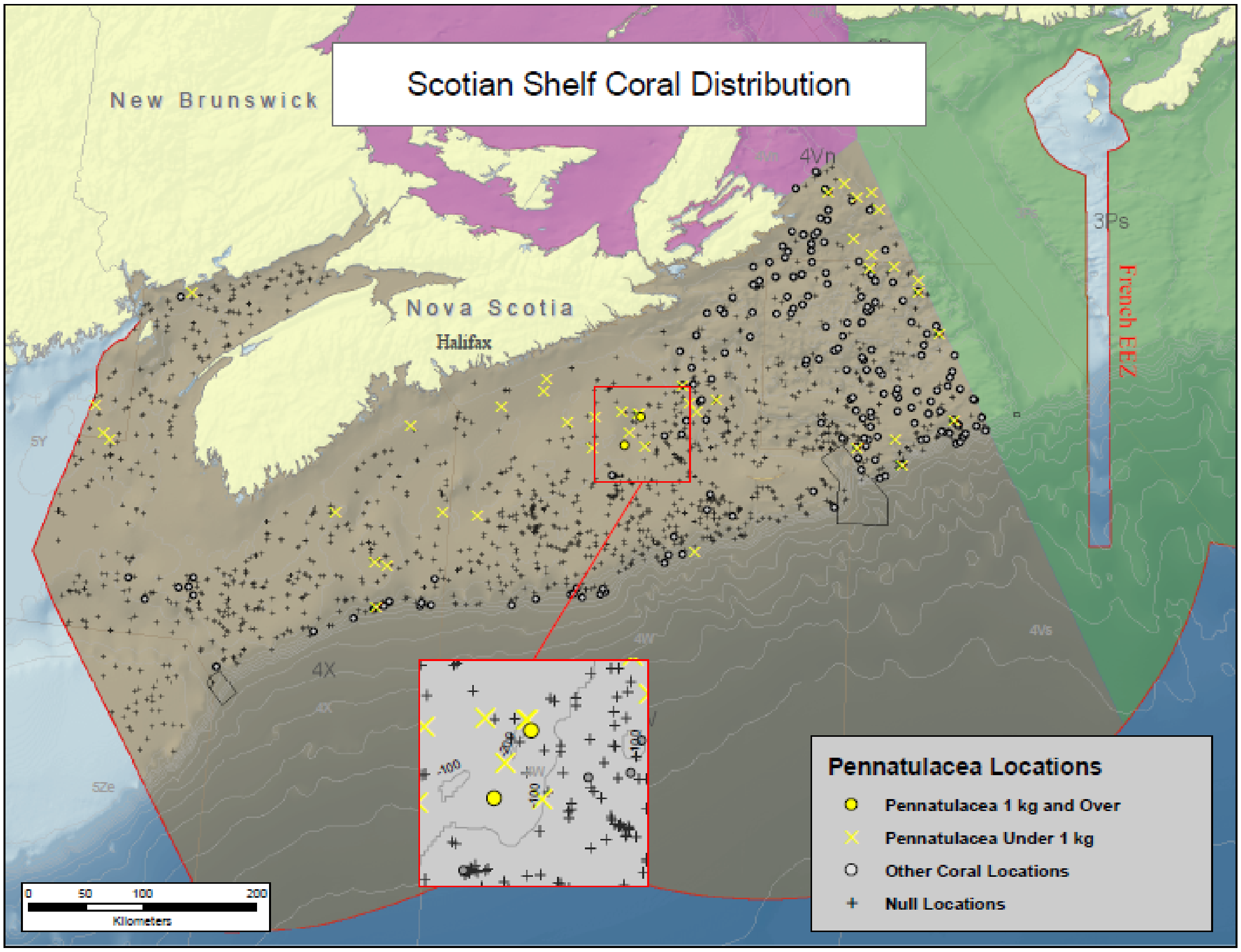


Figure 102. *Locations of significant concentrations of sea pens (Table 39) in the Scotian Shelf Biogeographic Zone determined from the 97.5% quantile of the catch distribution (Table 38). The Northeast Channel Coral Conservation Area and the Gully Marine Protected Area boundaries are indicated on the map. In all cases these records lie outside the protected area boundaries.*

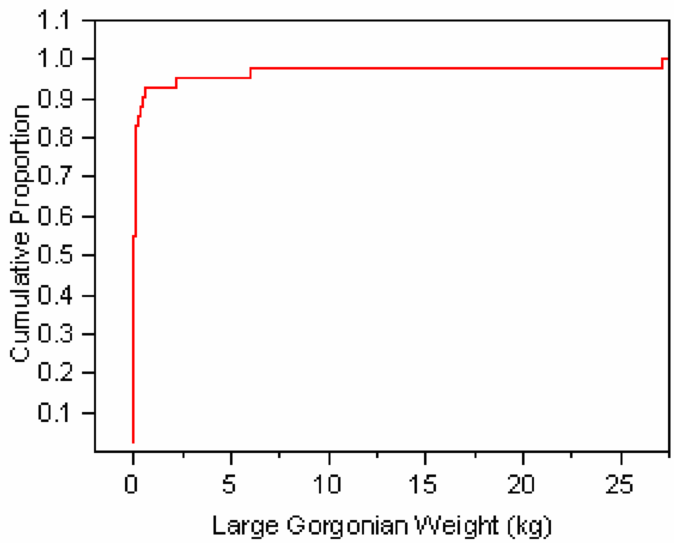


Figure 103. *Cumulative frequency distribution of large gorgonian by-catch from research vessel surveys in the Scotian Shelf Biogeographic Zone. All trawls were conducted with Western IIA gear.*

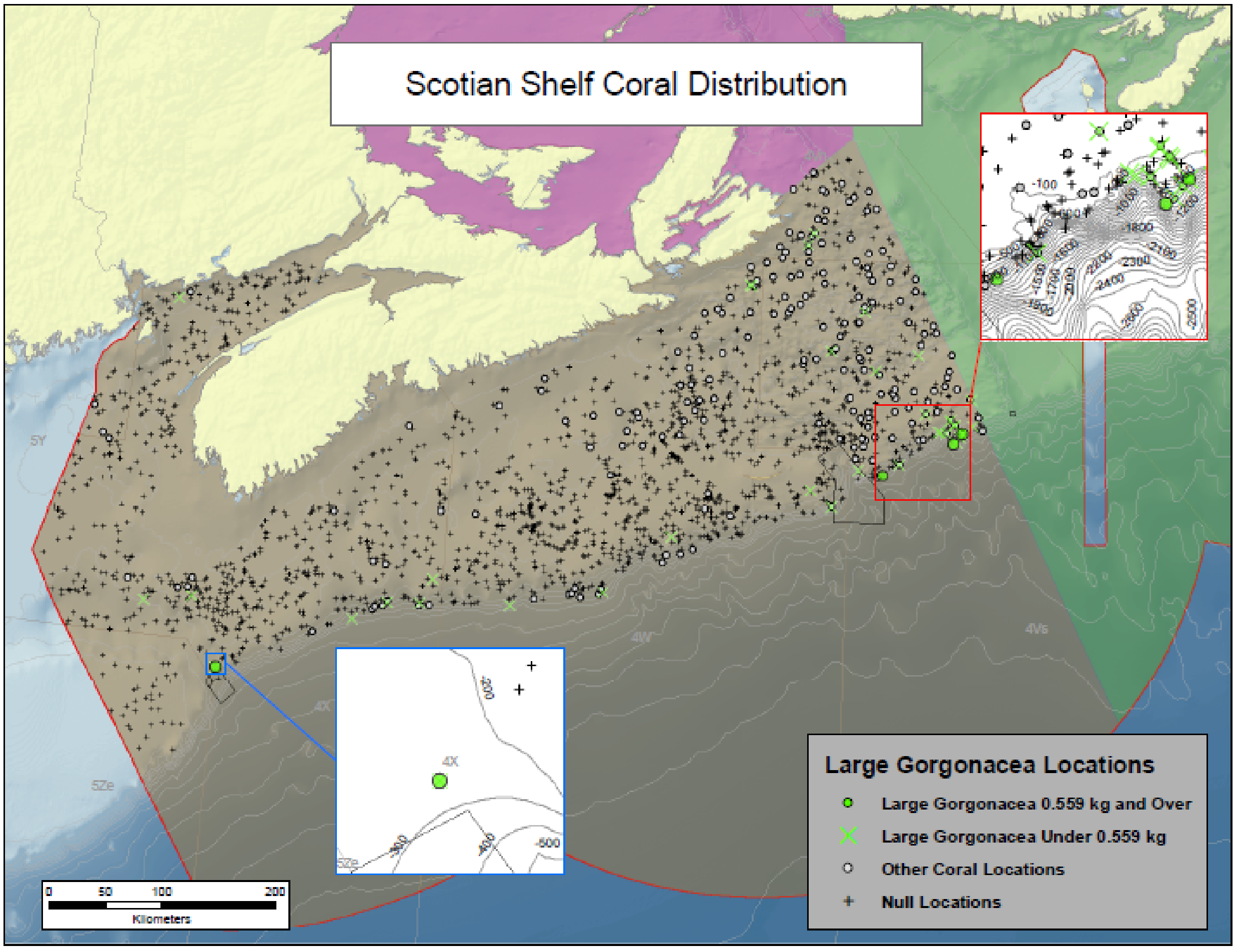


Figure 104. *Locations of significant concentrations of large gorgonian corals (Table 39) on the Scotian Shelf as determined from the 90% quantile of the catch distribution of research vessel survey by-catch using Western IIA trawls. The Northeast Channel Coral Conservation Area and the Gully Marine Protected Area boundaries are indicated on the map. In all cases these records lie outside the protected area boundaries.*

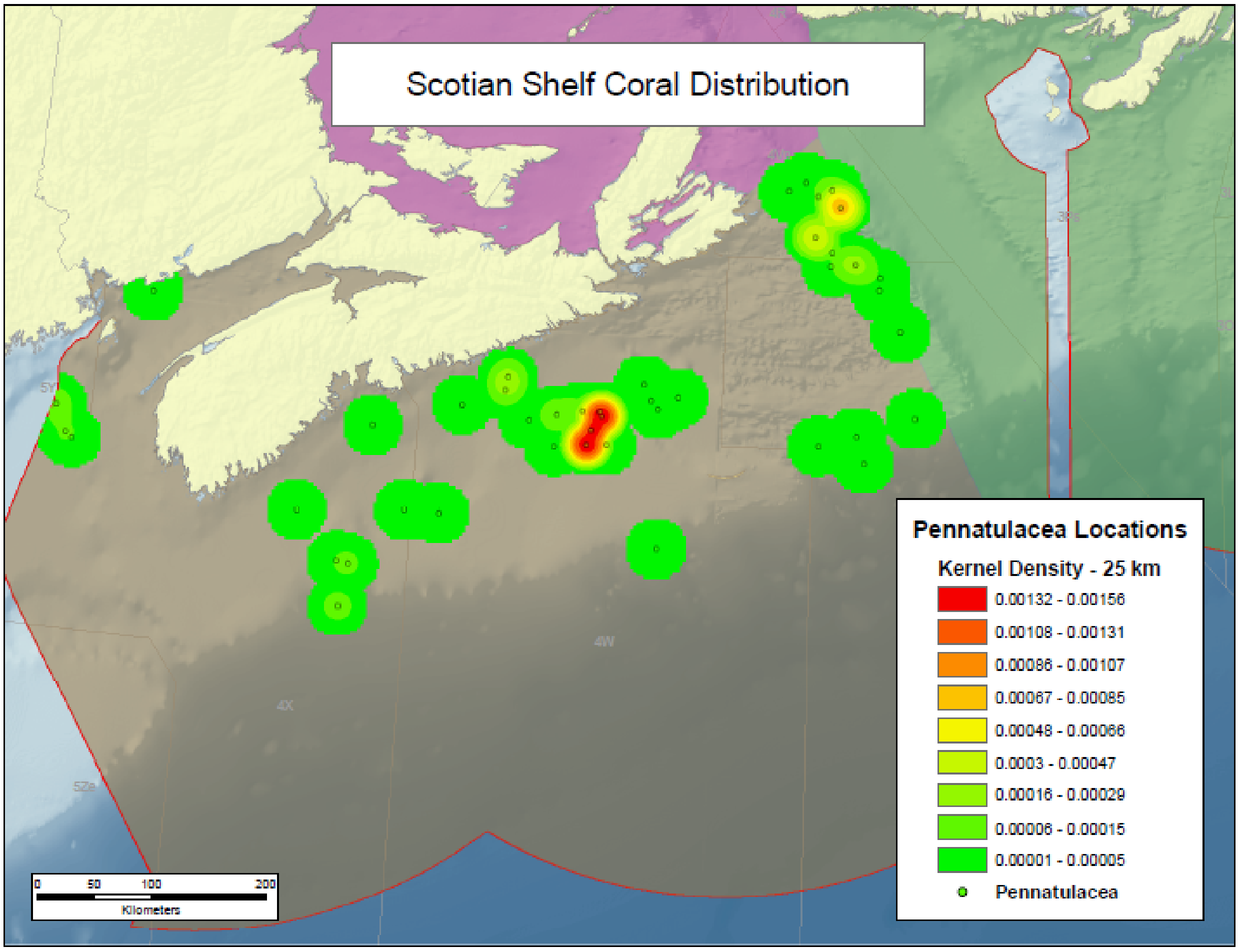


Figure 105. *Interpolated density distribution (kg/km^2) of sea pens in the Scotian Shelf Biogeographic Zone sampled with a Western IIA trawl (see Table 36).*

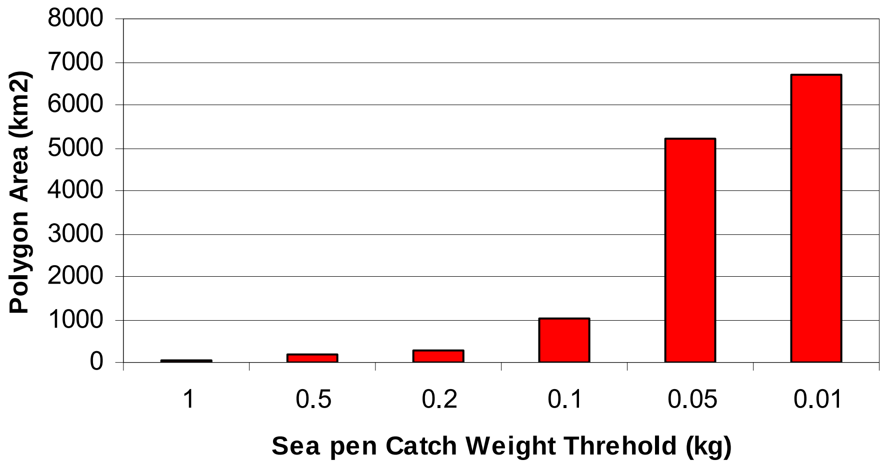


Figure 106. *The area occupied by polygons encompassing specific weight thresholds of sea pen by-catch (all catches ≥ the threshold level) from research vessel surveys using Western IIA trawl gear in the Scotian Shelf Biogeographic Zone (see Table 36).*

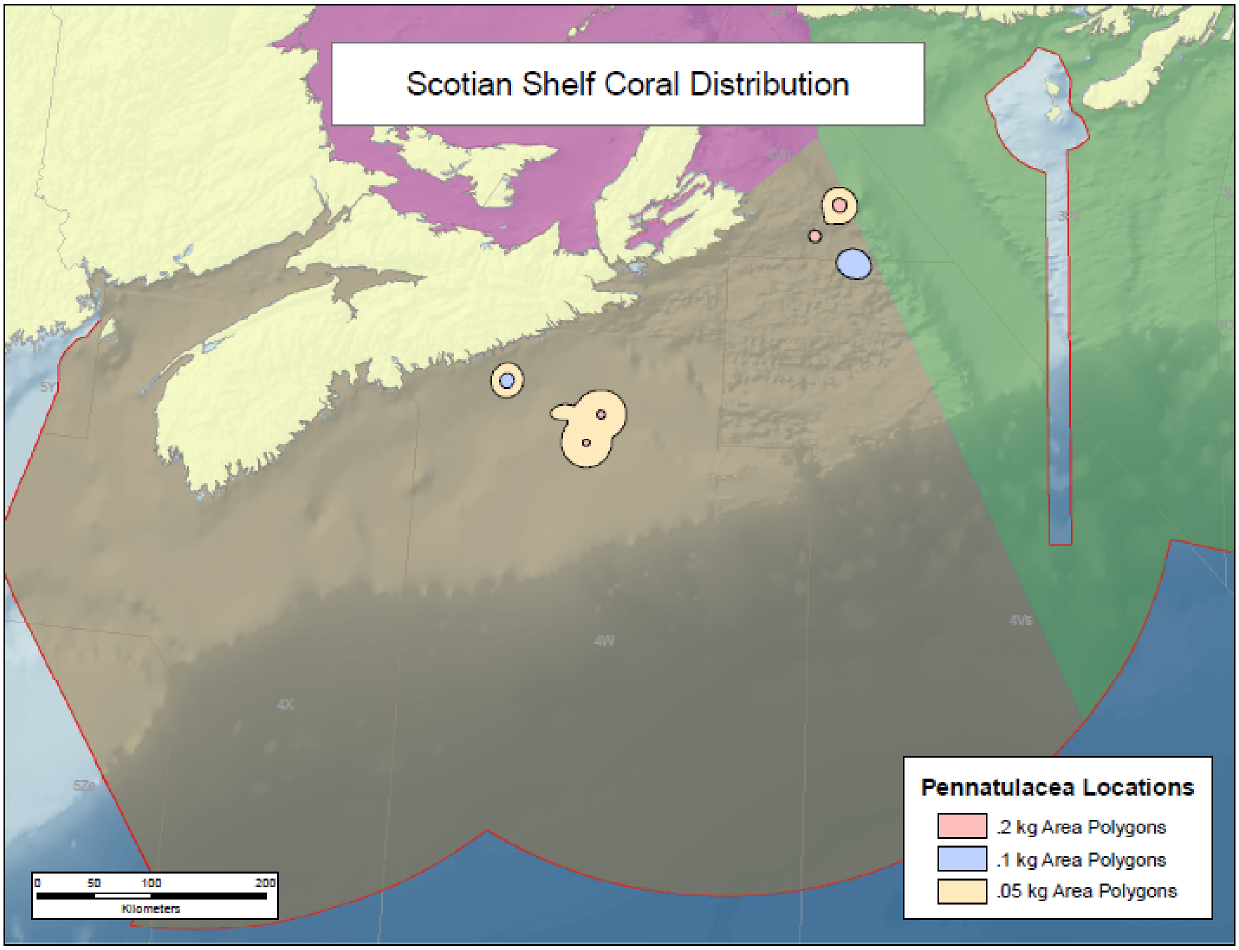


Figure 107. *Polygon areas encompassing sea pen by-catch from the Scotian Shelf Biogeographic Zone caught with Western IIA trawl gear of greater than 0.2 kg, 0.1 kg and 0.05 kg. Note the increasing polygon area between 0.1 and 0.05 kg weight thresholds.*

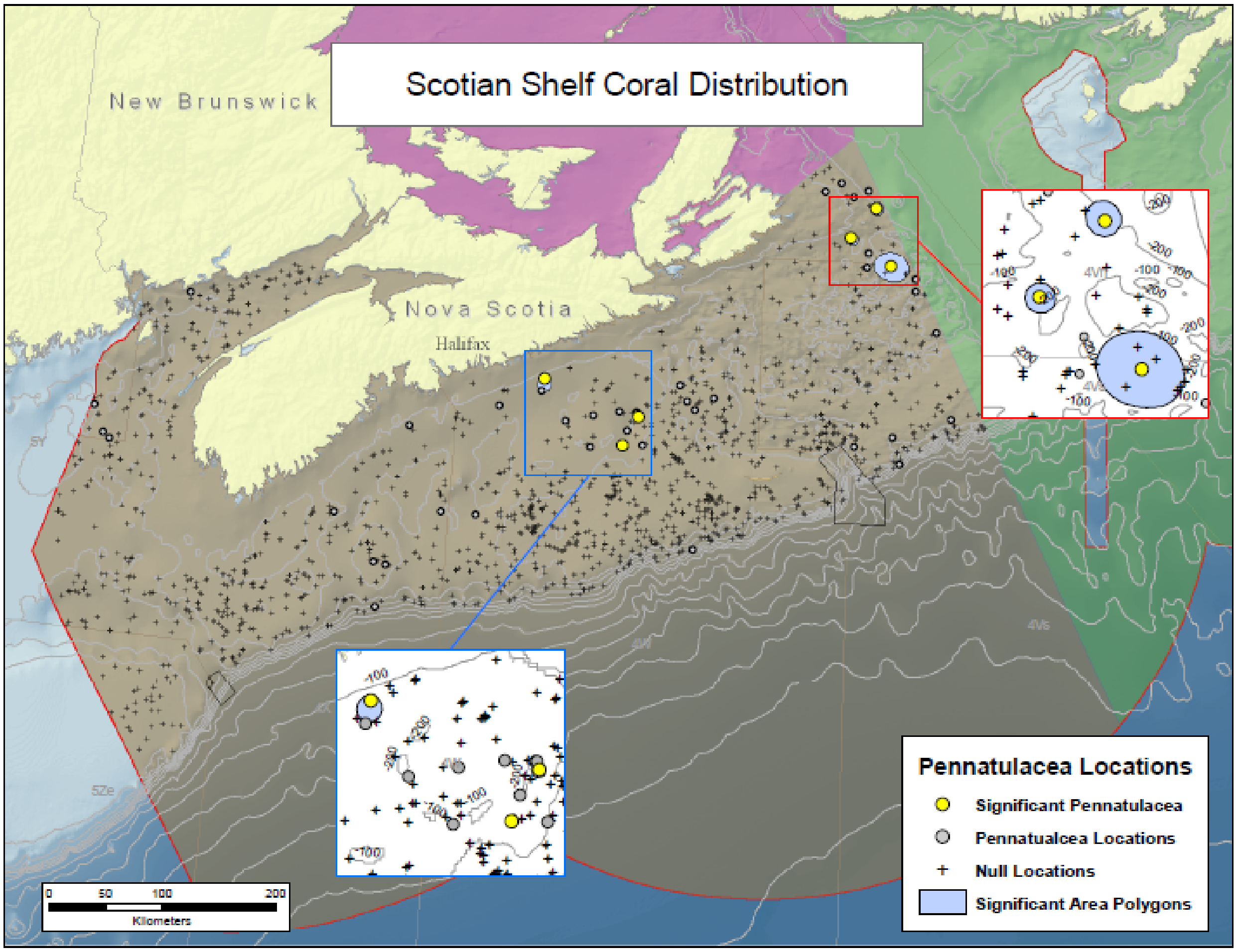


Figure 108. *Locations of significant concentrations of sea pens (Table 40) on the Scotian Shelf as determined from spatial analyses of research vessel by-catch using Western IIA trawls. The Northeast Channel Coral Conservation Area and the Gully Marine Protected Area boundaries are indicated on the map. In all cases these records lie outside the protected area boundaries.*

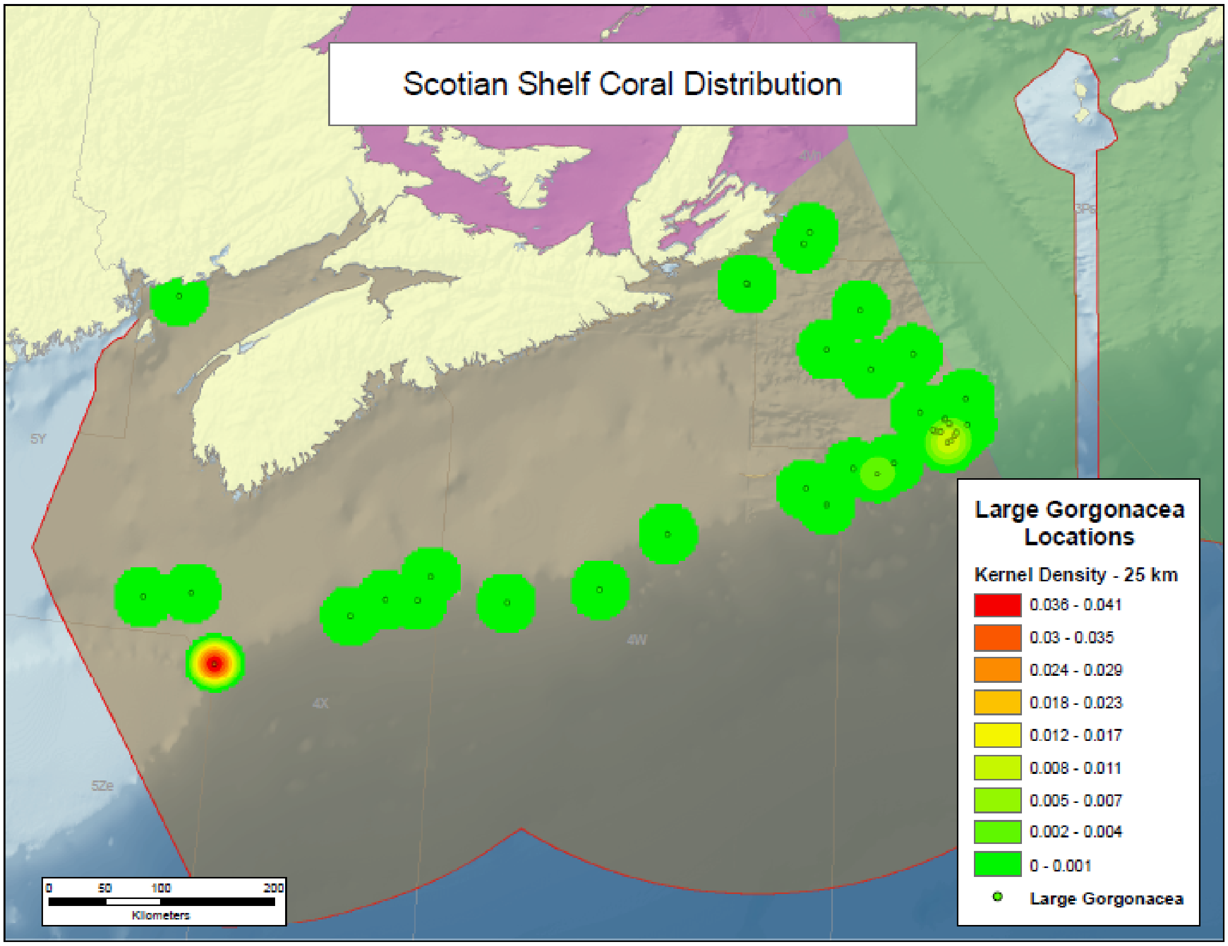


Figure 109. *Interpolated density distribution (kg/km^2) of large gorgonians in the Scotian Shelf Biogeographic Zone sampled with a Western IIA trawl using a kernel density of 25 km and 9 density bins (see Table 36).*

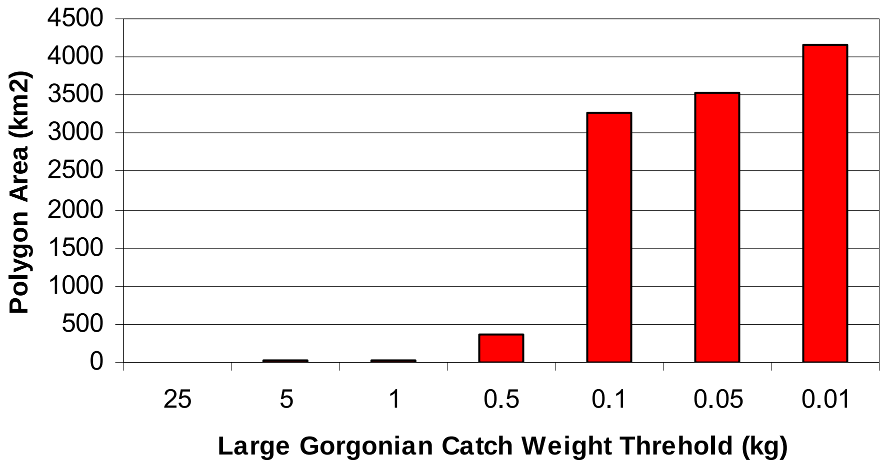


Figure 110. *The area occupied by polygons encompassing specific weight thresholds of large gorgonian catch (all catches ≥ the threshold level) from research vessel surveys using Western IIA trawl gear in the Scotian Shelf Biogeographic Zone (see Table 36).*

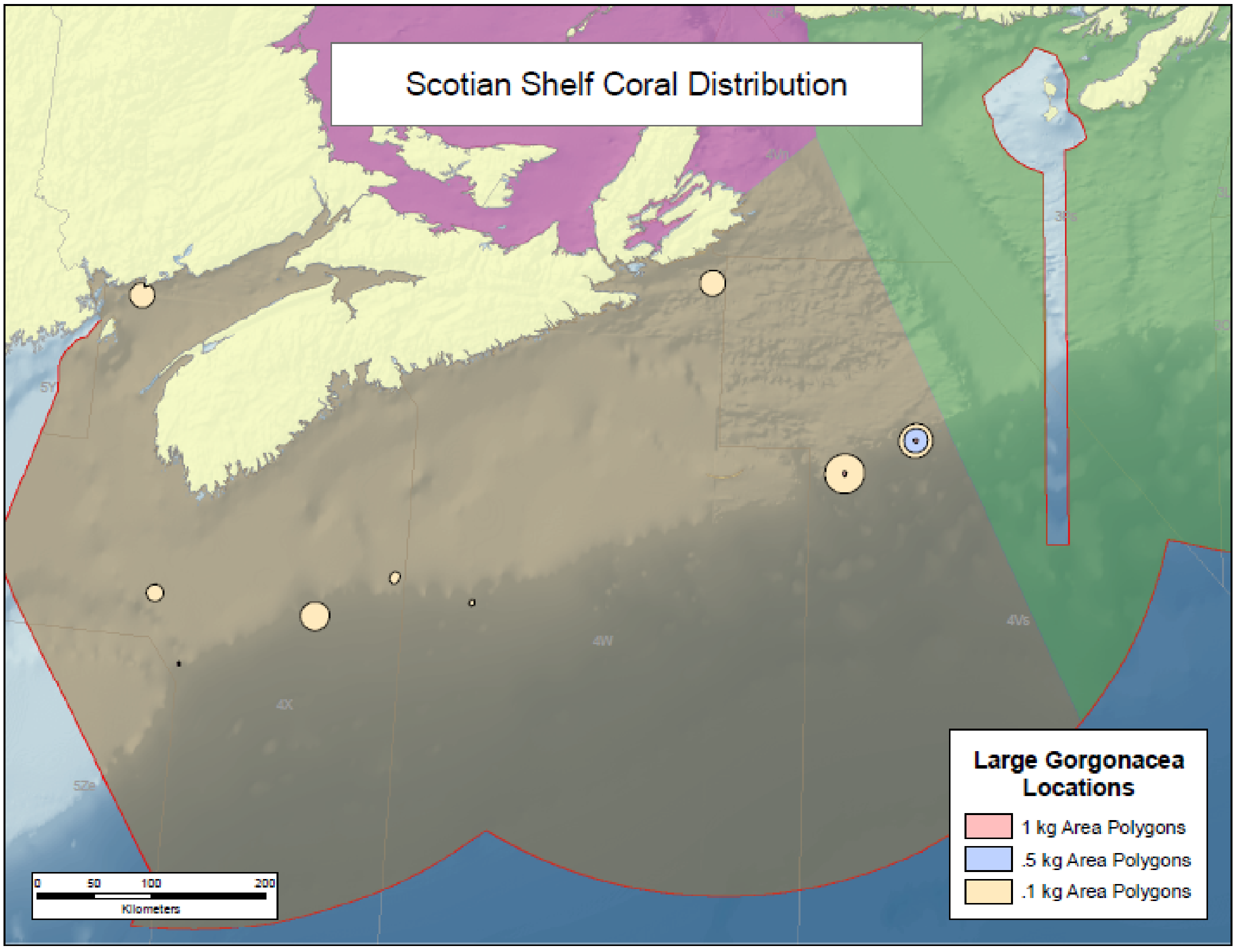


Figure 111. *Polygon areas encompassing large gorgonian by-catch from the Scotian Shelf Biogeographic Zone caught with Western IIA trawl gear of greater than 1 kg, 0.5 kg and 0.1 kg. Note the increasing polygon area between 0.5 kg and 0.1 kg weight thresholds.*

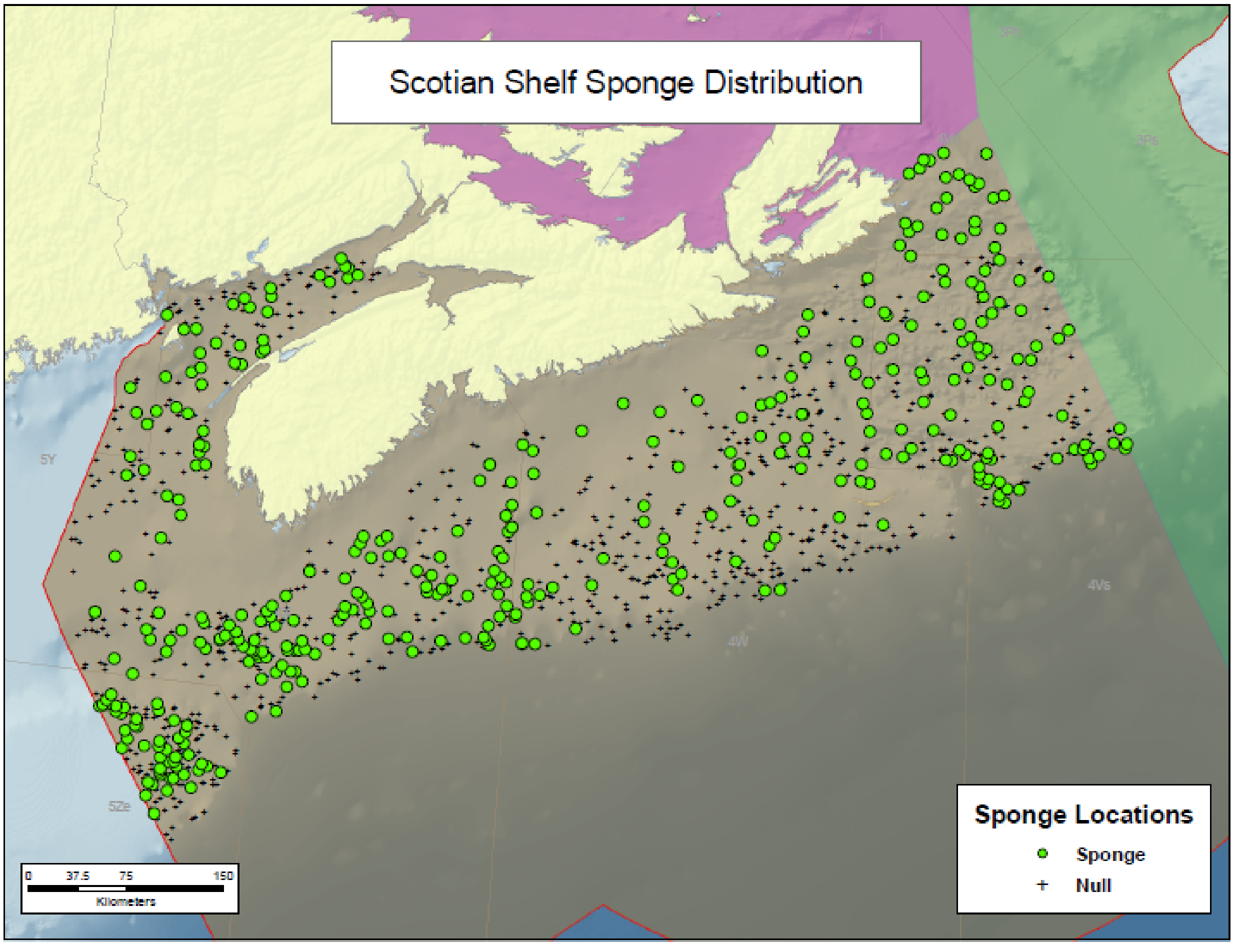


Figure 112. *Distribution of sponge by-catch records from the Scotian Shelf Biogeographic Zone collected from research vessel surveys using Western IIA trawls (see Table 41).*

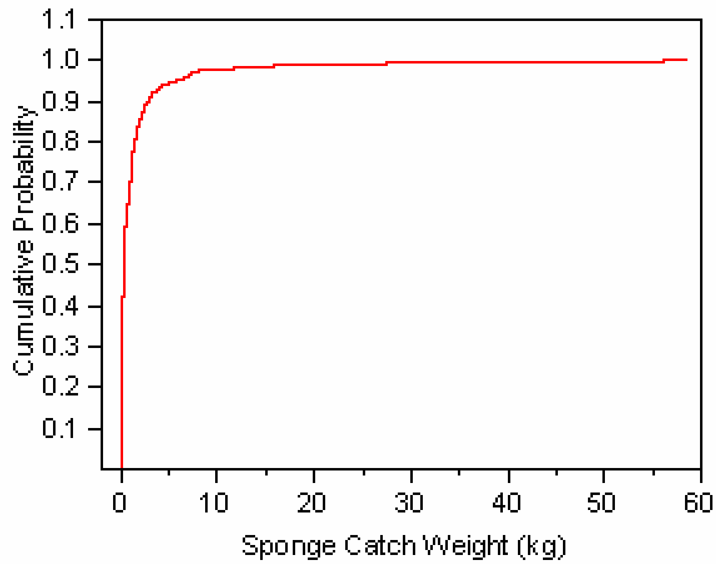


***Figure 113.** Cumulative frequency distribution of sponge by-catch records from the Scotian Shelf Biogeographic Zone collected from research vessel surveys using Western IIA trawls (see Table 42).*

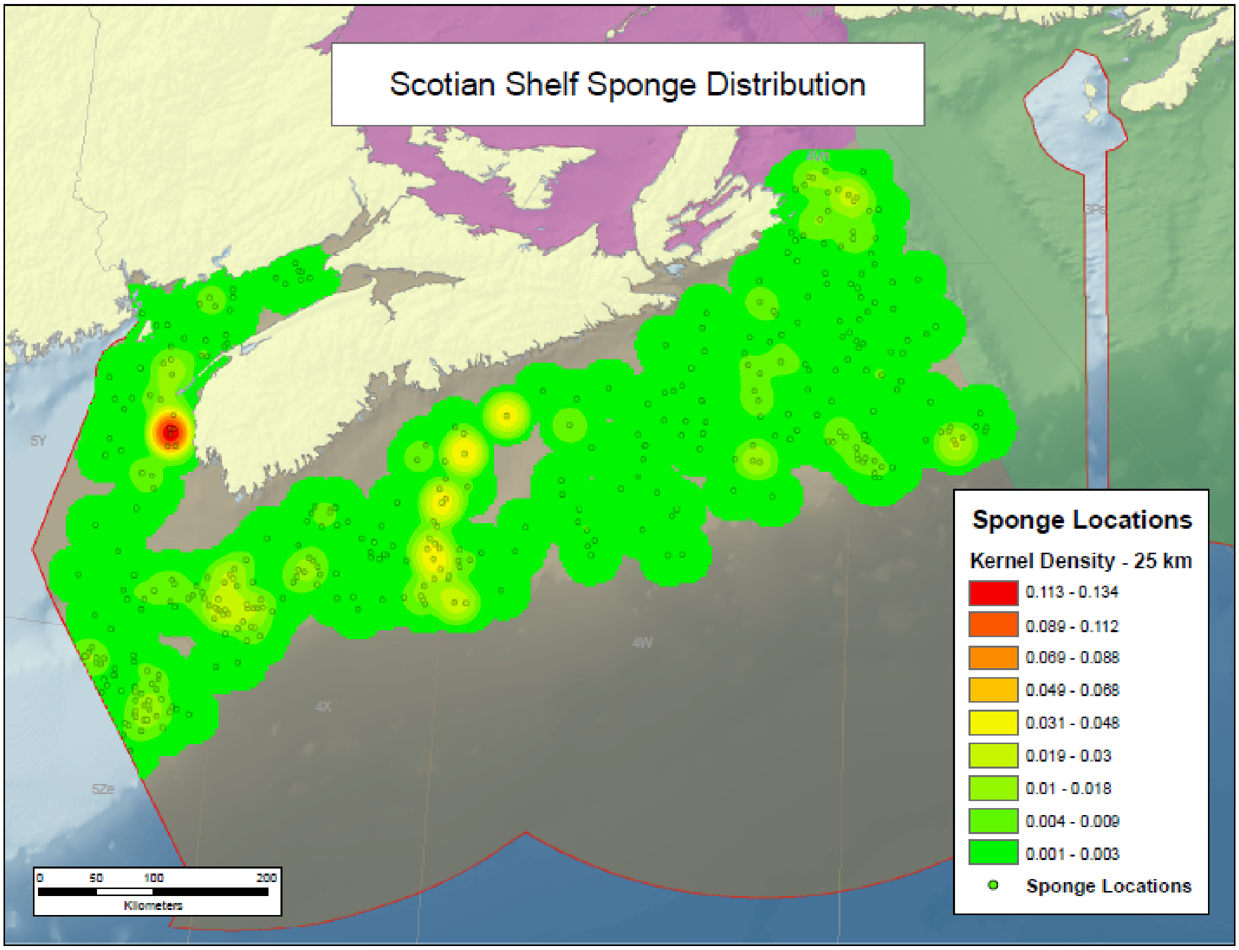


Figure 114. *Interpolated density distribution (kg/km^2) of sponges from the Scotian Shelf Biogeographic Zone collected from research vessel surveys using Western IIA trawls (see Table 41).*

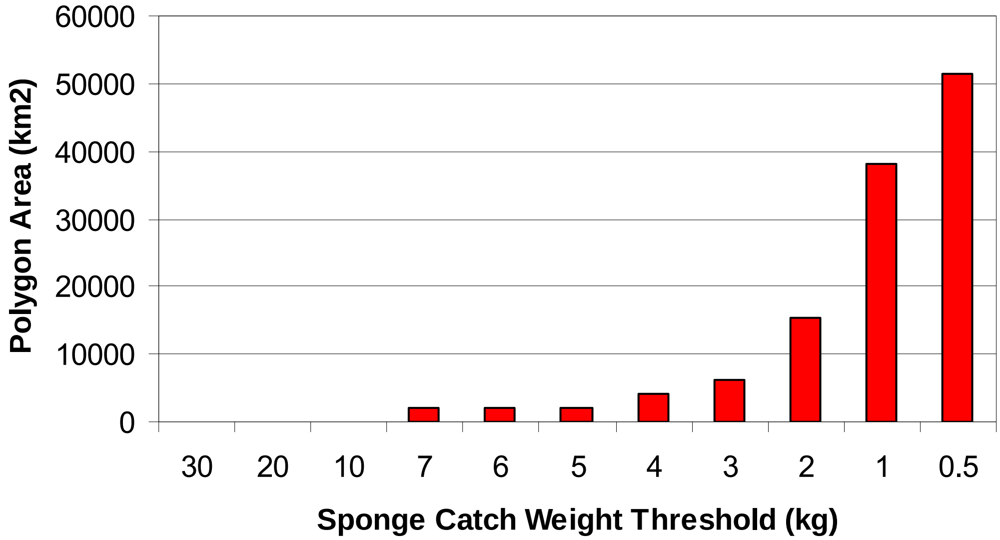


Figure 115. *The area occupied by polygons encompassing specific weight thresholds of sponge by-catch (all catches ≥ the threshold level) from research vessel surveys using Western IIA trawl gear in the Scotian Shelf Biogeographic Zone (see Table 41).*

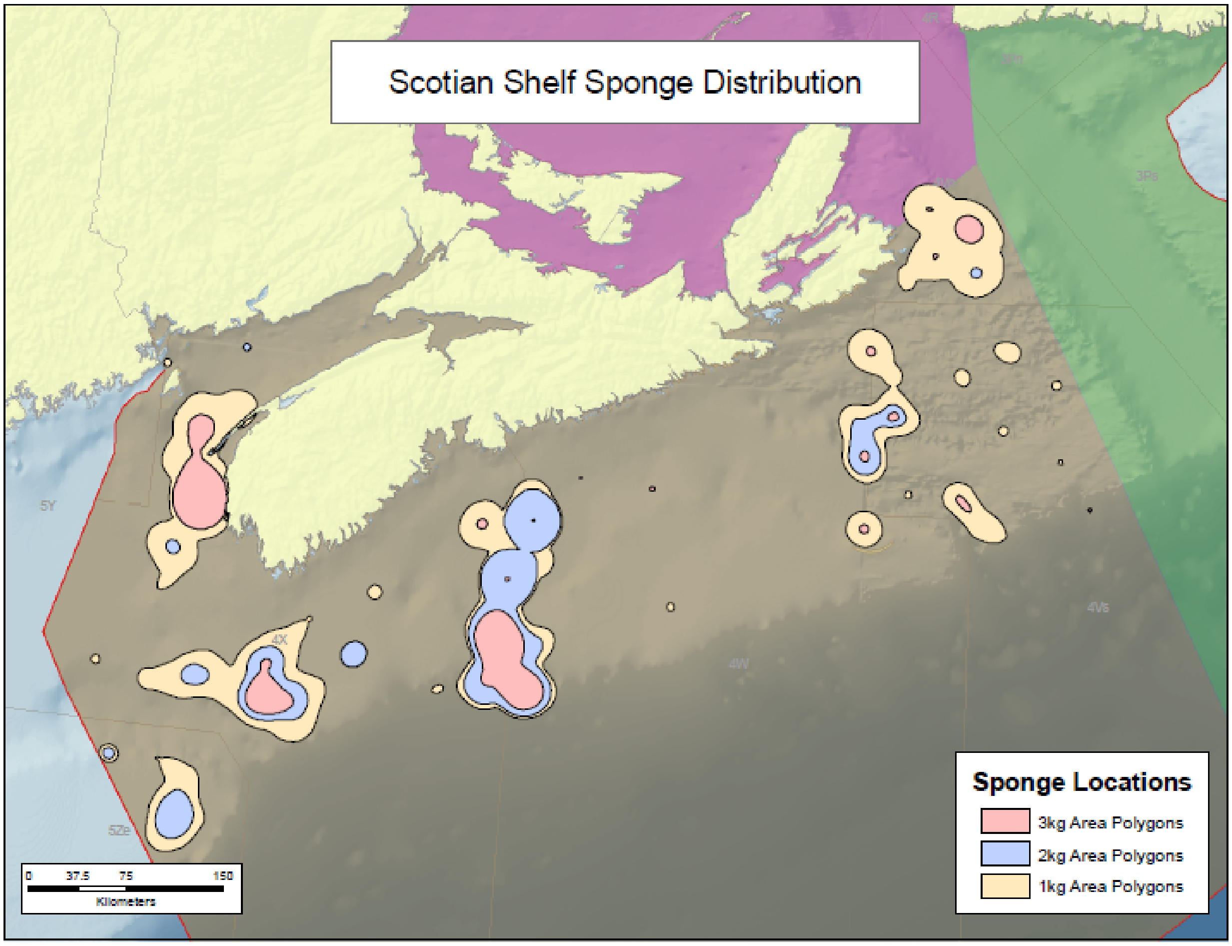


Figure 116. *Polygon areas derived from the density distribution of sponges from the Scotian Shelf Biogeographic Zone collected from research vessel surveys using Western IIA trawls. Polygon areas are illustrated for by-catch ≥3 kg, ≥ 2 kg and ≥ 1 kg.*

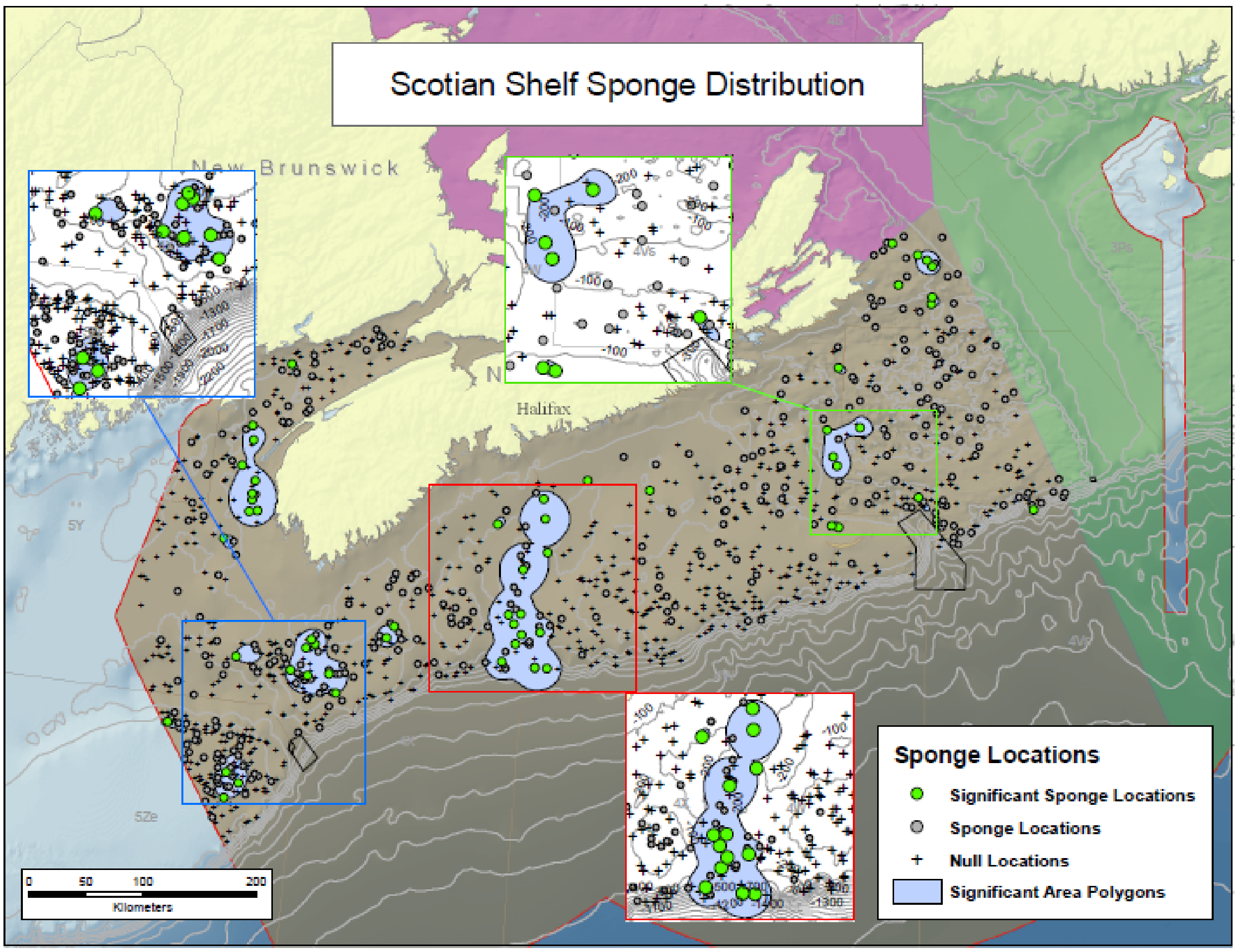


Figure 117. *Locations of significant catches of sponge in the Scotian Shelf Biogeographic Zone as determined from spatial analyses of the research vessel by-catch using a Western IIA trawl. The area surrounded by the red box indicates the location of the Russian Hat (Vazella pourtalesi) sponge grounds (see Figure 118).*

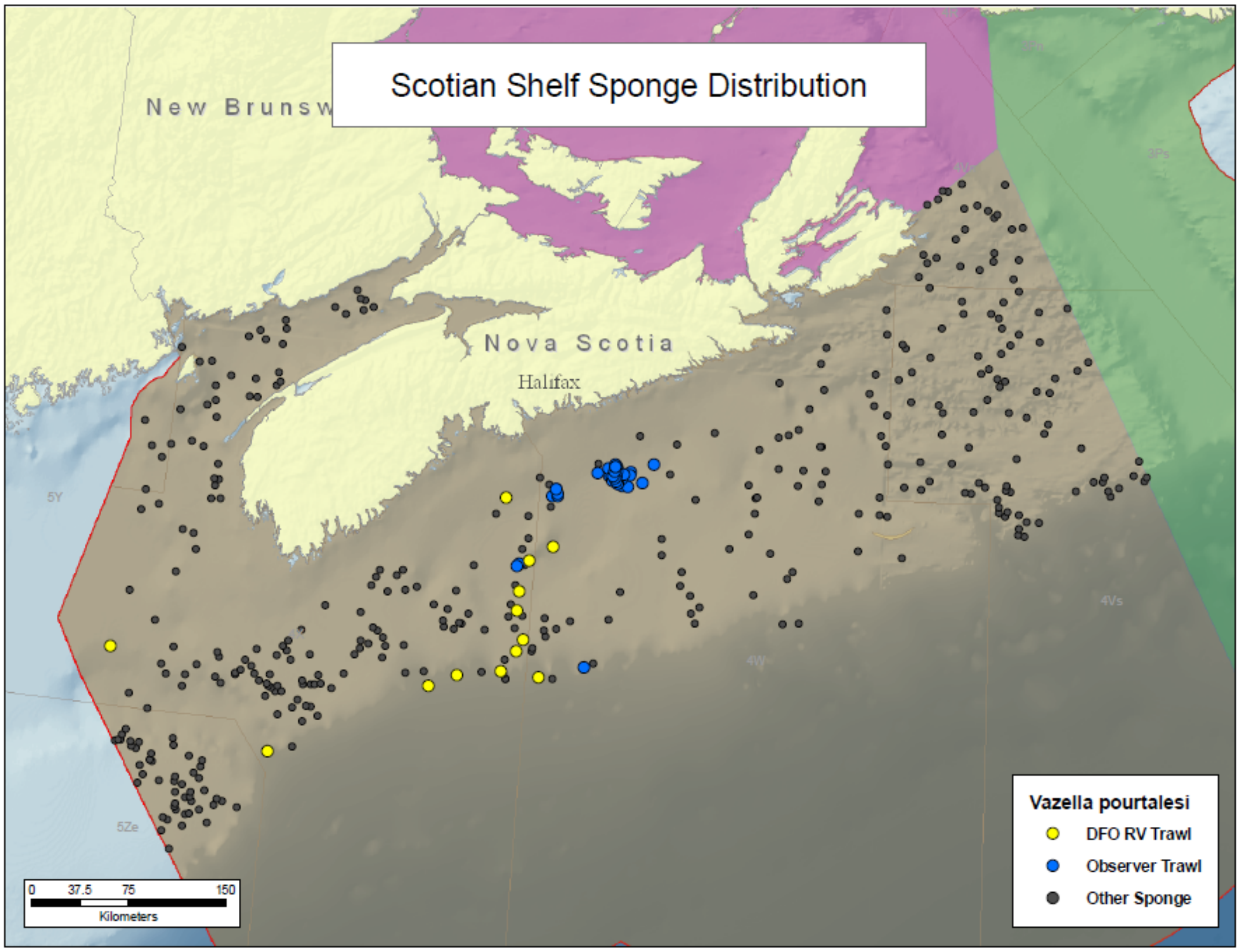


Figure 118. *Locations of Vazella pourtalesi (Russian Hat) sponge in the Scotian Shelf Biogeographic Zone as determined from research vessel by-catch using a Western IIA trawl and from commercial fishing operations through the Fisheries Observer Program. The commercial data identifies important new locations for this species in Emerald Basin.*

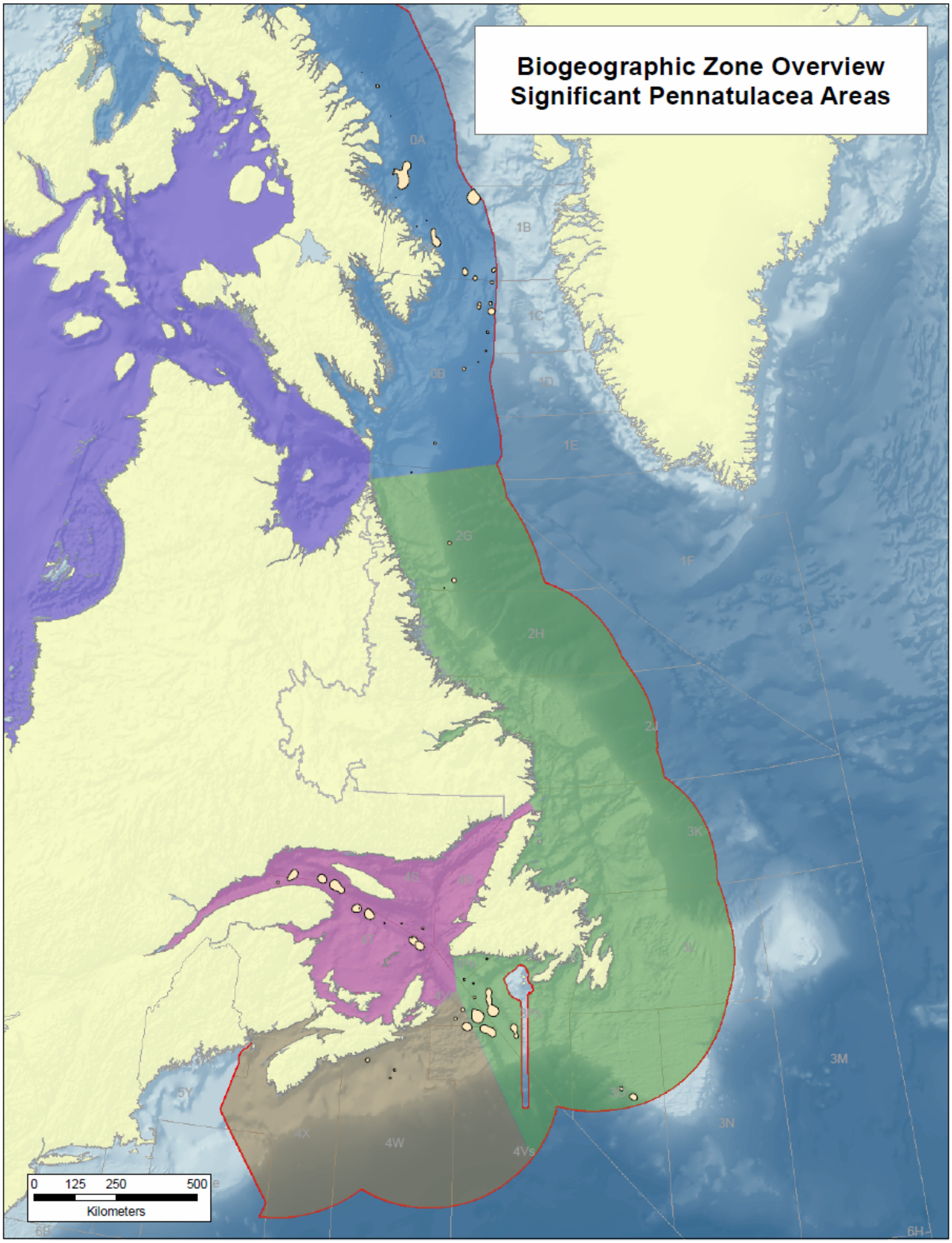


Figure 119. *Locations of significant concentrations of sea pens in each of the Biogeographic Zones (shaded colours) in Eastern Canada as determined from spatial analyses of research vessel by-catch data. Note that significance is determined relative to by-catch within Zones and not across Zones.*

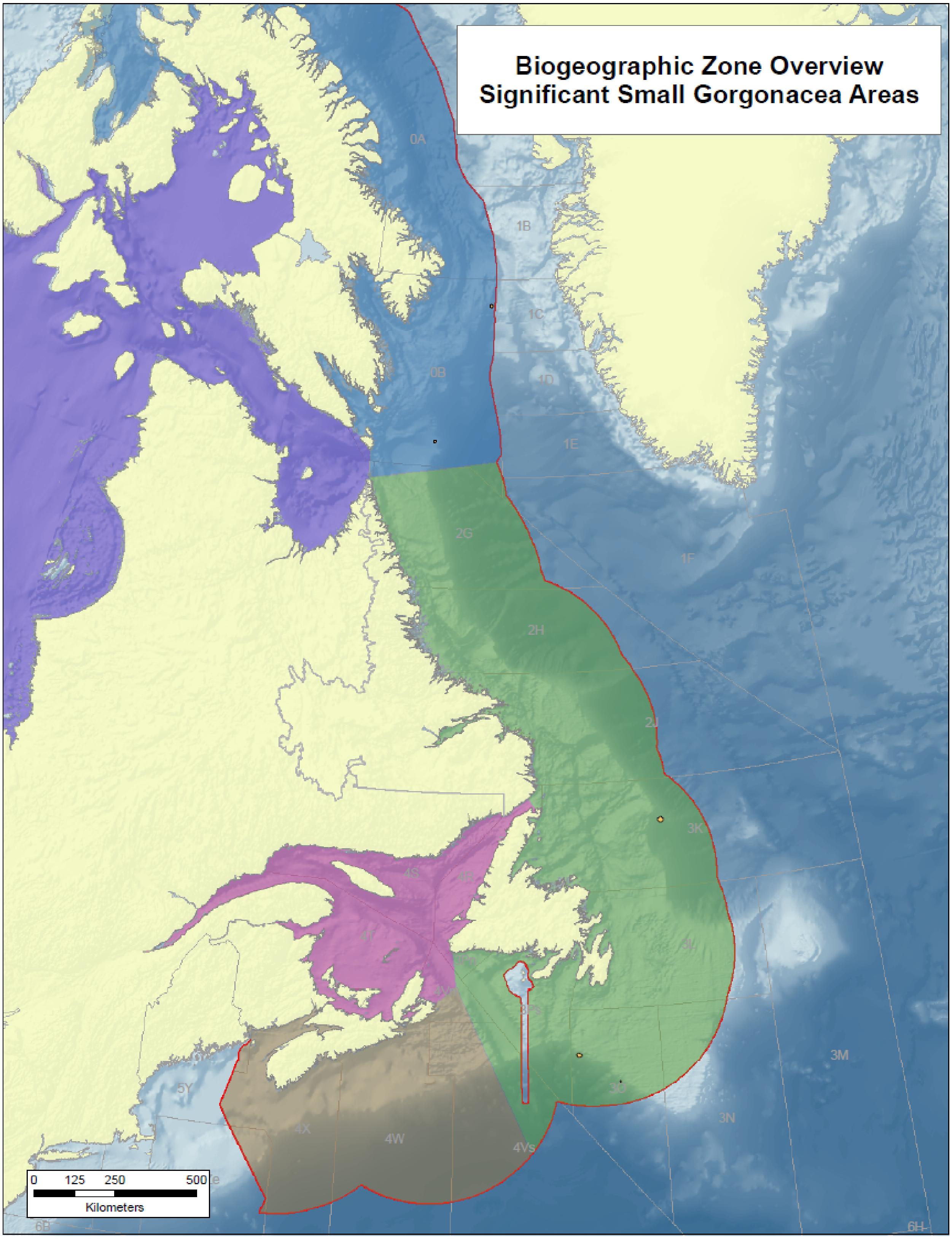


Figure 120. *Locations of significant concentrations of small gorgonian corals in each of the Biogeographic Zones (shaded colours) in Eastern Canada as determined from spatial analyses of research vessel by-catch data. Note that significance is determined relative to by-catch within Zones and not across Zones.*

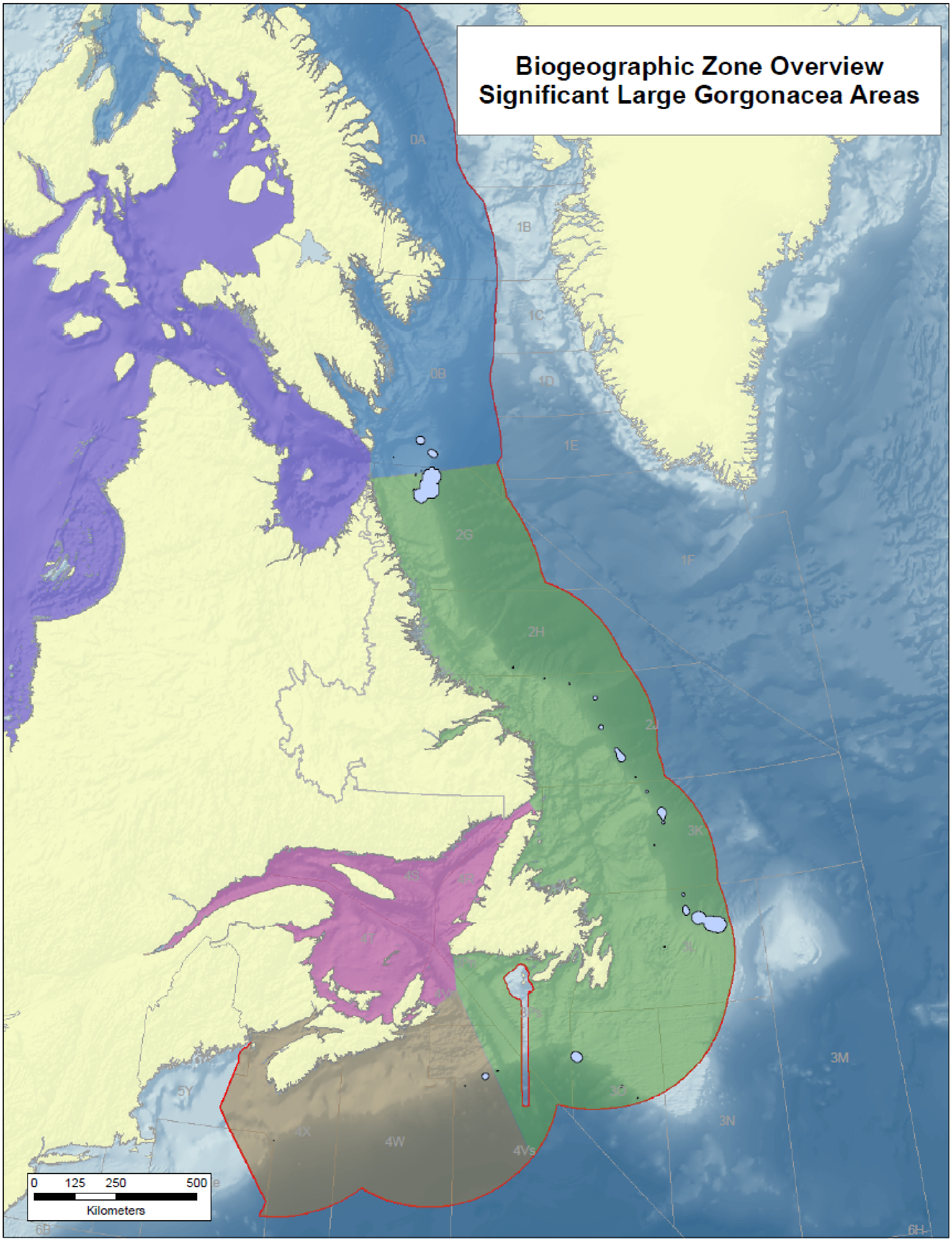


Figure 121. *Locations of significant concentrations of large gorgonian corals in each of the Biogeographic Zones (shaded colours) in Eastern Canada as determined from spatial analyses of research vessel by-catch data. Note that significance is determined relative to by-catch within Zones and not across Zones.*

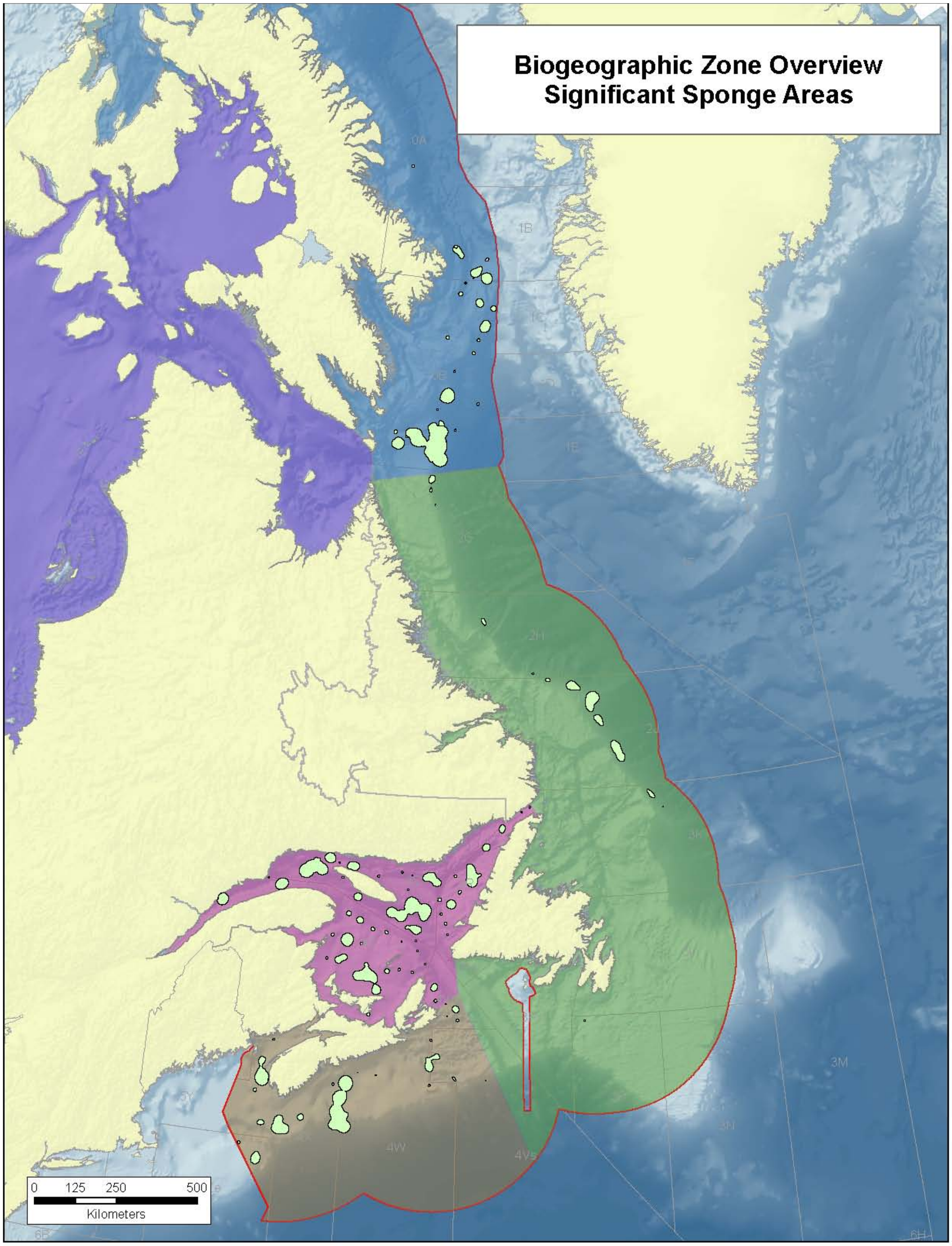


Figure 122[1]. Locations of significant concentrations of sponges in each of the Biogeographic Zones (shaded colours) in Eastern Canada as determined from spatial analyses of research vessel by-catch data. Note that significance is determined relative to by-catch within Zones and not across Zones.

[1] Erratum; December 2012, overview map of all regions combined corrected for southern Gulf of St. Lawrence.