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Delineation of Coral and Sponge Significant Benthic Areas in Eastern Canada Using Kernel Density Analyses and Species Distribution Models

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

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ABSTRACT

Significant Benthic Areas are defined in DFO’s Ecological Risk Assessment Framework (ERAF) as “significant areas of cold-water corals and sponge dominated communities”, where significance is determined “through guidance provided by DFO-lead processes based on current knowledge of such species, communities and ecosystems”. Here we provide maps of the location of significant concentrations of corals and sponges on the east coast of Canada produced through quantitative analyses of research vessel trawl survey data, supplemented with other data sources where available. We have conducted those analyses following a bio-regionalization approach in order to facilitate modelling of similar species, given that many of the multispecies surveys do not record coral and sponge catch at species level resolution. The taxa analyzed are sponges (Porifera), large and small gorgonian corals (Alcyonacea), and sea pens (Pennatulacea). We applied kernel density estimation (KDE) to create a modelled biomass surface for each of those taxa, and applied an aerial expansion method to identify significant concentrations, following an approach first applied in 2010 to this region. We compared our results to those obtained previously. KDE uses only geo-referenced biomass data to identify “hot spots”. The borders of the areas so identified can be refined using knowledge of null catches and species distribution models that predict species presence-absence and/or biomass, both incorporating environmental data. We present such predictive models produced using a random forest machine-learning technique, and in one region compare the biomass random forest models for sea pens to those produced by generalized additive models (GAMs). Together, these distribution maps can be used to identify significant concentrations of corals and sponges in eastern Canada; an essential first step in the identification of Sensitive Benthic Areas.

Délimitation des zones benthiques importantes de coraux et d’éponges dans l’est du Canada à l’aide des analyses des noyaux de densité et des modèles de répartition des espèces

RÉSUMÉ

Dans le Cadre d’évaluation du risque écologique (CERE) de Pêches et Océans Canada (MPO), les zones benthiques importantes sont définies comme étant des « zones importantes qui hébergent des communautés à prédominance de coraux d’eau froide et d’éponge » et l’importance est déterminée « à partir des résultats de processus menés par le MPO qui reposent sur la connaissance actuelle de ces espèces, de ces communautés et de ces écosystèmes ». Le présent document contient des cartes de l’emplacement des concentrations importantes de coraux et d’éponges sur la côte est du Canada, lesquelles ont été produites au moyen d’analyses quantitatives des données des relevés au chalut effectués sur un navire scientifique ainsi que d’autres sources de données lorsque cela était possible. Nous avons effectué ces analyses en suivant une approche biorégionale afin de faciliter la modélisation d’espèces similaires étant donné que bon nombre des relevés plurispécifiques ne tiennent pas compte des prises de coraux et d’éponges à l’échelle des espèces. Les taxons analysés sont les éponges (*Porifera*), les grandes et petites gorgones (*Alcyonacea*) et les pennatules (*Pennatulacea*). Nous avons appliqué l’estimation de la densité par la méthode du noyau afin de créer une surface de biomasse modélisée pour chacun de ces taxons, et appliqué une méthode d’expansion aérienne pour déterminer les concentrations importantes en suivant une approche qui a été appliquée pour la première fois en 2010 dans cette région. Nous avons ensuite comparé nos résultats à ceux obtenus précédemment. Selon l’estimation de la densité par la méthode du noyau, seulement les données géoréférencées sur la biomasse sont utilisées pour trouver les « points névralgiques ». Les limites des zones ainsi définies peuvent être affinées à l’aide de la connaissance des captures nulles et des modèles de répartition des espèces qui prévoient la présence ou l’absence ou encore la biomasse des espèces, lesquels tiennent compte des données environnementales. Nous présentons les modèles prédictifs produits à l’aide d’algorithmes d’apprentissage automatique avec forêts d’arbres décisionnels et, dans une région, nous comparons les modèles de forêts d’arbres décisionnels de la biomasse des pennatules à ceux produits à l’aide de modèles additifs généralisés. Ensemble, ces cartes de répartition peuvent être utilisées pour déterminer les concentrations importantes de coraux et d’éponges dans l’est du Canada. Il s’agit d’une première étape essentielle dans la désignation des zones benthiques vulnérables.

INTRODUCTION

Canada has engaged in the identification and protection of sensitive benthic marine ecosystems under two separate, but similar, policies. In international waters (ABNJ), Canada has jurisdiction over the extended continental shelf for attached and sedentary species. Working through the Northwest Atlantic Fisheries Organization (NAFO), Canada has led the science support for the identification of vulnerable marine ecosystems (VMEs), so identified through United Nations General Assembly (UNGA) resolutions following guidance from UN agencies such as the Food and Agricultural Organization (FAO) and to a lesser extent the United Nations Environment Programme (UNEP). This work catalyzed with the passing of the 2006 UNGA resolution 61/105, which under paragraph 83 calls for the identification of VMEs and an assessment of whether bottom fishing activities will negatively influence the long term survival and sustainability of such ecosystems. Domestically, DFO's Policy on Managing the Impacts of Fishing on Sensitive Benthic Areas (SBA Policy) was established in 2009, in response to the same UNGA resolution. Under our domestic policy, areas of ecological or biological significance (EBSAs) are also identified and assessed for their sensitivity to fishing in terms of risk of serious or irreversible harm.

Science support for the two processes has followed similar pathways, with the science further developed in NAFO due to its longer history and the need to report on implementation progress to the UNGA at regular intervals. In NAFO, the approach has been to first identify vulnerable marine ecosystem indicator species or species groups following FAO guidance (FAO, 2009), then to identify significant concentrations (UN language) of those indicators (i.e., VMEs), followed by the adoption of management strategies to protect them (closed areas and encounter protocols), and then to assess the NAFO fisheries for significant adverse impacts on the VMEs. This sequence of activities is laid out in the UNGA 61/105 and has resulted in closures to protect sponge grounds, sea pen fields and corals within the fishing footprint of NAFO, as well as seamounts in the NAFO Regulatory Area (NAFO, 2015). NAFO adopted kernel density analysis (KDE) of research vessel catch data and an associated areal expansion approach (Kenchington et al., 2014) to identify significant concentrations of VME indicators (NAFO, 2014).

During 2010, a Canadian Science Advisory Secretariat (CSAS) meeting was held to identify sensitive benthic areas (corals and sponges) in Canadian waters (DFO, 2010). At that meeting the KDE-based approach used by NAFO was presented (Kenchington et al., 2010) and through that process, and with early support by a segment of the fishing industry, a unique population of glass sponges (*V. pourtalesi*) on the Scotian Shelf was identified. In 2013, two areas were closed to protect those sponges from the harmful effects of fishing and they became the first area closure under the SBA policy. At the CSAS meeting, an alternative approach to identification of sensitive benthic areas was used by scientists in the Pacific Region. There, available data supported Maxent species distribution modelling (SDM) as a useful management tool for identification of the distribution of sensitive benthic taxa. Subsequently, species distribution modelling was explored on the east coast, first with sponge grounds from the Laurentian Channel to the eastern Arctic (Knudby et al., 2013a), and latterly to black corals, sea pens and large gorgonian corals within the NAFO Regulatory Area on Flemish Cap and the Nose and Tail of Grand Bank (Knudby et al., 2013b). The thought was that such models could be used to refine the boundaries of the KDE polygons (VMEs), which do not include any environmental data in their identification. SDMs have the added characteristic in that they can more broadly interpolate and extrapolate predictions to areas not surveyed by the trawls but are within the environmental domain of the occurrence data.

Here, we present an updated KDE analysis for large and small gorgonian corals, sea pens and sponges following Kenchington et al. (2010, 2014) for the east coast of Canada, including new data contributed by the regional research trawl surveys over the past five years (detailed in Kenchington et al., 2016). We then present the results of extensive work completed over the past two years on species distribution modelling (SDM) of those taxa. This later body of work was initiated with a review of data that could be used as predictor environmental variables (e.g., Beazley et al., 2016b). This was done separately for five geographic areas following, where applicable, DFO marine protected area planning boundaries: Maritimes Region, the Gulf Region (Gulf and Quebec DFO administrative regions), Newfoundland and Labrador Region, Hudson Strait and the Eastern Arctic. Within each of those regions SDM models were performed using a non-parametric random forest (RF) model to predict the occurrence of each VME indicator taxon. This approach is superior to Maxent and utilizes verified absence data. The same modelling approach was used in a regression mode to model biomass, and in some cases generalized additive models (GAMs) were performed to compare methods (e.g., Murillo et al., 2016). The results of our review of predictor variables, KDE and SDM work will be published in the Canadian Technical Reports of Fisheries and Aquatic Sciences series, a peer-reviewed open access publication, so that the details and nuances of each analysis can be fully reported. Here, we provide the results of that work and compare KDE with SDM in order to facilitate the delineation of significant benthic areas (referred to hereafter as SBAs) of coral and sponge as well as the mapping of fishing effort as key steps to implementing the Managing the Impacts of Fishing on Sensitive Benthic Areas policy for these species.

MATERIALS AND METHODS

DATA SOURCES

Details of the data sources for all analyses are found in the associated technical reports for each region (Beazley et al., 2016a, b, c; Murillo et al., 2016; Guijarro et al., 2016; Kenchington et al., 2016). DFO research vessel trawl survey data (RV) was used for the KDE analyses and for the response data in the species distribution models. In some regions, data from scientific surveys with underwater cameras and commercial observer data were used to improve SDM performance.

KERNAL DENSITY ESTIMATION

Kernel density estimation (KDE) utilizes spatially explicit data to model the distribution of a variable of interest. It is a simple non-parametric neighbour-based smoothing function that relies on few assumptions about the structure of the observed data (Kenchington et al., 2016). It has been used in ecology to identify hotspots, that is, areas of relatively high biomass/abundance. With respect to marine benthic invertebrate species, it was first applied to the identification of significant aggregations of sponges in the NAFO Regulatory Area in 2009 (Kenchington et al., 2009) and published in the primary literature applied to VME indicators in 2014 (Kenchington et al., 2014).

Evaluation of Optimum Search Radius

Kernel estimators smooth out the contribution of each data point over a specified local neighbourhood. The extent of that contribution is determined by the shape of the kernel function used, and the search radius or bandwidth which acts as a smoothing function. The latter is particularly influential as, if it is too small, then the surface can be under-smoothed creating discontinuities with sharp peaks and troughs and noisy density estimates; if too large it can be over-smoothed, blurring hotspots (Bowman, 1984).

The analysis fits a circle around each data point (here, around each trawl catch position; Figure 1). We used an optimum search radius to define the circle, based on the ArcGIS v. 10 (ESRI, 2011) Spatial Analysis Kernel Density tool's default calculations (note these calculations are different in version 10.2), which is the shortest of the width or height of the data spatial extent (a rectangle encompassing all of the data used in the analysis), divided by 30. The rectangle must be larger than the default radius to ensure that the whole density surface is created. In most cases the width was the shortest extent. In order to reduce arbitrary and suboptimal choices about the amount of smoothing, we applied this commonly used optimal bandwidth. It is designed to minimize the estimated mean square error. However, if the surface was highly discontinuous we increased the search radius above the default value, while if it was continuous but with data spread at low density, we lowered the search radius. Both were done in order to examine the effect of smoothing produced by those changes. We have not explored the use of an adaptive kernel algorithm to compare the effect of the bandwidth (Brunsdon, 1995). In this technique the parameters which control the surface estimation are adjusted over geographic space, allowing for local variations in the density of observations. This approach limits the influence of a single record to a small spatial extent when the density of points is high through the use of a small bandwidth. Conversely, in areas where density is lower, the kernel is geographically larger and the influence of a single data point is greater. This could give a more precise surface for each analysis but would still differ over time as new data are incorporated. Another established method for determining an optimal bandwidth, i.e. cross validation, results in small bandwidths with large sample sizes, and so was not pursued for this application (Bowman, 1984).

Production of the Kernel Density Surface

Once the search radius was established, a curve was fit centered over each data point (biomass of the species of interest in the RV catch) such that the surface value is highest at the location of the point and decreases outwards in all directions to reach zero at the search radius distance to define a circular neighbourhood for each point observation (Figure 2). We used a Gaussian (normal) function in fitting that curve. In this way biomass is predicted for the area covered by the circle. A quadratic kernel density function was then used to fit a smooth curve over each data point in ArcGIS using the UTM projected coordinate system North American Datum 1983 Zone appropriate to each region. This kernel surface sums the values under each Gaussian curve in areas of overlap (Figure 1) to produce a smooth surface (Figure 3).

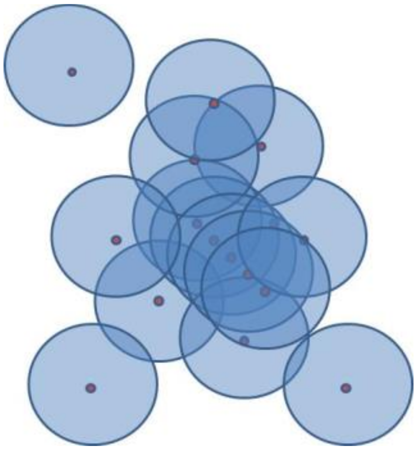


Figure 1. *An illustration of the application of the optimum search radius (blue circles) to hypothetical data points (red closed circles) representing research vessel trawl start of tow locations.*

A grid is placed over the kernel density surface and the value of the kernel surface at its midpoint is extracted. The cell size (resolution) of this grid was also based on the tool's default, which is the shorter of the width or height of the output extent, divided by 250 (see Kenchington et al., 2016 for more details). Each cell kernel value in the grid is the KDE biomass value divided by the search neighbourhood area. If two search circles are used to create the KDE biomass then the divisor is the area of both circles combined. This will standardize the KDE value. The effect of this is to produce lower values where there is less data to support the prediction than when there are multiple intersections. The kernel surface is by default displayed on this gridded surface which is subsequently smoothed using bilinear interpolation (Figure 4) to create a smooth surface from the gridded raster. This final surface was used to identify hotspots in the data so that significant concentrations could be distinguished from the broader distribution of the species. The surface represents relative biomass in that the data were not used as true or actual biomass values. This is because we know that catchability differed among species and that the trawls were not good benthic samplers of these organisms (e.g., Kenchington et al., 2011).

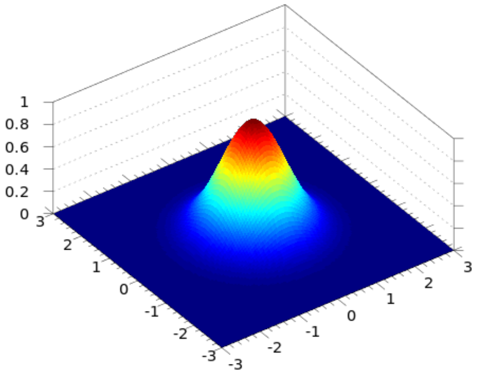


Figure 2. *A Gaussian curve fit in two dimensions (from Wikimedia Commons, the free media repository). When applied in KDE the peak of the curve is centered over the data point and the base of the curve is delineated by the optimum search radius circle.*

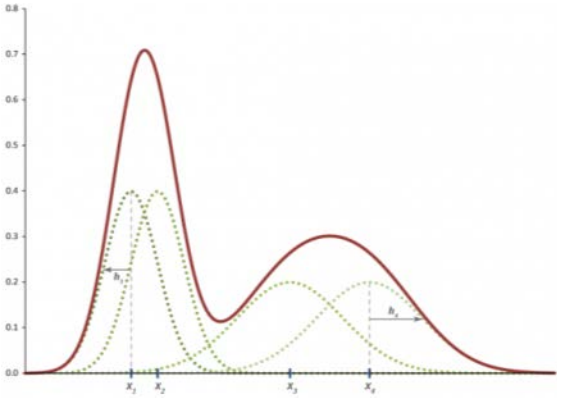
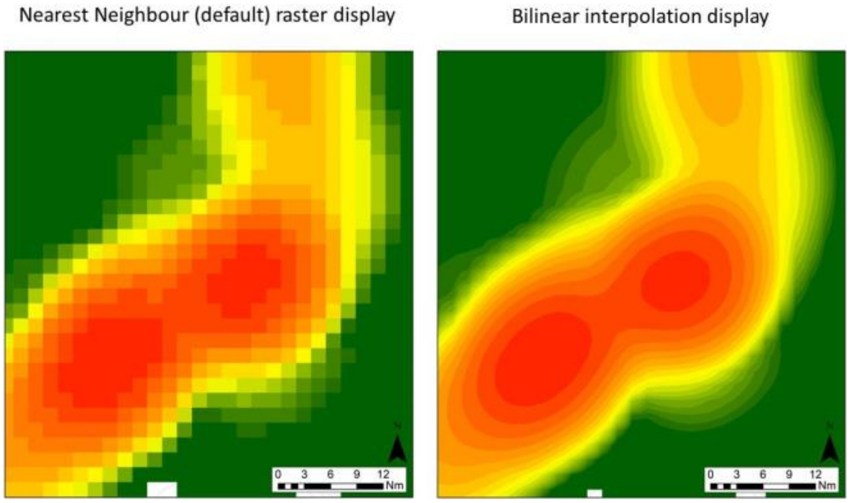


Figure 3. *An illustration of how the kernel surface (red line) is created through summing the values under each curve (dashed green lines) in areas of overlapping search radii. Note that where data are not overlapping such as at the extreme right, the kernel surface takes the form of the underlying Gaussian surface. (Image from open access publication Google Images: Larmarange et al. 2011).*


Nearest Neighbour (default) raster display

Bilinear interpolation display

Figure 4. *An example of how a KDE gridded surface is smoothed using bilinear interpolation.*

Use of KDE Surface to Identify Hotspots

Once the smoothed KDE biomass surface (Figure 4) was produced, contours were placed over its surface. These contours were finely spaced (10^{-4} – 10^{-7} kg intervals) (Figure 5). Each contour line was then converted to a density polygon in ArcGIS. An iterative tool called Density Polygon Dissolver was then applied. This tool selected the contour polygon which most tightly encompassed the subset of points within a given biomass threshold value and outputted the area occupied by the polygon. The full ArcGIS model is presented in Kenchington et al. (2016).

For each benthic taxon, we then produced histograms of the area occupied by successively decreasing biomass values (Figure 6). Typically, for these benthic species that form habitats through dense aggregations, the threshold-area curves initially showed a slow increase in total area as the threshold values decrease. This slow increase in area reflects the fact that the arbitrary thresholds keep “mapping out” the areas that contain the dense aggregations (i.e., better delineating the areas of high density, where density may decrease near their boundaries, while also starting to incorporate smaller new aggregation areas with relatively lower densities). After this initial “phase” of slow increase in area, the threshold-area curves showed a rapid and sharp increase in area as the thresholds keep decreasing; this rapid increase in area is associated with threshold values that are beginning to capture isolated/non-aggregating individuals of the species represented by small catch values in the data. Finally, as the thresholds reached their lowest values, the area covered often stabilizes again, reflecting the entire distribution of the species in the study area. The selection of weight bins does not have a large effect on the results within the dense aggregations. This is because the area can only increase (never decrease) with decreasing weight. For example, placing another weight bin at 190 kg in Figure 6 would mean that the bar would have to fall between the area produced by the 200 and 175 kg bins. Where bin selection does make a difference is in the area of rapid change. For example, placing a bin of 30 kg between 50 and 25 kg in Figure 6 could reduce the degree of change in area depending on where the data fell relative to the bin. This type of fine tuning of the polygon was not pursued given that the original data was not precise to meter accuracy and that the catch could have been taken anywhere along the tow length which was approximately 1 km on average.

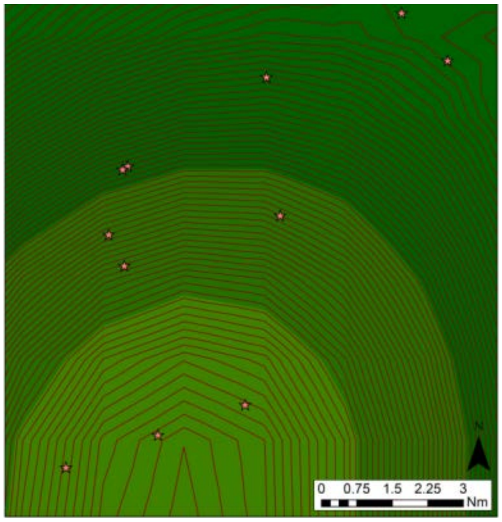


Figure 5. *An illustration of contour lines fitted to the KDE surface. Stars represent original data points.*

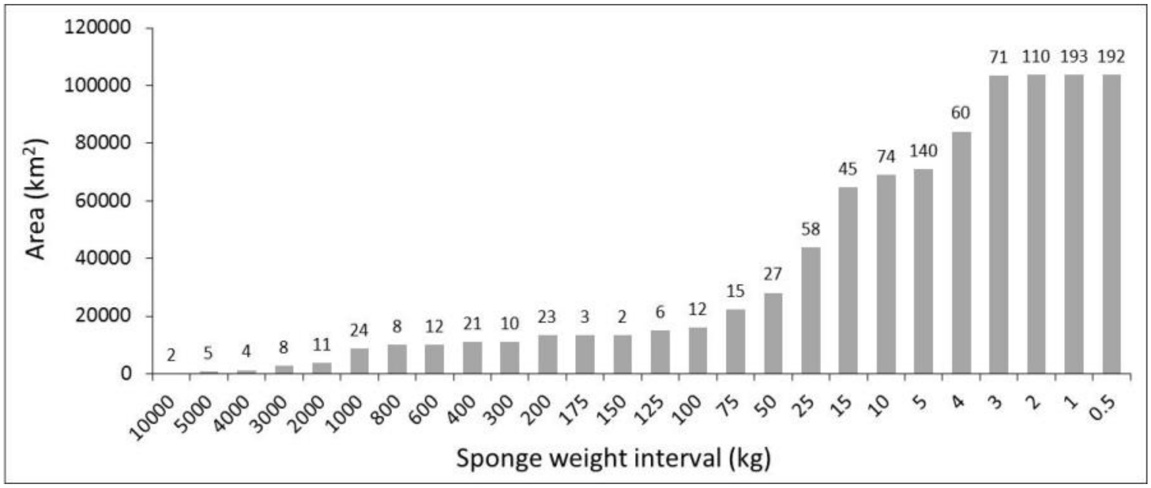


Figure 6. *The area occupied by successive weight thresholds of sponges. The numbers of additional data points contributing to each weight bin are displayed above the bars on the histogram.*

Consequently, when interpreting the catch weight defining the significant concentrations a number of criteria were *simultaneously* considered:

1. identification of the catch biomass which showed the largest change in area after the initial establishment of the aggregations;
2. consideration of the number of data points contributing to those changes in area between successive catch thresholds;
3. examination of the spatial relationship of the polygons created by biomass thresholds greater and lesser than the potential threshold using geographic information systems (GIS); and
4. the position of the new data points relative to previously established polygons.

These two last criteria were the spatial component to criterion 2 and are necessary as polygon area can increase by the joining of two or more high density polygons. If this occurs the evidence for connecting the areas (i.e., number of points between the smaller areas) was reviewed. In this instance the threshold was considered to be valid when there was an increase in area through a reasonable number of widely spaced data points. Cases for rejecting the threshold other than insufficient data included:

1. joining of smaller polygons with little evidence for a continuous distribution within the newly formed area;
2. a gradual increase in area with every new polygon added, creating a situation where no one successive change in area was especially larger or smaller than others (this indicated that there was no aggregation);
3. an increase in area established by creation of new areas of very low density; and
4. no large increase in area.

This decision framework was followed herein and results from two independent reviewers were compared. These proved to be identical with only a few cases requiring joint discussion to achieve consensus.

Polygons Delineating Significant Concentrations

Using KDE as described above, areas with significant biomass concentrations of the target species groups were identified. Within these polygons all of the catches above the delimiting threshold were included, but the areas also contained smaller catches. This is expected as those could represent recruitment, different species compositions or areas thinned by bottom contact fishing gears. Consequently, the conservation unit (i.e. SBA) is the polygon area rather than the individual research vessel tows. In some cases, particularly where there are single tows forming a KDE-derived polygon, the surrounding areas can be examined using the null data which is not used in KDE to see whether the single tow was isolated.

RANDOM FOREST MODELLING

Random forest (RF; Breiman, 2001), is a non-parametric machine learning technique, where multiple regression or classification trees (usually $\geq$ 500) are built using random subsets of the data (Figure 7). Each tree is fit to a bootstrap sample of the biological observations (i.e. the ‘in-bag’ observations), and the best split at each node is selected based on a randomly-chosen subset of predictor variables. Regression trees are used for response variables consisting of continuous data and classification trees for factor variables. RF is a robust statistical method requiring no distributional assumptions on covariate relation to the response in comparison to other classical statistical models such as generalized linear models (GLM) or generalized additive models (GAM). It can handle a large amount of input variables effectively without variable deletion (Chen and Ishwaran, 2012) and can also account for correlation as well as interactions among variables.

For classification with presence-absence response data, random forest can be used to predict the probability of a species’ presence in non-sampled areas by identifying areas with similar environmental conditions. In the case of regression using biomass response data, random forest can predict the species’ biomass distribution. The models were built in the statistical computing software package R (R Core Team, 2015) using the ‘randomForest’ package (Liaw and Wiener, 2002). Default values were used for RF parameters, and 500 trees were constructed.

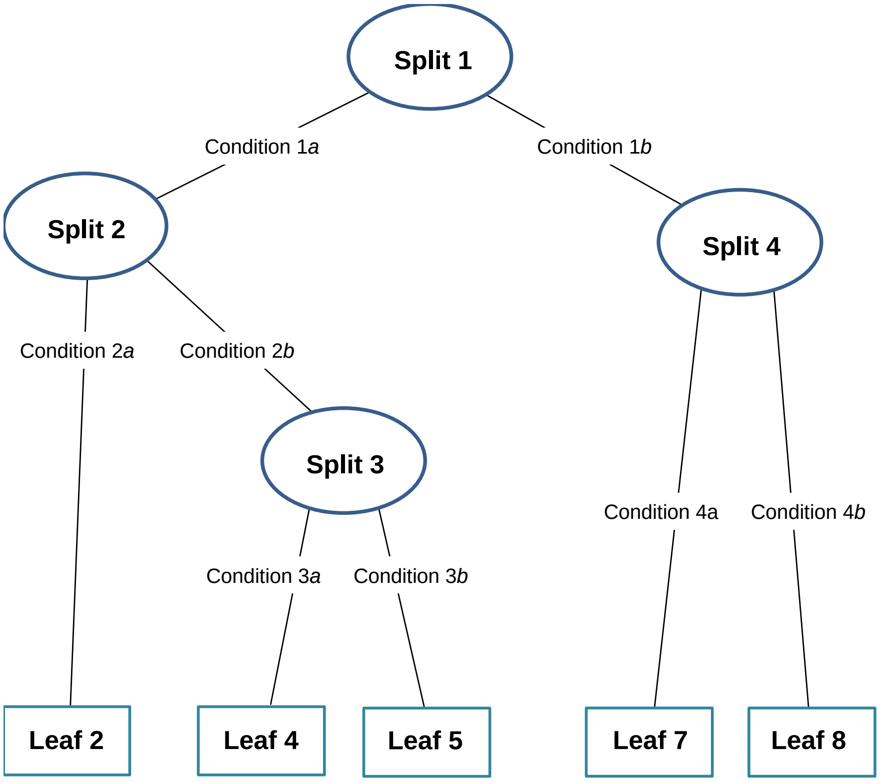


Figure 7. *An example of a regression model tree (modified from Kuhn and Johnson, 2013).*

Model Evaluation

Presence-Absence Response Data – Classification Model

The catch records for some taxonomic groups are characterized by a higher number of absences relative to presences (i.e. unbalanced species prevalence). Classification accuracy in random forest is prone to bias when the categorical response variable is highly imbalanced (Chen et al., 2004). This is due to over-representation of the majority class in the bootstrap sample leading to a higher frequency in which the majority class is drawn, therefore skewing predictions in that favour (Evans et al., 2011). Several different approaches have been used to address imbalanced data:

1. assign a high cost to misclassification of the minority class,
2. down-sample the majority class, and
3. up-sample the minority class (Evans et al., 2011).

Although several studies suggest a balanced modelling prevalence of 0.5 (McPherson et al., 2004; Liu et al., 2005), this approach may result in a loss of information particularly for rare species, and may not be necessary when the model training data is reliable and not biased spatially and/or environmentally (Jiménez-Valverde and Lobo, 2006). Another widely-used approach is to adjust the threshold used to divide the probabilistic predictions of occurrence into discrete predictions of presence or absence, to match modelling prevalence (Liu et al., 2005). The latter approach has been shown to produce constant error rates and optimal model accuracy measures compared to balancing modelling prevalence (Liu et al., 2005; Hanberry and He, 2013).

For each taxonomic group we assessed the number of presences and absences and their spatial distribution across the study area. We employed two different modelling methods. The first method was to model the response data with a balanced species prevalence and threshold of 0.5. In these instances, the majority class was randomly down-sampled to give an equal number of presences and absences prior to modelling. In the second method we used all presence and absence records and used species prevalence as the threshold. The appropriateness of each modelling approach on the response data was assessed based on the model accuracy measures (see explanation below of model accuracy measures) and the spatial pattern of the predictions of presence probability in relation to the response data.

Accuracy measures were obtained using 10-fold cross validation (10 resamples over which performance estimates were obtained). In 10-fold cross validation the response data are randomly split into 10 equal-sized groups and the model is trained on a combination of 9, while validated on the remaining group.

Three measures of accuracy were used to assess model performance:

1. sensitivity,
2. specificity, and
3. area under the receiver operating characteristic curve (AUC).

In a classification model with two classes (e.g. presence and absence), there are four possible predicted outcomes:

1. true positive, where observed presences are predicted as presences,
2. false negative, where observed presences are predicted as absences,
3. true negative, where observed absences are predicted as absences, and
4. false positive, where observed absences are predicted as presences (Fawcett, 2006).

Sensitivity measures the proportion of observed presences correctly predicted as presence (i.e. the true positive rate) (McPherson et al., 2004; Fawcett, 2006). Low sensitivity indicates high omission error (i.e. false negative rate). Specificity measures the proportion of observed absences correctly predicted as absence (i.e. the true negative rate). Low specificity indicates high commission error (i.e. the false positive rate). Both sensitivity and specificity are derived from a two-by-two confusion matrix of the tabulated predicted outcomes.

The AUC is a threshold-independent measure of model accuracy that is calculated from the combination of true positive rate (sensitivity) and false positive rate (1 – specificity), and equals the probability that the model will rank a randomly-chosen presence instance higher than a randomly-chosen absence instance (Fawcett, 2006). Its value ranges from 0 to 1, with values larger than 0.5 indicating performance better than random. It was calculated using 10-fold cross validation.

For models generated using a balanced species prevalence and threshold of 0.5, 10 data subsets were created with an equal number of presences and absences (balanced data) and 10 models were run. AUC was determined by averaging AUC values between folds within each run. The model with the highest average AUC was considered the most accurate in predicting the validated data and was used as the final model in which predicted presence probabilities of the response data were generated. The predicted outcomes from the two-by-two confusion matrices were summed across all 10 folds to give a complete confusion matrix for each model from which sensitivity and specificity were calculated. For models generated using all presence and absence data and a threshold equal to species prevalence, only one model was considered and the AUC was determined by averaging AUC values between folds. The predicted outcomes from the two-by-two confusion matrices were summed across all 10 folds to give one confusion matrix from which sensitivity and specificity were calculated.

Biomass Response Data – Regression Model

Regression random forest models were validated using 10-fold cross validation. Data were split using the createFolds function in R. This function performs stratified partitioning into k groups in order to evenly distribute the biomass within splits. Models were built using each calibrated and validated dataset and accuracy measures were calculated for each corresponding dataset. The accuracy measures used to validate the models included the goodness-of-fit statistic R^2, the Root-Mean-Square Error (RMSE) value and the percentage of variance explained. RMSE was normalized to a percentage of the range of observed biomass values ($y_{\max} – y_{\min}$) for each specific response (NRMSE) to facilitate the comparison between responses in the different models. The correlation between biomass and presence probability for some of the groups was also evaluated. Cross validation gives an average of the accuracy measures used, but can also be used to estimate the variability around the mean to evaluate the stability of the model fit, and to check for the arbitrary effects from subsampling data for calibrate and validate the model.

Model Extrapolation

In some regions, the modelling boundary extends far beyond the spatial extent of the training data. For instance, in the Maritimes Region data observations are limited to depths above ~2900m (multispecies trawl observations are limited to depths of 1850m and shallower). Extrapolation of model predictions to areas outside of the range of data observations may produce unreliable predictions in those areas (Elith et al., 2010). Random forest models average the decision across regression trees to predict piecewise constant functions, giving a constant value for inputs falling under each leaf. When extrapolating outside the domain of the training data, where different physical conditions from those used to train the model likely exist, random forest models predict the same value as they would for the closest value in the tree for which they had training data (Breiman et al., 1984). For each random forest model, we highlight those areas within the study extent where model predictions are extrapolated. We define areas of extrapolation as those areas where at least one environmental variable has values above or below its sampled range.

Ecological Interpretation

Ecological interpretation of the models was aided by predictor variable importance measures and partial dependence plots. In classification random forest, variable importance is measured as the mean decrease in Gini value, otherwise known as Gini impurity. When the response data are split into two child nodes based on a randomly-chosen variable, the data in the two descendent nodes are more homogeneous than that of the parent node. This difference in homogeneity between parent and child nodes is measured by the Gini index, where the increase in homogeneity equals a decrease in Gini value. The sum of all decreases in Gini index for each variable in each tree is averaged across all trees in the model ‘forest’ and then across all 10 repetitions of each model fold. The variable with the highest mean decrease in Gini value is considered the most important variable in the model. Variable importance in regression random forest is measured by the mean decrease in the residual sum of squares when the variable is included in a tree split.

Partial dependence plots using the partialPlot function in R were generated for the 6 highest variable importance scores. Partial dependence plots show the relationship between a particular predictor variable and log-transformed predicted probabilities of presence (for classification models) or the biomass regression function (for regression models),while the other predictor variables were held constant at their mean observed value and are useful in showing general trends in model accuracy's dependence on the predictors (Herrick et al., 2013). For classification models, the y axis ranges from $-\infty$ to ∞ and quantifies the log-odds of a positive classification for the total range of values in x. Log-odds are logarithmic transformations of the probabilities for values in x (Hastie et al., 2005). These values were transformed to the original presence probability scale using p = exp(y) / (1 + exp(y)), where p = the probability of presence, and y is the log-odds of presence, the standard output from the partialPlot function.

GENERALIZED ADDITIVE MODELS (GAMS)

A generalized additive model (GAM) (Hastie and Tibshirani, 1986) is a generalized linear model in which the linear predictor involves the sum of unknown smooth functions of some predictor variables. In general the model has a structure such as:

$$g(E(Y)) = \beta_0 + f_1(x_{1i}) + f_2(x_{2i}) + ...+ f_m(x_m)$$

where an exponential family distribution is specified for Y along with a link function g. The functions $f_{j}(x_{j})$ are smooth functions that can be specified by non-parametric means. The model allows for somewhat flexible specification of the dependence of the response on the covariates. This flexibility provides potential for better fits to data than purely parametric models.

The mgcv package in R (Wood, 2006) was used to construct GAM models to predict the biomass of some of the taxa considered in order to compare with the RF models. The top ten and top fifteen most important environmental variables obtained from the RF model based on biomass were used as covariates in these models as well as the environmental variables correlated less than 0.7. This differed slightly for the Maritimes and Newfoundland and Labrador Regions (Beazley et al., 2016a; Guijarro et al., 2016), where a natural break in the Mean Decrease in Sum of Squares was also used to select the environmental variables for GAM modelling. The autocorrelation of residuals was studied for the best of these models and in the case where it was significant latitude and longitude were included in the best model as a tensor product (i.e. te(lat, long)). The full model followed the formula:

y =s(var.1)+s(var.2)+…+s(var.n) +te(lat,long)

where *y* was specified as a Tweedie distribution and *s* indicated a thin plate regression spline smoothing function. In addition, for the Maritimes and Newfoundland and Labrador Regions, (see Beazley et al., 2016a; Guijarro et al., 2016), shrinkage smoothers (Zuur et al., 2009; Marra and Wood, 2011) were evaluated. A Tweedie model is an expansion of compound Poisson model derived from the stochastic process where the weight of the counted objects has a gamma distribution. This model has the advantage of handling the zero-catch data in a unified way and the statistical performance seems to be rather better than that of a Delta lognormal model (Shono, 2008). Tweedie factor was estimated inside the model. GAM models were run on some of the biomass data sets for comparison with RF regression models.

GAM Evaluation

Residual plots to evaluate the fitness of the model can be generated with the function gam.check of the mgcv package. However, an artifact of the link function shows exact zeros as a band along the residuals vs. linear predictor plot, making it difficult to see whether residuals show heteroskedasticity. In order to avoid this issue randomized quantile residuals (Dunn and Smyth, 1996) were generated using the rqgam.check function of the dsm package in R (Miller et al., 2015). Randomized quantile residuals transform the residuals to be exactly normally distributed making the residuals vs. linear predictor plot much easier to interpret as it does not include the artifacts generated by the link function.

The goodness-of-fit statistic R^2 and the percentage of variance explained were used to evaluate the performance of the models as well as the prediction map derivate of the model in comparison to the real data.

RESULTS

MARITIMES REGION

Sponges (Porifera)

The kernel density analysis identified high biomass areas across the spatial extent of the region (Figures 8 and 9). The SBAs identified in the present analysis are similar to those previously identified (Kenchington et al., 2010), despite the addition of nearly 3x the number of presence records over those available for the previous analysis (Kenchington et al., 2016).

The presence probability RF prediction surface of sponges is presented in Figure 10 with the KDE-derived polygons superimposed. This model performed well, with a cross-validated AUC of 0.760 ± 0.005 (Table 1). Of all 66 environmental predictor variables used in the model, Maximum Average Summer Mixed Layer Depth was the top environmental predictor variable in this model. Pockets of high presence probability were distributed across the study area, but several areas had notably high presence probability: Smokey and St. Anns Banks off northeastern Nova Scotia (Cape Breton), Misaine Bank, and the Bay of Fundy off Digby and Brier Island. The latter two areas corresponded to the location of the additional sponge records from the DFO scallop stock assessment surveys in SPA 3 and 4 (Beazley et al., 2016a). Other areas of high presence probability corresponded well with the occurrence of presence points at those locations. Interestingly, the area southwest of Nova Scotia where no data records occurred due to hard bottom had a moderate to high presence probability of sponges.

The accuracy measures of the regression random forest model on mean sponge biomass from DFO multispecies trawl surveys were poor ($R^2 \leq 0.1$ and/or negative percent variance explained), therefore the predicted biomass surface from this model was not presented here. The highest R^2 was 0.459, while the average and standard deviation (SD) was 0.130 ± 0.138 (Beazley et al., 2016a). The high SD indicates high variability between model folds. The average Normalized Root-Mean-Square Error (NRMSE) was 0.030 ± 0.013 SD. The highest percentage variance explained was 8.51%; however, half of the model folds had a negative variance explained, indicating poor predictive performance of the model.

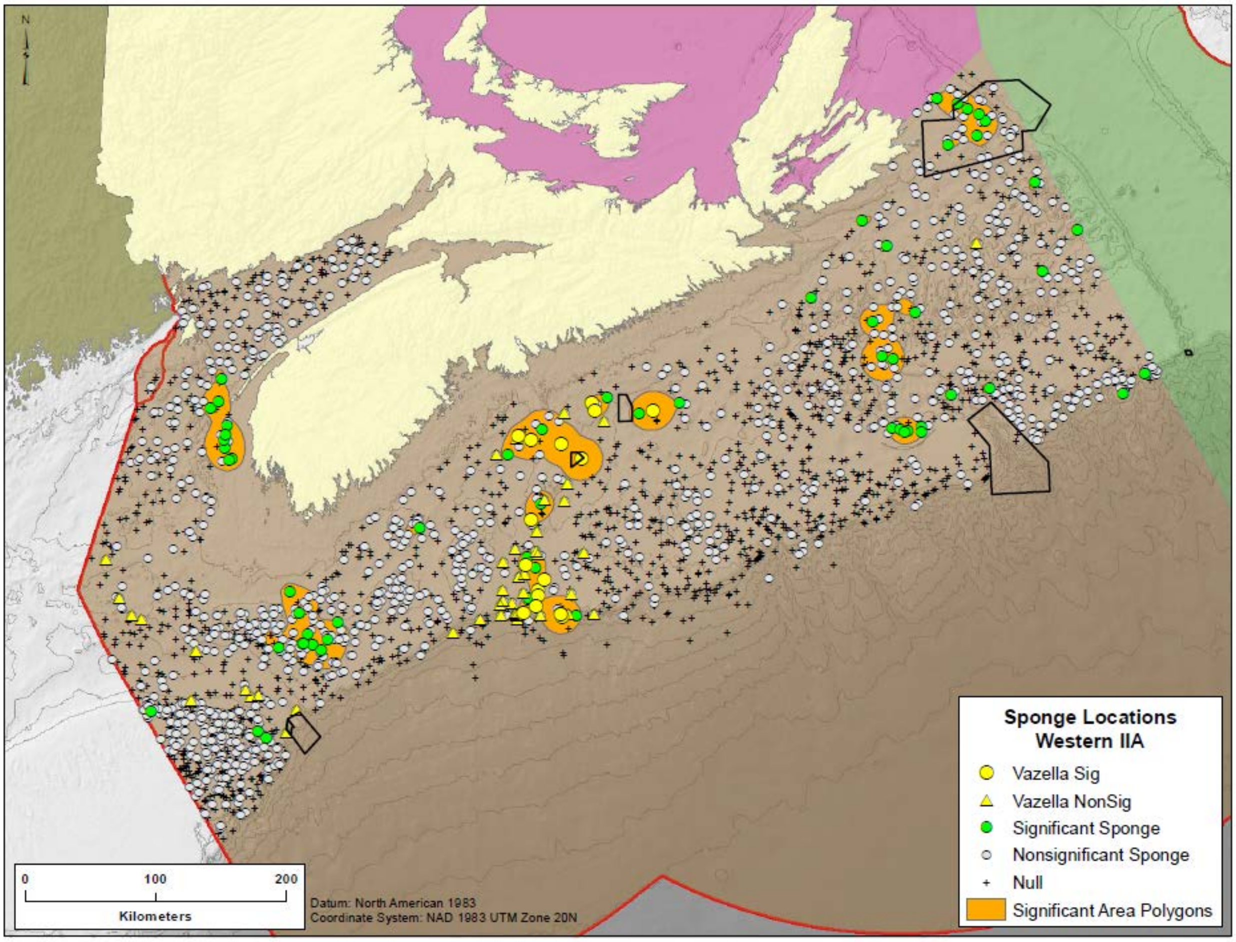


Figure 8. *Location of the KDE-derived polygons identifying significant sponge aggregations relative to the broader distribution of sponges and areas closed or proposed to be closed to protect benthic species and habitats in the Scotian Shelf Biogeographic Zone (black outline). Vazella pourtalesi is identified separately from Porifera in the VDC database and catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. Only trawl surveys conducted with Western IIA trawls were used in the analysis. Red lines indicate the exclusive economic zone (EEZ) of Canada.*

Vazella pourtalesi

Most sponges were not identified to species level on the DFO trawl surveys. This was because their identification required microscopic examination of their spicules. However, *V. pourtalesi* is a large, distinctive sponge and it has been separately recorded from Porifera in the Maritimes Region (Beazley et al., 2016a). We performed SDM on this species, separately from that of Porifera, in which it was included (Figure 11).

Given the low number of presence records of this unique population of *V. pourtalesi*, the DFO multispecies trawl survey data were augmented with presence records from all available data sources, including scientific surveys and commercial observer data (Beazley et al., 2016a). The combined dataset, consisting of 166 presences and 1983 absences, was modelled using an unbalanced design and a threshold equal to species prevalence (0.08) (Figure 11).

The cross-validated AUC was very high at 0.977 ± 0.013 SD (Table 2). Class error for the presence and absence classes was low. Sensitivity and specificity measures were both high, all indicating very good model performance. Bottom Salinity Average Maximum was the most important variable, followed by Bottom Salinity Mean and Bottom Temperature Average Minimum. This is consistent with the sponges being located in Emerald Basin, a warmer and saltier area of the Scotian Shelf.

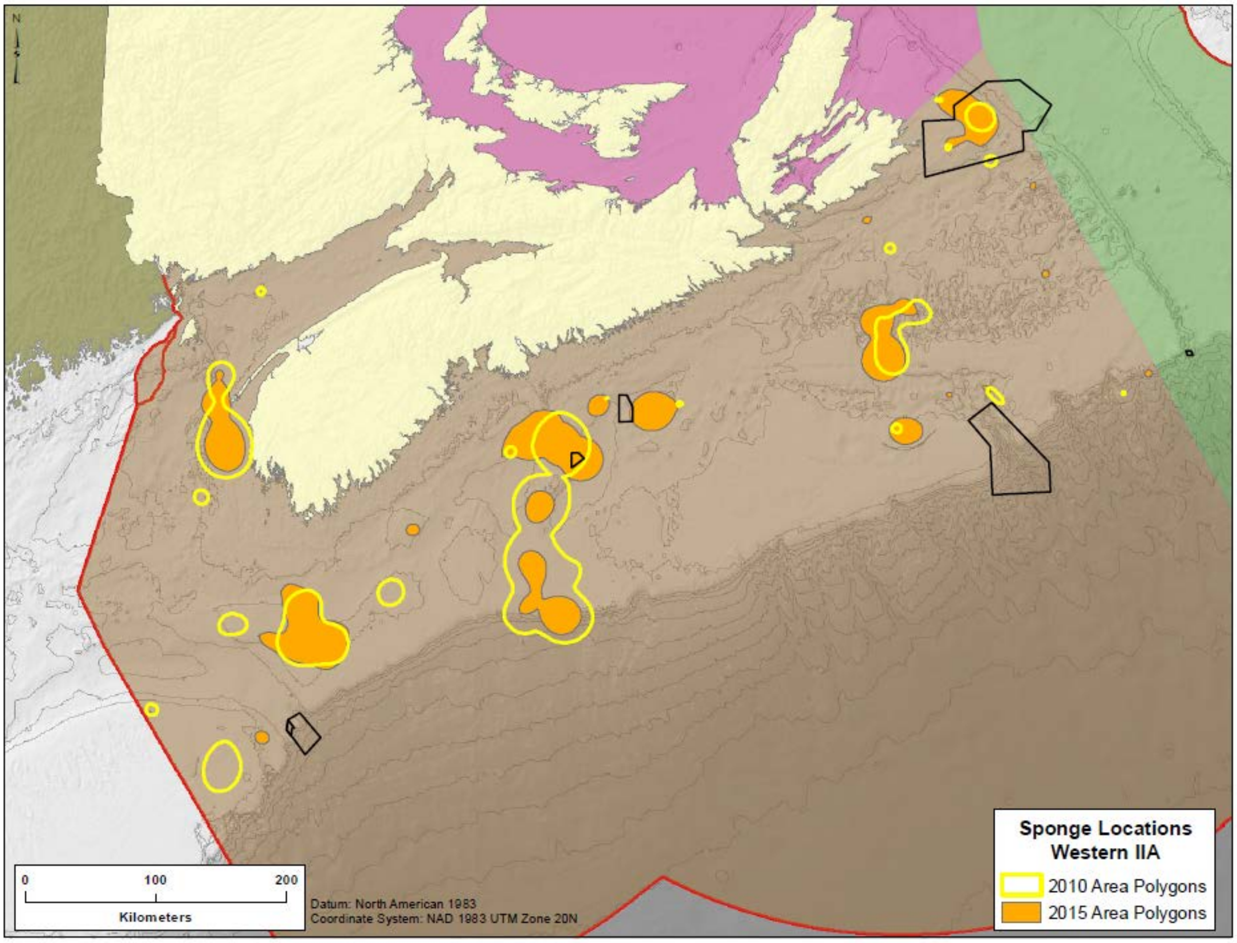


Figure 9. *Comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (gold/orange polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZ of Canada.*

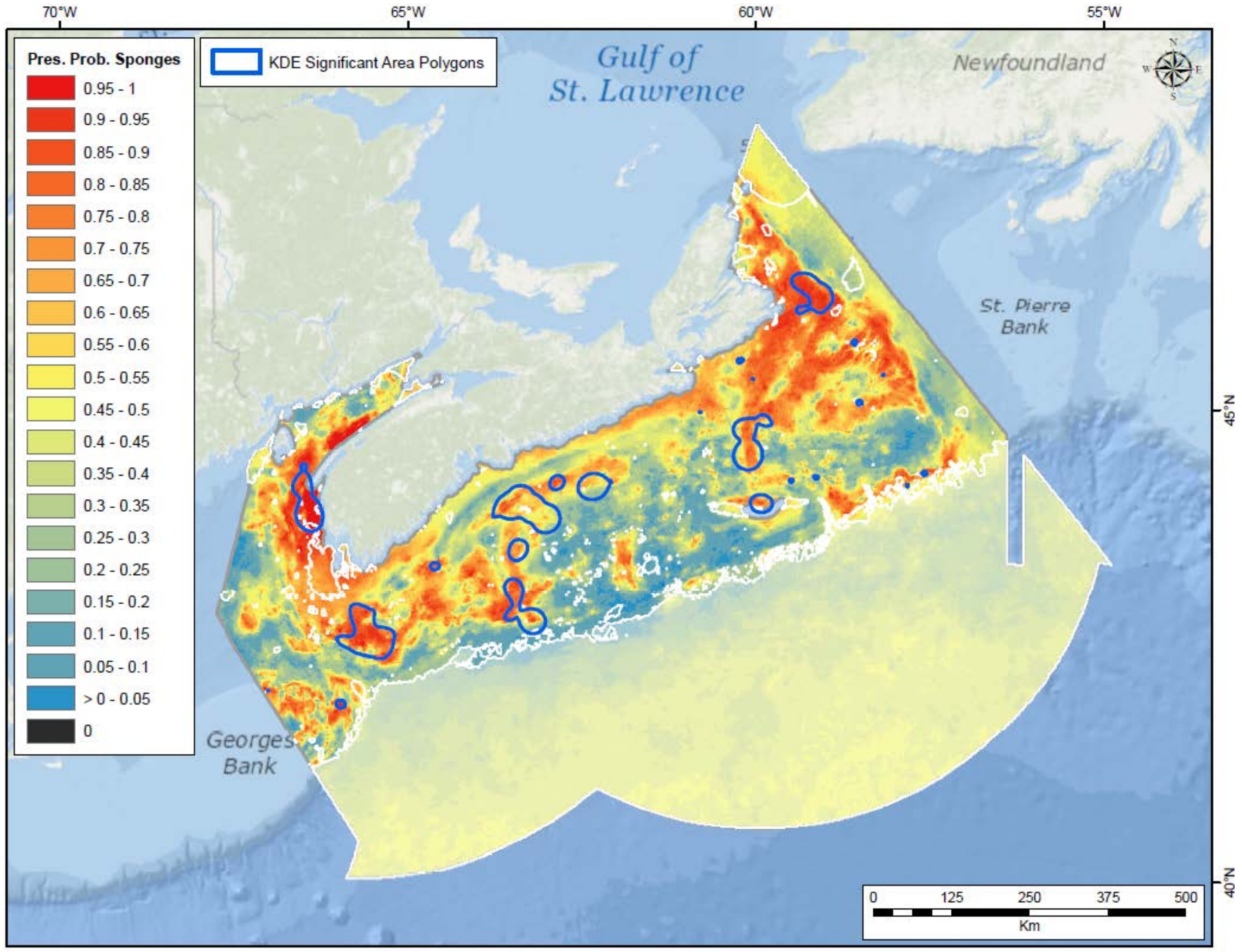


Figure 10. *Predictions of presence probability (Pres. Prob.) from the optimal RF model of sponge presence and absence data collected from DFO multispecies trawl and scallop stock assessment surveys between 1997 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE are shown in blue outline.*

Table 1. *Accuracy measures and confusion matrix from 10-fold cross validation for the RF model with the highest AUC value (Model Run 1) based on presence and absence of sponges from DFO multispecies trawl survey records collected within the Maritimes Region.*

Model Run	AUC	Sensitivity	Specificity
1	0.766	0.689	0.708
Mean	0.760	0.691	0.702
SD	0.005	0.005	0.007

Confusion Matrix of Model with Highest AUC:

Observations	Predictions		Total n	Class error
	Absence	**Presence**		
Absence	1003	414	1417	0.292
Presence	441	976	1417	0.311

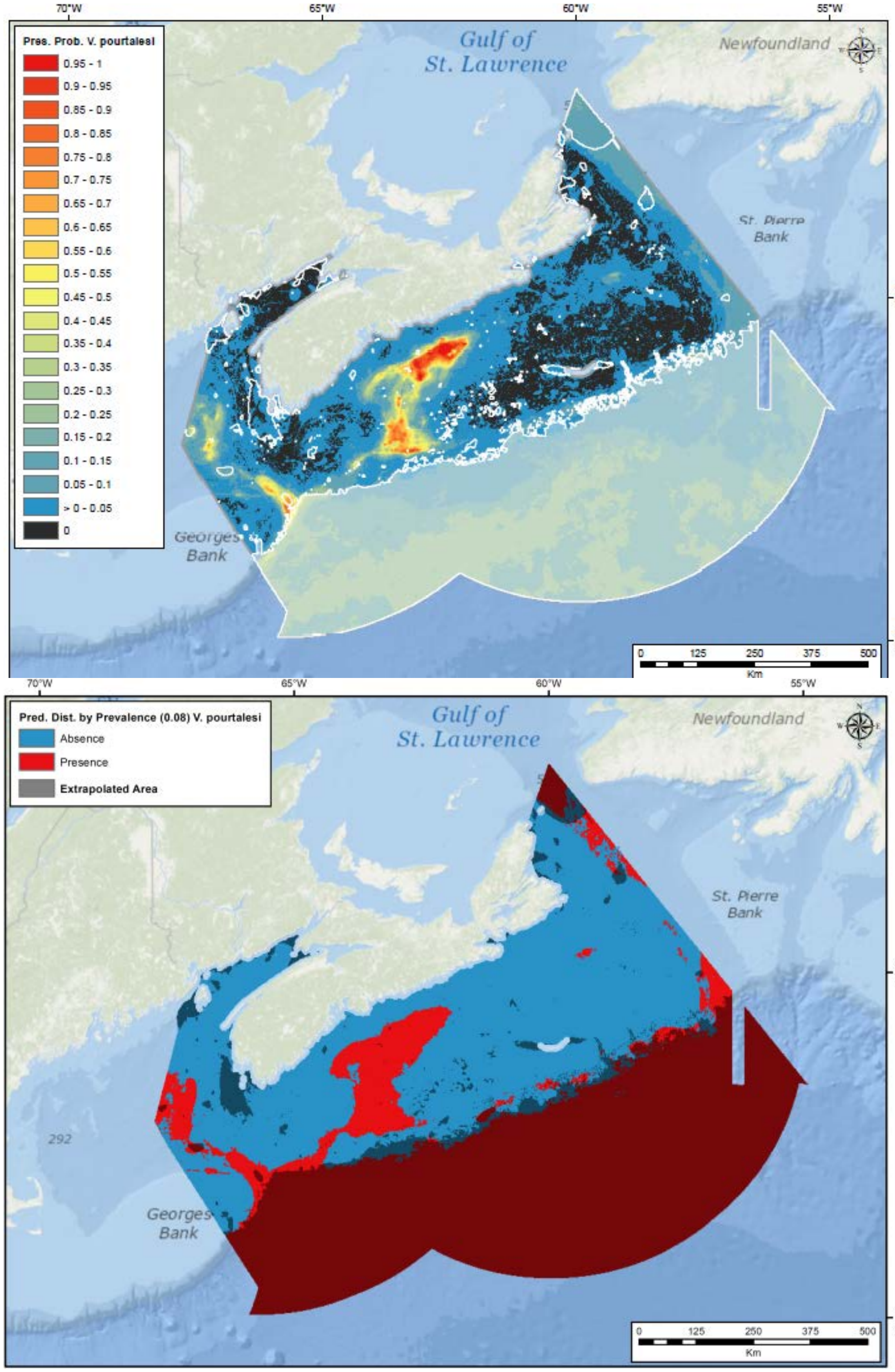


Figure 11. *(upper panel) Predictions of presence probability (Pres. Prob.) of Vazella pourtalesi based on a RF model on unbalanced presence and absence V. pourtalesi catch data collected from DFO trawl surveys between 2007 and 2015. White lines indicate areas of extrapolation. (lower panel) Classification of V. pourtalesi presence probability based on the prevalence threshold of 0.08 is shown. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

Table 2. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of V. pourtalesi from DFO trawl surveys, the Fisheries Observer Program, and in situ benthic imagery observations. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.977	**Absence**	1811	172	1983	0.087	0.952	0.913
SD	0.013	**Presence**	8	158	166	0.048		

The accuracy measures of the regression RF model on mean *V. pourtalesi* biomass were poor ($R^2 \leq 0.1$ and/or negative percent variance explained), and therefore the predicted biomass surface is not presented here. The highest R^2 value was 0.207, while the average was 0.087 ± 0.079 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.024 ± 0.021 SD. The high SD values for both of these metrics indicate high variability between model folds. The highest percent variance explained was 1.16%. The majority of the model folds had a negative variance explained, indicating poor predictive performance of the model.

Sea Pens (Pennatulacea)

In our KDE analyses, there were 129 records with sea pen catch and 2245 records of catches with no sea pens from the same surveys. In contrast there were only 46 records available for the previous analysis (Kenchington et al., 2010). The updated analysis identified new sea pen fields, and expanded the location of others identified previously, particularly in the St. Ann's Bank Proposed Closure (Figures 12 and 13).

The RF model using sea pen records from both DFO trawl surveys and *in situ* camera observations, and unbalanced species prevalence was selected as the best predictor of sea pen distribution in the Maritimes Region (Beazley et al., 2016a). This model performed excellently with a cross-validated AUC of 0.901 ± 0.031 SD (Table 3). The top environmental predictor variable was Depth. Figure 14 shows the predicted presence probability surface with the KDE-derived polygons superimposed. This model predicted high presence probability of sea pens in the Laurentian Channel and along the Scotian Slope and in several deep-water canyons in the study area. Most KDE-derived polygons overlapped with areas of moderate to high presence probability.

The accuracy measures of the regression RF model on mean sea pen biomass from DFO multispecies trawl surveys indicated that the model performed well. The highest R^2 value was 0.815, while the average was 0.518 ± 0.301 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.018 ± 0.018 SD. The high SD indicated high variability between model folds. This model explained a relatively high percentage of variance in the biomass data (average = 18.41% ± 2.48 SD). Bottom Salinity Average Range was the most important variable in the model (Beazley et al., 2016a). The model predicted the highest biomass along the Laurentian Channel (Figure 15). The KDE analyses for this area coincide with this location (Figure 42).

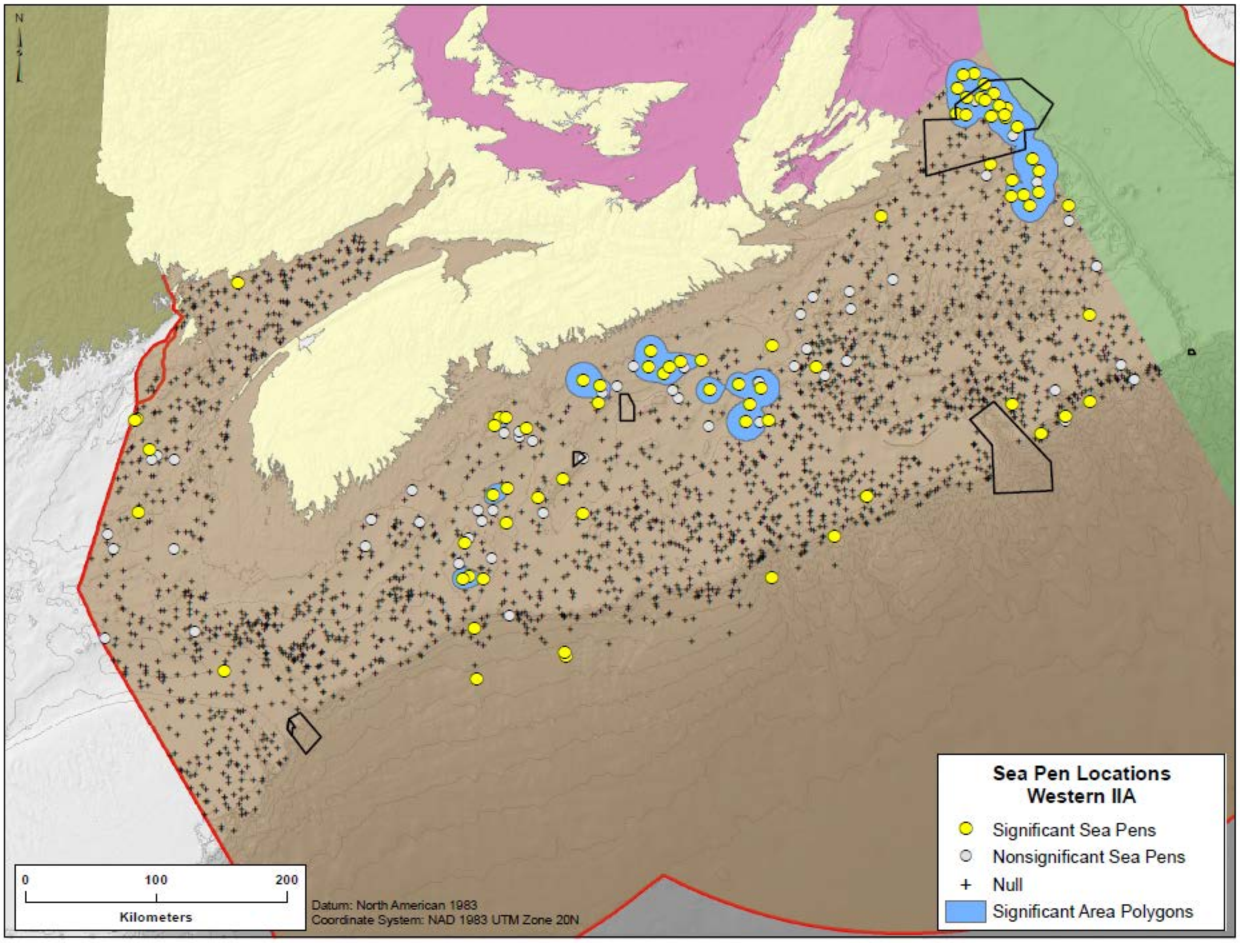


Figure 12. *Location of the polygons (blue) identifying significant sea pen aggregations relative to the broader distribution of sea pens and areas closed or proposed to be closed to protect benthic species and habitats (black outline). Catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. Red lines indicate the EEZ of Canada.*

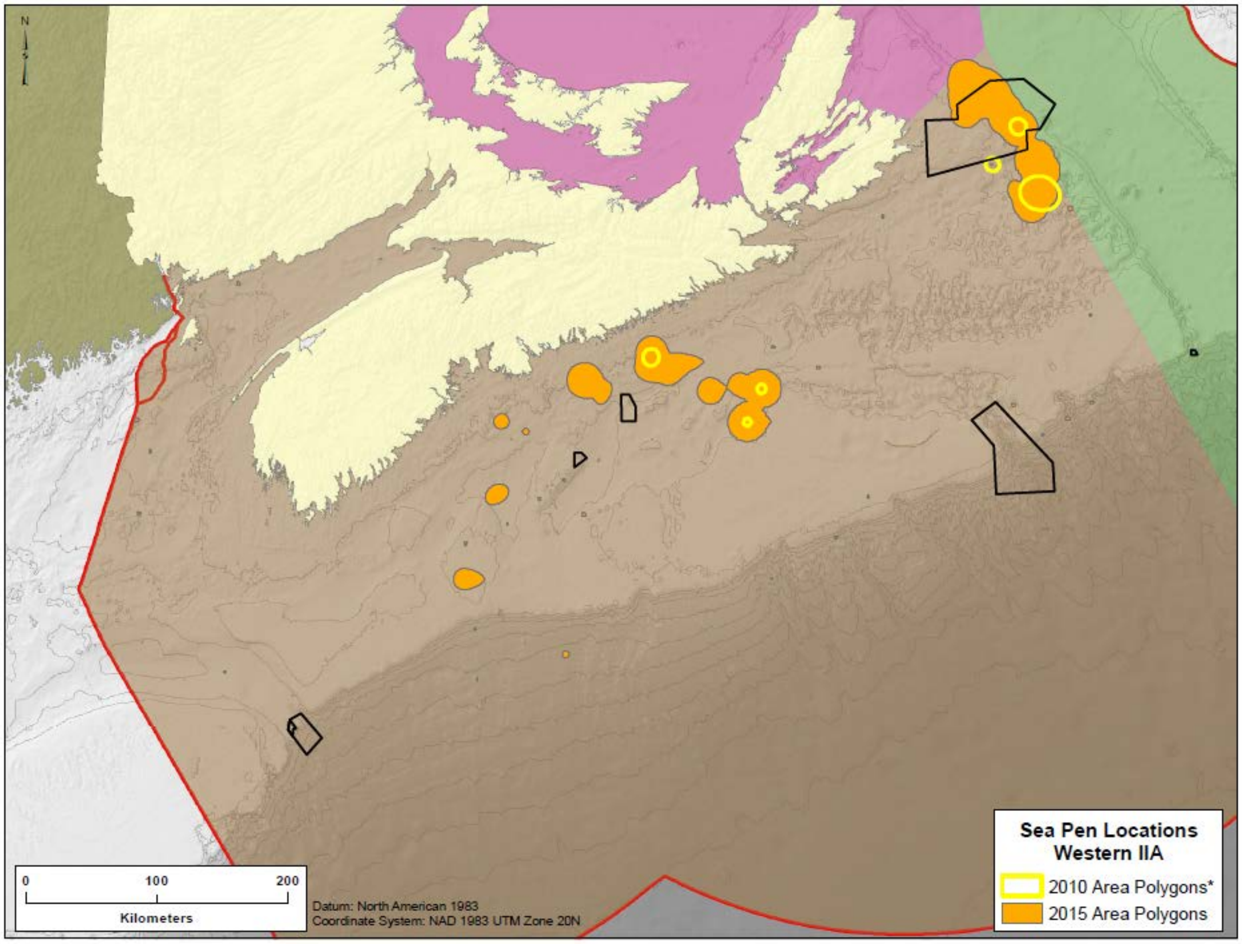


Figure 13. *Comparison of the location of the significant concentrations of sea pens identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (gold/orange polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZ of Canada.*

Table 3. *Accuracy measures for 10-fold cross validation of a random forest model of presence and absence of sea pens from DFO multispecies trawl survey records and in situ benthic imagery observations. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.901	**Absence**	2219	489	2708	0.181	0.813	0.819
SD	0.031	**Presence**	65	283	348	0.187		

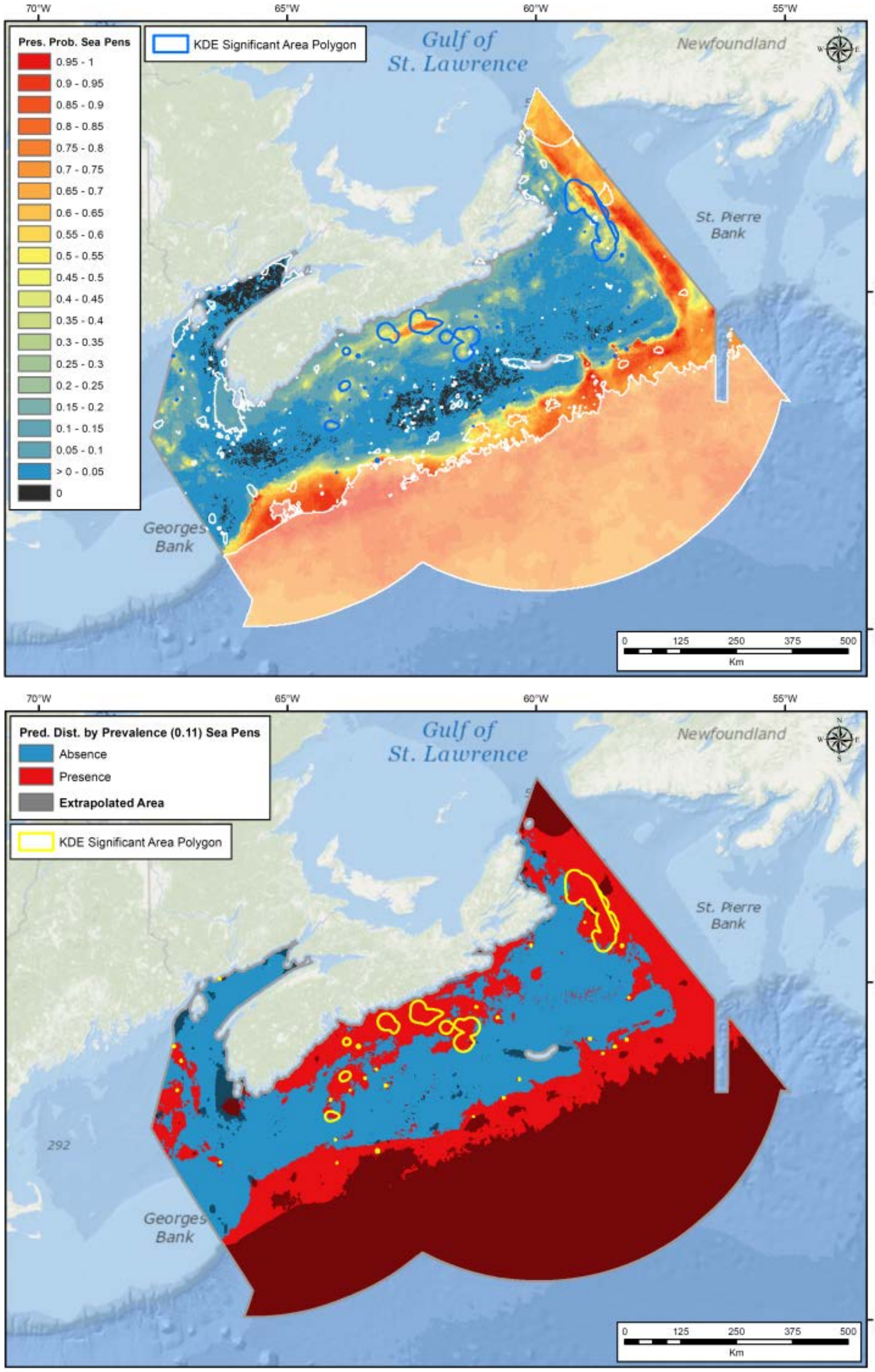


Figure 14. *(upper panel) Predictions of presence probability (Pres. Prob.) of sea pens based on a RF model on unbalanced presence and absence sea pen catch data from DFO multispecies trawl surveys and in situ benthic imagery observations of sea pens. White lines indicate areas of extrapolation. (lower panel) Binary classification of sea pen presence probability based on the prevalence threshold of 0.11 is shown. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface.*

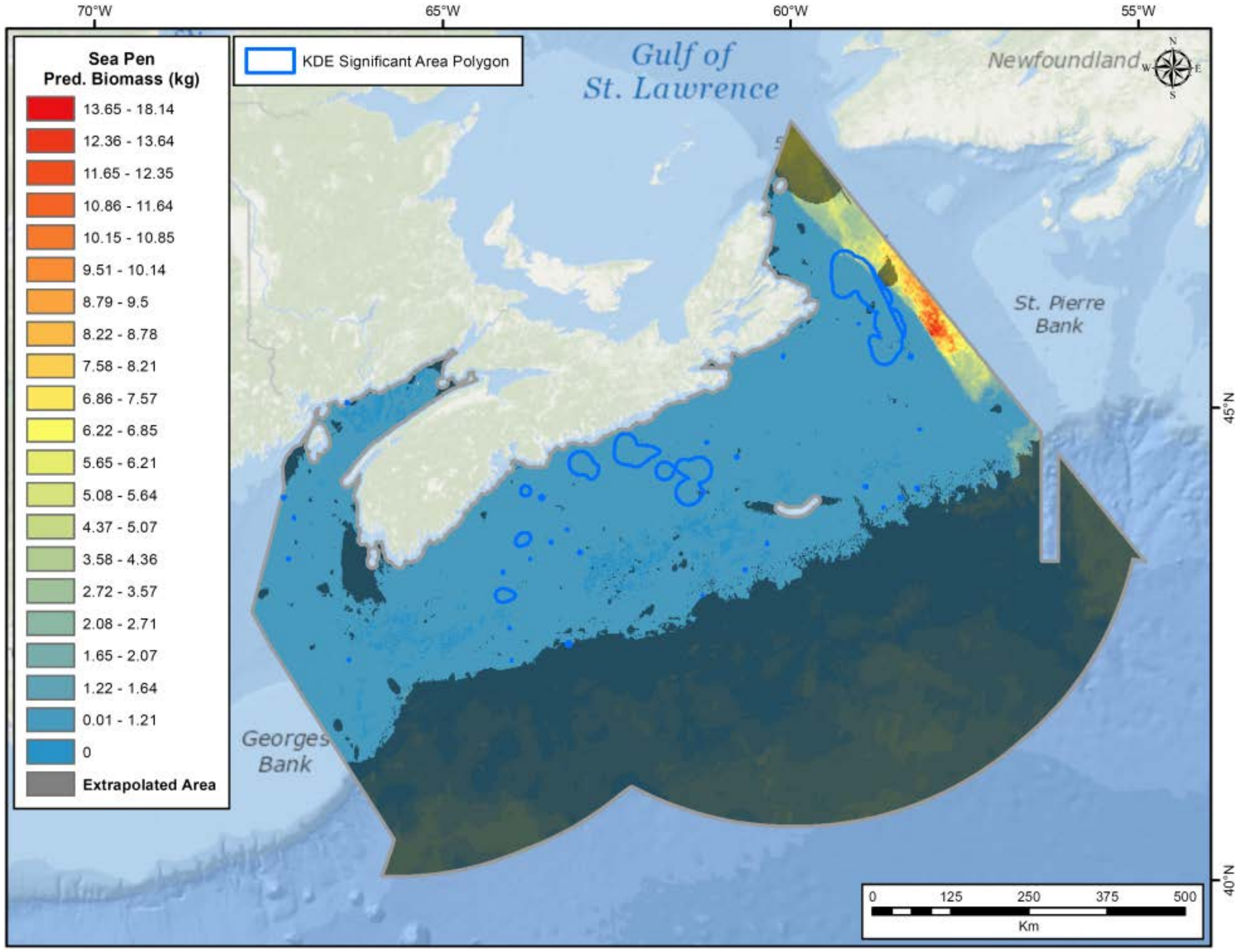


Figure 15. *Predictions of biomass (kg) of sea pens from catch data recorded in DFO multispecies trawl surveys conducted in the Maritimes Region between 2002 and 2014. Grey areas indicate areas of extrapolation.*

Large Gorgonian Corals

The research trawl surveys did not sample the large gorgonian corals very well. This was due to a number of factors, including avoidance. Significant concentrations were identified on the eastern Scotian Shelf Slope (Figures 16 and 17) as in 2010. However, known locations, such as the coral conservation areas and the Gully MPA, were not sampled. In this case the SDM can be very useful in complementing the KDE work (Figure 18). The RF models which included data from DFO multispecies trawl surveys as well as DFO and NRCan *in situ* camera observations, performed excellently (Table 4) and the probability of occurrence maps showed these corals concentrated along the continental slopes in the Northeast Channel, the Gully MPA and the Stone Fence (Figure 18). The most important environmental predictor variable for the classification of the large gorgonian coral presence and absence data was Slope (Beazley et al., 2016a).

The accuracy measures of the regression random forest model on mean large gorgonian coral biomass from DFO multispecies trawl surveys indicated that the model performed reasonably well. The highest R^2 value was 0.975, while the average was 0.285 ± 0.410 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.016 ± 0.016 SD (Beazley et al., 2016a). The high SD of these metrics indicated high variability between model folds. This model explained a relatively high percentage of variance in the biomass data (average = 24.53% ± 7.08 SD).

Figure 19 shows the predicted biomass surface of large gorgonian corals. The majority of the spatial extent was predicted to have low (0 – 2.19 kg) large gorgonian biomass. The slope between Haldimand Canyon and Stone Fence had the highest predicted biomass up to 34.72 kg. Several canyons that intersect the eastern Scotian Slope, such as The Gully and Shortland Canyon, and the Northeast Channel on the western Scotian Slope, were predicted to have a moderate to high biomass. Like the classification model, Slope was the top predictor in the regression random forest model on the large gorgonian coral biomass data.

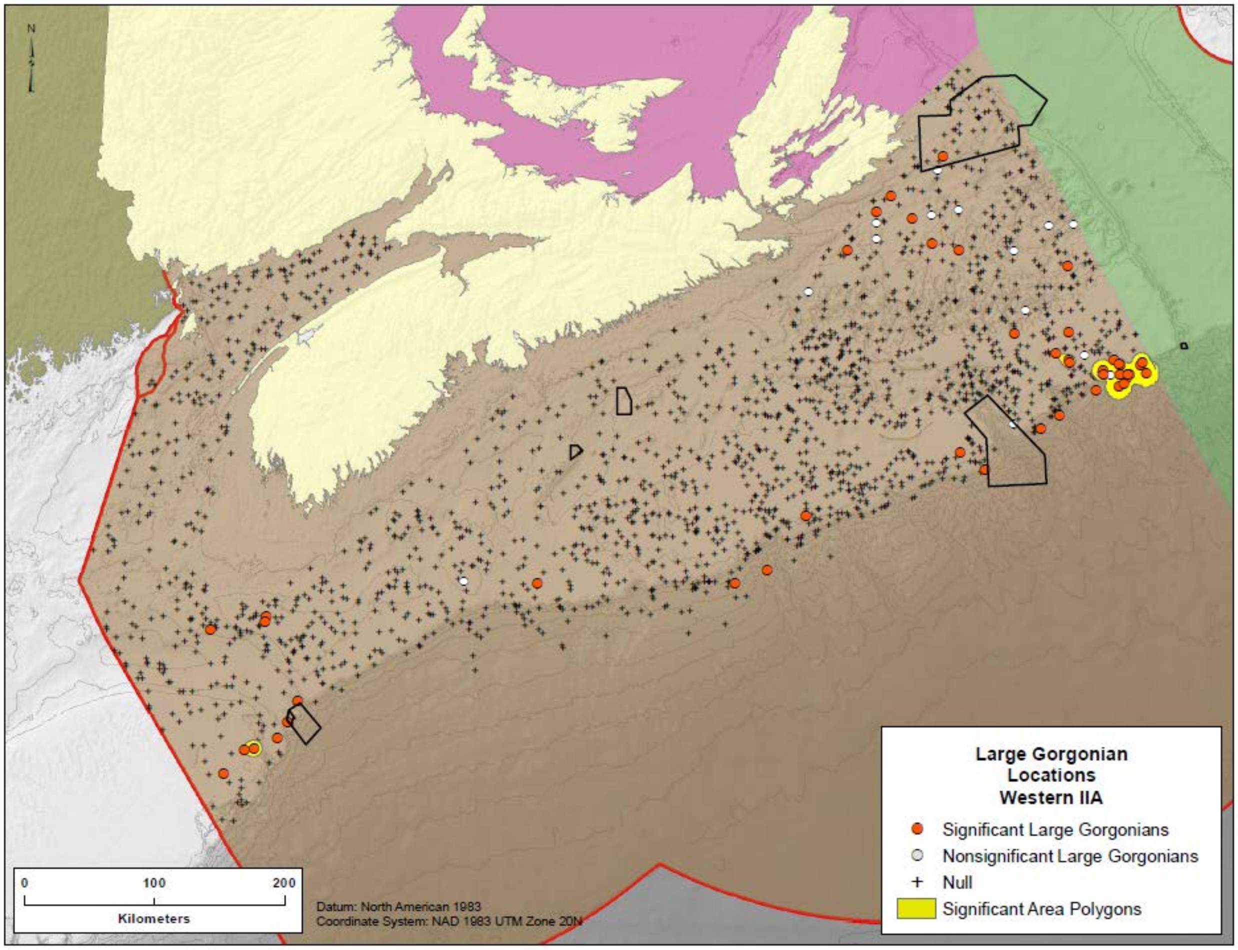


Figure 16. *Location of the polygons (yellow) identifying significant large gorgonian coral aggregations relative to the broader distribution of large gorgonian corals and areas closed or proposed to be closed to protect benthic species and habitats (black outline). Catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. Red lines indicate the EEZ of Canada.*

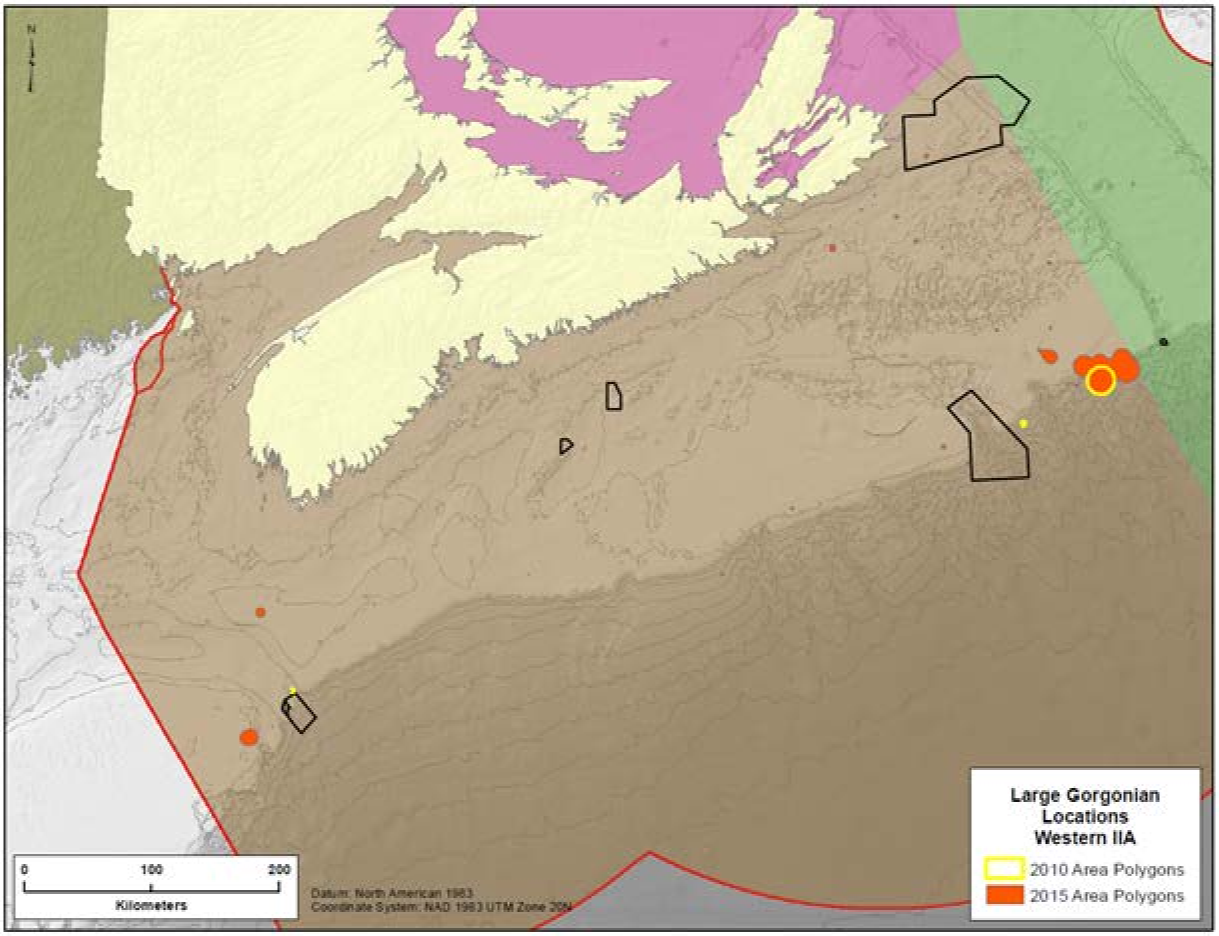


Figure 17. *Comparison of the location of the significant concentrations of large gorgonian corals identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (red polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZ of Canada.*

Table 4. *Accuracy measures for 10-fold cross validation of a random forest model of presence and absence of large gorgonian corals from DFO multispecies trawl survey records and in situ benthic imagery observations collected within the Maritimes Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	AUC	Observ.	Predictions		Total n	Class Error	Sensit.	Specif.
			Absence	**Presence**				
Mean	0.928	**Absence**	2063	250	2313	0.108	0.833	0.892
SD	0.033	**Presence**	38	189	227	0.167		

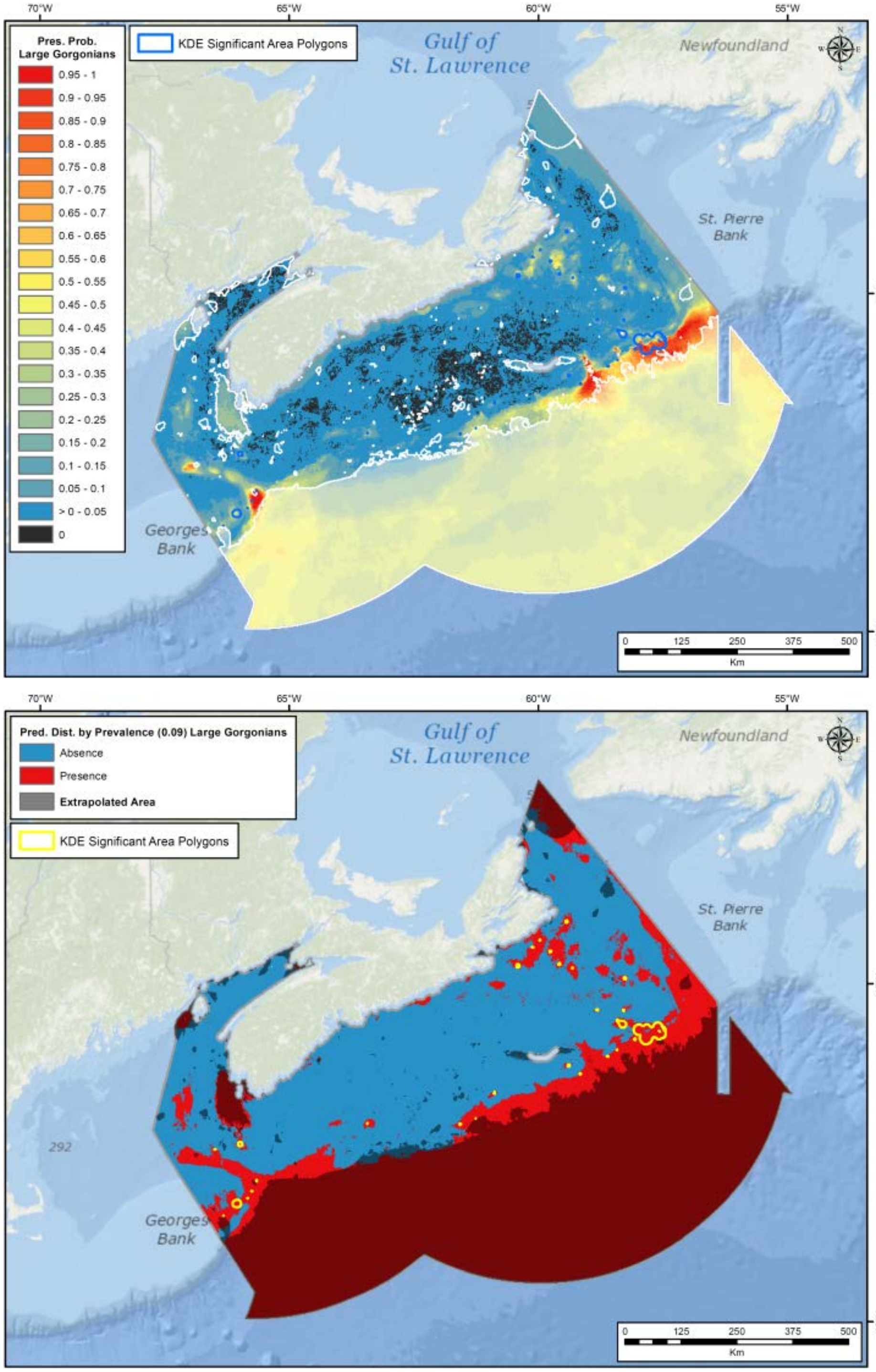


Figure 18. *(upper panel) Predictions of presence probability (Pres. Prob.) of large gorgonian corals based on a RF model on unbalanced presence and absence large gorgonian coral catch data from DFO multispecies trawl surveys and in situ benthic imagery observations of large gorgonian corals. White lines indicate areas of extrapolation.(lower panel) Classification of large gorgonian corals presence probability based on the prevalence threshold of 0.09 is shown. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface. The KDE-derived significant concentrations are shown in yellow outline.*

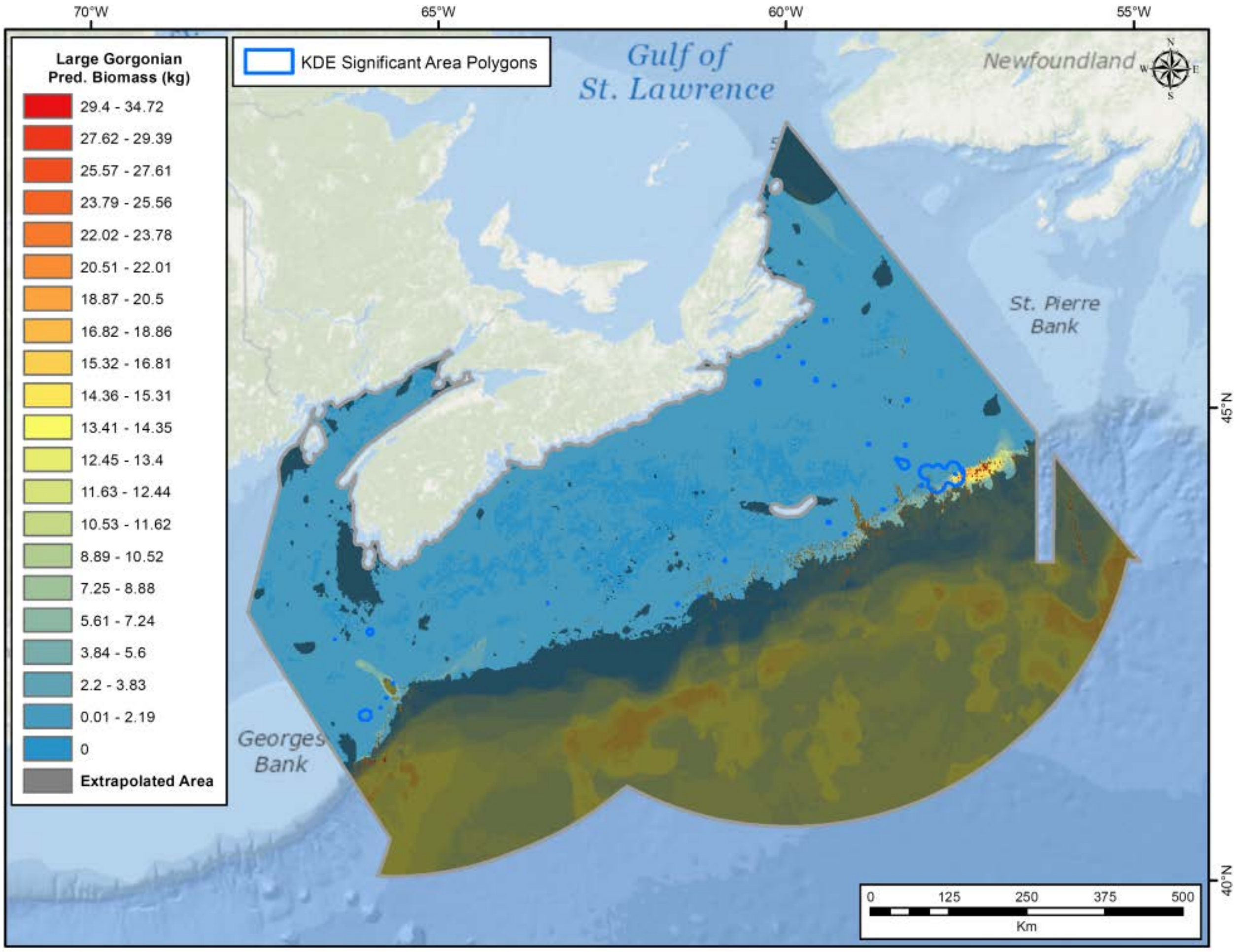


Figure 19. *Predictions of biomass (kg) of large gorgonian corals from catch data recorded in DFO multispecies trawl surveys conducted in the Maritimes Region between 2002 and 2015. Grey areas indicate areas of extrapolation. KDE-derived significant concentrations are shown in blue outline.*

Small Gorgonian Corals

In Maritimes Region there were too few records to apply KDE to the small gorgonian corals and so that analysis was omitted. The RF model using small gorgonian records from both DFO trawl surveys and *in situ* camera observations, and unbalanced species prevalence was selected as the best predictor of small gorgonian coral distribution in the Maritimes Region (Figure 20). This model performed excellently, with a cross-validated AUC of 0.949 ± 0.033 SD (Table 5). The most important environmental predictor variable for the classification of the small gorgonian coral presence and absence data was Depth. This was followed more distantly by Slope and Bottom Salinity Average Range (Beazley et al., 2016a).

The accuracy measures of the regression random forest model on mean small gorgonian coral biomass from DFO multispecies trawl surveys were poor ($R^2 \leq 0.1$ and/or negative percent variance explained), therefore the predicted biomass surface was not presented here. The highest R^2 value of this model was 0.423, while the average was 0.135 ± 0.155 SD. The average Normalized Root-Mean-Square Error (RMSE) was 0.027 ± 0.019 SD (Beazley et al., 2016a). The percent variance explained for each fold was negative, indicating that the model had no predictive power.

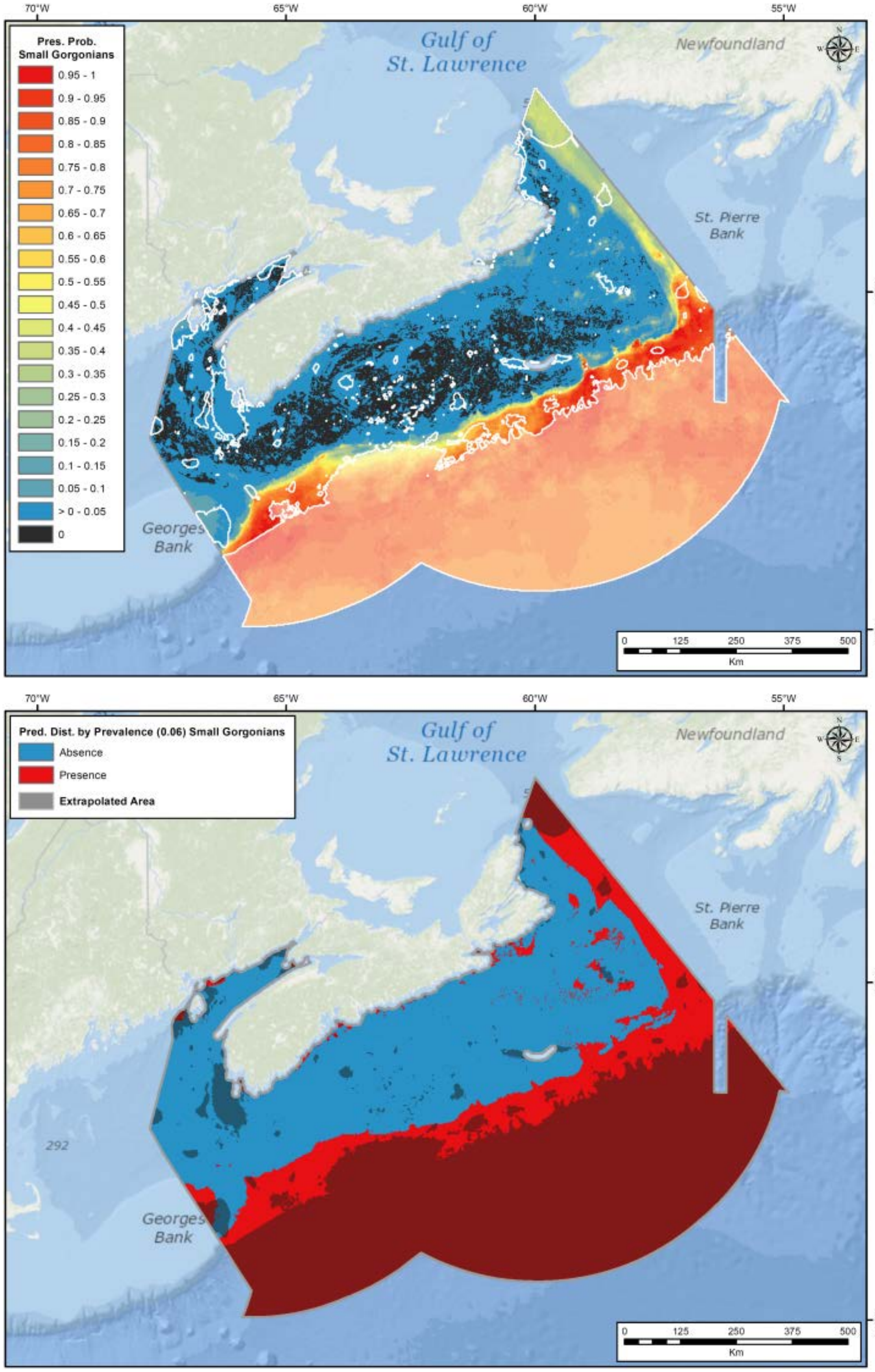


Figure 20. *(upper panel) Predictions of presence probability (Pres. Prob.) of small gorgonian corals based on a RF model on unbalanced presence and absence gorgonian catch data from DFO multispecies trawl surveys and in situ benthic imagery observations. (lower panel) Prediction of presence and absence probability using the prevalence threshold of 0.06 is shown. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface.*

Table 5. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of small gorgonian corals from DFO multispecies trawl survey records and in situ benthic imagery observations collected within the Maritimes Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.949	**Absence**	1662	153	1815	0.084	0.876	0.916
SD	0.033	**Presence**	15	106	121	0.124		

GULF OF ST. LAWRENCE

The Gulf of St. Lawrence Biogeographic Unit was used for the KDE analysis and the DFO MPA Network Planning Area for the Estuary and Gulf of St. Lawrence for the SDM. The DFO MPA Network Planning Area combines two of DFO's six administrative regions across Canada, the Gulf Region in the southern portion, and the Quebec Region to the north.

Southern Portion of the Gulf Biogeographic Zone

Sponges (Porifera)

The kernel density analysis identified high biomass areas across the spatial extent of the region (Figures 21 and 22). The areas identified in the present analysis were smaller than those previously identified (Kenchington et al., 2010), despite the addition of nearly 3x the number of presence records over those available for the previous analysis (Kenchington et al., 2016). The reasons for this are not clear. In part, this could be due to the use of the optimal search radius of 12.7 km in the current analysis, as opposed to the 25 km fixed search radius used in the previous analyses. However, this was not seen with the sea pens (see below) that had a smaller search radius as well (15.8 km). We suspect that the data distribution (referred to as the population density) is the reason for this difference. The distribution of the data influences the kernel surface and the additional data likely had more impact on the broadly distributed sponges than it did on the more concentrated sea pens. Also, the result may represent real degradation. It had previously been shown that in the southern portion of the Gulf Biogeographic Zone, the sponge biomass had been reduced between the periods 1990-2002 and 2003-2009 (Figure 90 in Kenchington et al., 2016; Kenchington et al., 2010). We conducted a comparative analysis of the sponge biomass data from 2009-2014, to assess further loss of sponges that could be responsible for the reduction of area in the significant polygons. We noticed that the loss of sponges over the Magdalene Shallows has continued to occur, but with a lesser difference than was observed between 1990-2002 and 2003-2009 (Kenchington et al., 2016).

For sponges, the AUC computed from 10-fold cross validation was moderate (0.708; Table 6). Class error for presence and absence classes was high. The presence probability RF prediction surface is presented in Figure 23 with the KDE polygons overlain. Of all 78 environmental predictor variables used in the model, Depth was the most important for classification of the presence-absence data. Most of the southern portion of the Gulf of St. Lawrence was predicted to have high presence probability.

The accuracy measures of the regression random forest model on mean sponge biomass from DFO multispecies trawl surveys were poor ($R^2 \leq 0.1$ and/or negative percent variance explained), therefore the predicted biomass surface is not presented here. The highest R^2 was 0.066 ± 0.130 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.073, while the average was 0.017 ± 0.021 SD (Murillo et al., 2016). The high standard deviation for both of these metrics indicated high variability between model folds.

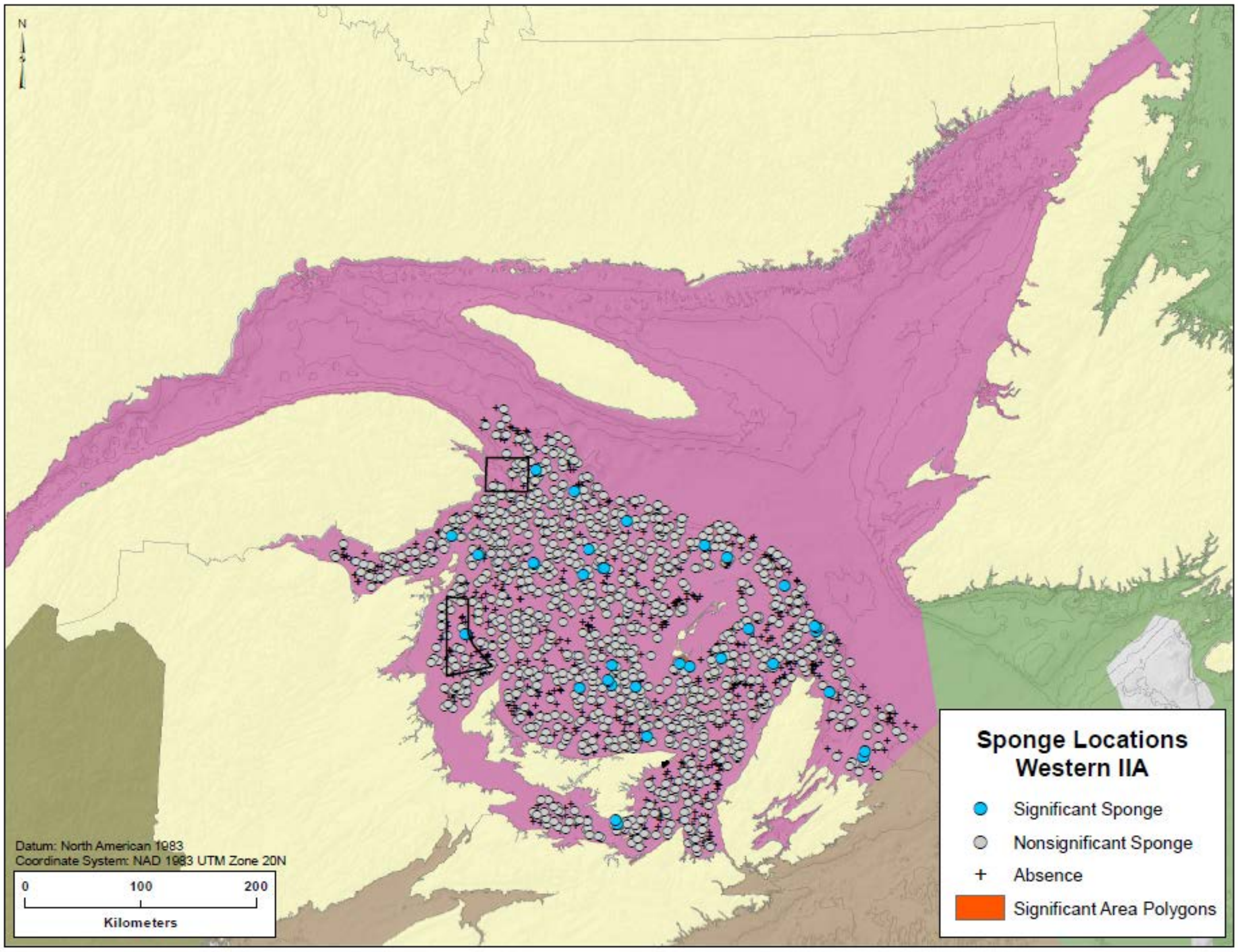


Figure 21. *Locations of the significant sponge catches relative to the broader distribution of sponges in the southern portion of the Gulf Biogeographic Zone. Catch locations that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. The polygons are very small and not visible in this map. Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline.*

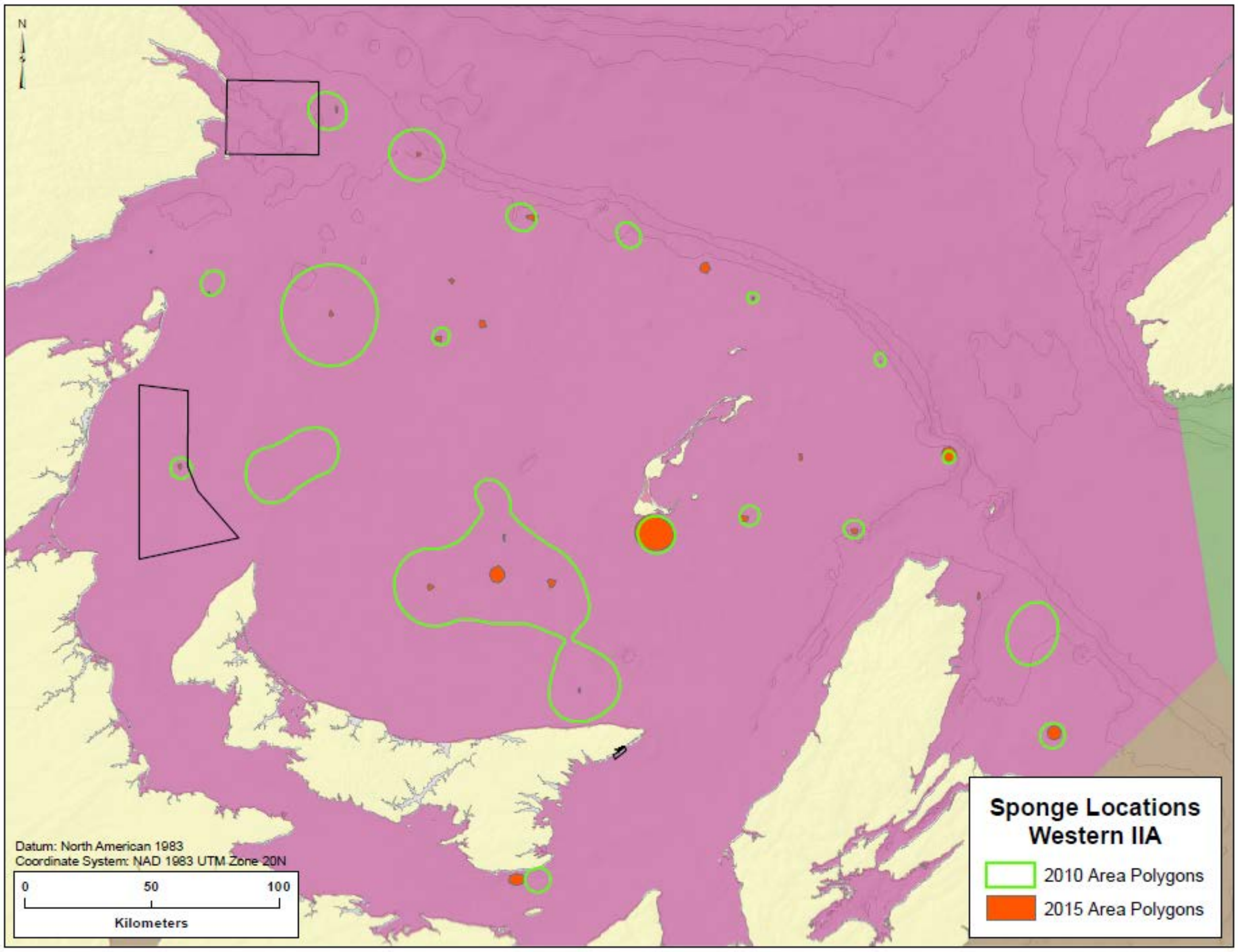


Figure 22. *Comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (green outline) and those identified in this study (red polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline.*

Table 6. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of sponges from DFO trawl surveys conducted within the Gulf Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.708	**Absence**	846	432	1278	0.338	0.646	0.662
SD	0.022	**Presence**	783	1431	2214	0.354		

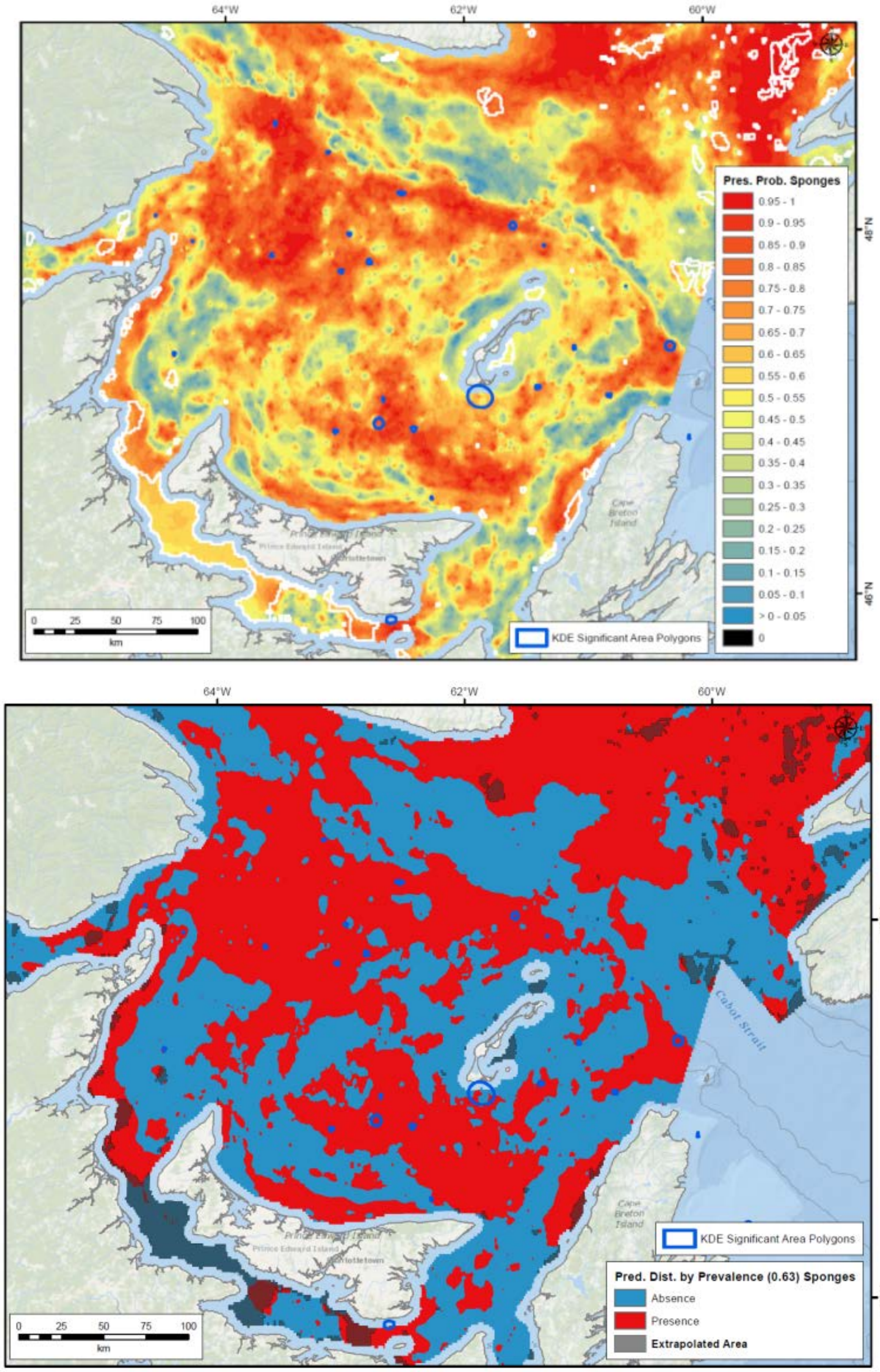


Figure 23. *(upper panel) Predictions of presence probability (Pres. Prob.) of sponges based on a RF model on unbalanced presence and absence sponge catch data collected from DFO multispecies trawl surveys between 2003 and 2015. White lines indicate areas of extrapolation. (lower panel) Classification of sponge presence probability based on the prevalence threshold of 0.63 is shown. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface. Areas of significant concentrations of sponges identified by KDE are shown in blue outline in both panels.*

Sea Pens (Pennatulacea)

In our KDE analyses, there were 272 records with sea pen catch and 1779 records of catches with no sea pens from the same surveys and significant polygons were found along the Laurentian Channel (Figure 24). The updated analysis expanded slightly the areas previously identified (Figure 25).

The RF model using balanced sea pen records was selected as the best predictor of sea pen distribution in the southern Gulf of St. Lawrence (Murillo et al., 2016). The presence probability RF prediction surface of sea pens (Table 7) is presented in Figure 26 with the KDE polygons overlaid. Of all 78 environmental predictor variables used in the model, Bottom Salinity Average Minimum was the most important for the classification. The highest predictions of presence probability occurred along the Laurentian Channel.

The accuracy measures of the regression RF model on mean sea pen biomass from DFO multispecies trawl surveys indicated that the model performed well. The highest R^2 value was 0.777, while the average was 0.370 ± 0.217 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.038 ± 0.020 SD. Spring Primary Production Average Minimum was the most important variable in the model (Murillo et al., 2016). High predicted biomass coincided with the significant area polygons identified by KDE (Figure 27).

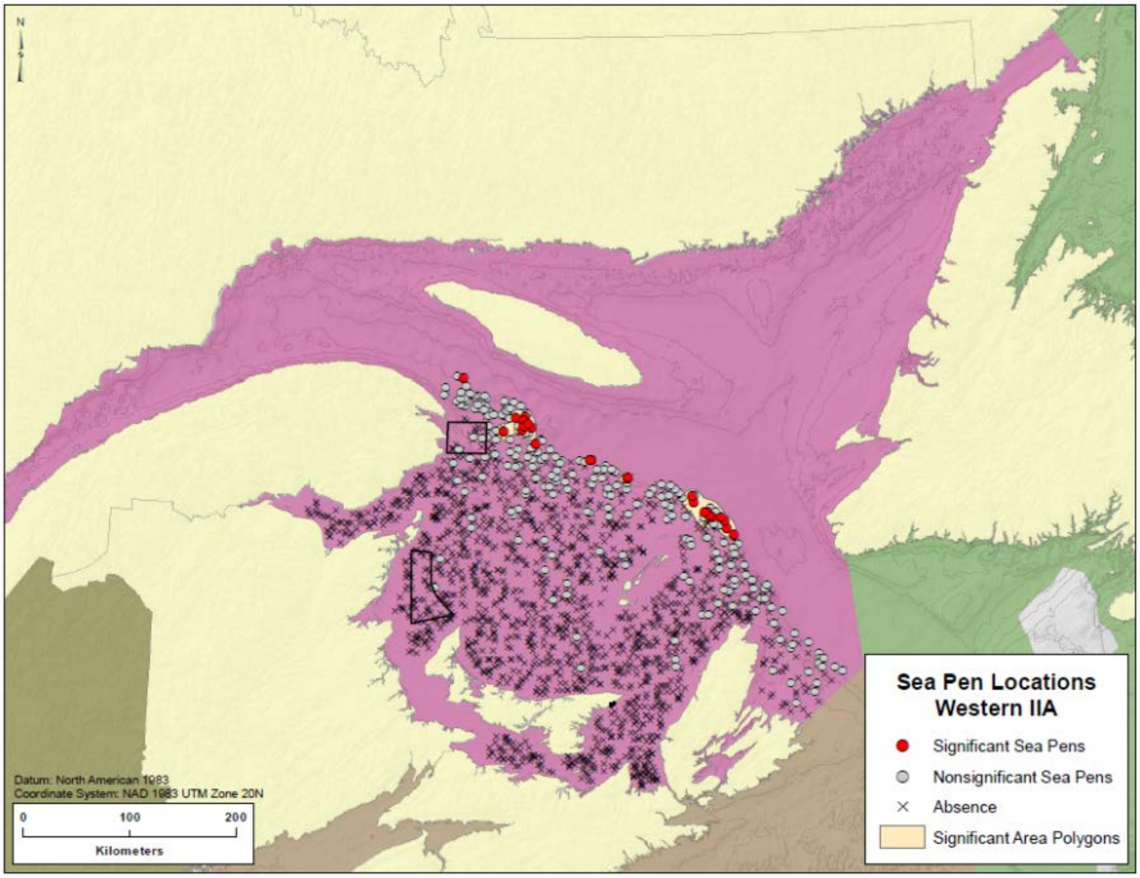


Figure 24. *Locations of the polygons identifying significant sea pen aggregations relative to the broader distribution of sea pens in the southern portion of the Gulf Biogeographic Zone. Catch locations that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline.*

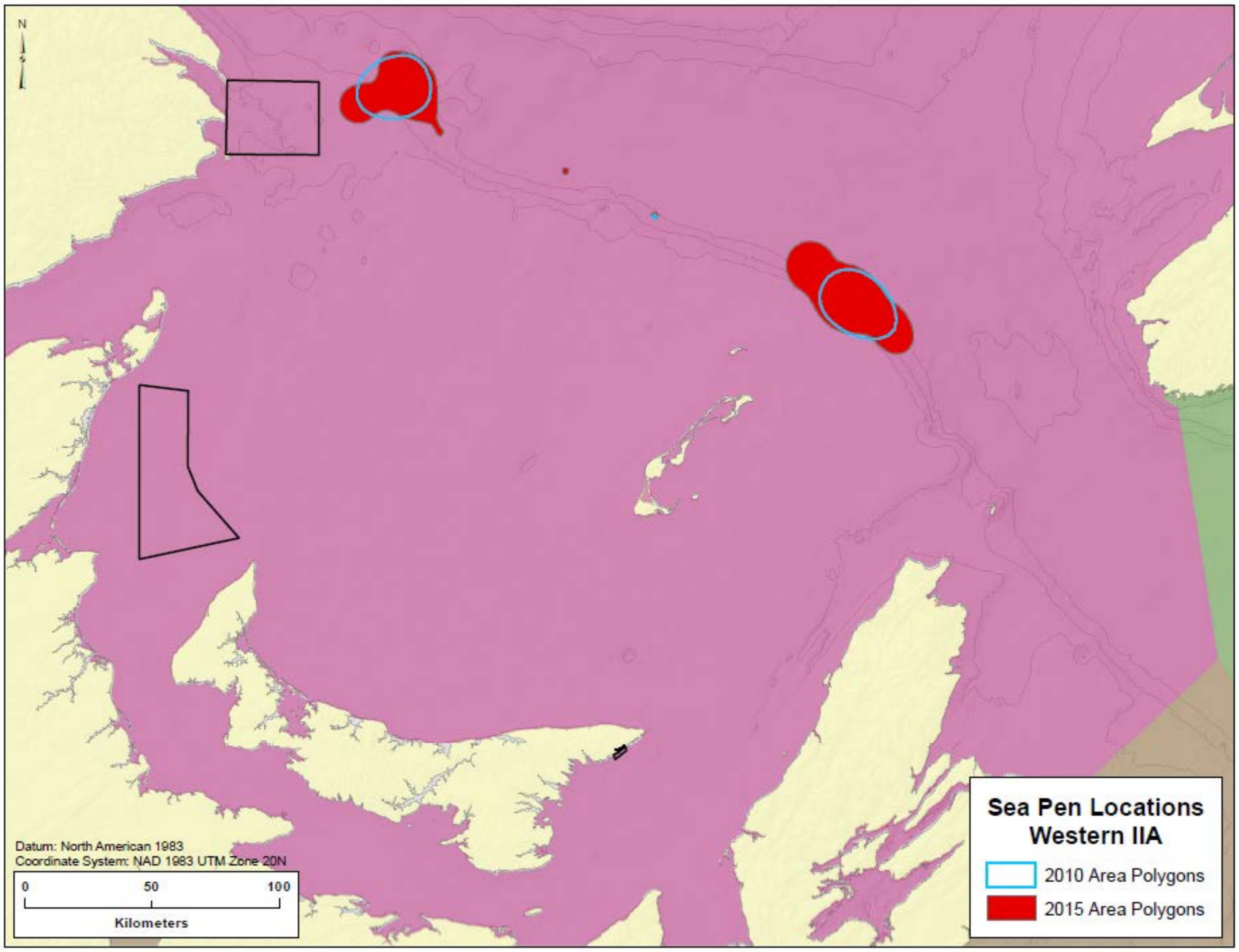


Figure 25. *Comparison of the location of the significant concentrations of sea pens identified in Kenchington et al. (2010) (blue outline) and those identified in this study (red polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline.*

Table 7. *Accuracy measures and confusion matrix from 10-fold cross validation for the RF model with the highest AUC value (Model Run 3) based on presence and absence of sea pens from DFO multispecies trawl survey records collected within the Gulf Region.*

Model Run	AUC	Sensitivity	Specificity
3	0.912	0.840	0.822
Mean	0.907	0.845	0.815
SD	0.003	0.007	0.006

Confusion Matrix of Model with Highest AUC:

Observations	Predictions		Total n	Class Error
	Absence	**Presence**		
Absence	1046	204	2544	0.178
Presence	226	1068	2544	0.160

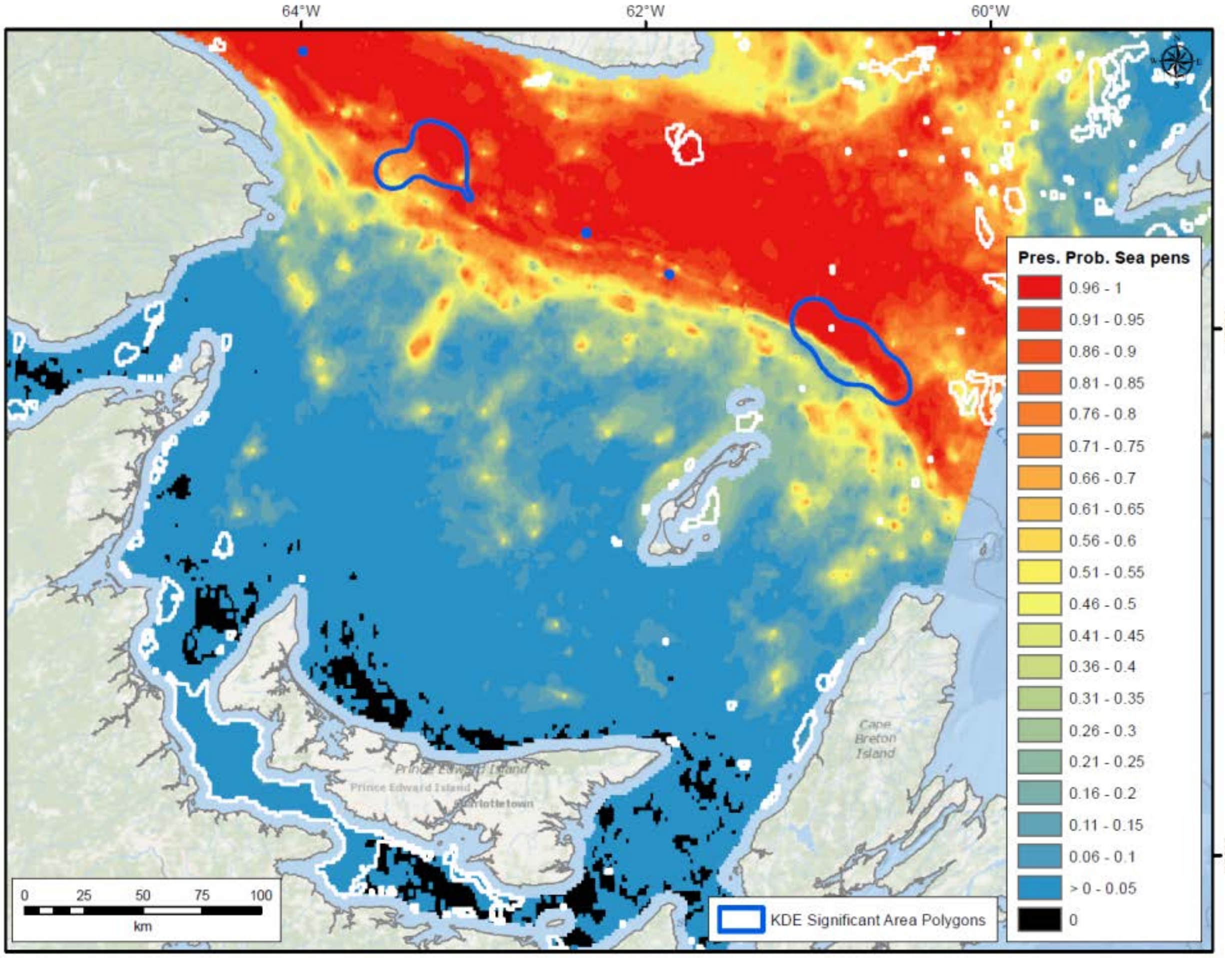


Figure 26. *Predictions of presence probability (Pres. Prob.) from the optimal RF model of sea pen presence and absence data collected from DFO multispecies trawl surveys between 2003 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of sea pens identified by KDE are shown in blue outline.*

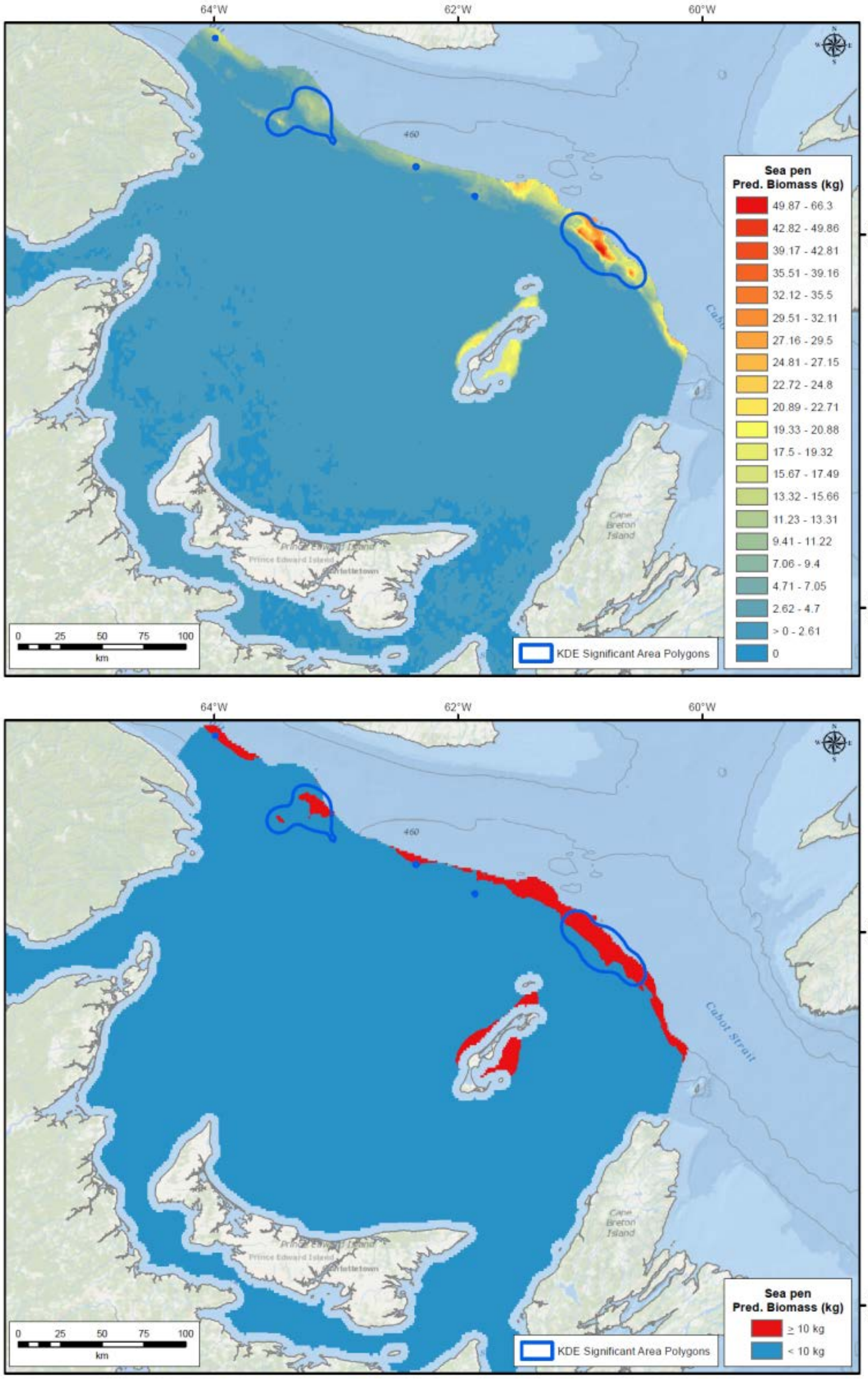


Figure 27. *Predictions of biomass (kg) of sea pens from catch data recorded in DFO multispecies trawl surveys conducted in the southern Gulf of St. Lawrence between 2003 and 2014 (upper panel). Predictions of biomass (kg) of sea pens above and below the threshold (10 kg) of significant concentrations of sea pens identified by the KDE analysis (lower panel). Areas of significant concentrations of sea pens identified by KDE are shown in blue outline.*

Northern Portion of the Gulf Biogeographic Zone

Sponges (Porifera)

The kernel density analysis identified high biomass areas across the spatial extent of the region (Figures 28 and 29). The areas identified in the present analysis were in the same locations but with different extensions to those previously identified (Kenchington et al., 2010), despite the addition of nearly 3x the number of presence records over those available for the previous analysis (Kenchington et al., 2016).

Accuracy measures of the random forest model on sponge presence-absence data collected from the entire Gulf Region were presented in Table 6. The presence probability RF prediction surface is presented in Figure 30 with the KDE polygons from the northern Gulf analysis overlaid. Most of the area was predicted to have high presence probability.

The accuracy measures of the regression random forest model on mean sponge biomass from DFO multispecies trawl surveys were poor ($R^2 \leq 0.1$ and/or negative percent variance explained), therefore the predicted biomass surface is not presented here. The highest R^2 was 0.145, while the average was 0.033 ± 0.41 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.044 ± 0.021 SD (Murillo et al., 2016). The negative variance explained indicated poor predictive performance of the model.

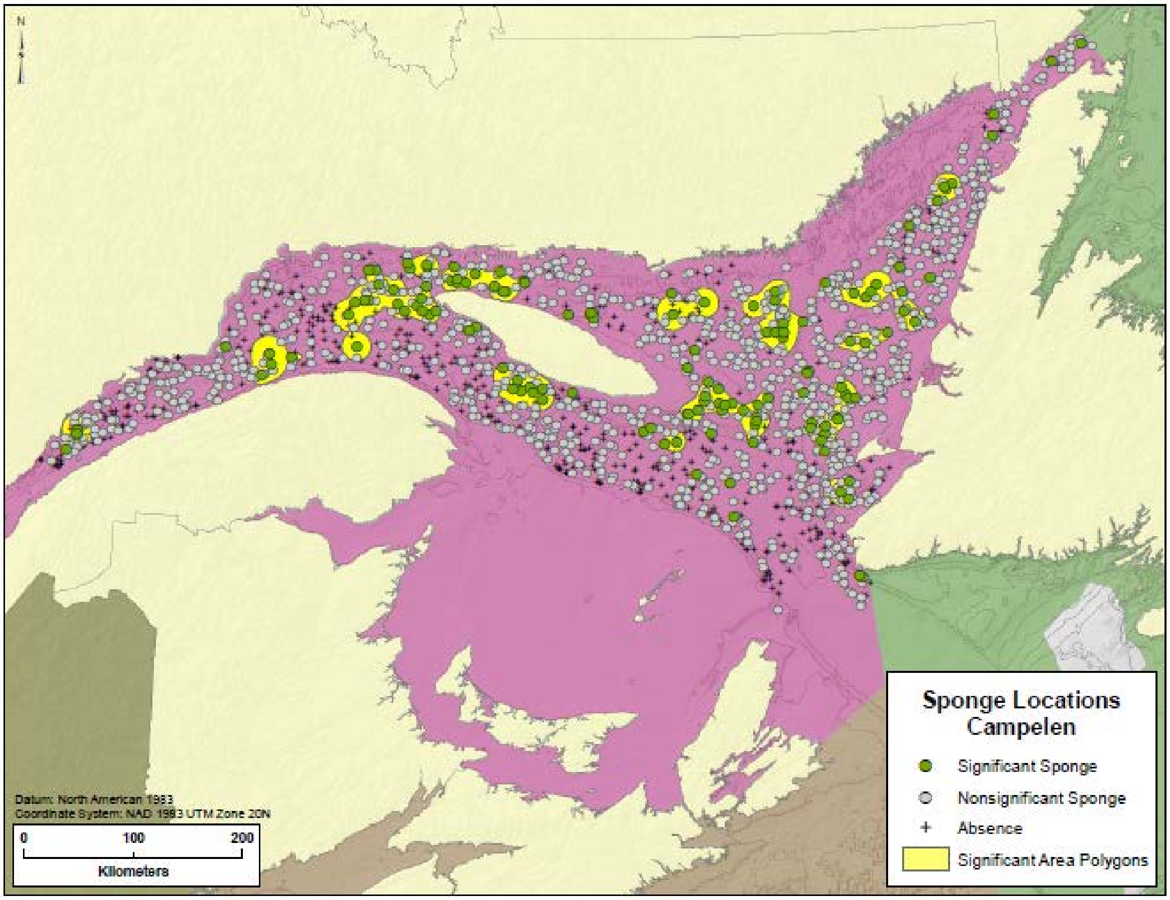


Figure 28. *Locations of the significant sponge catches relative to the broader distribution of sponges in the northern portion of the Gulf Biogeographic Zone. Catch locations that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross.*

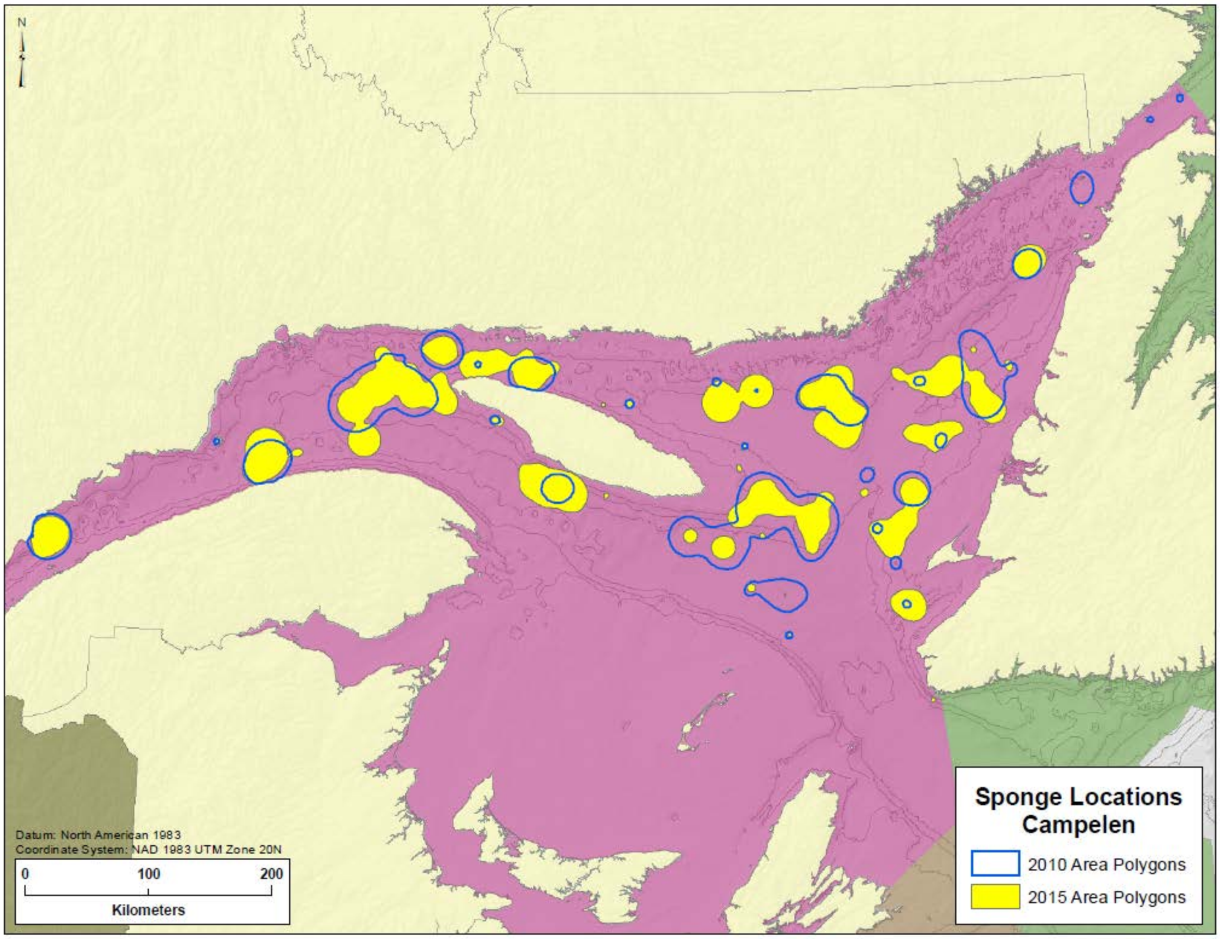


Figure 29. *Comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (blue outline) and those identified in this study (yellow polygons).*

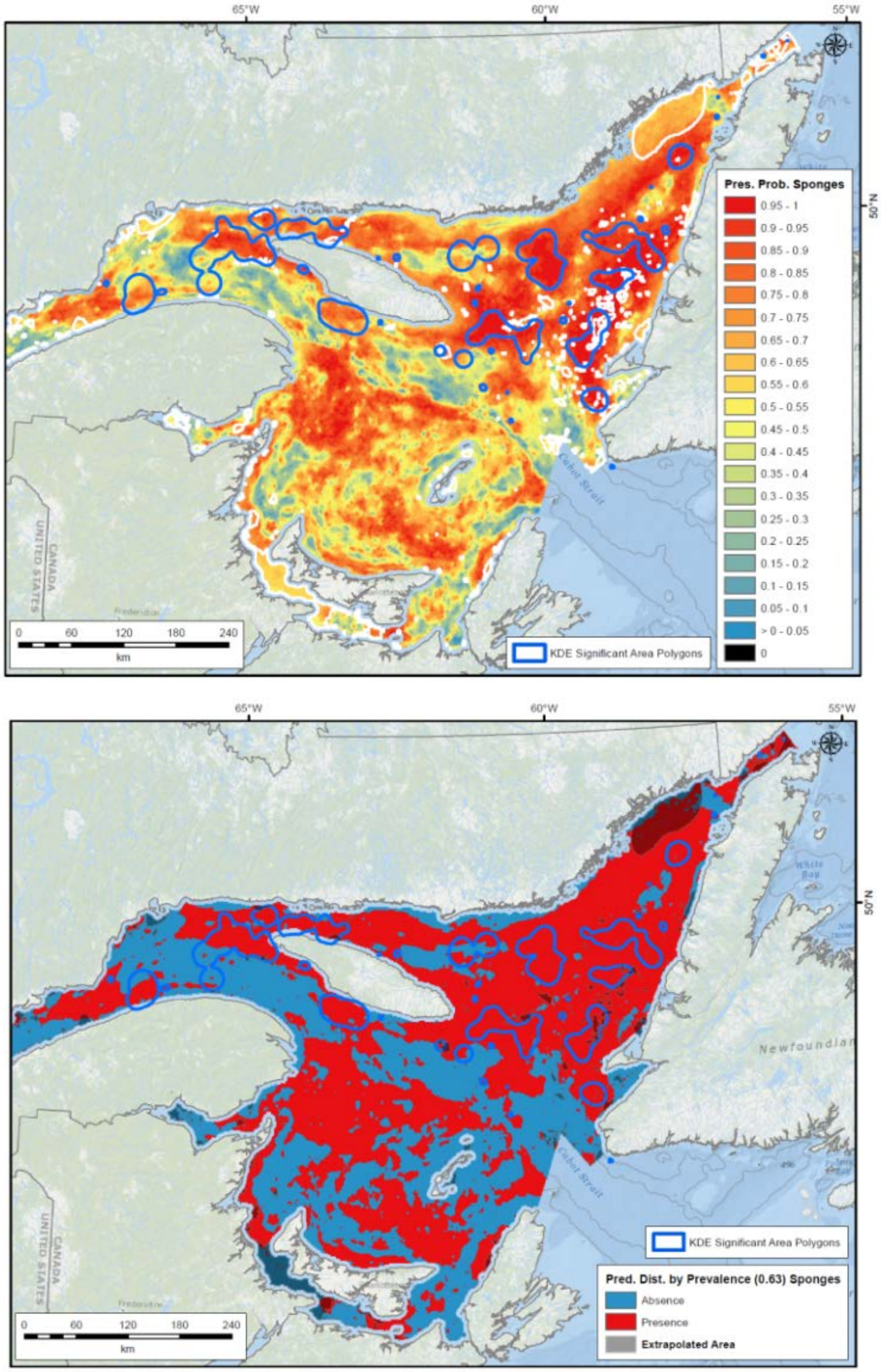


Figure 30. *(upper panel) Predictions of presence probability (Pres. Prob.) of sponges based on a RF model on unbalanced presence and absence sponge catch data collected from DFO multispecies trawl surveys between 2003 and 2015. White lines indicate areas of extrapolation. (lower panel) Classification of sponge presence probability based on the prevalence threshold of 0.63 is shown. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface. Areas of significant concentrations of sponges identified by KDE are shown in blue outline in both panels.*

Sea Pens (Pennatulacea)

Sea pens were distributed in the Gulf of St. Lawrence Estuary, along the Laurentian Channel and north to the deeper waters of the Anticosti and Esquiman Channels (Figure 31). In our KDE analyses, there were 1098 records with sea pen catch and 808 records of catches with no sea pens from the same surveys. The significant area polygons were found along the Laurentian Channel (Figure 31). The updated analysis expanded the areas previously identified (Figure 32).

Accuracy measures of the random forest model using balanced sea pen records collected across the entire Gulf Region are presented in Table 7. The presence probability RF prediction surface is presented in Figure 33 with the KDE polygons from the northern analysis overlaid. The highest predictions of presence probability occurred along the Laurentian, Anticosti and Esquiman Channels. All the significant area polygons identified by KDE were predicted with high presence probability.

The accuracy measures of the regression RF model on mean sea pen biomass from DFO multispecies trawl surveys indicated good performance of the model. The highest R^2 value was 0.502, while the average was 0.273 ± 0.137 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.039 ± 0.021 SD. Surface Temperature Average Maximum was the most important variable in the model (Murillo et al., 2016). High predicted biomass coincided with the significant area polygons identified by KDE (Figure 34).

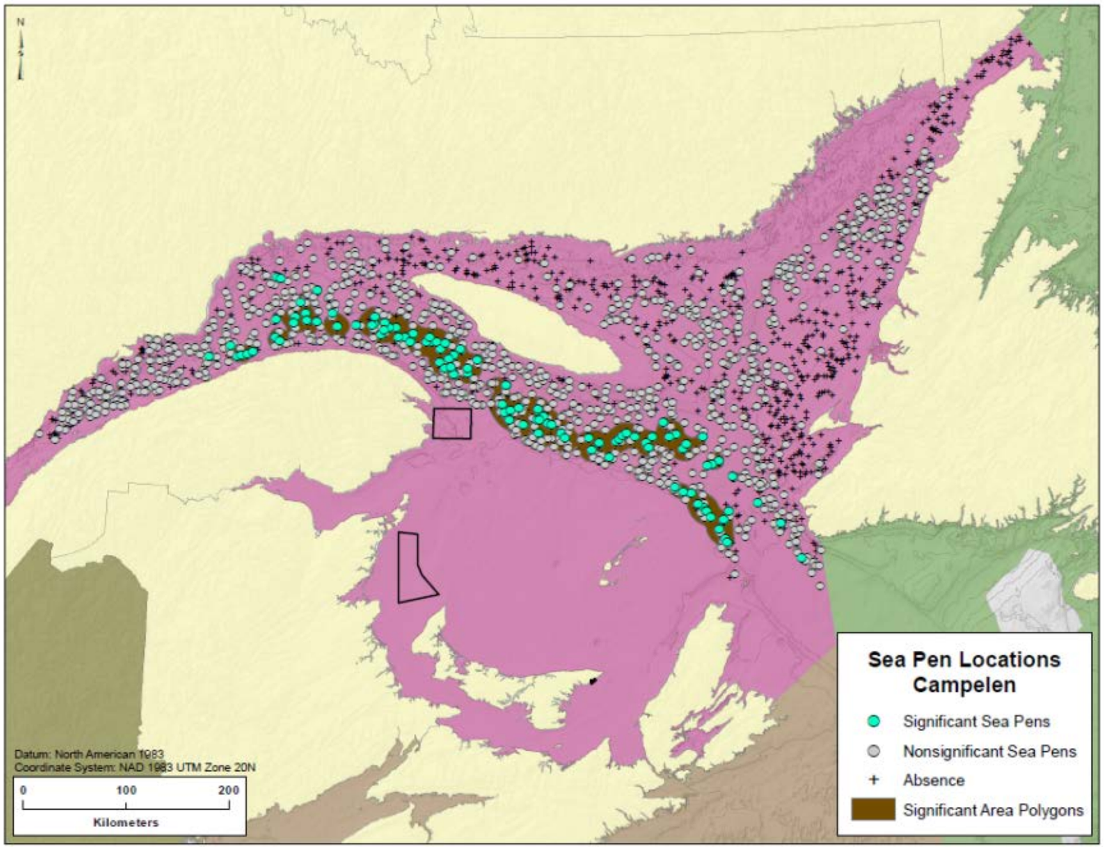


Figure 31. *Locations of the polygons identifying significant sea pen aggregations relative to the broader distribution of sea pens in the northern portion of the Gulf Biogeographic Zone. Catch locations that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross.*

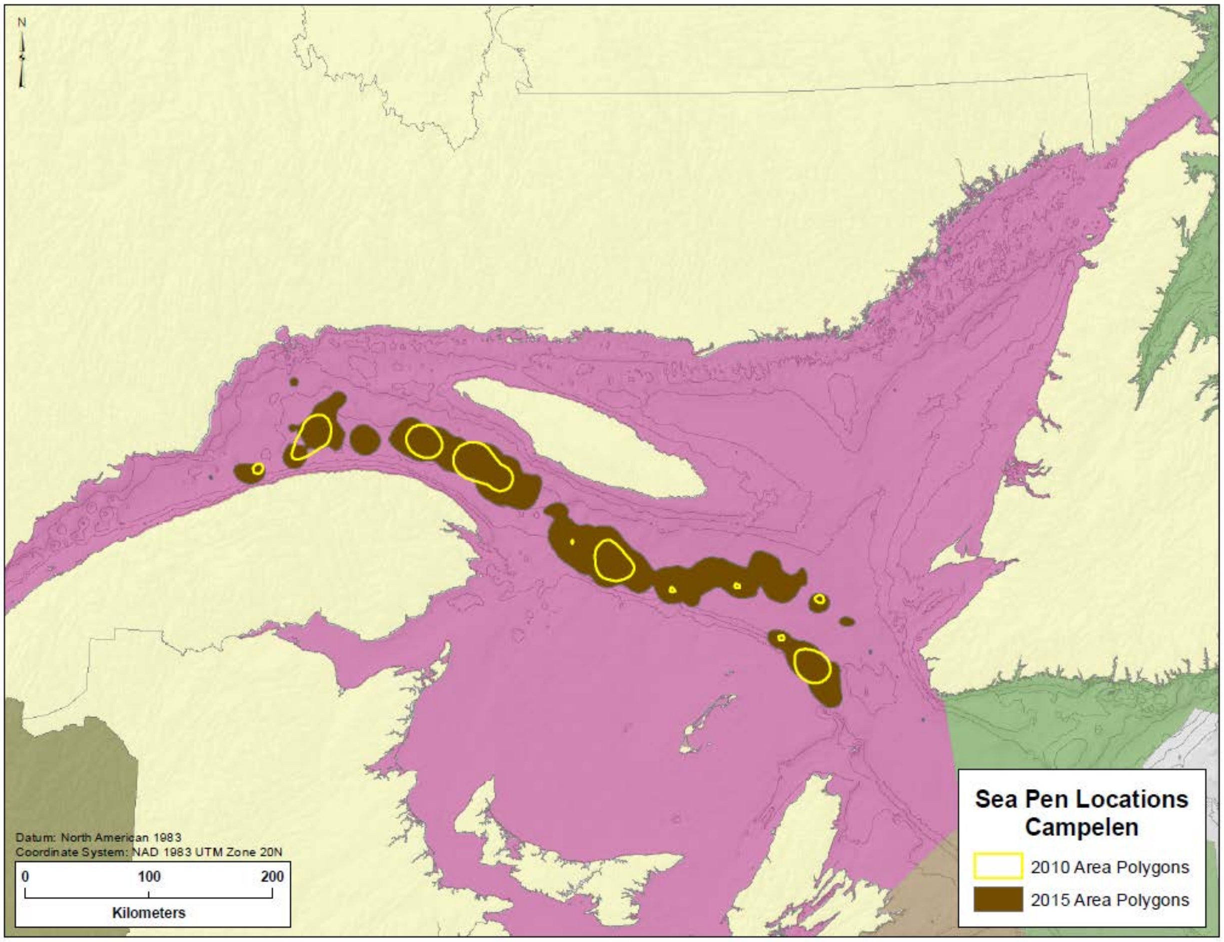


Figure 32. *Comparison of the location of the significant concentrations of sea pens identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (brown polygons).*

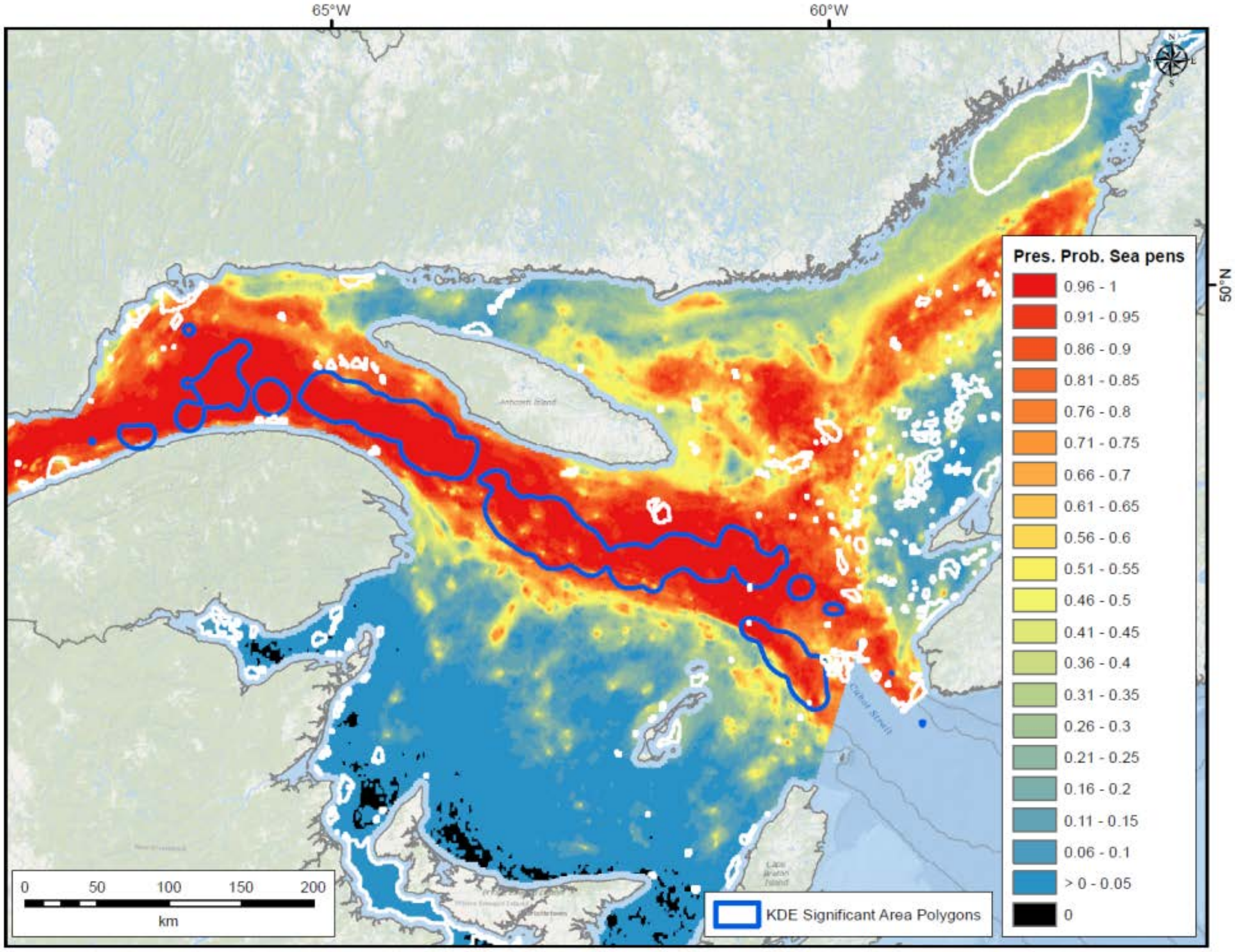


Figure 33. *Predictions of presence probability (Pres. Prob.) from the optimal RF model of sea pen presence and absence data collected from DFO multispecies trawl surveys between 2003 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of sea pens identified by KDE are shown in blue outline.*

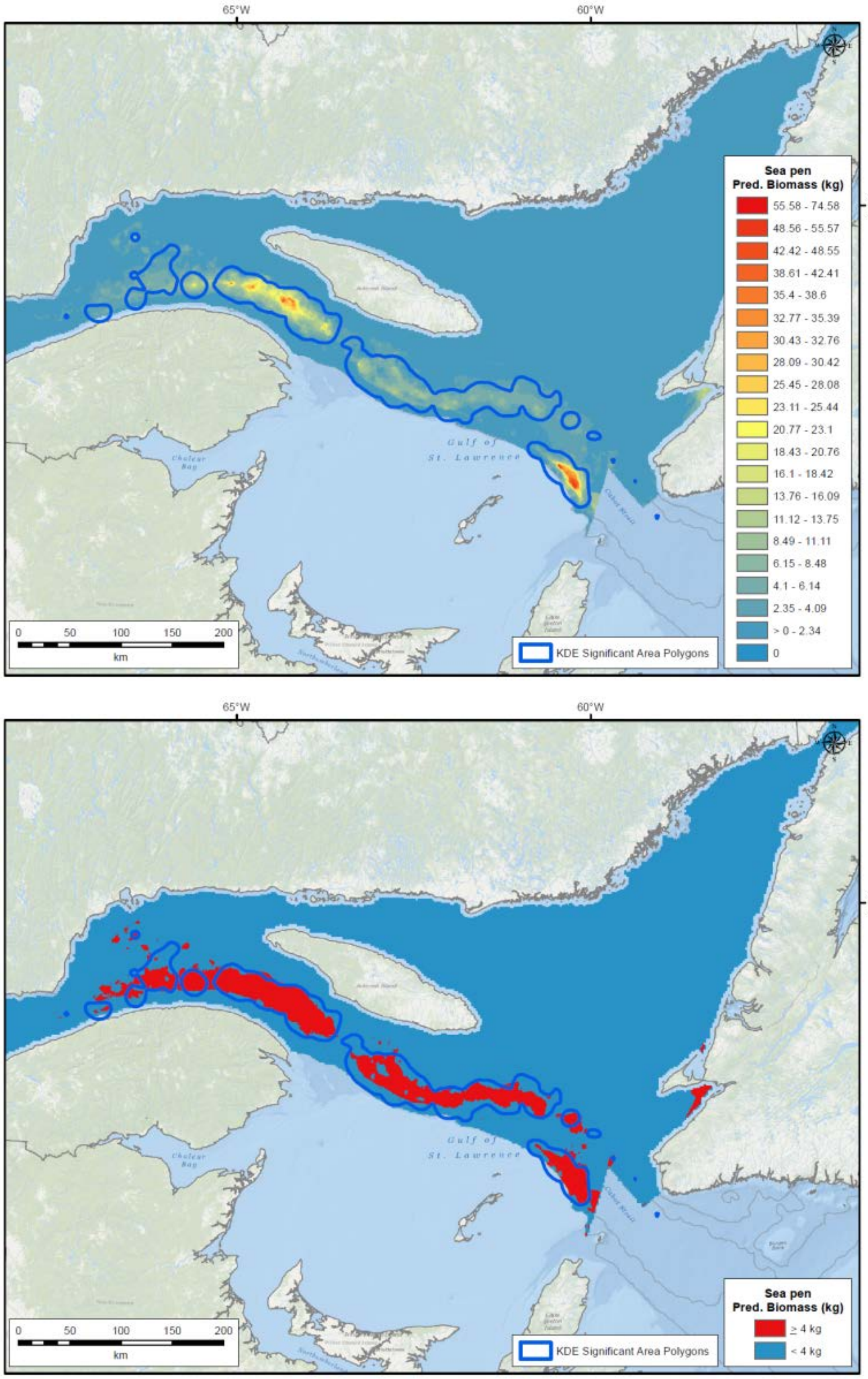


Figure 34. *Predictions of biomass (kg) of sea pens from catch data recorded in DFO multispecies trawl surveys conducted in the northern Gulf of St. Lawrence between 2004 and 2015 (upper panel). Predictions of biomass (kg) of sea pens above and below the threshold (4 kg) of significant concentrations of sea pens identified by the KDE analysis (lower panel). Areas of significant concentrations of sea pens identified by KDE are shown in blue outline.*

Comparison between GAM and RF Models

RF models performed better (in terms of R^2) than GAM models in the northern and southern Gulf of St. Lawrence, except when latitude and longitude were used as a tensor product in the GAM model with predictors correlated < 0.7 (Murillo et al., 2016). A RF model for the northern Gulf with the environmental variables correlated < 0.7 was created but it did not improve the performance compared to models where all the predictors were considered ($R^2 = 0.22$ vs 0.27). When the areas of significant concentrations of sea pens identified by KDE analysis were overlaid to the predictions of biomass (kg) of sea pens above and below the threshold of significant concentrations we observed that both models presented similar patterns (Figure 35).

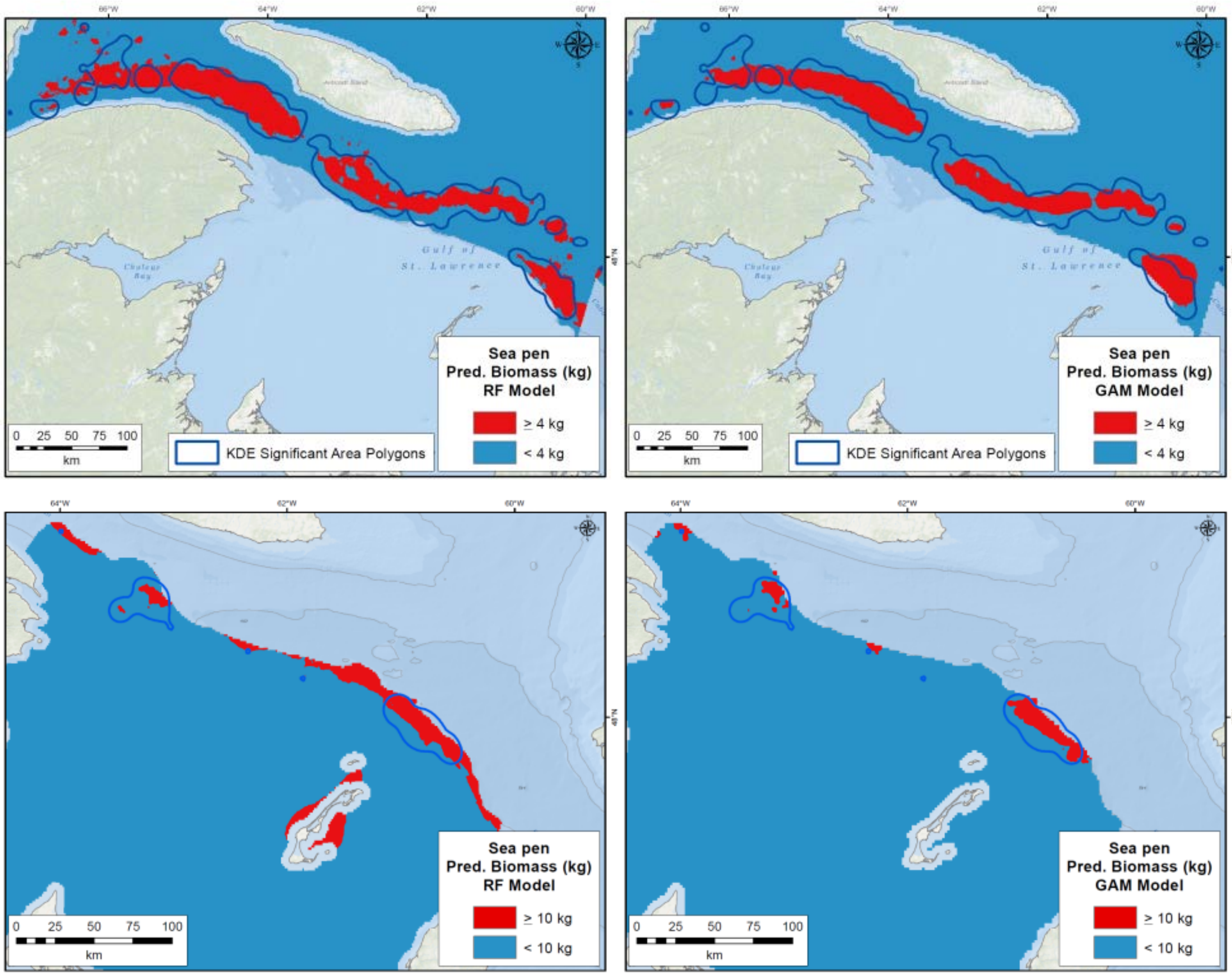


Figure 35. *Predictions of biomass (kg) of sea pens based on RF models (left panels) and GAM models (right panels) above and below the threshold of significant concentrations of sea pens identified by KDE in the northern (upper panels) and southern (lower panels) portion of the Gulf of St. Lawrence. Areas of significant concentrations of sea pens identified by KDE are shown in blue outline.*

NEWFOUNDLAND AND LABRADOR SHELVES

Sponges (Porifera)

The kernel density analysis identified high biomass areas along the Labrador Slope (Figure 36). In the present analysis, sponge areas along the Labrador Slope identified in the previous analysis were greatly expanded (Figure 37). Several new polygons were identified, including two on the Northeast Newfoundland Shelf.

The RF model using sponge records from DFO multispecies surveys and DFO/industry northern shrimp surveys and unbalanced species prevalence was selected as the best predictor of sponge distribution in the Newfoundland and Labrador Region (Figure 38 and Table 8; Guijarro et al., 2016). The AUC of this model was moderate (0.786), and the top environmental predictor variable was Fall Primary Production Average Maximum. The highest predicted sponge presence probabilities occurred along the Labrador Slope and on Saglek Bank. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Small pockets of extrapolated area were distributed across the continental shelf. All deep water beyond the slope was considered extrapolated area. With the exception of Nain and Saglek Banks, most of the shelf and slopes off Labrador were classified as sponge presence, while the majority of the Grand Banks of Newfoundland was classified as sponge absence (Figure 39).

The highest predicted sponge biomass (up to 763.92 kg) occurred on the slope off Saglek Bank in northern Labrador (Figure 40; Guijarro et al., 2016). The accuracy measures of this model indicated good model performance. The highest R^2 was 0.510, while the average was 0.360 ± 0.108 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.026 ± 0.006 SD. This model explained an average percent variance of 31.29% ± 1.92 SD, and the top environmental predictor variable was Summer Primary Production Average Minimum.

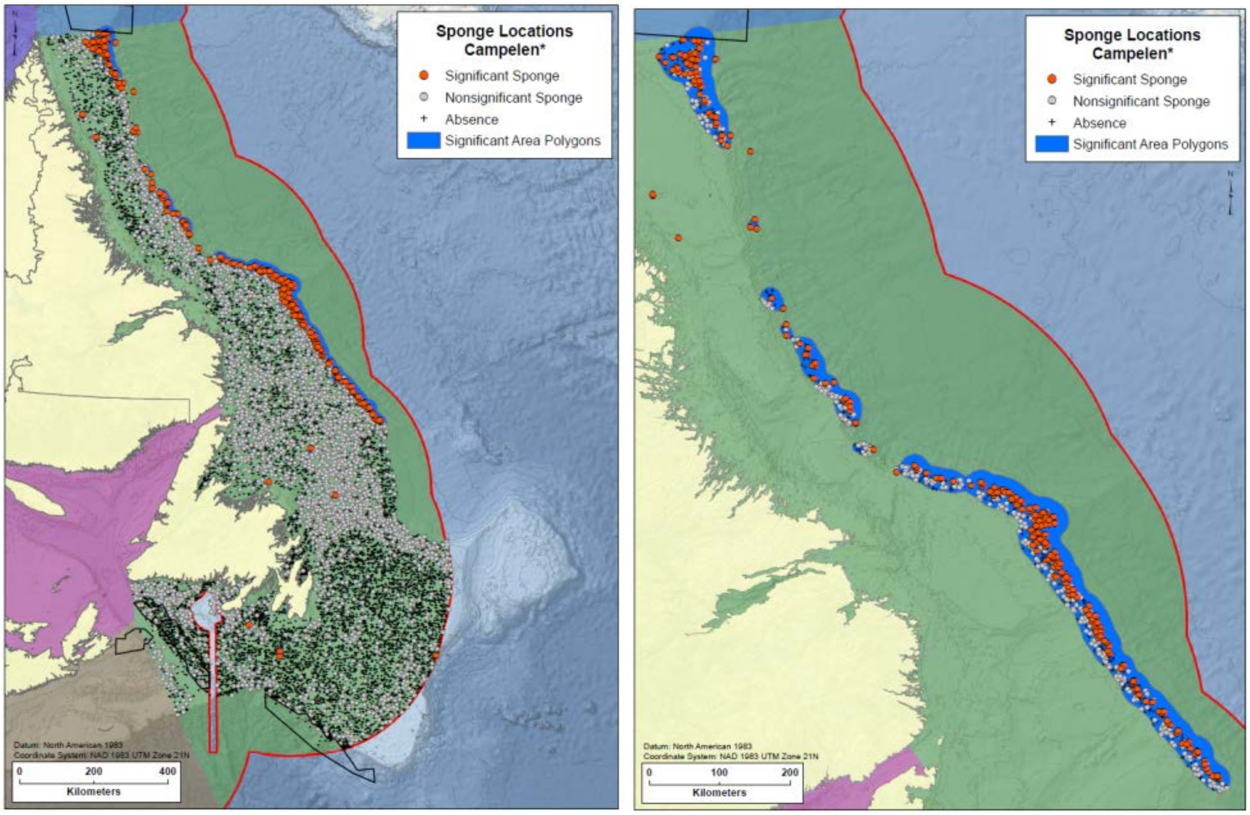


Figure 36. *Location of the polygons (blue) identifying significant sponge aggregations relative to the broader distribution of sponges and areas closed or proposed to be closed to protect benthic species and habitats in the Newfoundland and Labrador Shelves Biogeographic Zone (black outline). Catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. The left panel shows the full distribution while the right panel shows a close-up of the polygons on the Labrador Slope with all records inside each polygon illustrated. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

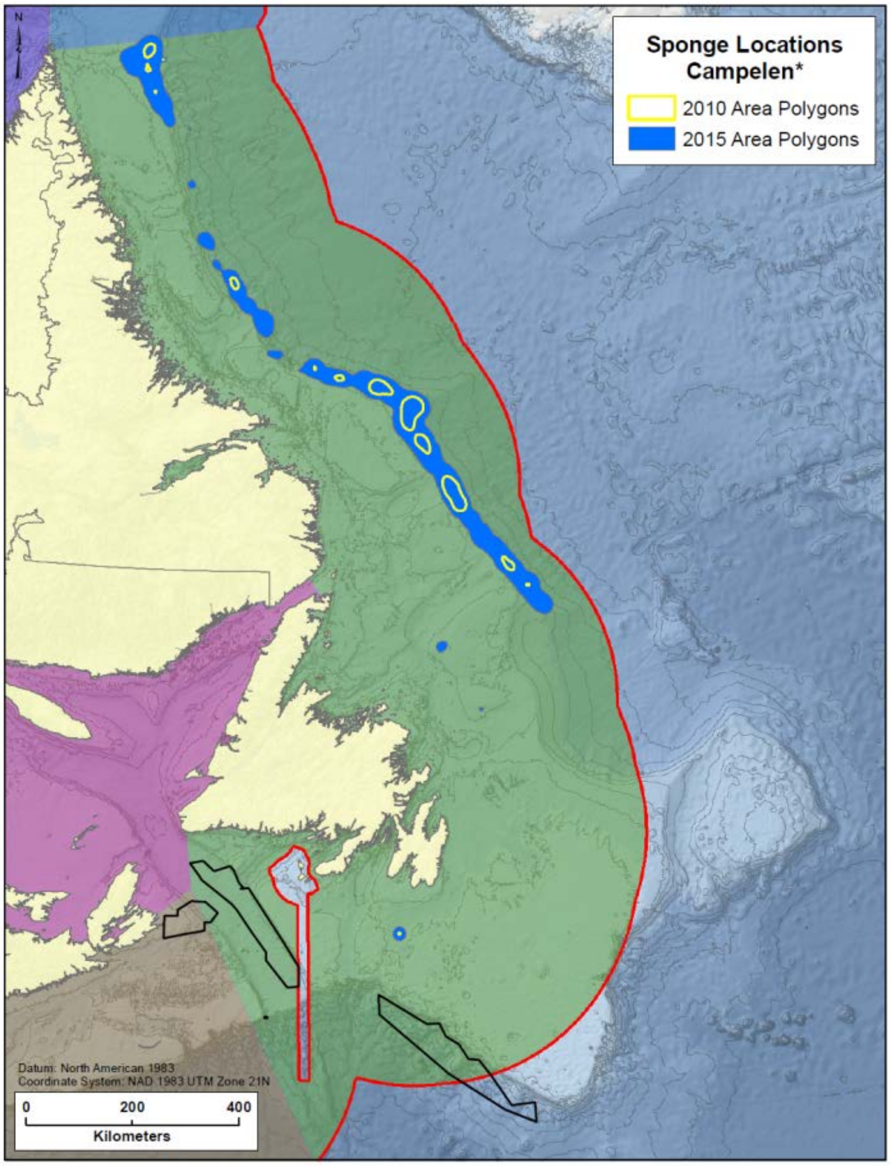


Figure 37. *Comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (blue polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

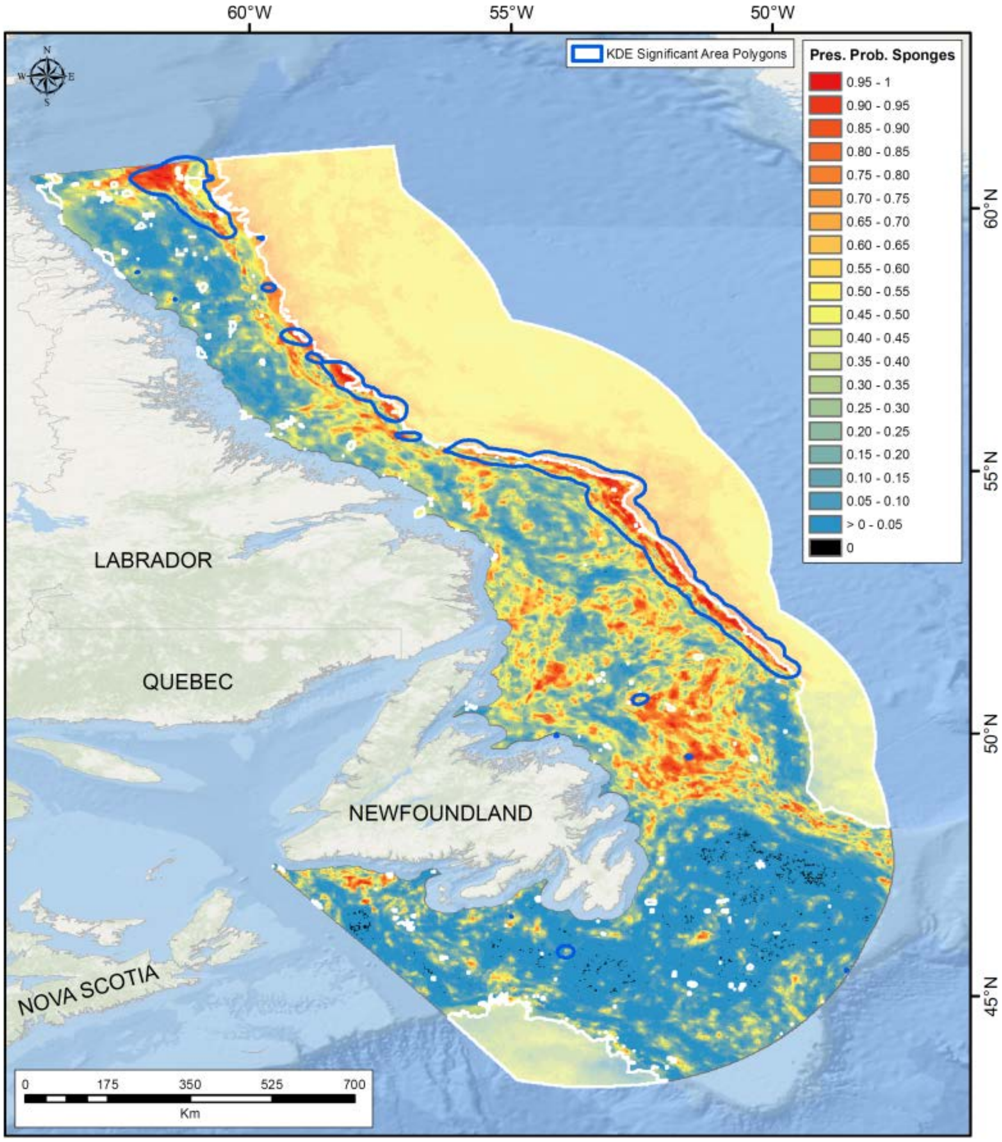


Figure 38. *Predictions of presence probability (Pres. Prob.) of sponges based on a RF model on unbalanced presence and absence sponge catch data collected from DFO multispecies and shrimp trawl surveys and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 1995 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE are shown in blue outline.*

Table 8. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of sponges from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted within the Newfoundland and Labrador Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.786	**Absence**	7728	3235	10980	0.296	0.729	0.704
SD	0.010	**Presence**	1045	2815	3860	0.271		

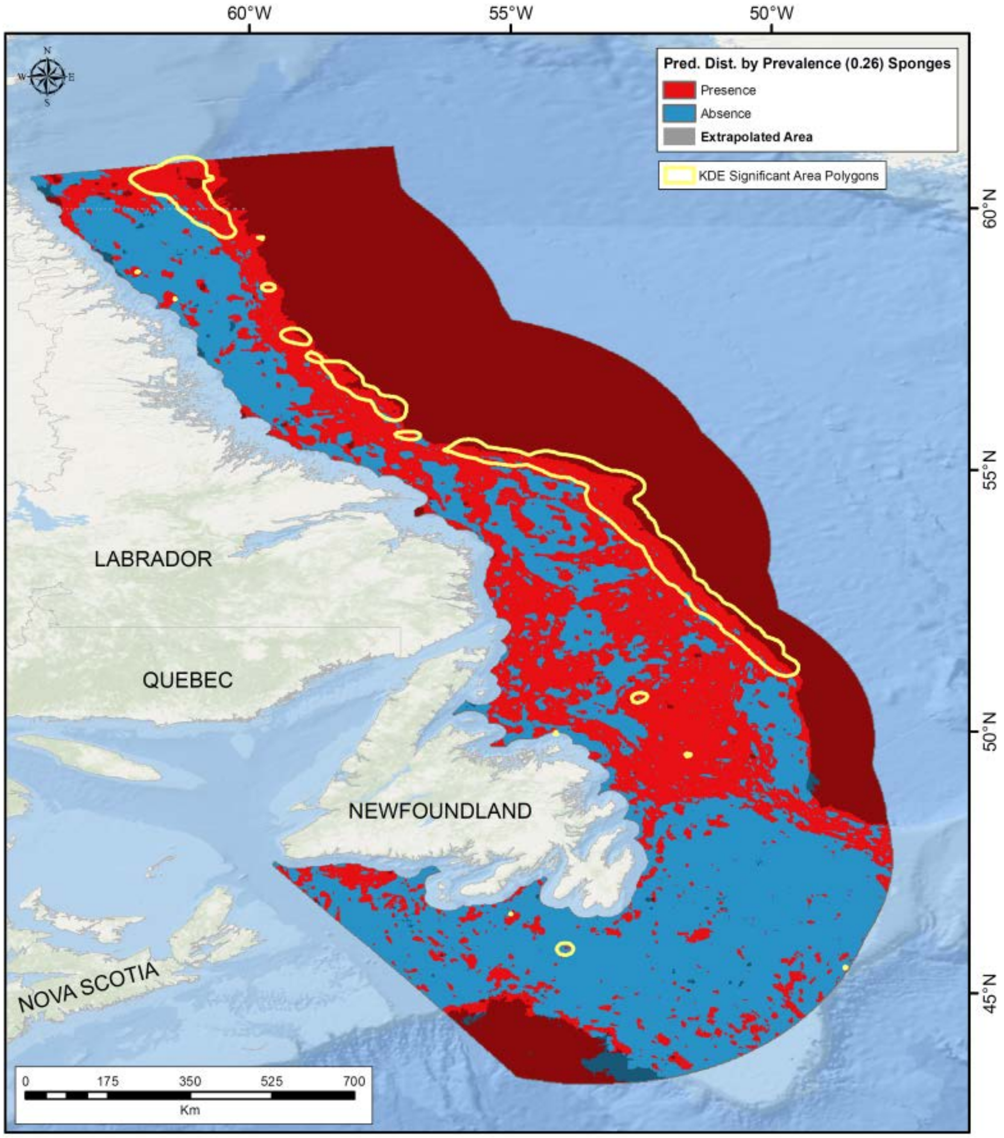


Figure 39. *Classification of sponge presence probability based on the prevalence threshold of 0.26. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface. Areas of significant concentrations of sponges identified by KDE are shown in yellow outline.*

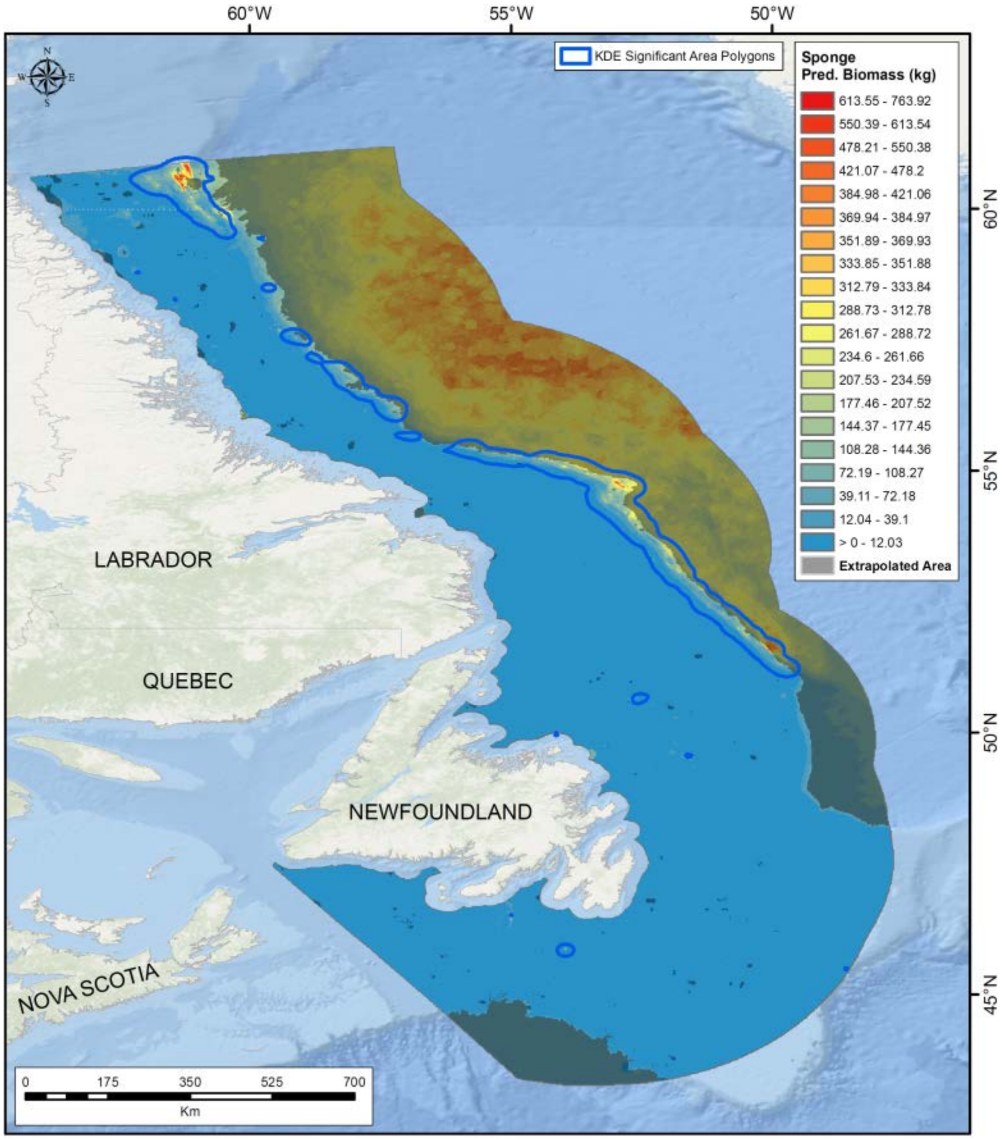


Figure 40. *Predictions of biomass (kg) of sponges from catch data recorded in DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 1995 and 2015. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE are shown in blue outline.*

Sea Pens (Pennatulacea)

In our KDE analyses, there were 1033 records with sea pen catch and 5119 records of catches with no sea pens from the same surveys. In contrast there were only 403 records available for the previous analysis (Kenchington et al., 2010). The updated kernel density analysis identified high biomass in the Laurentian Channel (Figure 41). New sea pen fields in the northwest border of the NAFO 3O Closure Area were identified and existing fields in the Laurentian Channel were expanded (Figure 42).

The RF model using all available sea pen records and unbalanced species prevalence was selected as the best predictor of sea pen distribution in the Newfoundland and Labrador Region (Figure 43 and Table 9; Guijarro et al., 2016). The AUC of this model was excellent (0.926). Depth was the top environmental predictor variable in this model. The highest predicted sea pen presence probability occurred in the Laurentian Channel and on the slope off the Northeast Newfoundland Shelf. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Small pockets of extrapolated area were distributed across the continental shelf. All deep water beyond the slope was considered extrapolated area. Much of the continental shelf was predicted as absence of sea pens (Figure 44).

A small area in the Laurentian Channel was predicted to have high (up to 24.27 kg) biomass of sea pens by the regression random forest model (Figure 45). The accuracy measures of this model indicated good model performance. The highest R^2 was 0.642, while the average was 0.376 ± 0.202 SD. The average Normalized Root-Mean-Square Error (NRMSE) was 0.018 ± 0.010 SD (Guijarro et al., 2016). This model explained an average percent variance of 28.74% ± 3.25 SD. Maximum Average Winter Mixed Layer Depth was the top environmental predictor.

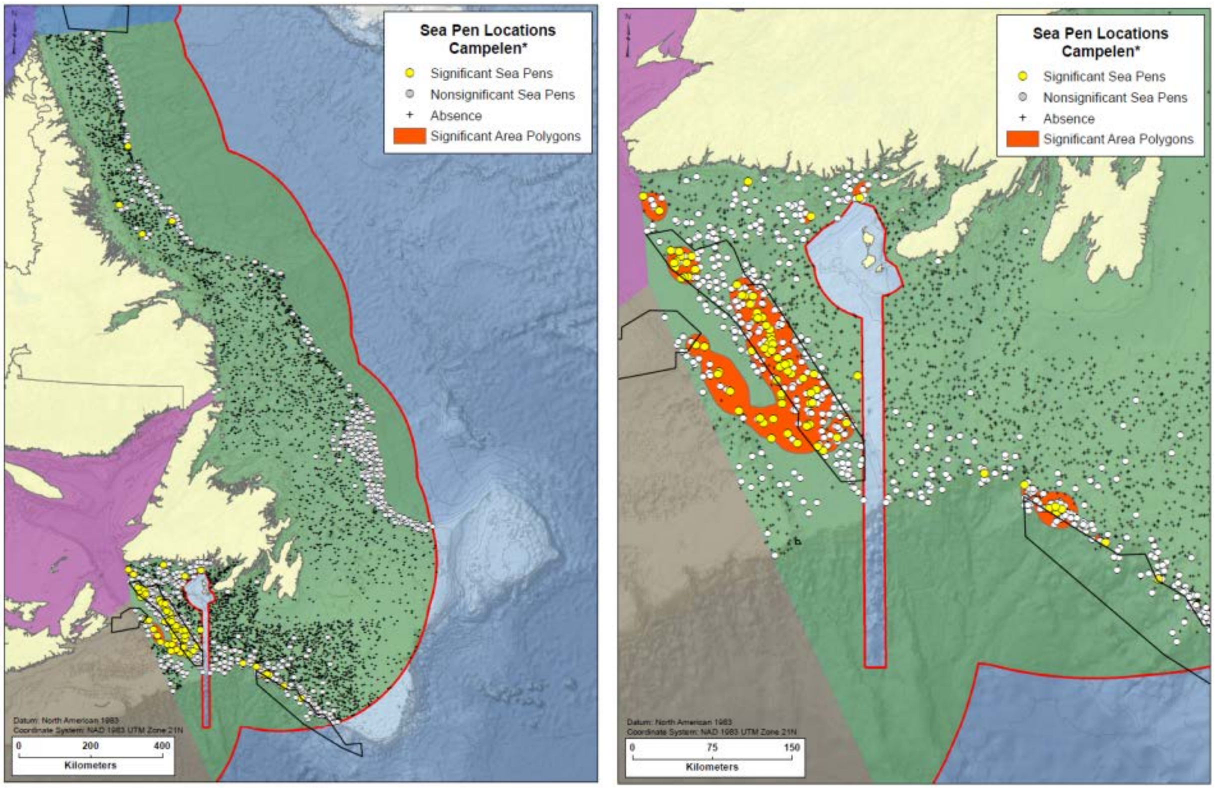


Figure 41. *Location of the polygons identifying significant sea pen aggregations relative to the broader distribution of sea pens and areas closed or proposed to be closed to protect benthic species and habitats in the Newfoundland and Labrador Shelves Biogeographic Zone (black outline). Catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. A close up of the area in the Laurentian Channel is shown in the panel to the right. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

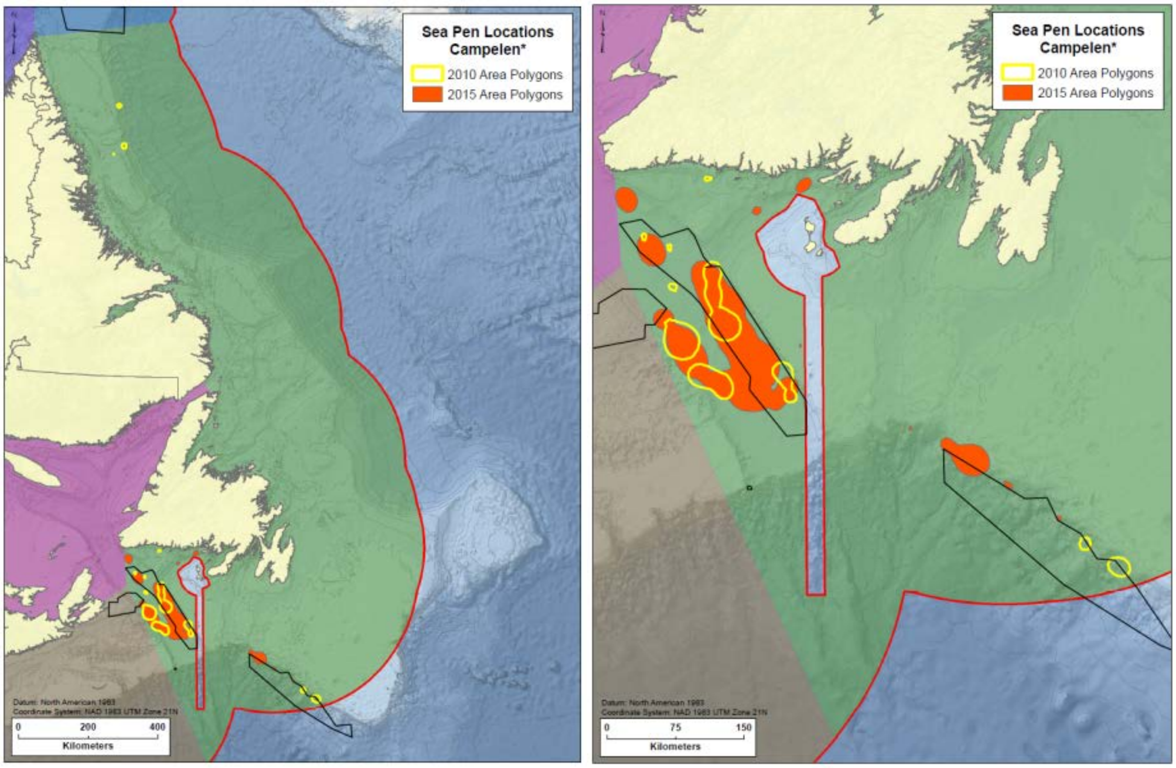


Figure 42. *Comparison of the location of the significant concentrations of sea pens identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (orange polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).The left panel shows areas to the north that were identified in 2010 but that did not appear in the 2015 analyses.*

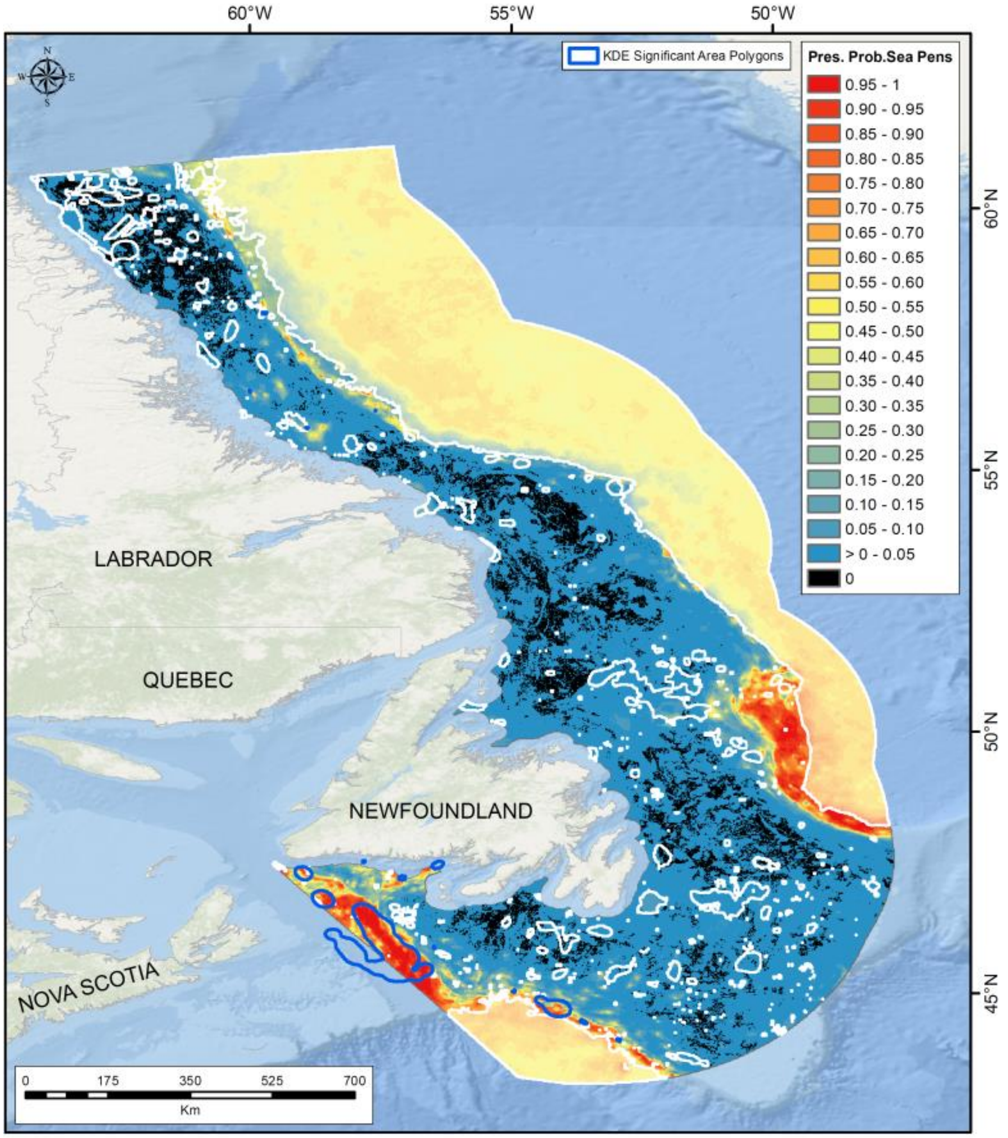


Figure 43. *Predictions of presence probability (Pres. Prob.) of sea pens based on a RF model on unbalanced presence and absence sea pen catch data collected from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 2003 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE are shown in blue outline.*

Table 9. *Accuracy measures for 10-fold cross validation of a random forest model of presence and absence of sea pens from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted within the Newfoundland and Labrador Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.926	**Absence**	4030	743	4773	0.156	0.847	0.844
SD	0.009	**Presence**	145	801	946	0.153		

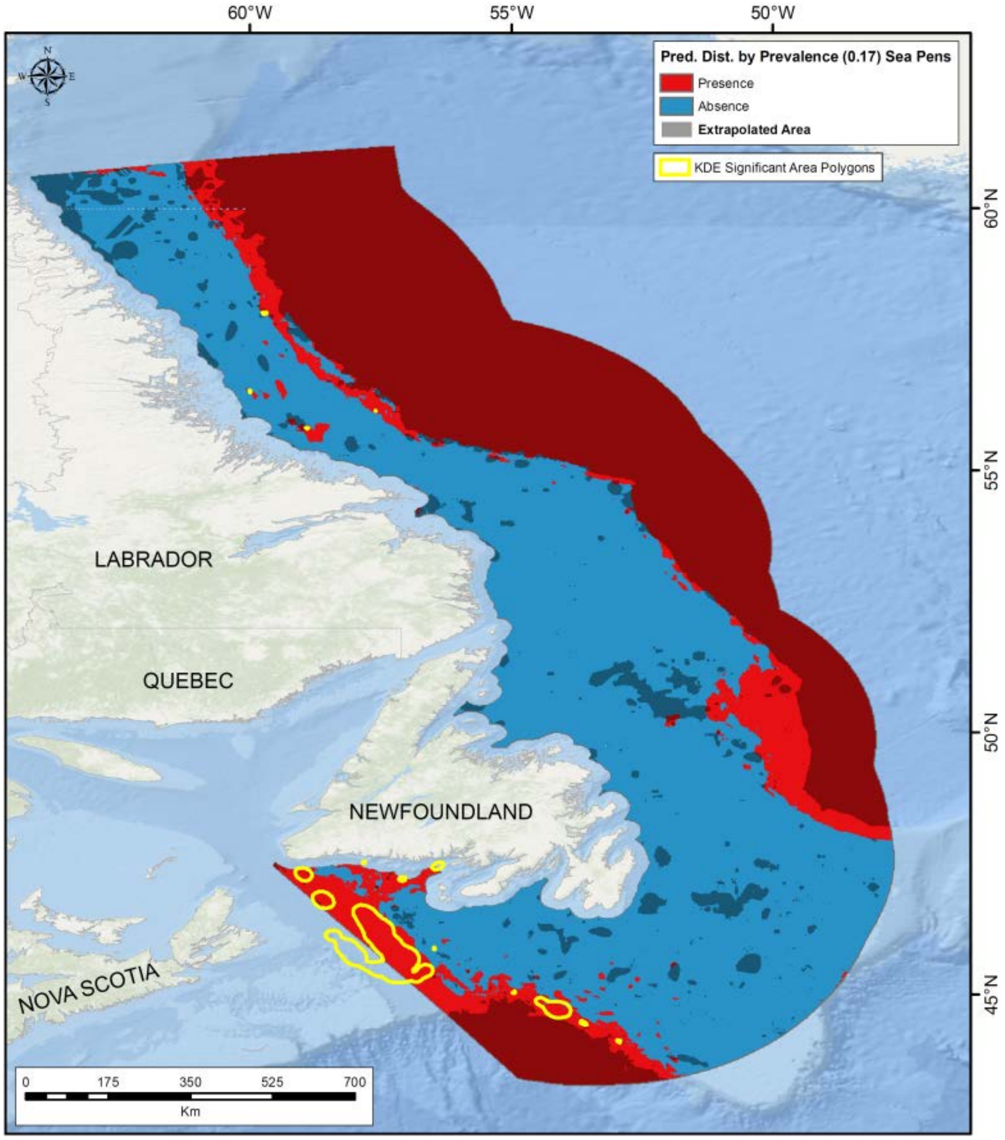


Figure 44. *Classification of sea pen presence probability based on the prevalence threshold of 0.17. Also shown are the grey areas of model extrapolation, which appear dark red when overlain on the presence surface and dark blue when overlain on the absence surface. Areas of significant concentrations of sponges identified by KDE are shown in yellow outline.*

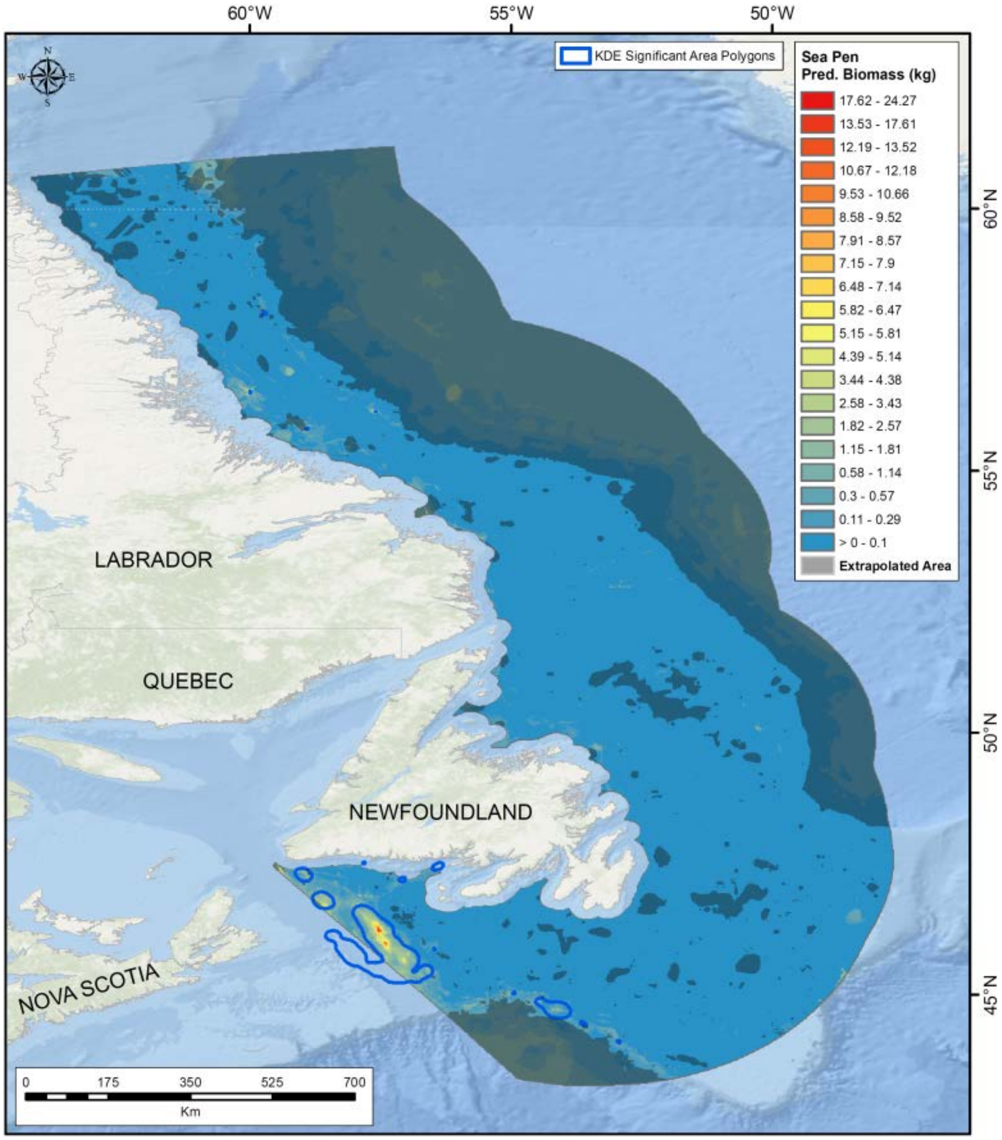


Figure 45. *Predictions of biomass (kg) of sea pens from catch data recorded in DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 2003 and 2015. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE are shown in blue outline.*

Large Gorgonian Corals

In our KDE analyses, there were 530 records with large gorgonian coral catch and 6121 records of catches with no large gorgonians from the same surveys. In contrast there were only 199 records available for the previous analysis (Kenchington et al., 2010). The updated analysis identified several new large gorgonian coral areas along the Labrador Slope and slope northwest of the NAFO 3O Closure Area (Figure 46). The large polygon on the Saglek Bank and slope in northern Labrador identified from the 2010 analysis was greatly expanded in the current analysis (Figure 47). Several significant area polygons from 2010 are no longer present in the current analysis.

The RF model using all available large gorgonian coral records and unbalanced species prevalence was selected as the best predictor of large gorgonian coral distribution in the Newfoundland and Labrador Region (Figure 48 and Table 10; Guijarro et al., 2016). The AUC of this model was good (0.806). Depth was the top environmental predictor variable. The highest predicted presence probability of large gorgonian corals occurred on the edge of Saglek Bank and slope in northern Labrador. Moderate large gorgonian coral presence probability was predicted along the Labrador Slope. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Much of the continental shelf was predicted as absence of large gorgonian corals (Figure 49). Small pockets of extrapolated area were distributed across the continental shelf. All deep water beyond the slope was considered extrapolated area.

A small area on the edge of Saglek Bank was predicted to have high (up to 175.14 kg) biomass of large gorgonian corals by the regression random forest model (Figure 50). The accuracy measures of this model indicated relatively fair model performance. The highest R^2 was 0.690, while the average was 0.203 ± 0.218 SD. The average Normalized Root-Mean-Square Error (RMSE) was 0.017 ± 0.012 SD (Guijarro et al., 2016). This model explained an average percent variance of 5.70% ± 3.34 SD. Summer Primary Production Average Minimum was the top environmental predictor variable.

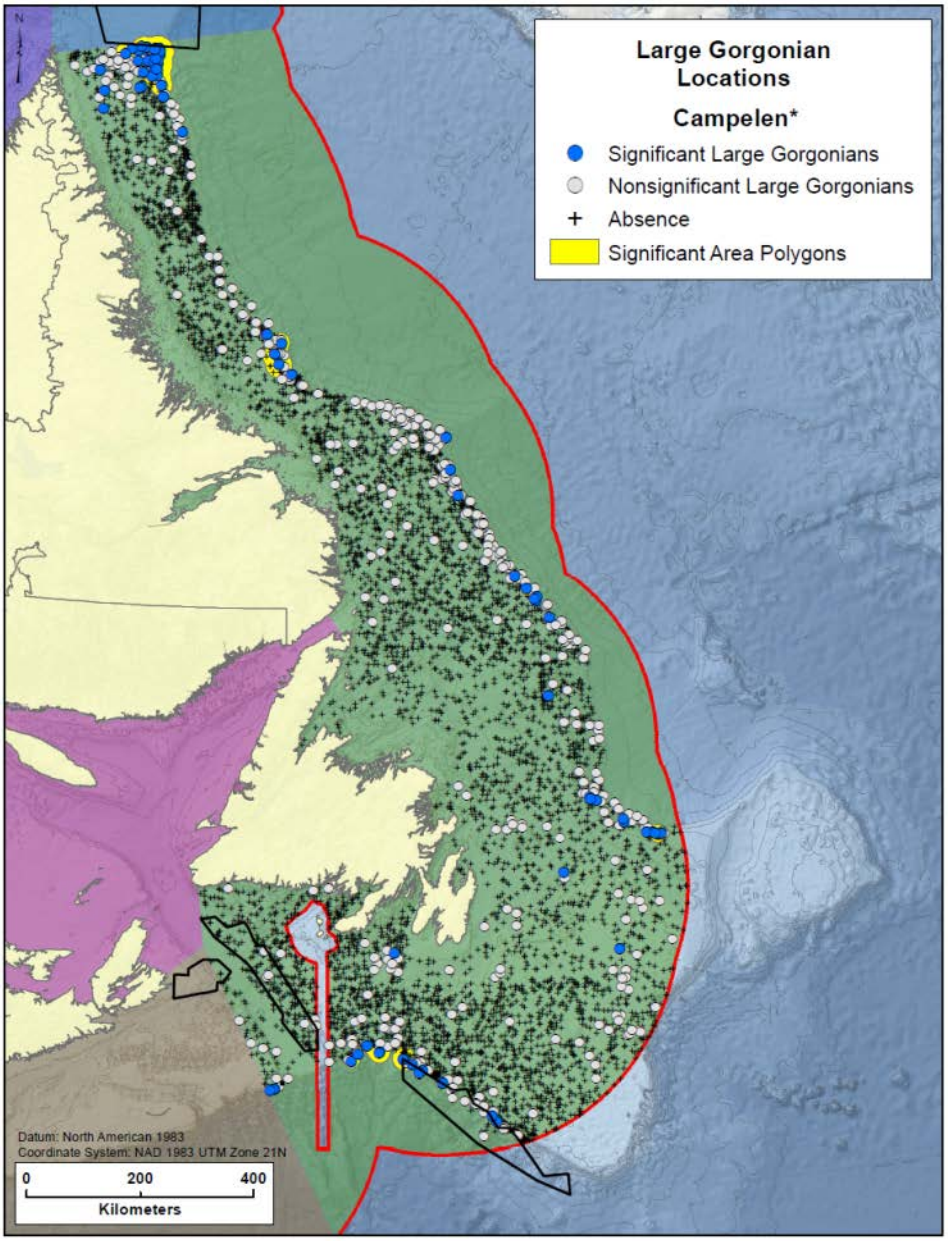


Figure 46. *Location of the polygons identifying significant large gorgonian corals relative to the broader distribution of large gorgonian corals and areas closed or proposed to be closed to protect benthic species and habitats in the Newfoundland and Labrador Shelves Biogeographic Zone (black outline). Catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

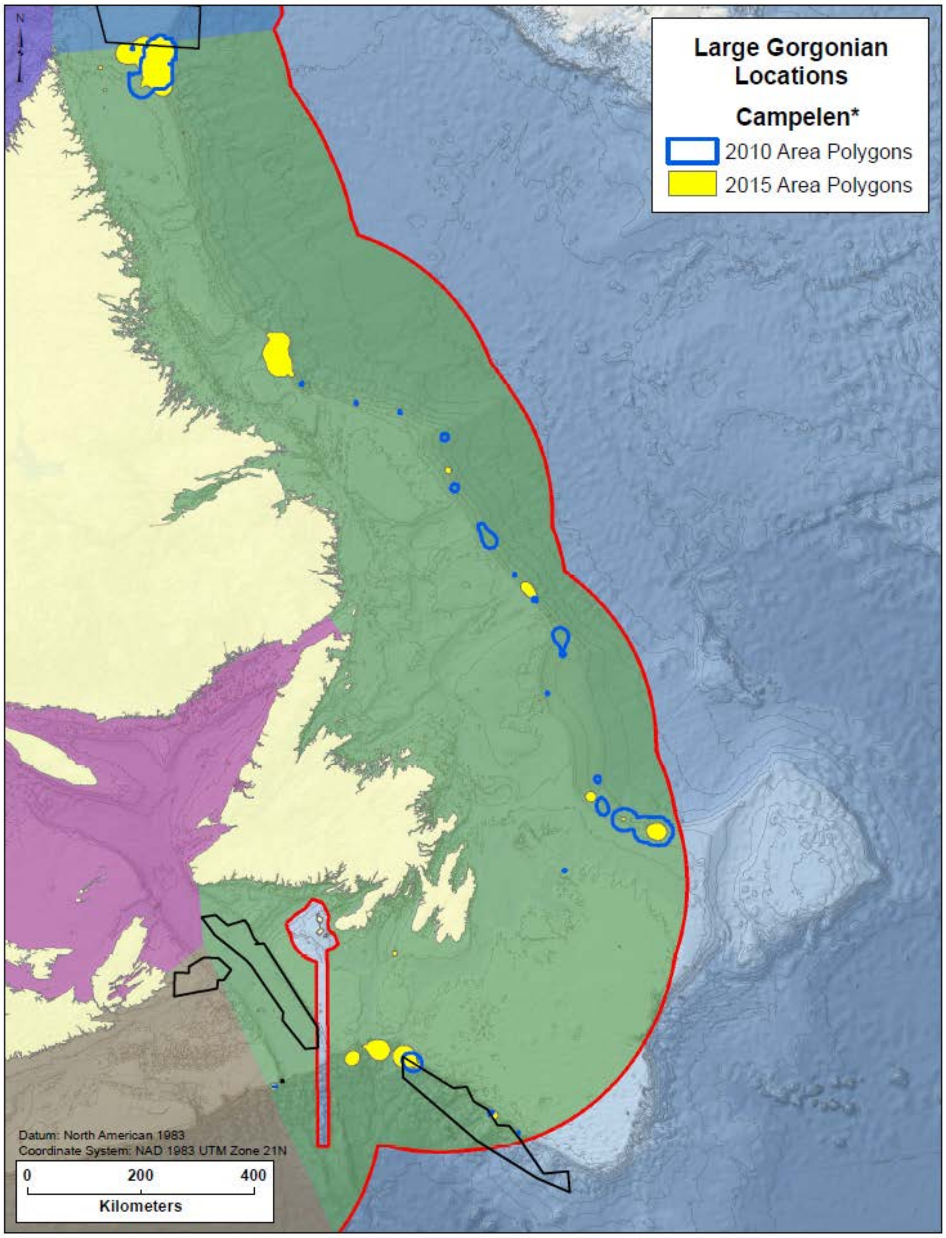


Figure 47. *Comparison of the location of the significant concentrations of large gorgonian corals identified in Kenchington et al. (2010) (blue outline) and those identified in this study (yellow polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

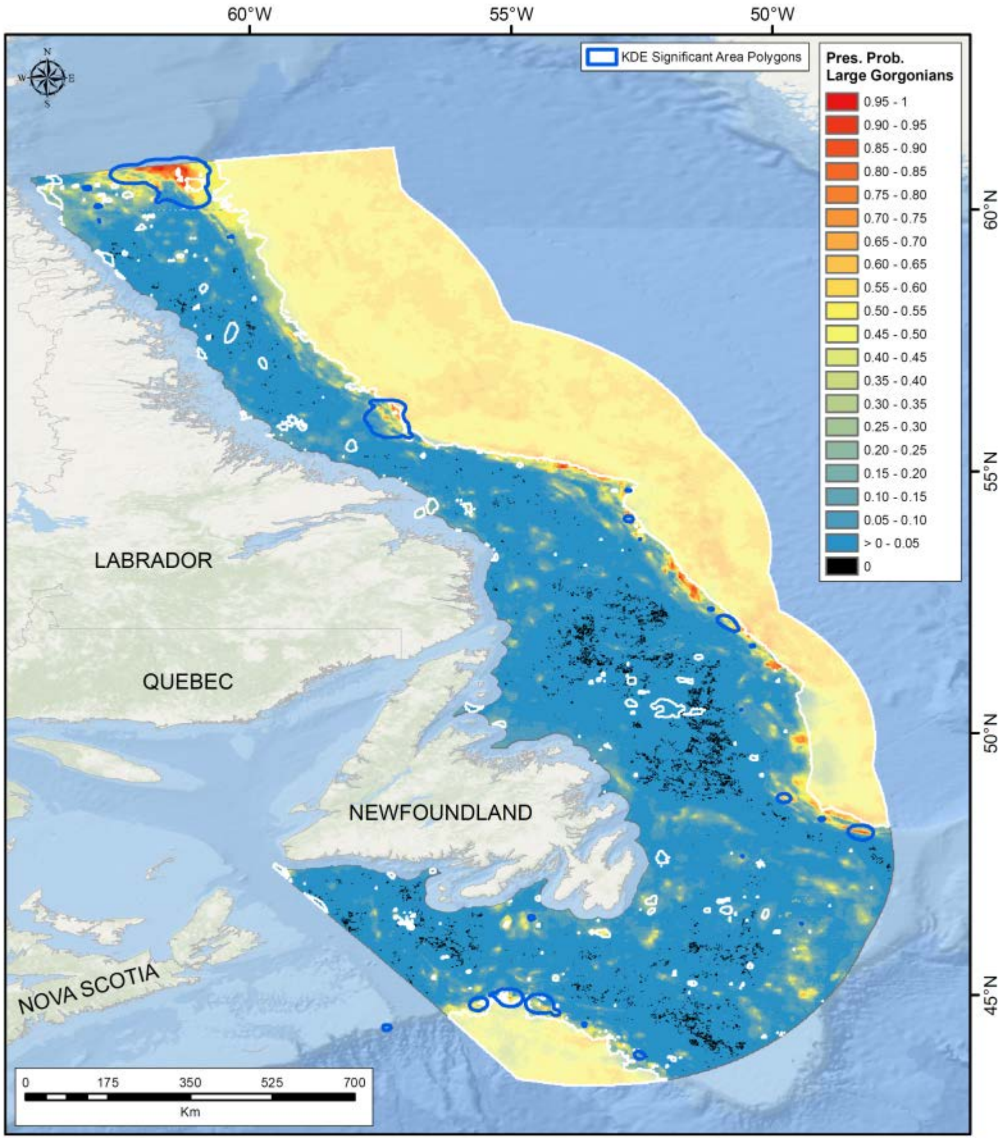


Figure 48. *Predictions of presence probability (Pres. Prob.) of large gorgonian corals based on a RF model on unbalanced presence and absence large gorgonian coral catch data collected from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 2003 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of large gorgonian corals identified by KDE are shown in blue outline.*

Table 10. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of large gorgonian corals from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted within the Newfoundland and Labrador Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.806	**Absence**	4330	1321	5651	0.234	0.726	0.766
SD	0.039	**Presence**	141	373	514	0.274		

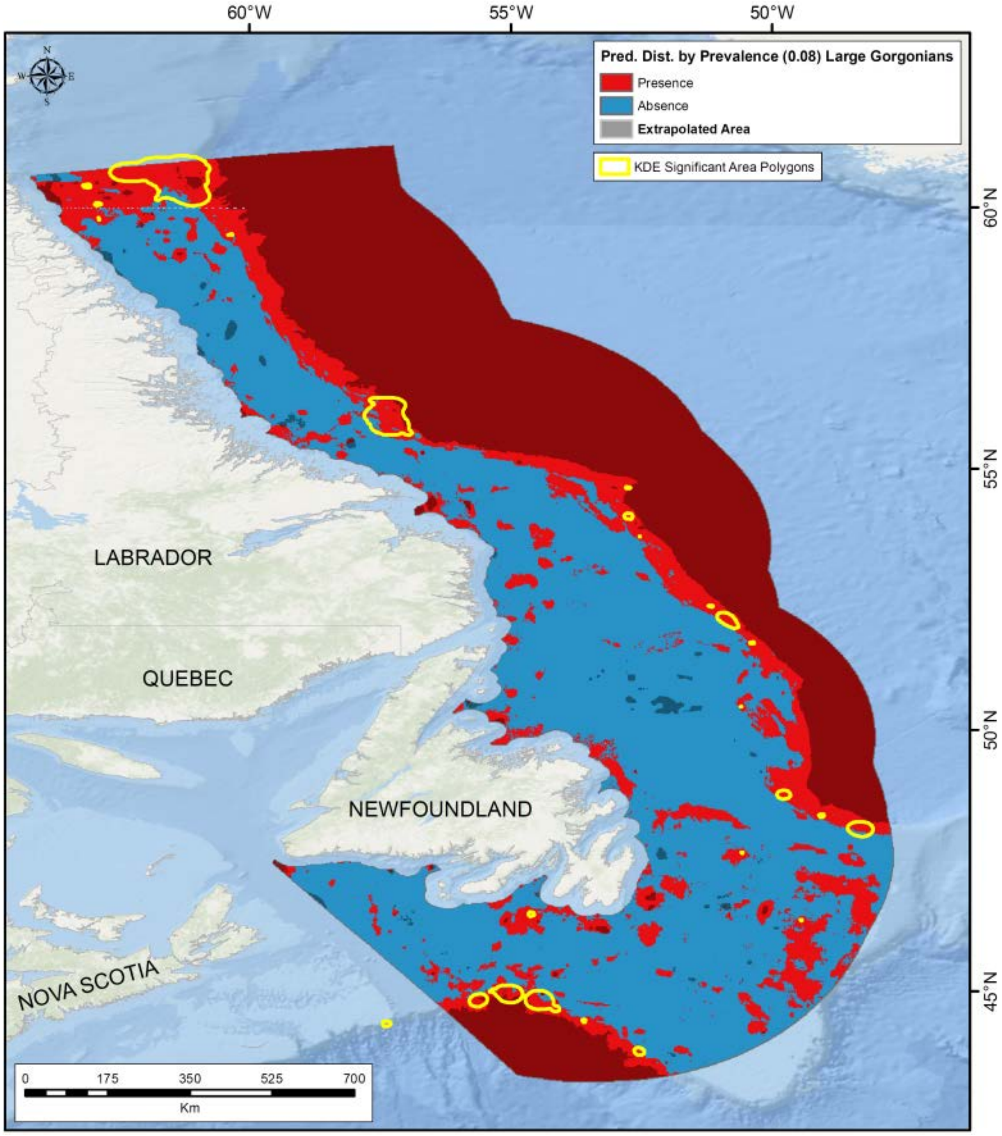


Figure 49. *Classification of large gorgonian coral presence probability based on the prevalence threshold of 0.08. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface. Areas of significant concentrations of large gorgonian corals identified by KDE are shown in yellow outline.*

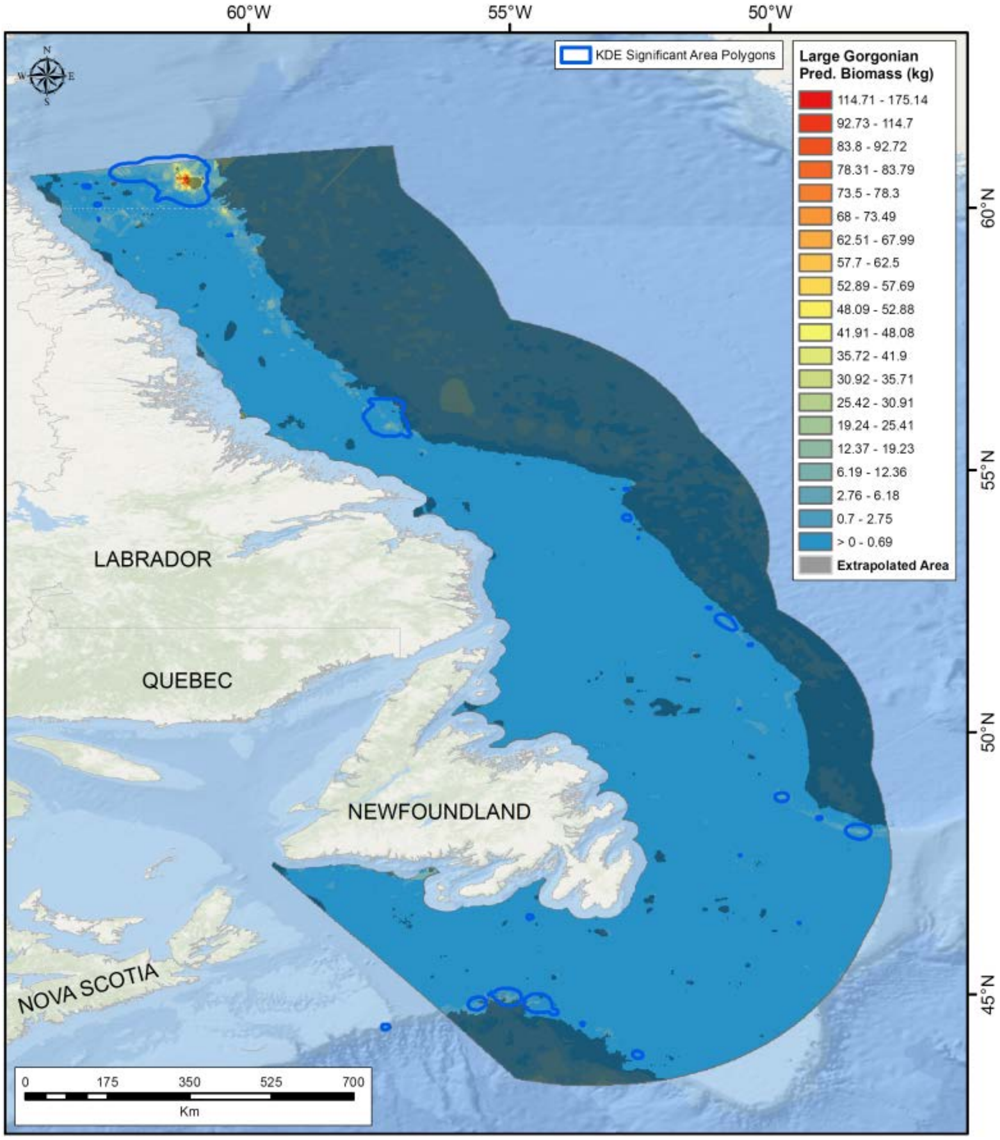


Figure 50. *Predictions of biomass (kg) of large gorgonian corals from catch data recorded in DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 2003 and 2015. Grey areas indicate areas of extrapolation. Areas of significant concentrations of large gorgonian corals identified by KDE are shown in blue outline.*

Small Gorgonian Corals

In our KDE analyses, there were 396 records with small gorgonian coral catch and 5419 records of catches with no small gorgonians from the same surveys. In contrast there were only 152 records available for the previous analysis (Kenchington et al., 2010). The updated analysis identified several new small gorgonian coral areas along the Labrador Slope and slope northern boundary of the NAFO 3O Closure Area (Figure 51). Polygons identified in 2010 along the northern boundary of the 3O Closure were greatly expanded in the current analysis (Figure 52).

The RF model using all available small gorgonian coral records and unbalanced species prevalence was selected as the best predictor of small gorgonian coral distribution in the Newfoundland and Labrador Region (Figure 53 and Table 11; Guijarro et al., 2016). The AUC of this model was very good (0.859). Depth was the top environmental predictor variable in this model. The highest predicted presence probability of small gorgonian corals occurred along the slope in the 3O Closure Area southwest of Grand Bank. Small pockets of moderate small gorgonian coral presence probability were predicted along the Labrador Slope. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Small pockets of extrapolated area were distributed across the continental shelf. All deep water beyond the slope was considered extrapolated area. Much of the continental shelf was predicted as absence of small gorgonian corals, while the slopes of Newfoundland and Labrador were predicted as presence of small gorgonian corals (Figure 54).

The regression random forest model on small gorgonian biomass had little predictive power (average $R^2 = 0.108 \pm 0.080$ SD; average percent variance explained = -1.23% ± 2.46 SD) and consequently, the predicted biomass surface was not presented here.

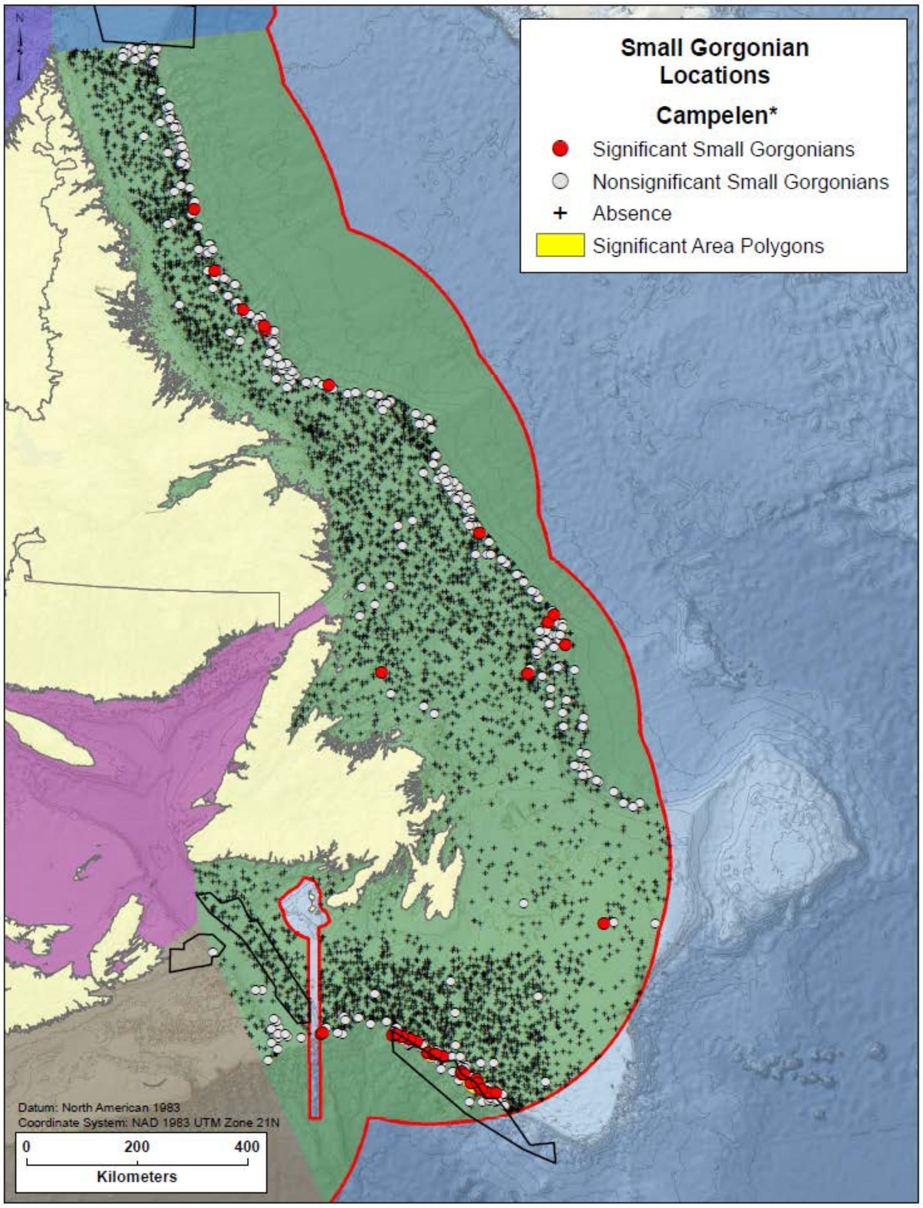


Figure 51. *Location of the polygons identifying significant small gorgonian coral aggregations relative to the broader distribution of small gorgonian corals and areas closed or proposed to be closed to protect benthic species and habitats in the Newfoundland and Labrador Shelves Biogeographic Zone (black outline). Catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as nonsignificant. Null data (absence) is indicated by the black cross. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

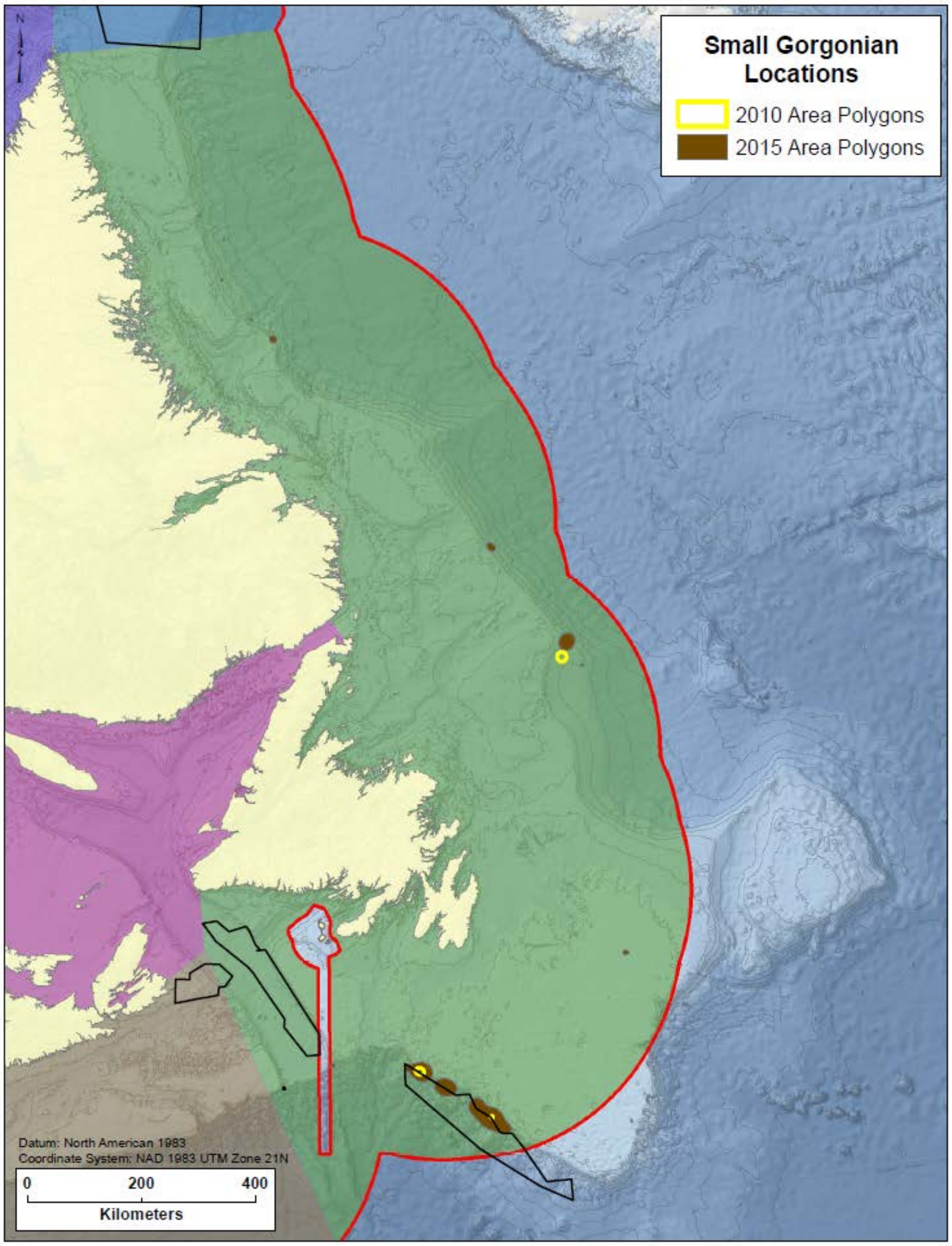


Figure 52. *Comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (brown polygons). Areas closed or proposed to be closed to protect benthic species and habitats are indicated in black outline. Red lines indicate the EEZs of Canada and France (St. Pierre and Miquelon).*

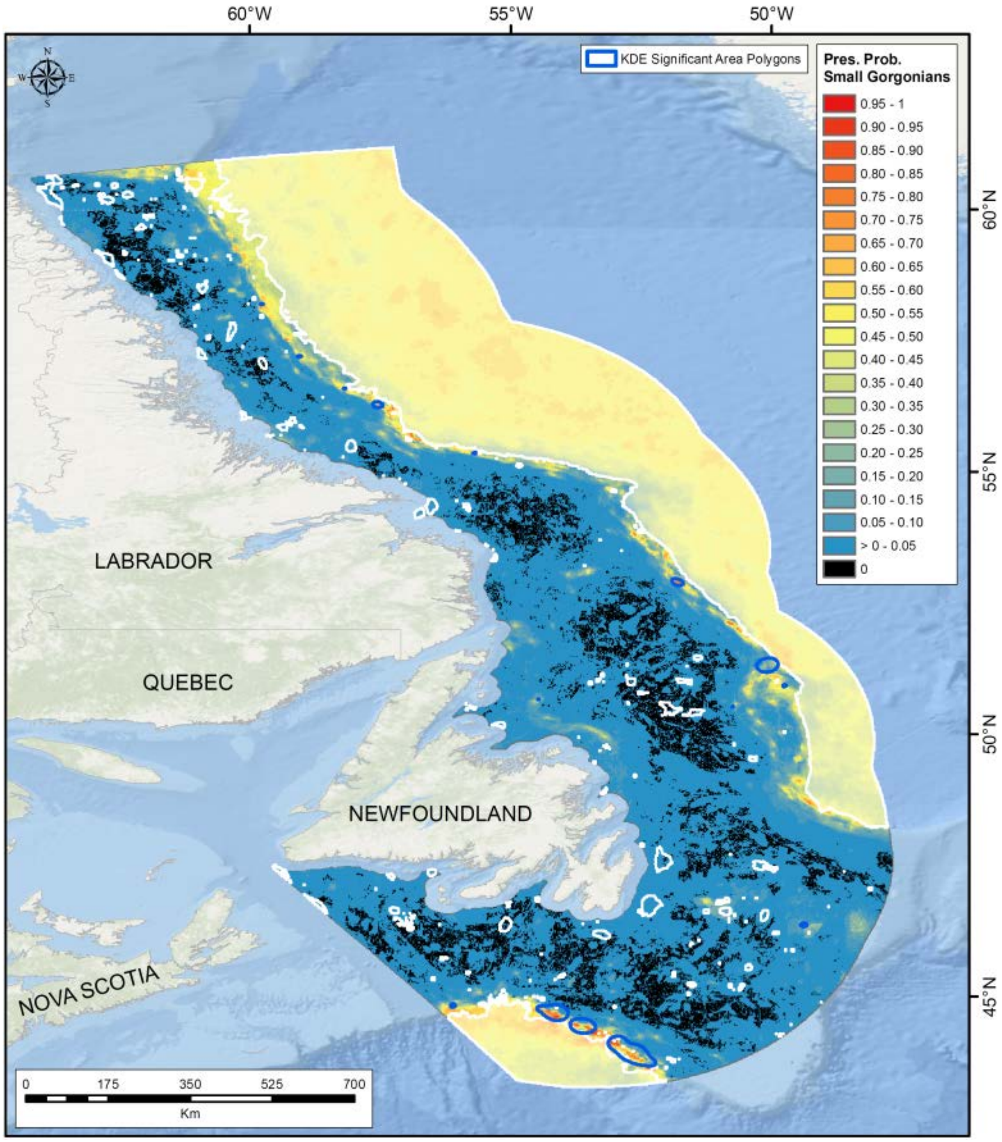


Figure 53. *Predictions of presence probability (Pres. Prob.) of small gorgonian corals based on a RF model on unbalanced presence and absence small gorgonian coral catch data collected from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted in the Newfoundland and Labrador Region between 2003 and 2015. White lines indicate areas of extrapolation. Areas of significant concentrations of small gorgonian corals identified by KDE are shown in blue outline.*

Table 11. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of small gorgonian corals from DFO multispecies surveys, DFO/industry shrimp surveys, and Spanish trawl surveys conducted within the Newfoundland and Labrador Region. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.859	**Absence**	3975	992	4967	0.200	0.800	0.800
SD	0.041	**Presence**	74	296	370	0.200		

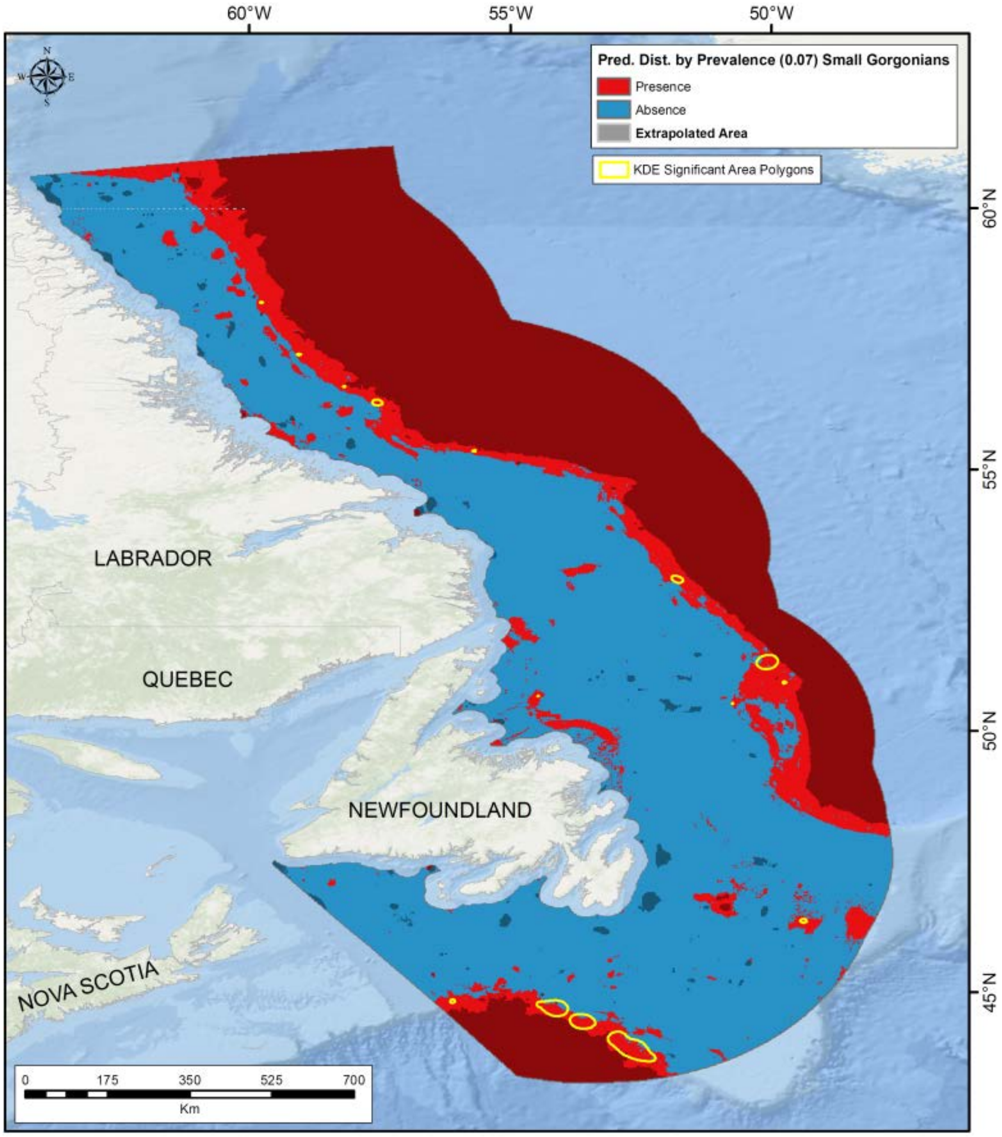


Figure 54. *Classification of small gorgonian coral presence probability based on the prevalence threshold of 0.07. Also shown are the grey areas of model extrapolation, they appear dark red when overlain on the red presence surface and dark blue when overlain on the blue absence surface. Areas of significant concentrations of small gorgonian corals identified by KDE are shown in yellow outline.*

HUDSON STRAIT

In this biogeographic zone there were too few records to apply KDE to the large or small gorgonian corals and sea pens. Our analyses were conducted on sponges within Hudson Strait and Ungava Bay (termed the Hudson Strait – Ungava Bay Region herein) in the eastern portion of the Hudson Bay Complex Biogeographic Zone.

Sponges (Porifera)

Sponge catch records for the Hudson Strait – Ungava Bay Region were derived from trawl surveys using both Campelen and Cosmos trawl gear. Campelen trawl records were insufficient for KDE, and therefore, only Cosmos records were analyzed. From this gear type, there were 229 records with sponge catch and 109 records of catches with no sponges from the same surveys. This represented 57 more presence records with this gear type than were available for the previous analysis (Kenchington et al., 2010). Several small significant area polygons were identified in the Ungava Bay portion of the region, northwest and southeast of Atpatok Island (Figure 55).

The accuracy measures of the regression random forest model on mean sponge biomass from Cosmos trawl surveys were poor ($R^2 \leq 0.1$ and/or negative percent variance explained) and therefore the predicted biomass surface from this model is not presented here. The highest R^2 from this model was 0.246, while the average was 0.101 ± 0.086 SD (Beazley et al, 2016c). The average Normalized Root-Mean-Square Error was 0.075 ± 0.042 SD. This model explained a negative percent variance (mean = -8.67% ± 2.41 SD).

The RF model was generated on sponge presence and absence records from both Campelen and Cosmos trawl surveys combined. The model using all available sponge records and unbalanced species prevalence was selected as the best predictor of sponge distribution in the Hudson Strait- Ungava Bay Region (Figure 56 and Table 12; Beazley et al., 2016c). The AUC of this model was poor (0.643). Surface Current Mean was the top environmental predictor variable in this model. Western Hudson Strait was predicted to have high and even presence probability of sponges (Figure 56). Pockets of sponge presence probability were distributed across eastern Hudson Strait and Ungava Bay, with larger areas of high presence probability located northwest of Akpatok Island and south of Baffin Island. Several KDE polygons generated from the Cosmos biomass records fall outside of the SDM extent along the southern coast of Baffin Island. Areas of high and low presence probability of sponges corresponded well with the location of presence and absence data points. The largest area of model extrapolated was along the coast of southern Ungava Bay. Most of western Hudson Strait was classified as presence of sponges (Figure 57). The northern portion of Ungava Bay east of Akpatok Island was classified as absence of sponges.

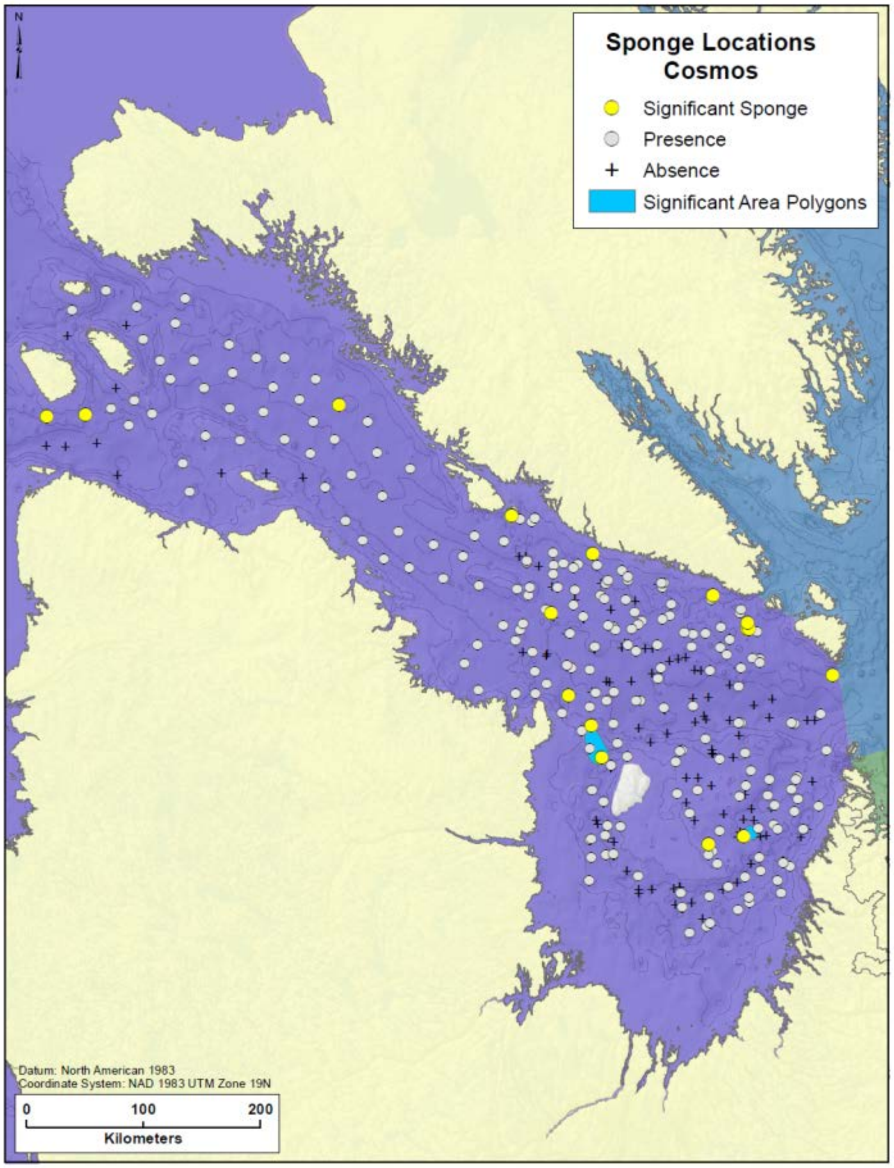


Figure 55. *Location of the polygons identifying significant sponge aggregations relative to the broader distribution of sponges in Hudson Strait. Porifera catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross.*

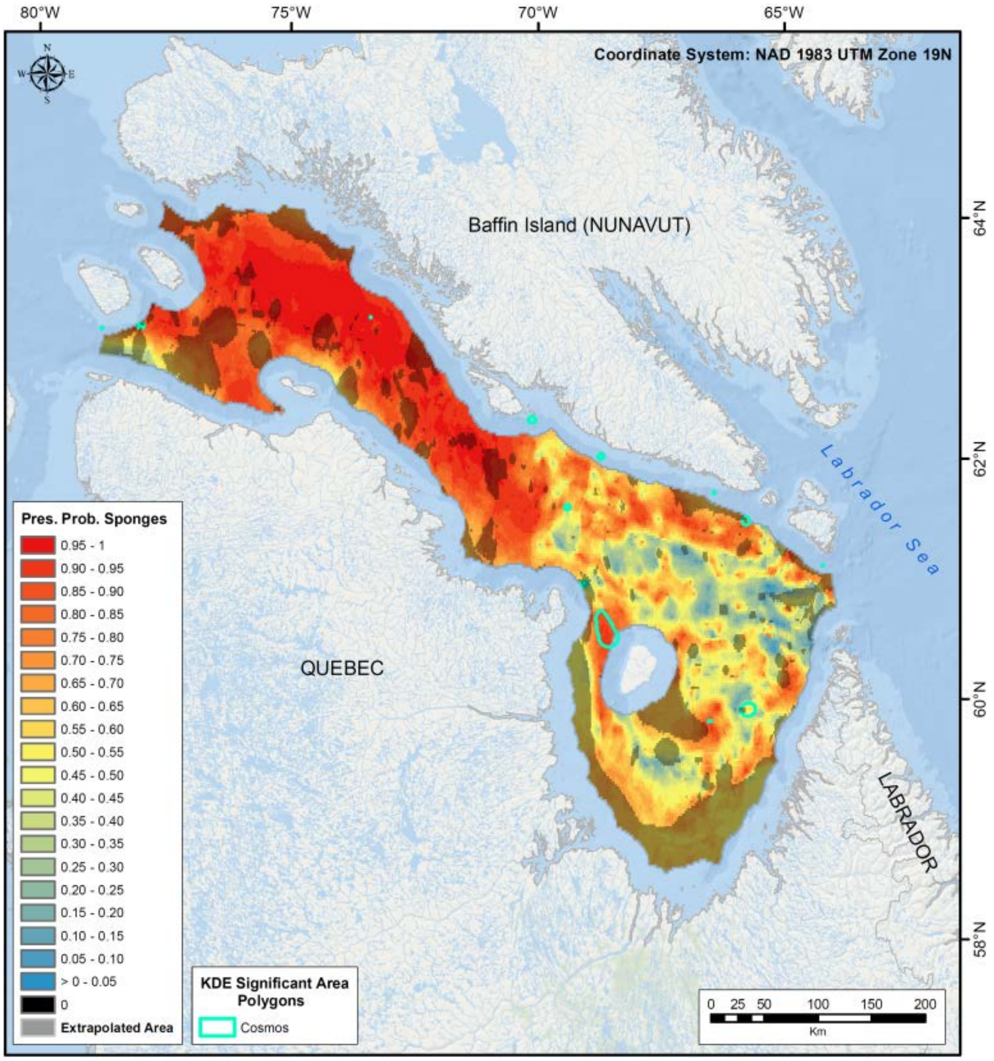


Figure 56. *Predictions of presence probability (Pres. Prob.) of sponges based on a RF model on unbalanced presence and absence sponge by-catch data collected from DFO multispecies surveys and DFO/industry shrimp surveys conducted in the Hudson Strait – Ungava Bay Area between 2006 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE are shown in cyan blue outline.*

Table 12. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of sponges from DFO multispecies surveys and DFO/industry shrimp surveys. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.643	**Absence**	104	66	170	0.388	0.574	0.612
SD	0.085	**Presence**	98	132	230	0.426		

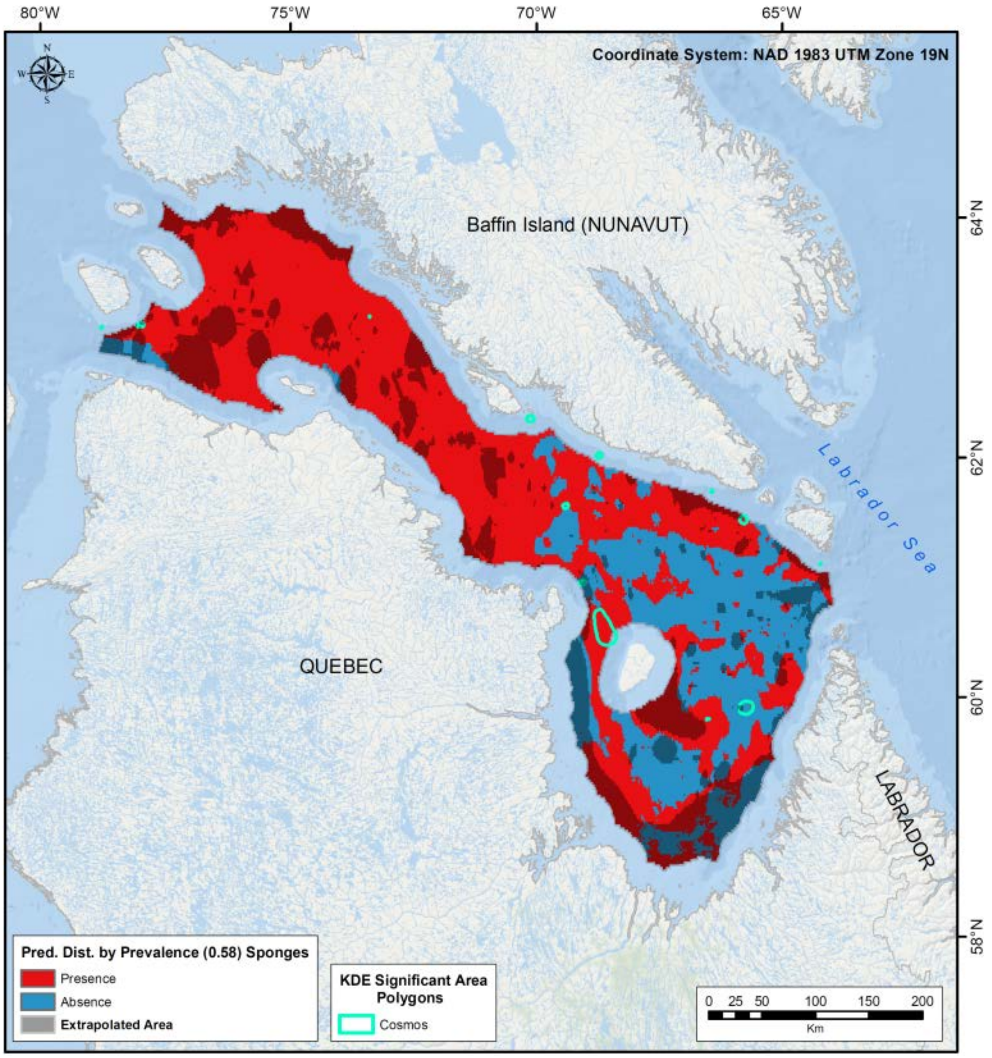


Figure 57. *Classification of sponge presence probability based on the prevalence threshold of 0.58. Also shown are the grey areas of model extrapolation, which appear dark red or dark blue when overlain on the presence-absence surface. Areas of significant concentrations of sponges identified by KDE are shown in cyan blue outline.*

EASTERN ARCTIC

Sponges (Porifera)

Sponge catch records for the Eastern Arctic Region were derived from Alfredo, Campelen, and Cosmos trawl data. KDE analyses were run separately on catch records from each of the three gear types. For Alfredo gear there were 663 records with sea pen catch and 177 records of catches with no sponges from the same surveys from 1999 to 2014. In the present analysis, the same general areas are recognized but several polygons northeast of Hatton Basin were expanded (Figure 58). The largest sponge biomass is outside of the volunteer closed area put in place by industry but no data were collected within the closed area to examine it in more detail. Small pockets of high biomass were predicted to occur in the Davis Strait by the regression random forest model using Alfredo trawl records (Figure 59). These corresponded to large Alfredo catches that occurred there. The accuracy measures of this model indicated good model performance (Beazley et al., 2016c). The highest R^2 was 0.639, while the average was 0.327 ±

0.242 SD. The average Normalized Root-Mean-Square Error was 0.040 ± 0.026 SD. The average percent variance explained by the model was 15.44% ± 6.98 SD. Bottom Temperature Average Minimum was the top environmental predictor variable in this model.

From Campelen trawl surveys, there were 711 records with sponge catch and 862 records of catches with no sponges from the same surveys from conducted 2005 to 2014. The significant areas identified in the current analysis are very similar in location to those from 2010, with expansion of most polygons (Figure 60). The regression random forest model on sponge biomass from Campelen trawl survey records predicted high sponge biomass in the southeast corner of the study extent in Davis Strait (Figure 61; Beazley et al., 2016c). The accuracy measures of this model indicated good model performance. The highest R^2 was 0.803, while the average was 0.480 ± 0.174 SD. The average Normalized Root-Mean-Square Error was 0.032 ± 0.018 SD. The average percent variance explained by the model was 31.91% ± 4.82 SD. The top environmental predictor variable was Surface Salinity Average Minimum.

From Cosmos trawl surveys, there were 167 records with sponge catch and 62 records of catches with no sponges from the same surveys conducted from 2006 to 2012. The significant areas identified in the current analysis are almost identical to those from 2010 (Figure 62). The accuracy measures of the regression random forest model on mean sponge biomass records from Cosmos trawl surveys were poor ($R^2 \leq 0.1$ and/or negative percent variance explained) and consequently the biomass prediction surface is not presented here. The R^2 value of this model indicated good model performance (mean = 0.295 ± 0.208 SD), however, the percent variance explained was negative (-14.81% ± 11.93 SD).

The sponge RF model was generated on sponge presence and absence records from all three gear types combined. The model using all available sponge records and unbalanced species prevalence was selected as the best predictor of sponge distribution in the Eastern Arctic Region (Figure 63 and Table 13; Beazley et al., 2016c). The AUC of this model was good (0.791), with Depth being the top environmental predictor variable. The highest predicted sponge presence probability occurred in the deeper waters of Davis Strait and along Baffin Island Shelf. Areas in northern Baffin Bay were also predicted to have high sponge presence probability. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Areas of extrapolation occurred in Lancaster Sound, the Gulf of Boothia, in the deep water off Baffin Island Shelf, and in the southeast corner of the spatial extent in Davis Strait. Much of the Davis Strait, southeast Baffin Bay and Baffin Island Shelf were predicted as presence of sponges (Figure 64).

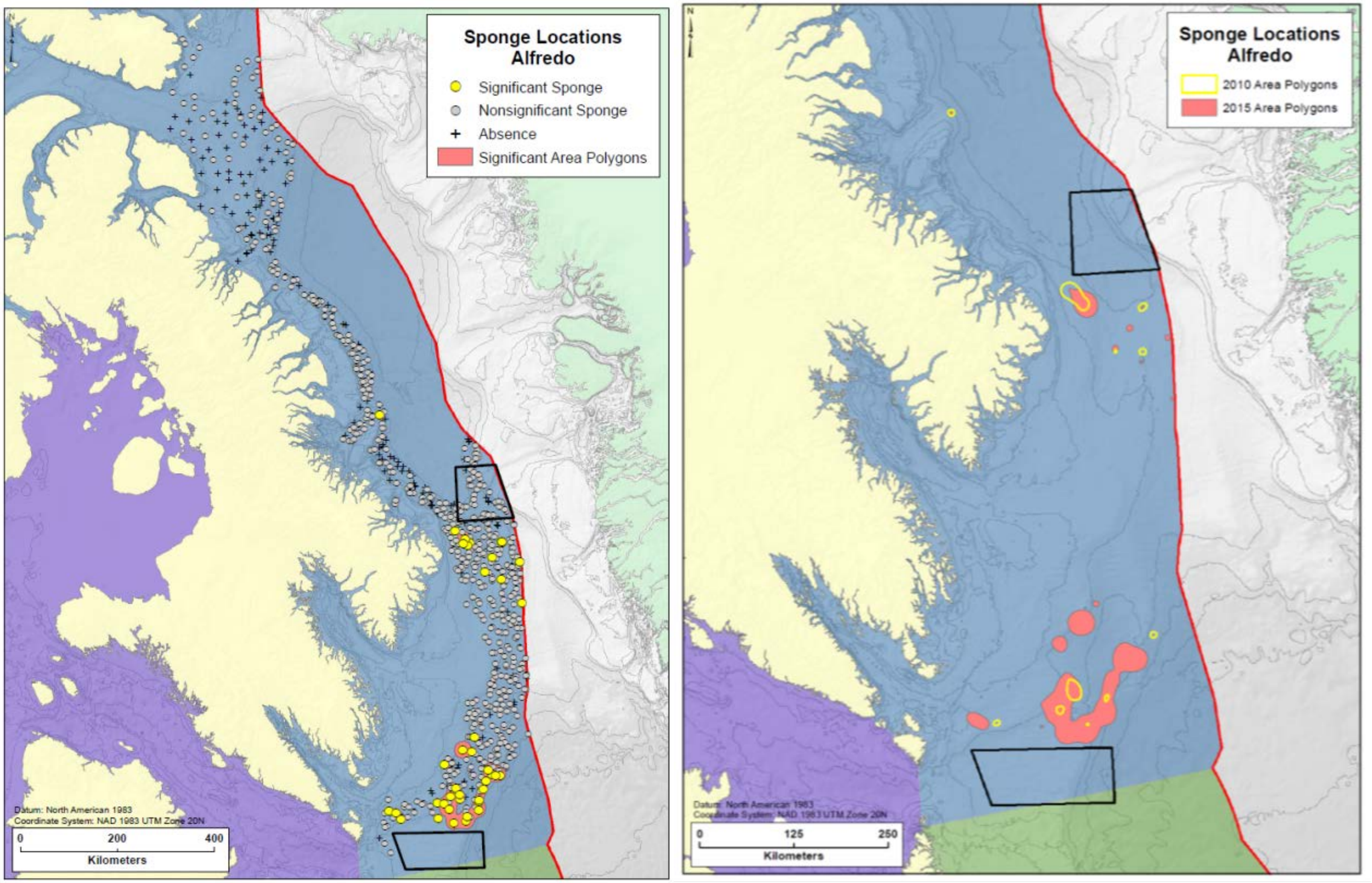


Figure 58. *Location of the polygons identifying significant sponge aggregations relative to the broader distribution of sponges from Alfredo gear in the Eastern Arctic (left panel). Porifera catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. Right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (pink polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

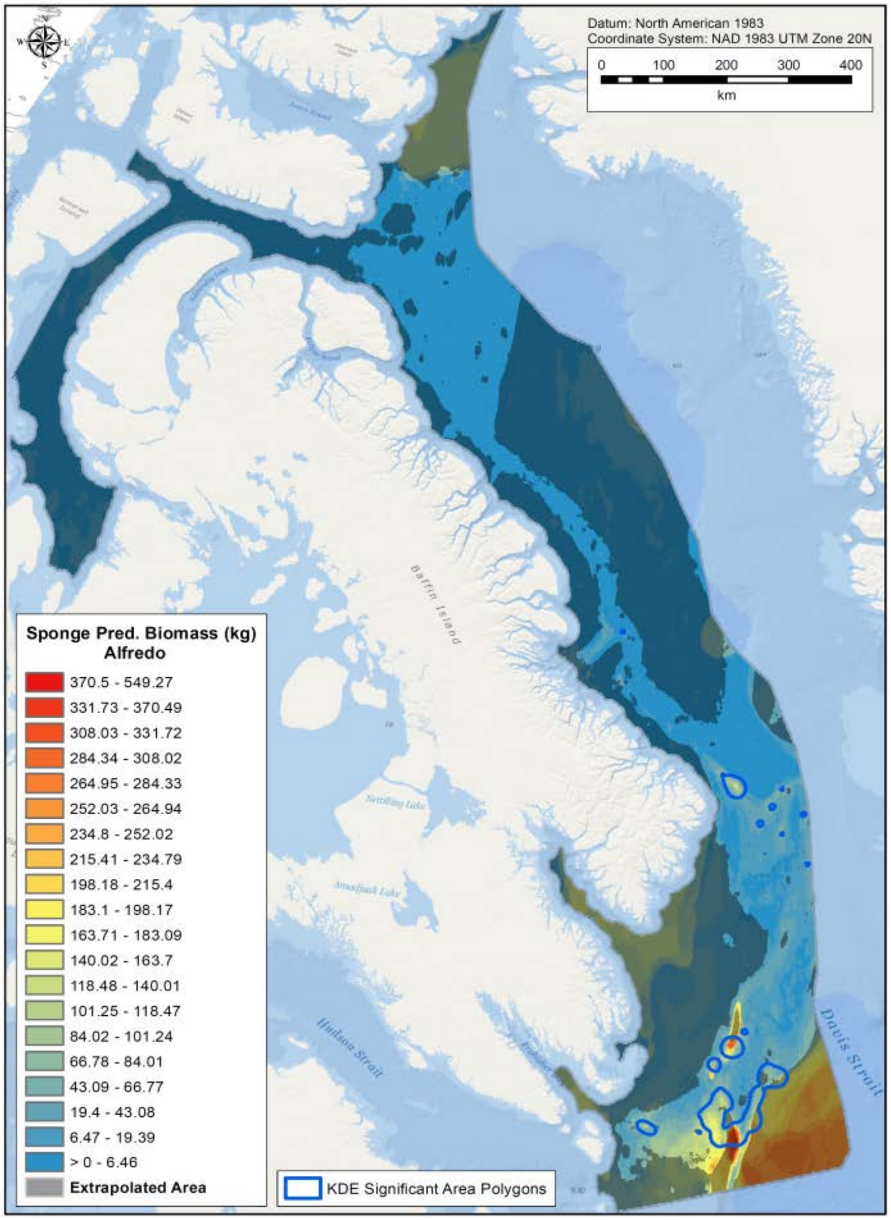


Figure 59. *Predictions of biomass (kg) of sponges from catch data recorded in DFO multispecies surveys conducted using Alfredo trawl gear in the Eastern Arctic Region between 1999 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE for Alfredo gear are shown in blue.*

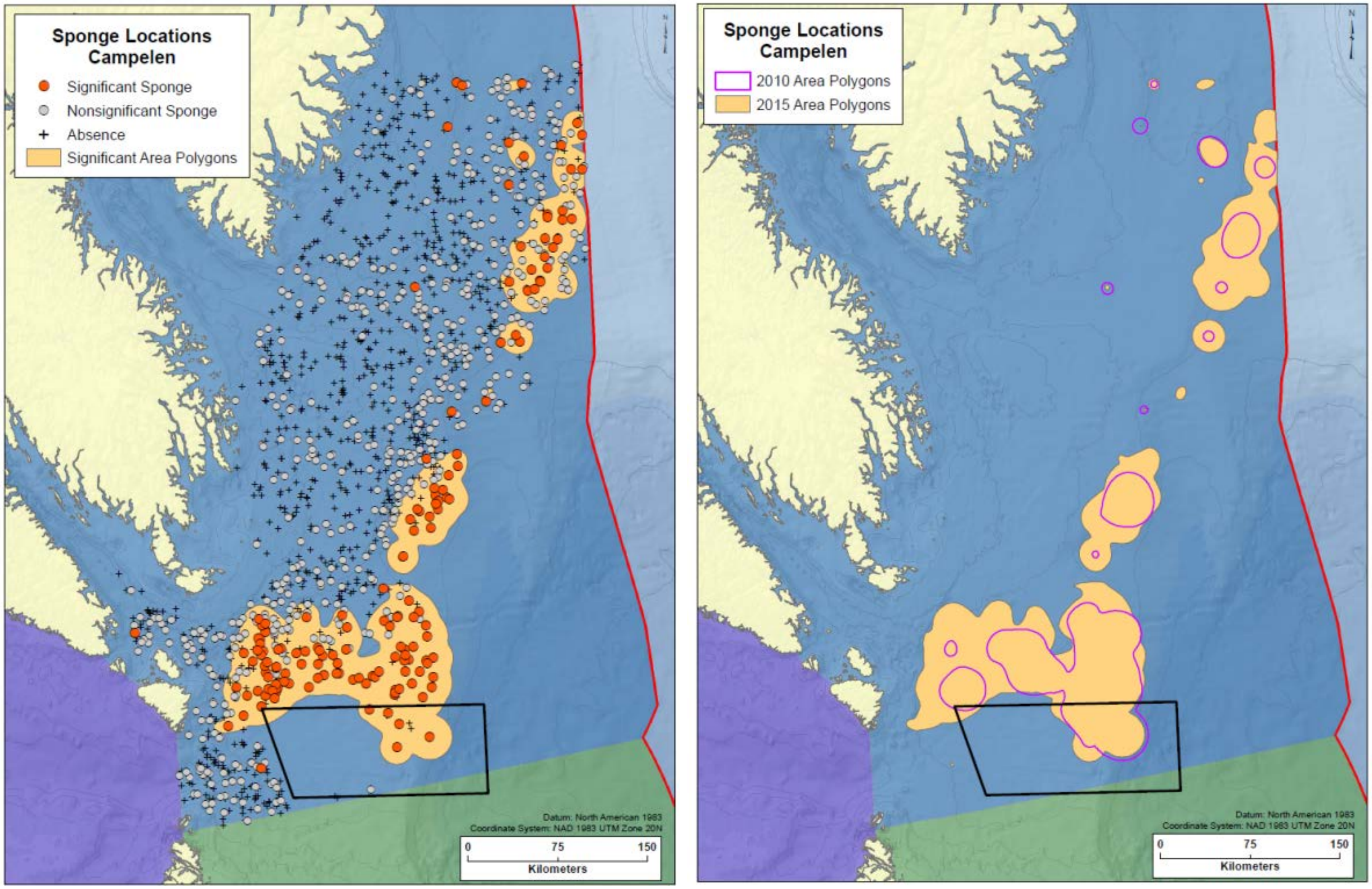


Figure 60. *Location of the polygons identifying significant sponge aggregations relative to the broader distribution of sponges from Campelen gear in the Eastern Arctic (left panel). Porifera catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. Right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (purple outline) and those identified in this study (light orange polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

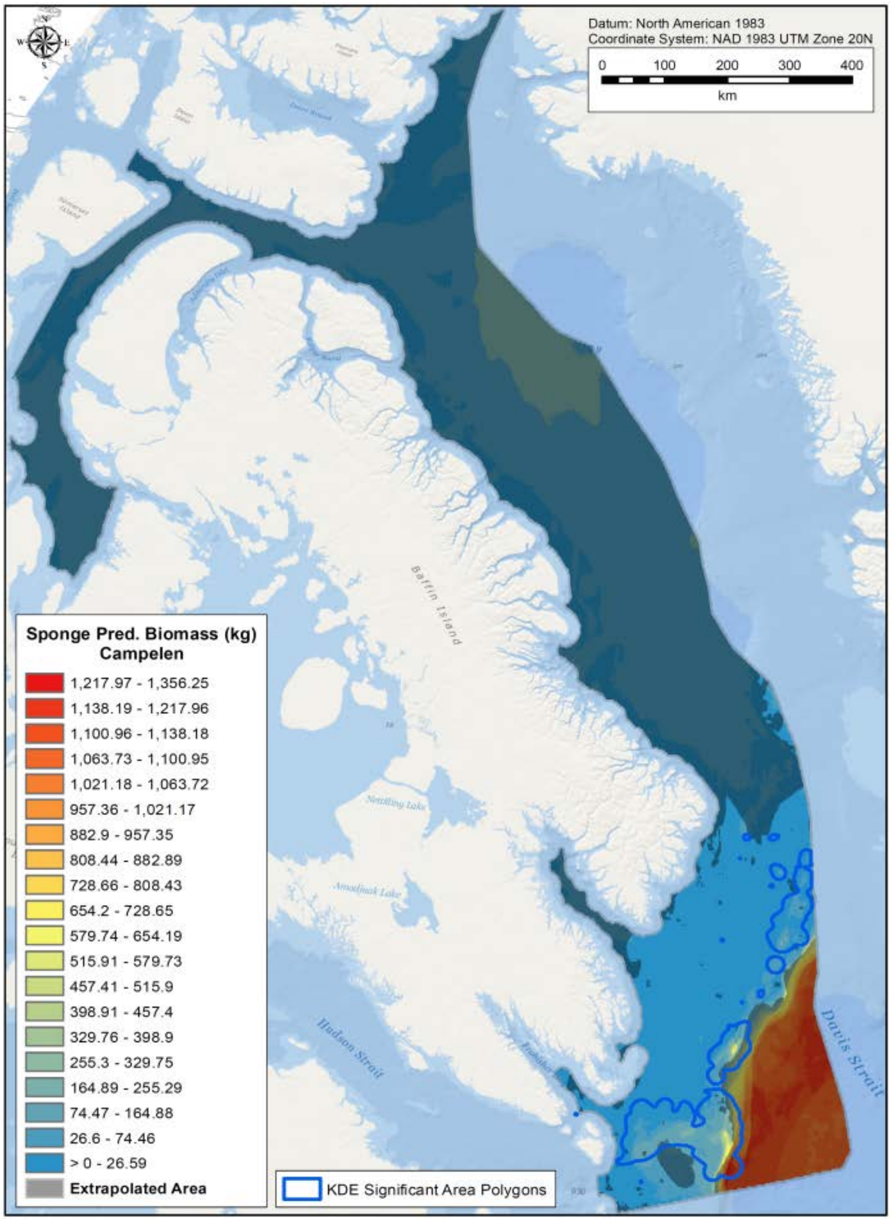


Figure 61. *Predictions of biomass (kg) of sponges from catch data recorded in DFO/industry shrimp surveys conducted using Campelen trawl gear in the Eastern Arctic Region between 1996 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sponges identified by KDE for Campelen gear are shown in blue outline.*

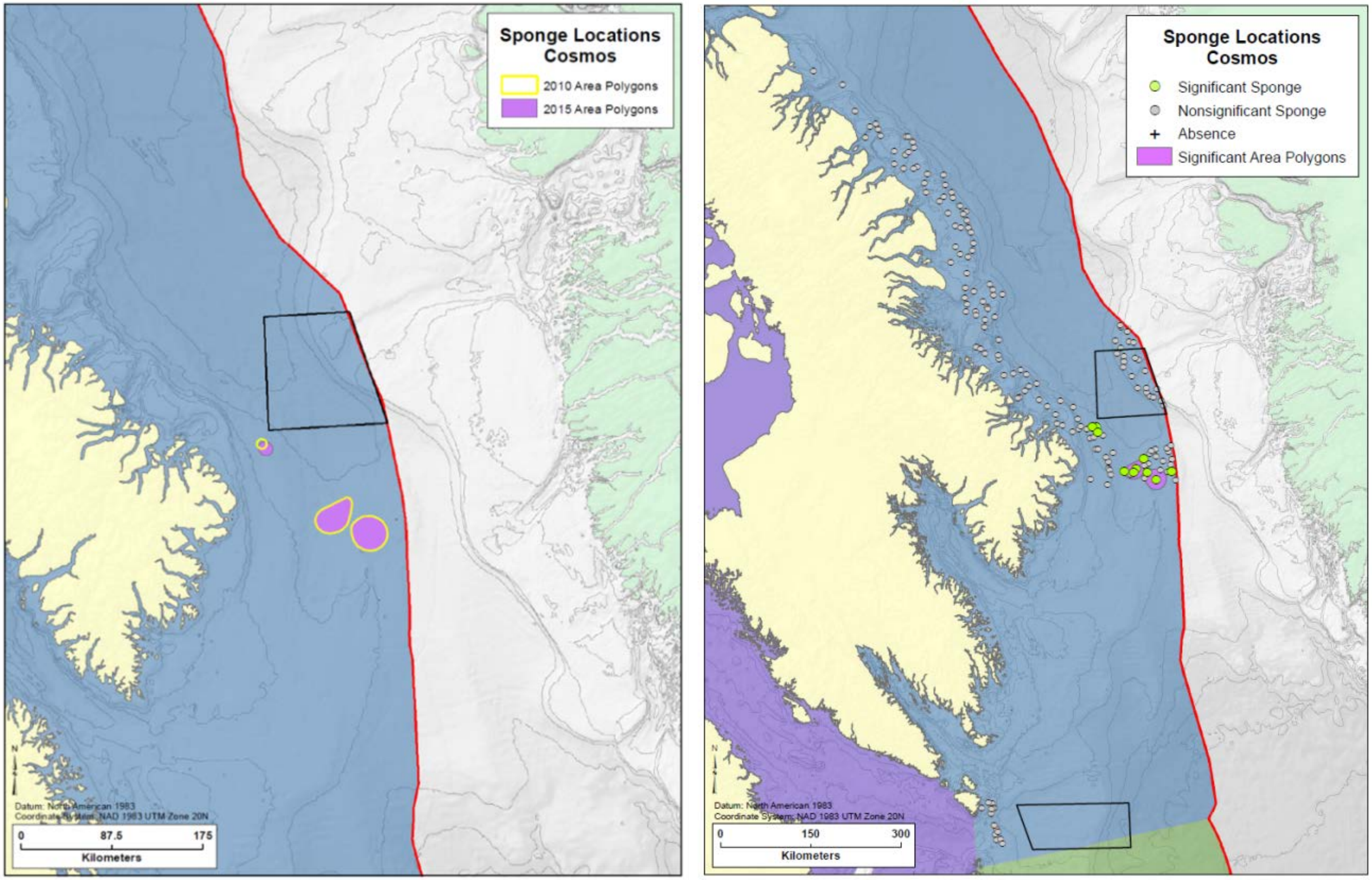


Figure 62. *Location of the polygons identifying significant sponge aggregations relative to the broader distribution of sponges from Cosmos gear in the Eastern Arctic (left panel). Sponge catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. Right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (purple polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

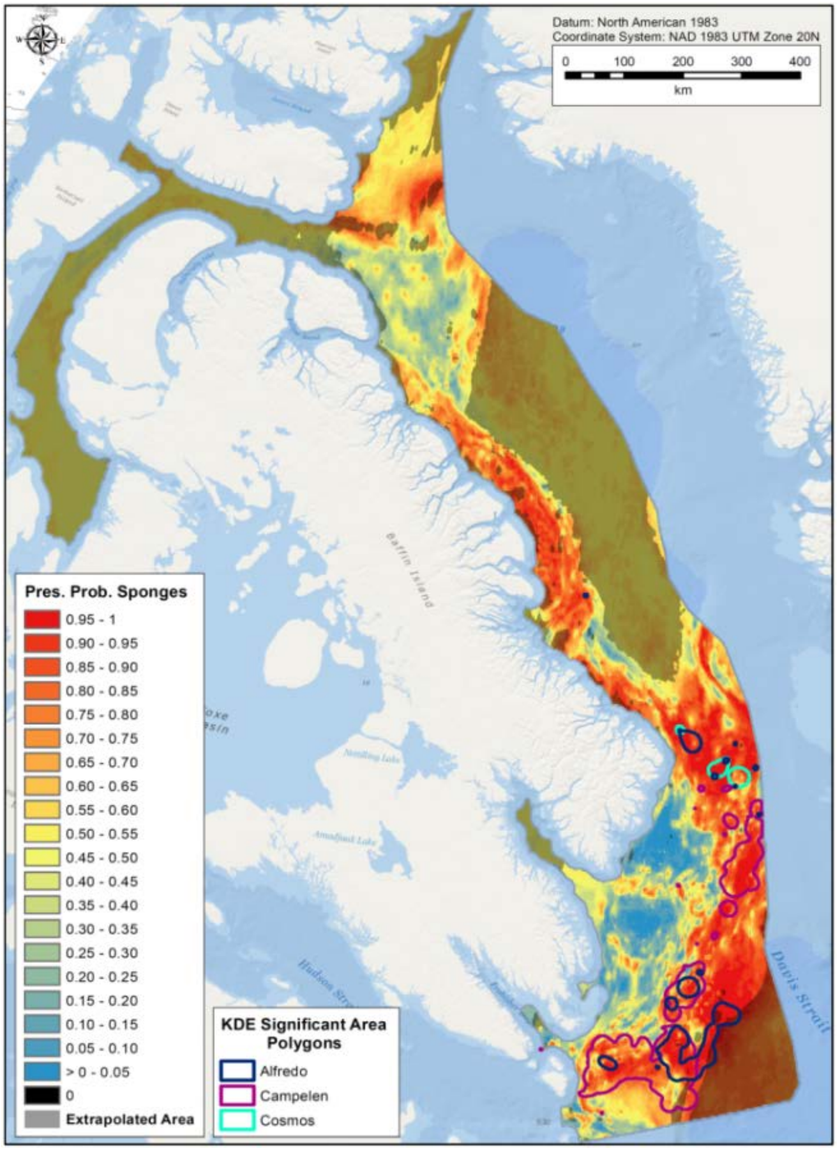


Figure 63. *Predictions of presence probability (Pres. Prob.) of sponges based on a RF model on unbalanced presence and absence sponge catch data collected from DFO multispecies surveys and DFO/industry shrimp surveys conducted in the Eastern Arctic Region between 1999 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sea pens from KDE are shown in the dark blue outline for Alfredo gear, purple outline for Campelen gear, and cyan blue outline for Cosmos gear.*

Table 13. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of sponges from DFO multispecies surveys and DFO/industry shrimp surveys in the Eastern Arctic. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.791	**Absence**	723	259	982	0.264	0.709	0.736
SD	0.029	**Presence**	421	1028	1449	0.291		

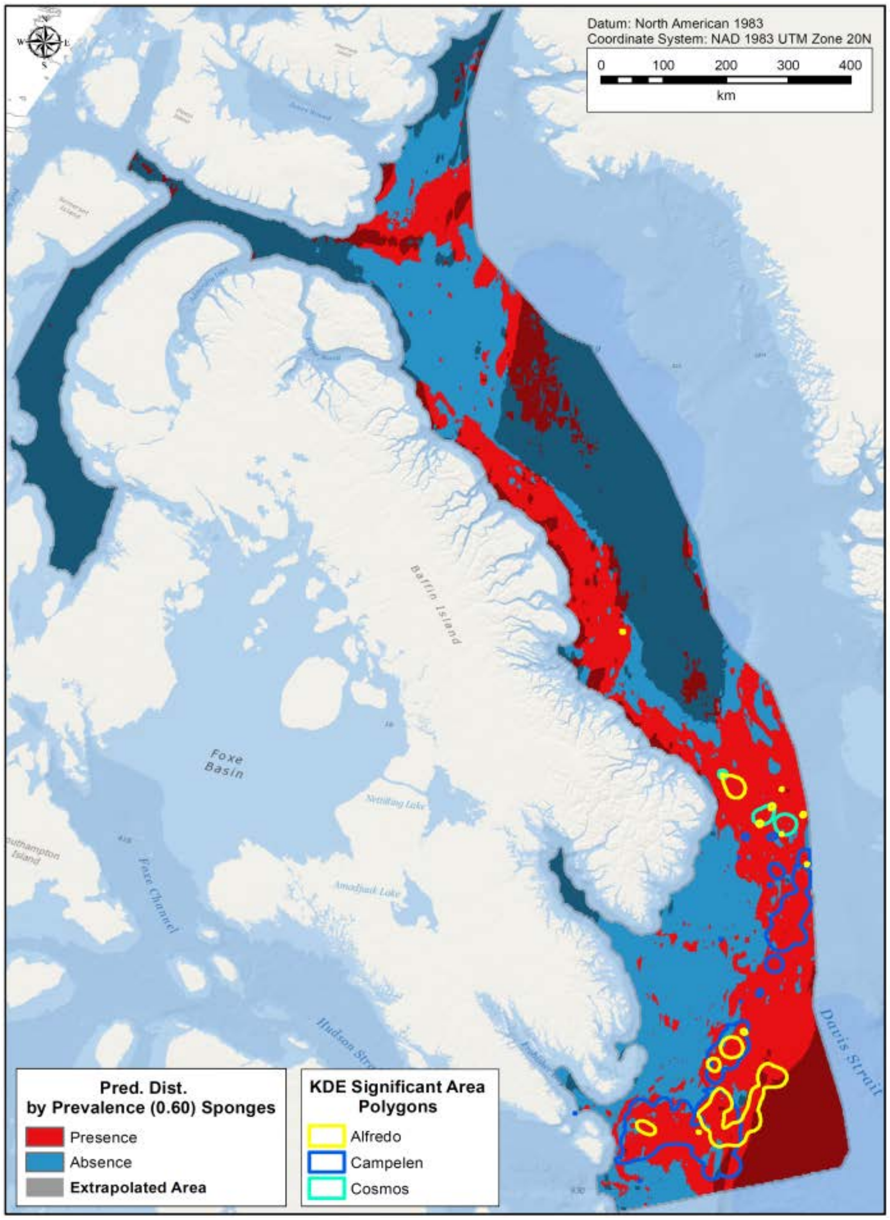


Figure 64. *Classification of sponge presence probability based on the prevalence threshold of 0.60. Also shown are the grey areas of model extrapolation, which appear dark red or dark blue when overlain on the presence-absence surface. Areas of significant concentrations of sponges identified by KDE are shown in yellow (Alfredo), dark blue (Campelen), and cyan blue (Cosmos) outline.*

Sea Pens (Pennatulacea)

Sea pen catch records for the Eastern Arctic Region were derived from Alfredo, Campelen, and Cosmos trawl data. KDE analyses were run separately on catch records from each of the three gear types. For Alfredo gear there were 316 records with sea pen catch and 470 records of catches with no sea pens from a subset of the surveys conducted from 2006 to 2014. In the present analysis, several new polygons were identified. These were located mainly on Baffin Island Shelf and in northern Baffin Bay southeast of Devon Island (Figure 65). Several significant area polygons from 2010 are no longer present in the updated analysis.

There were 67 Campelen records with sea pen catch and 1508 records of catches with no sea pens from the same surveys from 2005 to 2014. The significant areas identified in the current analysis are very similar in location to those from 2010 (Figure 66). Several new polygons were identified, and others were expanded.

There were 57 Cosmos records with sea pen catch and 171 records of catches with no sea pens from the same surveys from 2006 to 2012. Significant polygons from 2010 were much reduced in the updated analysis (Figure 67).

The accuracy measures of the regression random forest models on mean sea pen biomass records from each of the three gear types were poor ($R^2 \leq 0.1$ and/or negative percent variance explained) and are consequently the biomass prediction surfaces from all three models are not presented here. For the model using Alfredo records, the highest R^2 value was 0.202, while the average was 0.089 ± 0.069 SD (Beazley et al., 2016c). The average percentage variance explained was negative (-3.03% ± 2.41 SD). A similar result was found with the Campelen and Cosmos models, which had average R^2 values of 0.041 ± 0.062 SD and 0.087 ± 0.176 SD, respectively, and average percent variance explained of -8.99% ± 3.96 and -12.47% ± 3.43 SD, respectively.

The sea pen RF model was generated on presence and absence records from all three gear types combined. The model using all available sea pen records and unbalanced species prevalence was selected as the best predictor of sea pen distribution in the Eastern Arctic Region (Figure 68 and Table 14; Beazley et al., 2016c). The AUC of this model was very good (0.838), with Bottom Salinity Average Range being the top environmental predictor variable, followed by Depth. The highest predicted sea pen presence probability occurred in northern Baffin Bay southeast of Devon Island. The edge of the Baffin Island Shelf also had smaller pockets of high sea pen presence probability. Much of the Davis Strait was predicted to have zero or low presence probability of sea pens. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Predicted presence probability was low in locations where a high number of presence observations occurred, particularly along the shelf break of Baffin Island and in Davis Strait. This could be due to the high overlap between presence and absence data points in those areas and the inclusion of all absence data in the model. Areas of extrapolation occurred in Lancaster Sound, the Gulf of Boothia, in the deep water off Baffin Island Shelf, and in the southeast corner of the spatial extent in Davis Strait. Most of the study extent was predicted as presence of sea pens (Figure 69). The largest area predicted as absence of sea pens occurred in the southern portion of the study extent in Davis Strait. Smaller pockets of sea pen absence were located on Baffin Island Shelf.

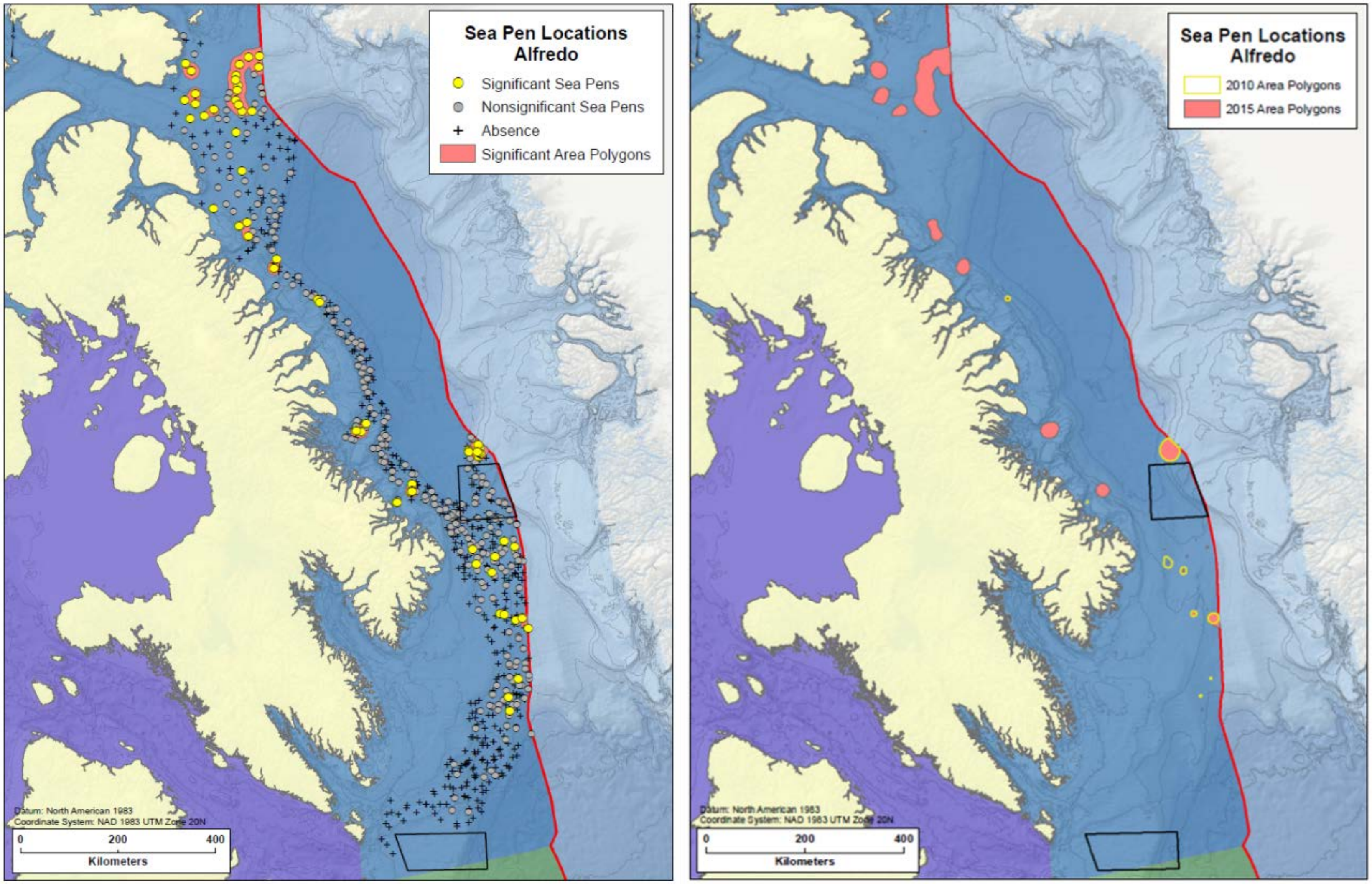


Figure 65. *Locations of the significant sea pen areas from Alfredo trawl gear relative to the broader distribution of sea pens in the Davis Strait – Baffin Bay area (left panel). Sea pen catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. The right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (pink polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

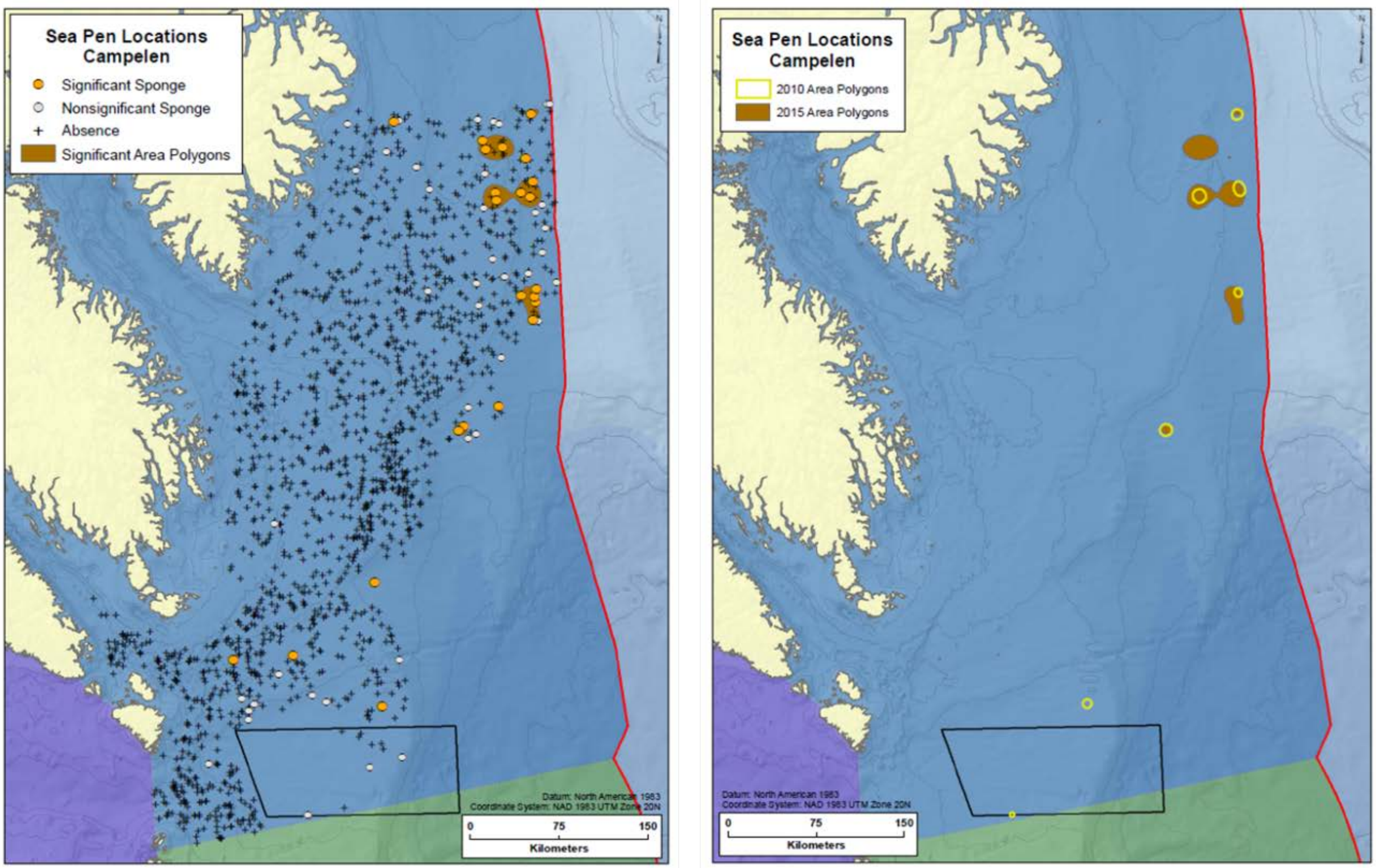


Figure 66. *Locations of the significant sea pen areas from Campelen trawl gear relative to the broader distribution of sea pens in the Davis Strait – Southern Baffin Bay area (left panel). Sea pen catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. The right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (pink polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

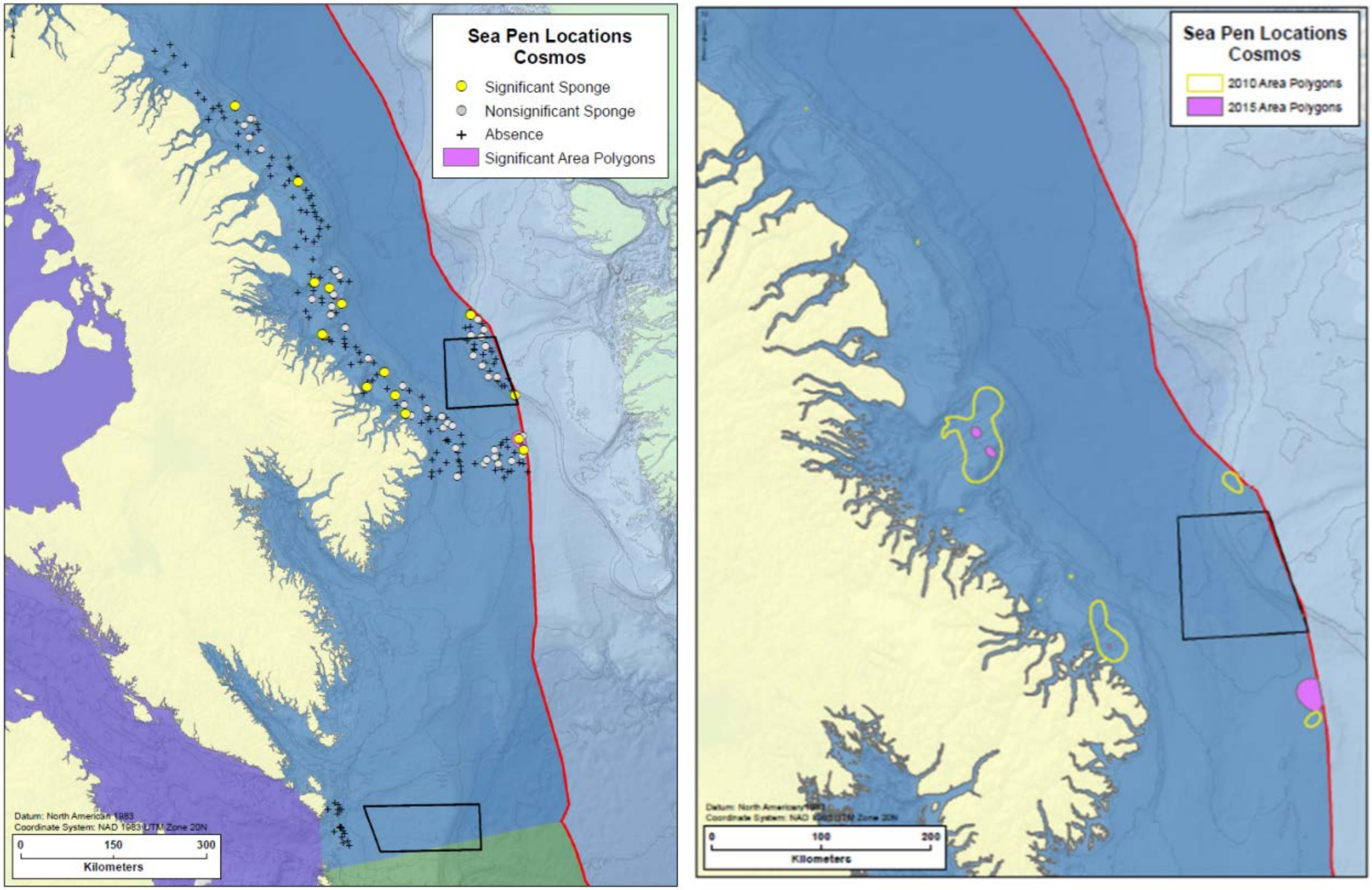


Figure 67. *Locations of the significant sea pen areas from Cosmos trawl gear relative to the broader distribution of sea pens in the Davis Strait – Southern Baffin Bay area (left panel). Sea pen catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. The right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (yellow outline) and those identified in this study (pink polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

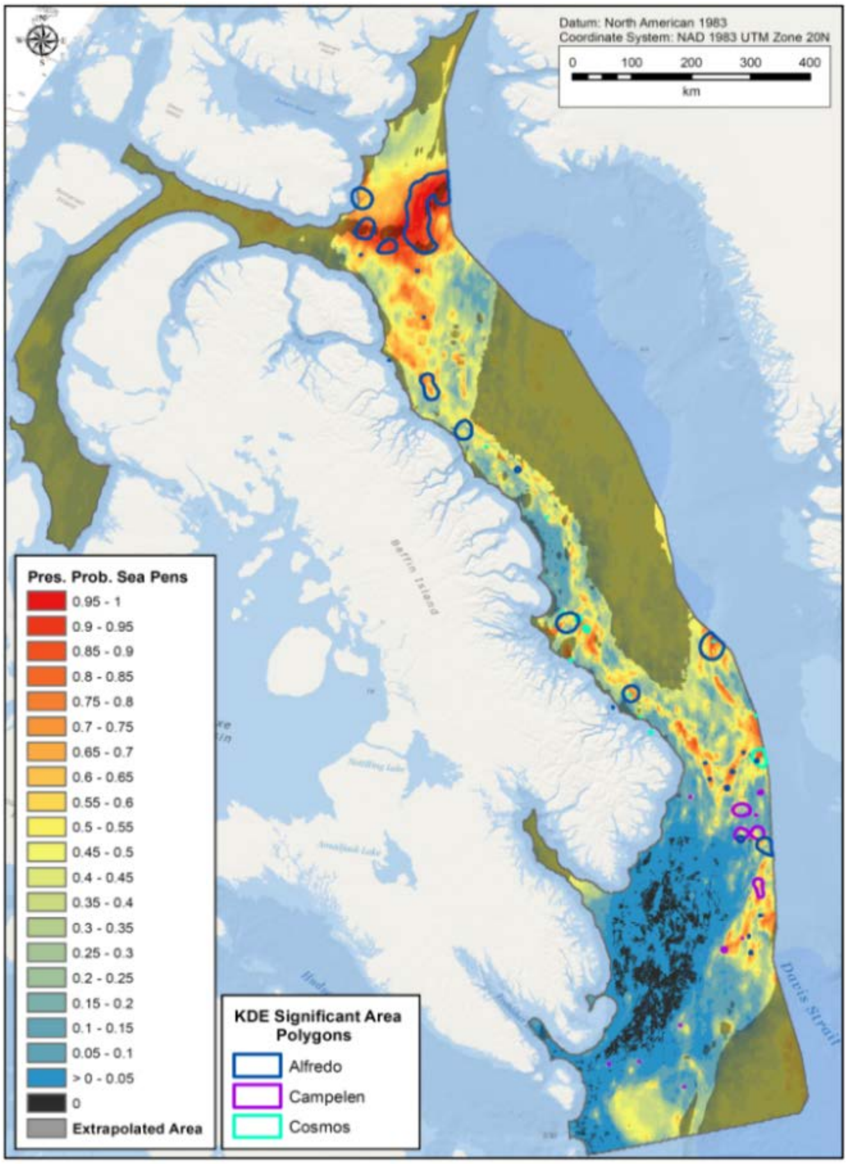


Figure 68. *Predictions of presence probability (Pres. Prob.) of sponges based on a RF model on unbalanced presence and absence sea pen catch data collected from DFO multispecies surveys and DFO/industry shrimp surveys conducted in the Eastern Arctic Region between 1999 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of sea pens from KDE are shown in the blue outline for Alfredo gear, purple outline for Campelen gear, and cyan blue outline for Cosmos gear.*

Table 14. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of sea pens from DFO multispecies surveys and DFO/industry shrimp surveys. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.838	**Absence**	1413	548	1961	0.279	0.814	0.721
SD	0.014	**Presence**	78	342	420	0.186		

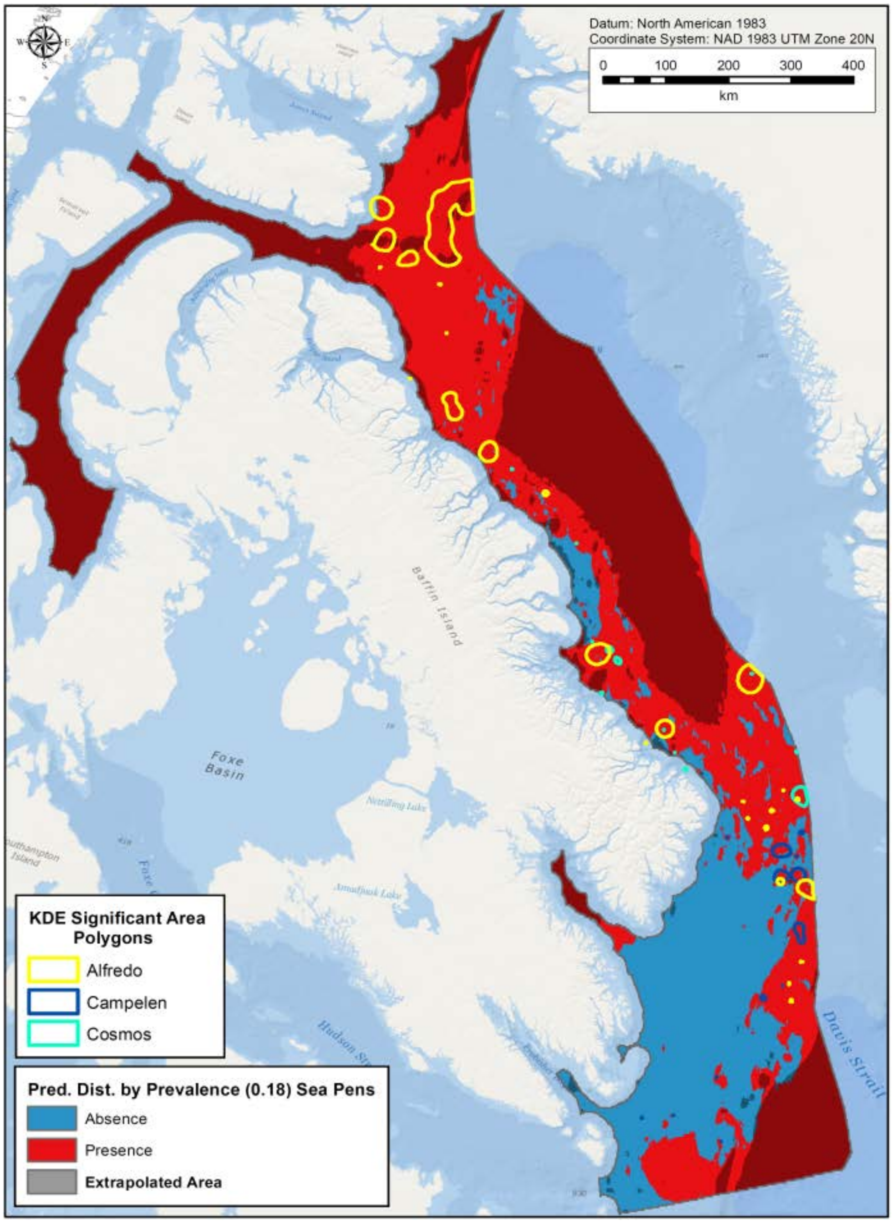


Figure 69. *Classification of sea pen presence probability based on the prevalence threshold of 0.18. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface. Areas of significant concentrations of sea pens from KDE are shown in the yellow outline for Alfredo gear, dark blue outline for Campelen gear, and cyan blue outline for Cosmos gear.*

Large Gorgonian Corals

Large gorgonian coral catch records for the Eastern Arctic Region were derived from Alfredo and Campelen trawl surveys. In the 2010 analysis, small gorgonian records from Alfredo gear were insufficient for KDE analysis and so KDE was run only on Campelen records. In the current analysis, KDE was run separately on catch records from each gear type. For Alfredo gear there were 39 records with large gorgonian coral catch and 733 records of catches with no large gorgonian corals from the same surveys conducted between 2006 and 2014. KDE analysis of this data revealed several significant area polygons in the Davis Strait (Figure 70).

The regression random forest model in large gorgonian catch from Alfredo gear performed poorly ($R^2 \leq 0.1$ and/or negative percent variance explained) and consequently the prediction surface of this model is not presented (Beazley et al., 2016c).

There were 120 Campelen records with large gorgonian coral catch and 1455 records of catches with no large gorgonians from the same surveys. Several new significant area polygons were identified in Davis Strait north of the voluntary coral closure (Figure 71). Existing polygons within and outside the closure were expanded in the current analysis. The regression random forest model on large gorgonian coral biomass from Campelen trawl survey records predicted several small pockets of high large gorgonian coral biomass in Davis Strait directly north of the voluntary closure area (Figure 72). Moderate biomass was predicted to occur in the southeast corner of the study extent in Davis Strait. The accuracy measures of this model indicated good model performance (Beazley et al., 2016c). The highest R^2 was 0.470, while the average was 0.186 ± 0.160 SD. The average Normalized Root-Mean-Square Error (NRSME) was 0.013 ± 0.007 SD. The average variance explained was 16.86% ± 4.99 SD. The top environmental predictor variable in this model was Bottom Temperature Average Minimum.

The large gorgonian coral RF model was generated on presence and absence records from both the Alfredo and Campelen gear types combined. The model using all available large gorgonian coral records and unbalanced species prevalence was selected as the best predictor of small gorgonian coral distribution in the Eastern Arctic Region (Figure 73 and Table 15; Beazley et al., 2016c). The AUC of this model was good (0.752). Bottom Temperature Average Minimum was the top predictor variable in this model. The highest predicted large gorgonian coral presence probability occurred in the Davis Strait within and north of the voluntary coral closure. The southeast corner of the study extent in Davis Strait was predicted to have moderate presence probability of large gorgonian corals. Much of Baffin Bay was predicted to have zero or low presence probability of small gorgonian corals. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. Lancaster Sound, Gulf of Boothia, the deep water off Baffin Island Shelf, and the southeast corner of the study extent in Davis Strait was considered extrapolated area by the model. With the exception of Lancaster Sound and the Gulf of Boothia, much of the shallow portion of the study extent in Baffin Bay and Davis Strait were classified as absence of large gorgonian corals (Figure 74). The deep waters in Baffin Basin and Davis Strait were predicted as presence of large gorgonian corals.

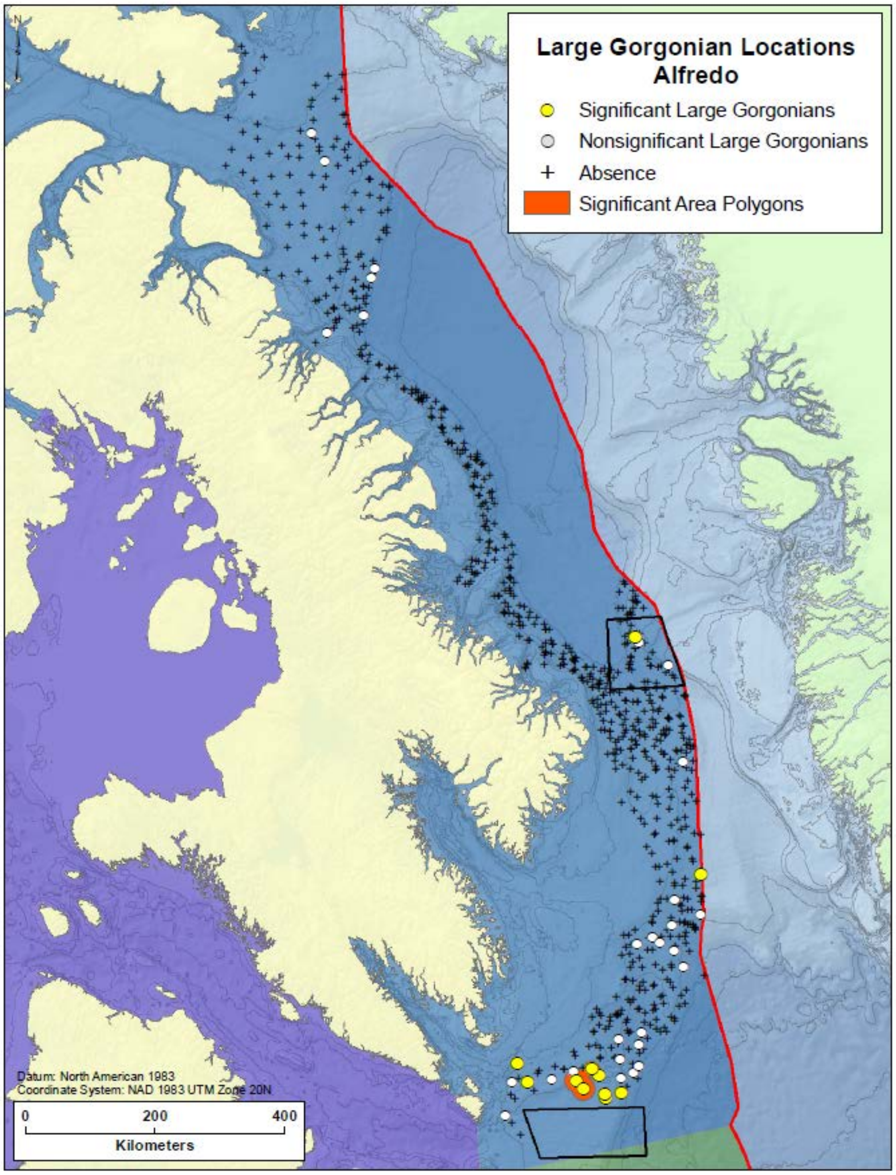


Figure 70. *Location of the polygons identifying significant large gorgonian coral aggregations relative to the broader distribution of large gorgonian corals in the Eastern Arctic. Large gorgonian coral catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

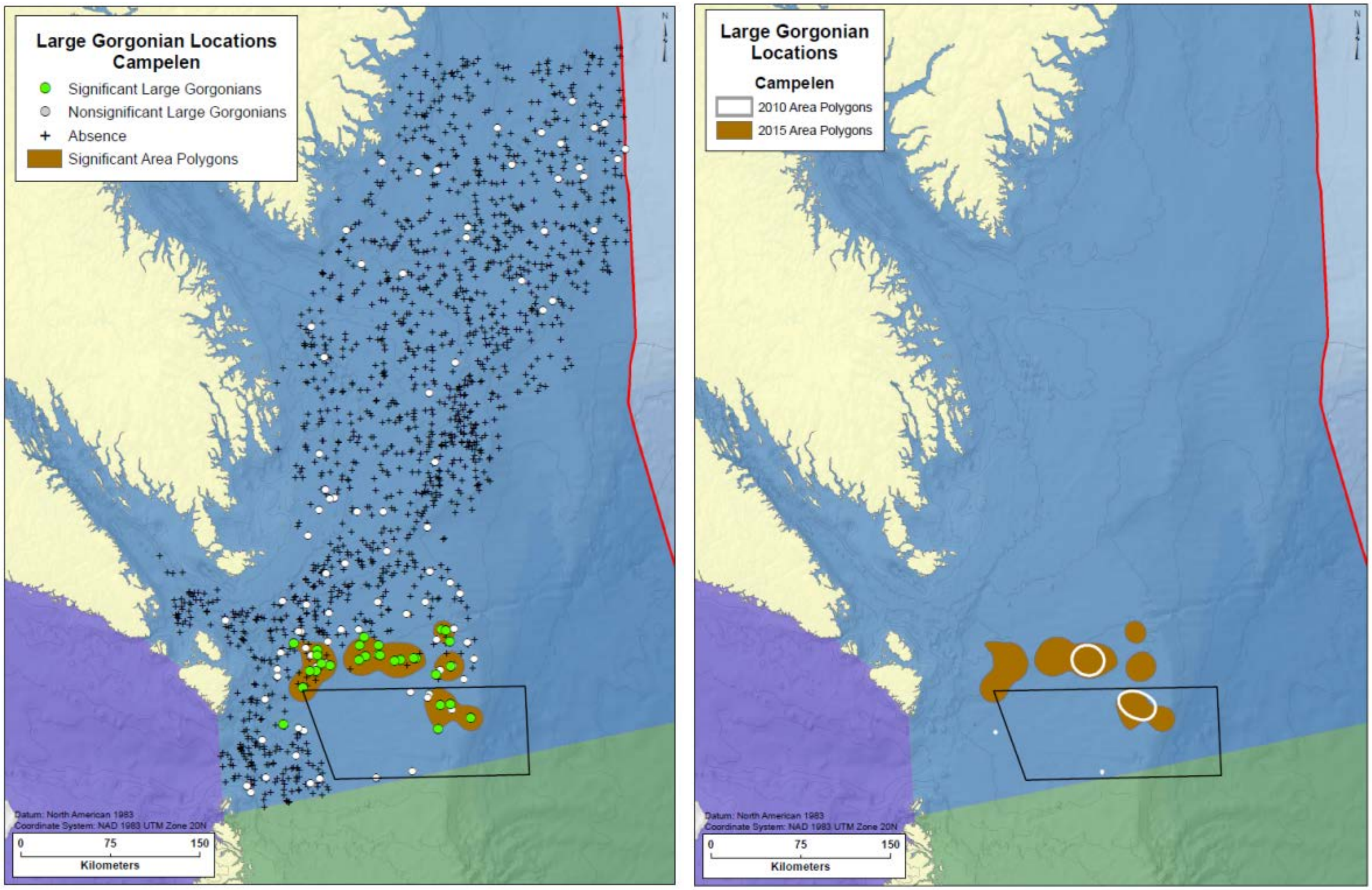


Figure 71. *Location of the polygons identifying significant large gorgonian coral aggregations relative to the broader distribution of large gorgonian coral in the Eastern Arctic (left panel). Large gorgonian coral catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. Right panel shows a comparison of the location of the significant concentrations of large gorgonian corals identified in Kenchington et al. (2010) (white outline) and those identified in this study (brown polygons). Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

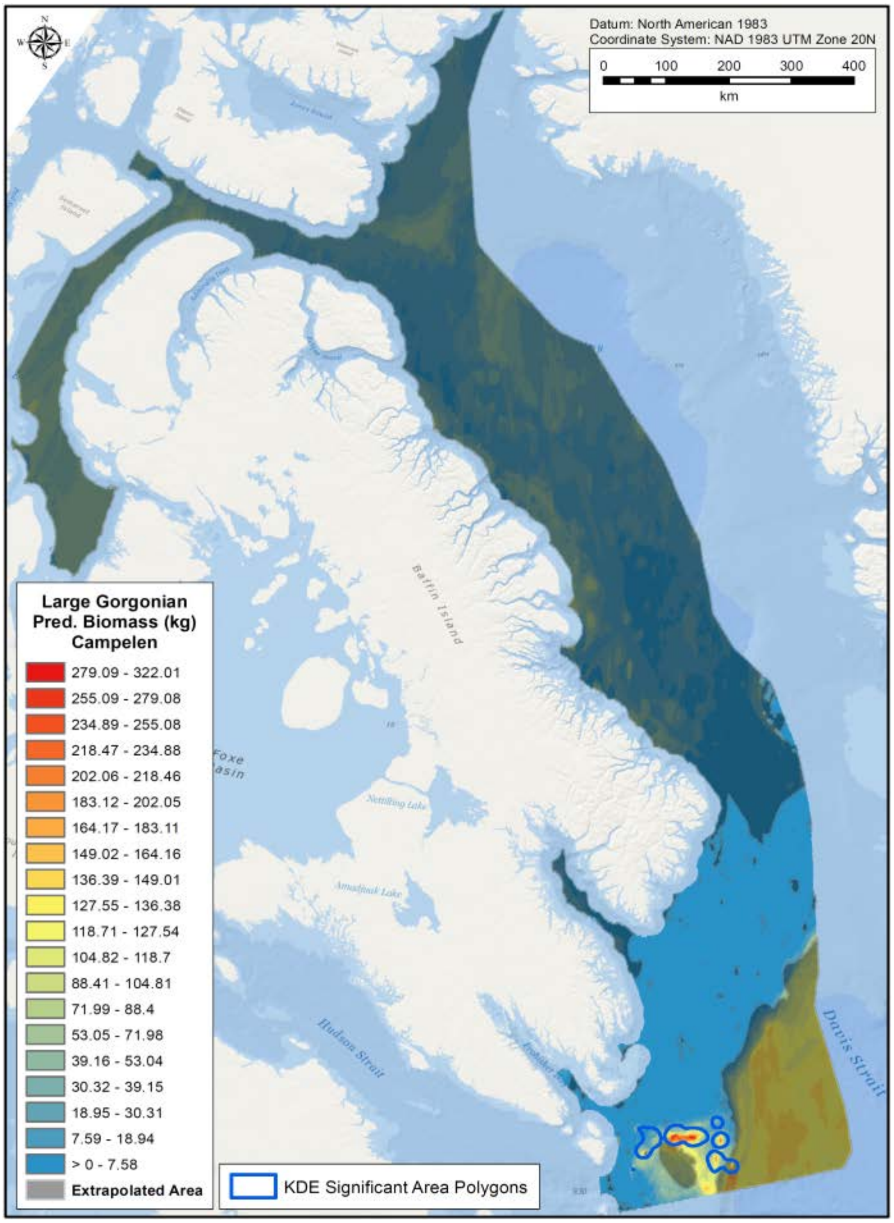


Figure 72. *Predictions of biomass (kg) of large gorgonian corals from catch data recorded in DFO/industry shrimp surveys using Campelen trawl gear in the Eastern Arctic between 2005 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of large gorgonian corals identified by KDE are shown in blue outline.*

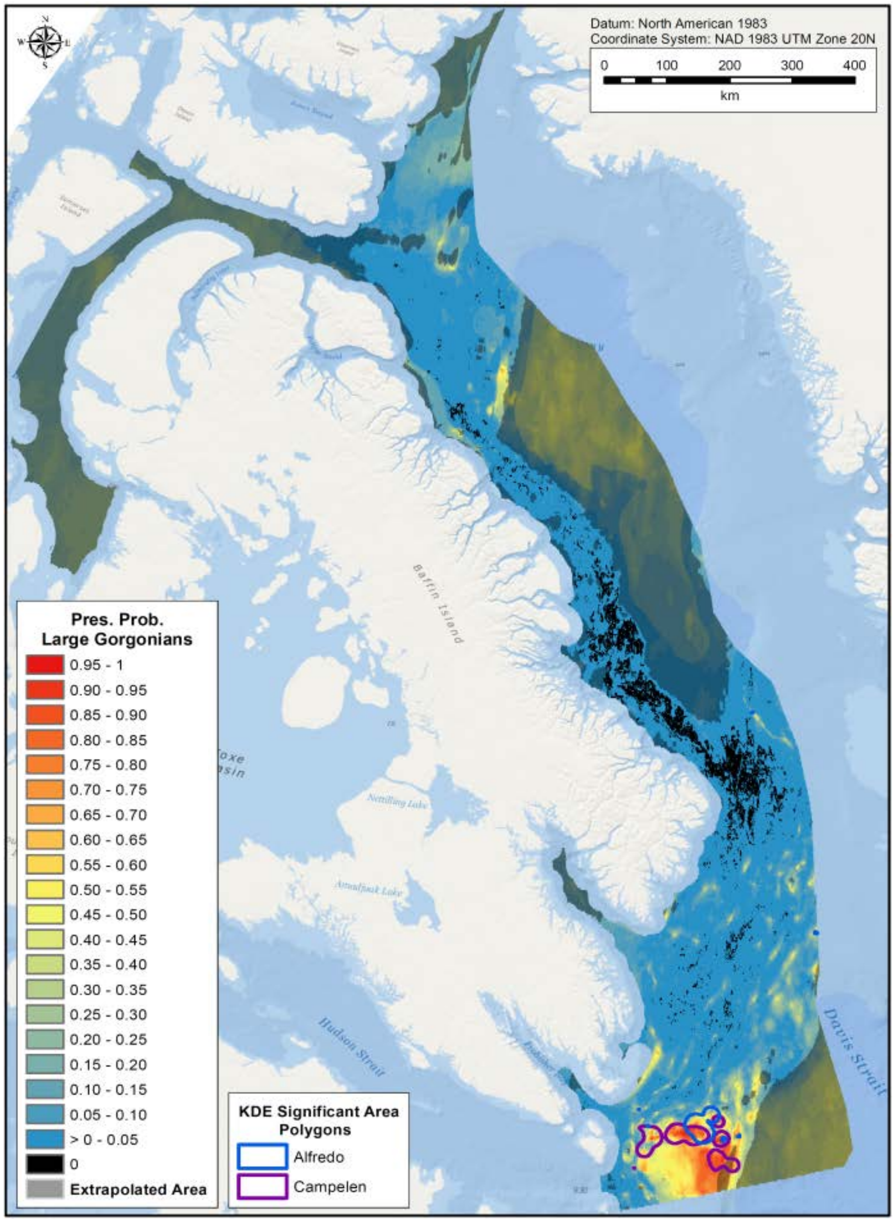


Figure 73. *Predictions of presence probability (Pres. Prob.) of large gorgonian corals based on a RF model on unbalanced presence and absence sponge catch data collected from DFO multispecies surveys and DFO/industry shrimp surveys conducted in the Eastern Arctic between 1999 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of large gorgonian corals identified by KDE are shown in blue (Alfredo) and purple (Campelen) outline.*

Table 15. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of large gorgonian corals from DFO multispecies surveys and DFO/industry shrimp surveys. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	AUC	Observ.	Predictions		Total n	Class Error	Sensit.	Specif.
			Absence	**Presence**				
Mean	0.752	**Absence**	1738	474	2212	0.214	0.626	0.786
SD	0.090	**Presence**	58	97	155	0.374		

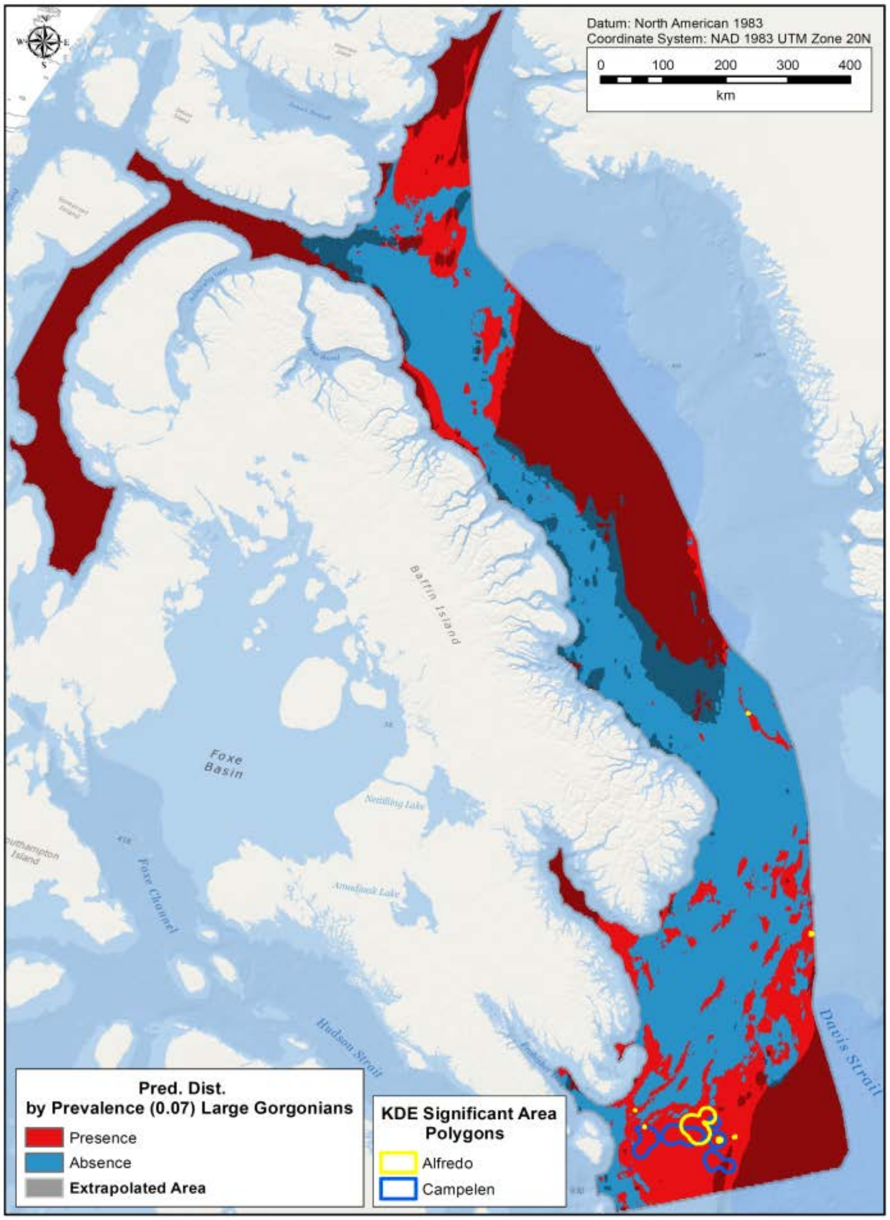


Figure 74. *Classification of large gorgonian coral presence probability based on the prevalence threshold of 0.07. Also shown are the grey areas of model extrapolation, which appear dark red or dark blue when overlain on the presence-absence surface. Areas of significant concentrations of large gorgonian corals identified by KDE are shown in yellow (Alfredo) and blue (Campelen) outline.*

Small Gorgonian Corals

Small gorgonian coral catch records for the Eastern Arctic Region were derived from Alfredo and Campelen trawl data. In the 2010 analysis, small gorgonian records from Alfredo gear were insufficient for KDE analysis and so KDE was run only on Campelen records. In the current analysis, KDE was run separately on catch records from each gear type. For Alfredo gear there were 88 records with small gorgonian coral catch and 684 records of catches with no small gorgonian corals from the same surveys conducted between 2006 and 2014. In the present analysis, several significant area polygons were identified in the Davis Strait (Figure 75).

The southeast corner of the study extent in Davis Strait was predicted to have high biomass of small gorgonians by the regression random forest model using Alfredo trawl records (Figure 76). The accuracy measures of this model indicated good model performance (Beazley et al., 2016c). The highest R^2 value was 0.677, while the average was 0.292 ± 0.213 SD. The average Normalized Root-Mean-Square Error was 0.044 ± 0.026 SD. The average percentage variance explained was 11.78% ± 6.32 SD). Bottom Shear Average Maximum was the top environmental predictor variable in this model.

There were 91 Campelen records with sea pen catch and 1484 records of catches with no sea pens from the same surveys from 2005 to 2014. Several significant polygons identified in the Davis Strait in the previous analysis were expanded in the current analysis (Figure 77). Some new polygons were identified. The regression random forest model of small gorgonian coral biomass using Campelen trawl records performed poorly ($R^2 \leq 0.1$ and/or negative percent variance explained), and therefore the predicted biomass surface from this model is not presented here.

The small gorgonian coral RF model was generated on presence and absence records from both the Alfredo and Campelen gear types combined. The model using all available small gorgonian coral records and unbalanced species prevalence was selected as the best predictor of small gorgonian coral distribution in the Eastern Arctic Region (Figure 78 and Table 16; Beazley et al., 2016c). The AUC of this model was very good (0.894), with Surface Salinity Mean being the top environmental predictor variable. The highest predicted small gorgonian coral presence probability occurred in the Davis Strait along the eastern edge of the boundary. The southeast corner of the study extent in Davis Strait was predicted to have moderate presence probability of small gorgonian corals. Much of Baffin Bay was predicted to have zero or low presence probability of small gorgonian corals. Areas of high presence probability corresponded well with the occurrence of presence points at those locations. At the location of some presence points predicted presence probability was not high due to the high overlap of presence and absence points. This could be due to the high overlap between presence and absence data points in those areas and the inclusion of all absence data in the model. Much of Lancaster Sound, Gulf of Boothia, and the deep water off Baffin Island Shelf was considered extrapolated area by the model. The deep waters off Baffin Island Shelf, northern Baffin Bay, and the southeast Davis Strait were classified as presence of small gorgonian corals (Figure 79).

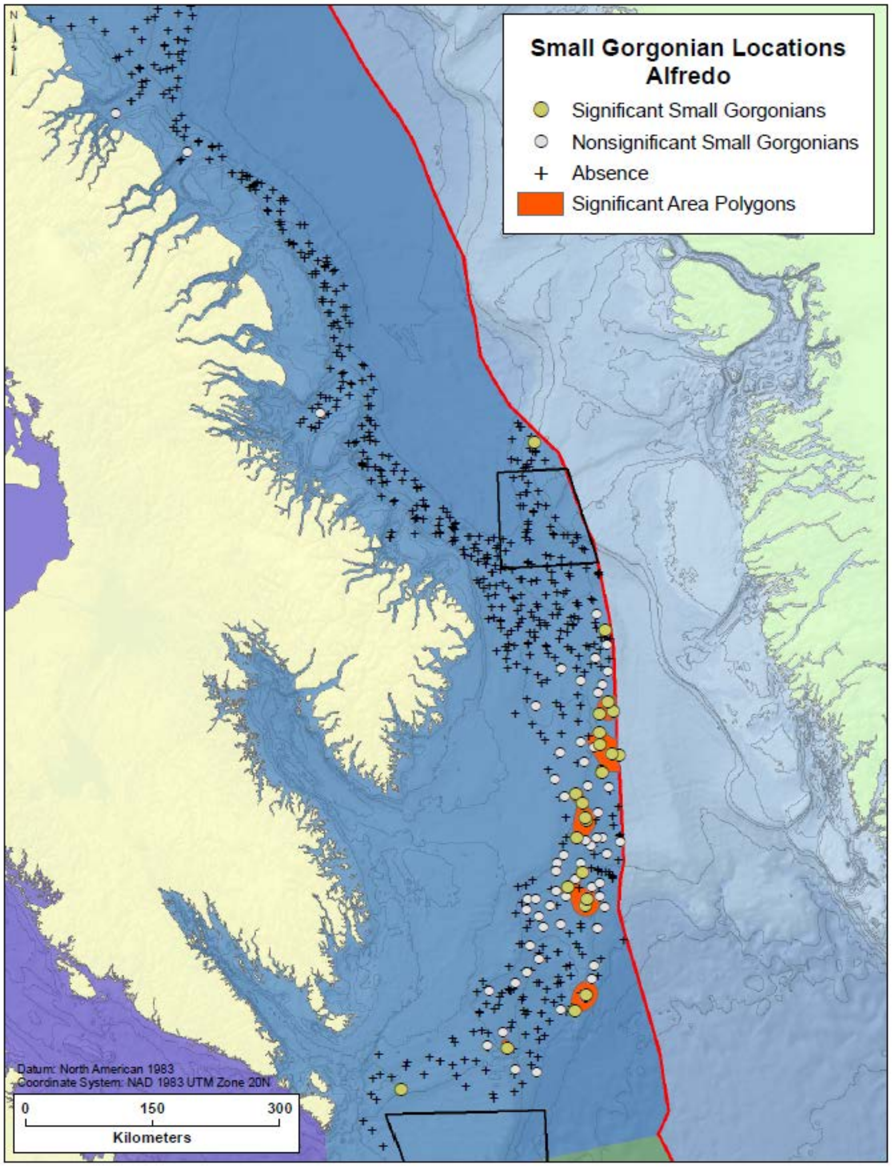


Figure 75. *Locations of the significant small gorgonian coral areas from Alfredo trawl gear relative to the broader distribution of small gorgonian in the Eastern Arctic. Small gorgonian coral catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence. Null data (absence) is indicated by the black cross. Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

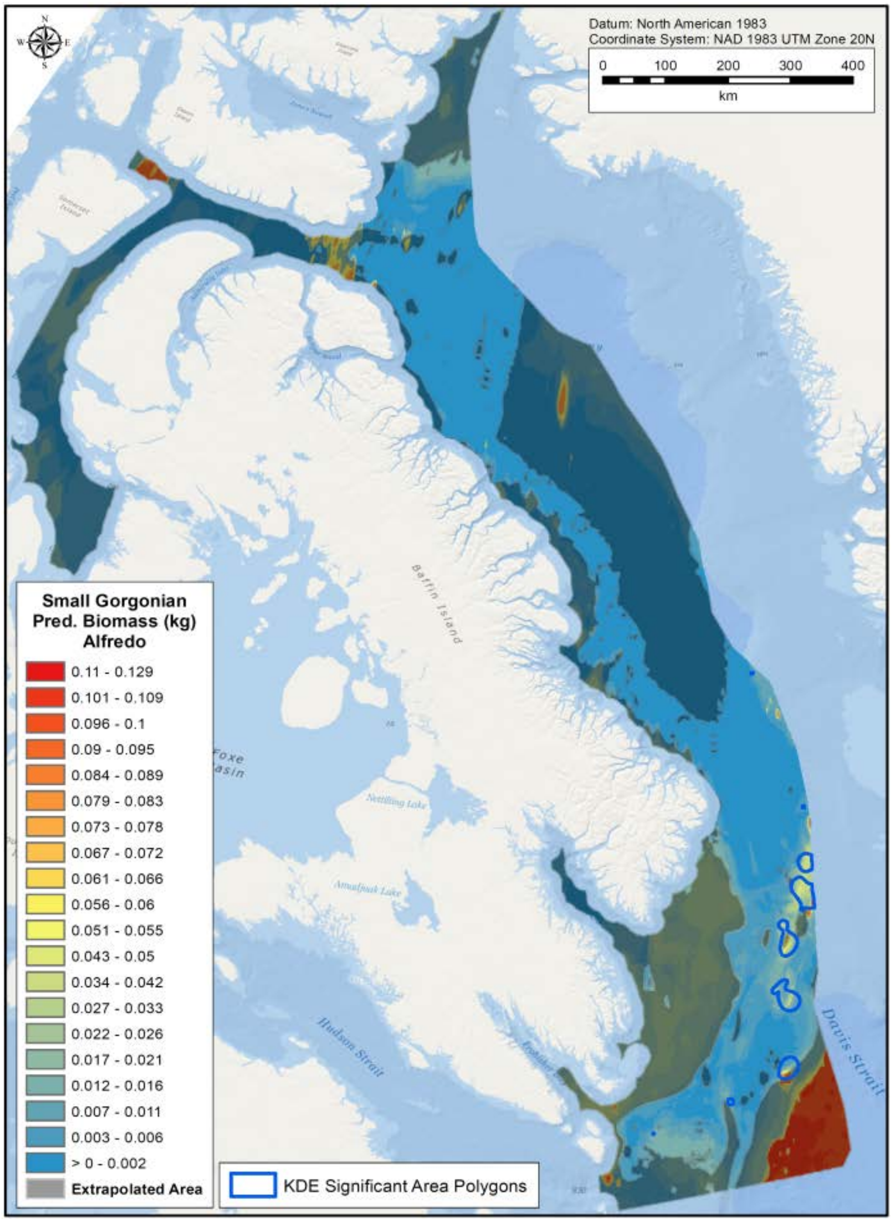


Figure 76. *Predictions of biomass (kg) of small gorgonian corals from catch data recorded in DFO multispecies surveys using Alfredo trawl gear in the Eastern Arctic between 2006 and 2014. Grey areas indicate areas of extrapolation. Areas of significant concentrations of small gorgonian corals identified by KDE are shown in blue outline.*

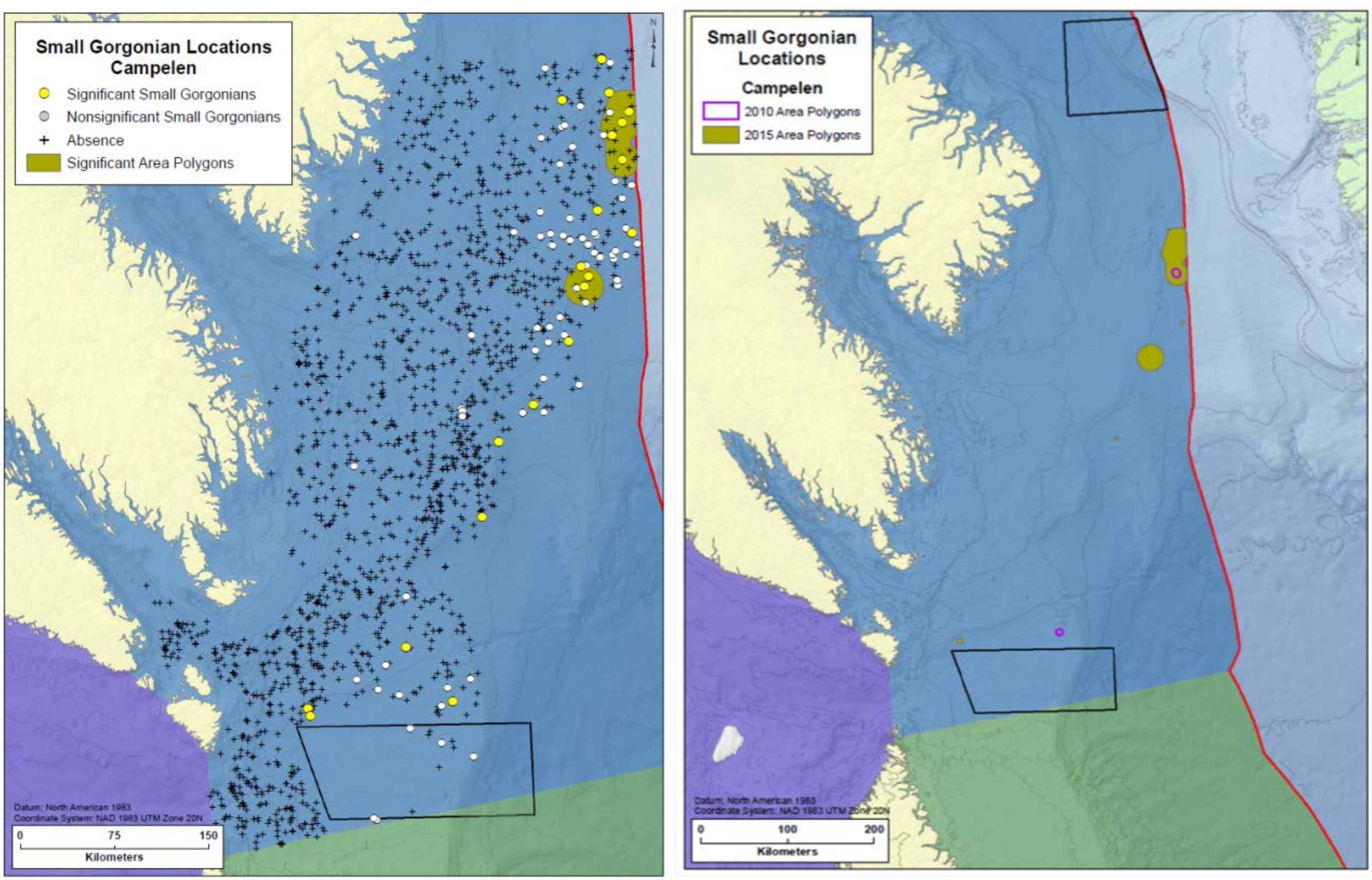


Figure 77. *Locations of the significant small gorgonian coral areas from Campelen trawl gear relative to the broader distribution of small gorgonians in the Davis Strait (left panel). Small gorgonian coral catches that contributed to the identification of the polygons are indicated as significant, while those not used to define the polygons are indicated as presence Null data (absence) is indicated by the black cross. The right panel shows a comparison of the location of the significant concentrations identified in Kenchington et al. (2010) (purple outline) and those identified in this study (brown polygons).Areas closed or voluntarily closed to protect benthic species and habitats are indicated in black outline. Red line indicates the EEZ of Canada.*

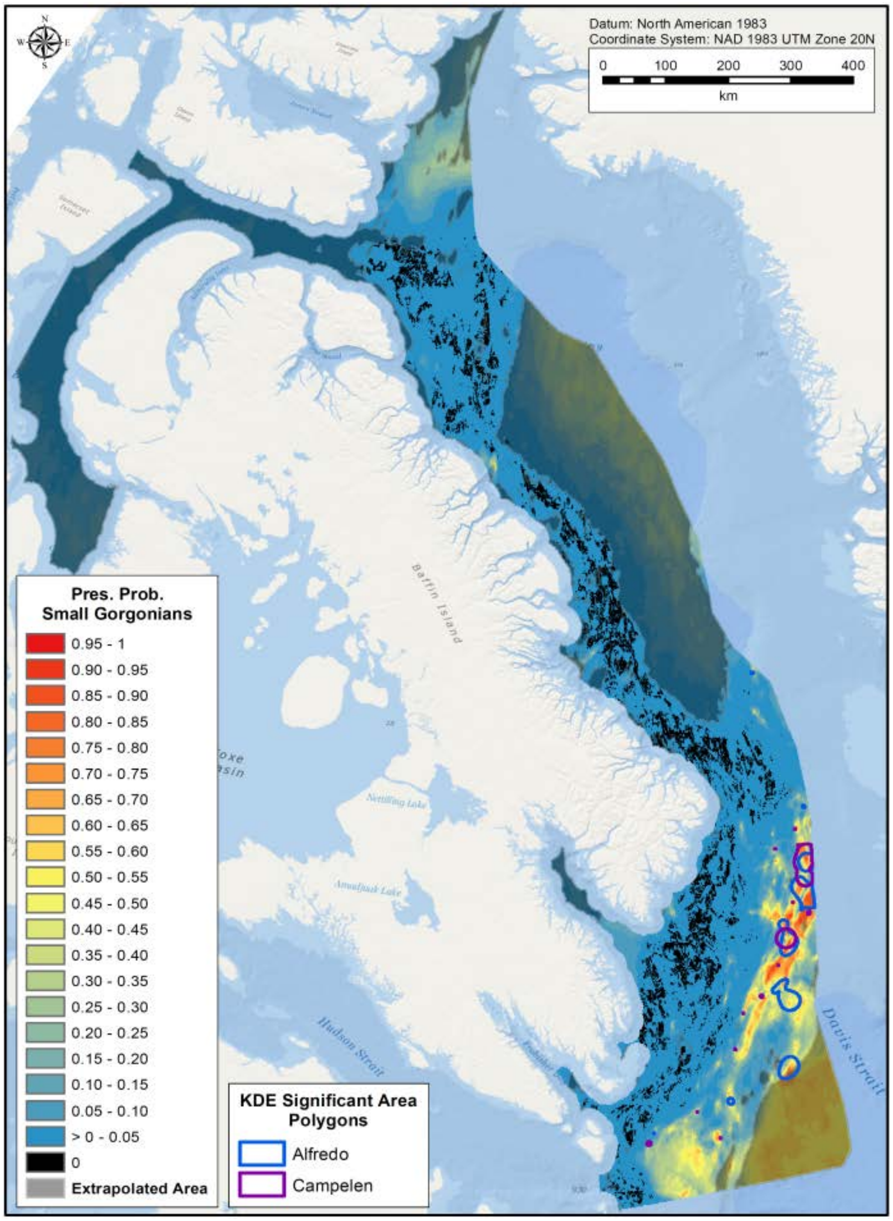


Figure 78. *Predictions of presence probability (Pres. Prob.) of small gorgonian corals based on a RF model on unbalanced presence and absence sponge catch data collected from DFO multispecies surveys and DFO/industry shrimp surveys conducted in the Eastern Arctic between 2005 and 2014. Areas of significant concentrations of small gorgonian corals identified by KDE are shown in blue (Alfredo) and purple (Campelen) outline.*

Table 16. *Accuracy measures for 10-fold cross validation of a RF model of presence and absence of small gorgonian corals from DFO multispecies surveys and DFO/industry shrimp surveys. Observ. = Observations; Sensit. = Sensitivity, Specif. = Specificity.*

Model	**AUC**	**Observ.**	**Predictions**		**Total n**	**Class Error**	**Sensit.**	**Specif.**
			Absence	**Presence**				
Mean	0.894	**Absence**	1800	387	2187	0.177	0.821	0.823
SD	0.042	**Presence**	32	147	179	0.179		

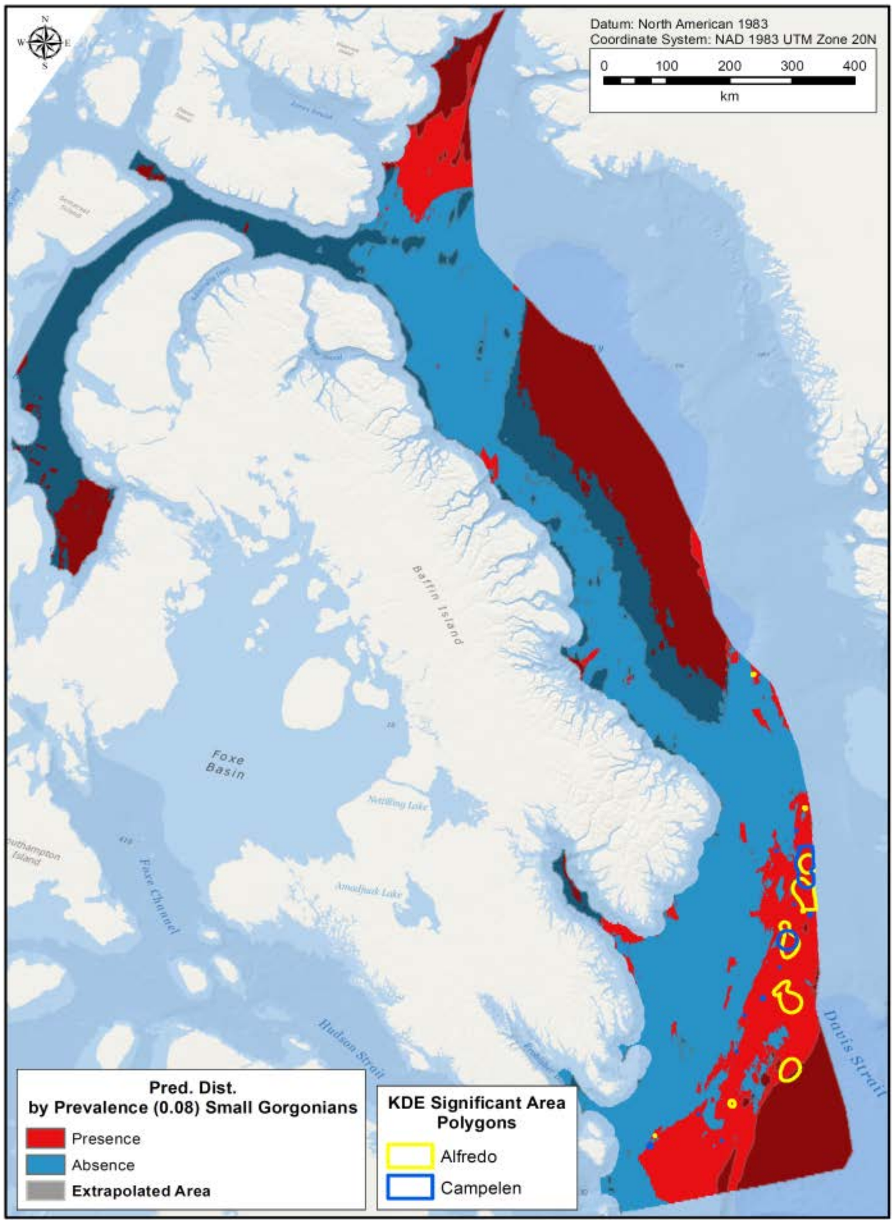


Figure 79. *Classification of small gorgonian coral presence probability based on the prevalence threshold of 0.08. Also shown are the grey areas of model extrapolation, which appear dark red or dark blue when overlain on the presence-absence surface. Areas of significant concentrations of small gorgonian corals identified by KDE are shown in yellow (Alfredo) and blue (Campelen) outline.*

UNCERTAINTIES

Our KDE analyses were conducted within biogeographic zones as an attempt to work with similar species compositions. This is particularly relevant when the data are not fully ascribed to species and can include species compositions with different morphologies and biomass. For this reason, the threshold values for a taxon (e.g., sponges) derived from the same survey gear can differ amongst the different biogeographic zones (e.g., comparing thresholds with Campelen gear for sponges across biogeographic regions). This is an expected result and is particularly relevant when shelf systems such as Hudson Strait are compared with regions with continental slope fauna. This will also influence the results within regions where both shelf and slope fauna with widely divergent species morphologies and biomass occur. This arises primarily with sponges in the Newfoundland and Labrador and Eastern Arctic biogeographic regions. There, large massive sponge grounds (Knudby et al., 2013a) occur on the slopes (these are not found in the Scotian Shelf Biogeographic Zone), and smaller more delicate species are found on the shelves. KDE will put an emphasis on the heavier, highly aggregated slope species, although this can be compensated for by selecting smaller thresholds. This issue is not so relevant to the gorgonian corals and sea pens, where the different species that could comprise the taxa have similar weights, if not morphologies. More precise identification of the sponges in each region would allow for separate analyses based on size/biomass as was done for the gorgonian corals.

Trawl catches of corals and sponges are the result of a stochastic sampling process from a latent (unobserved) mean density on the ocean floor. Catches sampled from the same latent density can vary considerably from one set to another due to the distributional properties of marine biota (e.g., fine scale patchiness in distribution) and an often low and variable catchability to survey trawl gear. This is generally termed observation error. KDE and RF analysis do not explicitly account for observation error. Catches are assumed to be ‘perfect’ observations and neighboring catches of different magnitude are effectively viewed as reflecting a small scale gradient in density when in fact these catches may be the result of sampling from the same latent density. Some caution is therefore required in interpreting the boundaries of purported areas of a certain density as these boundaries may be more dispersed than otherwise implied by the KDE and RF surfaces. Parametric statistical models (e.g., GAMs) explicitly account for observation error though care must be taken to ensure that an appropriate error distribution is specified and that models correctly account for zero-inflation and overdispersion if there is evidence of these properties in the data. If the parametric models happen to be mis-specified, the inferences drawn may be incorrect.

The polygons identified through the KDE analyses identify significant biomass aggregations from research vessel trawl catch data. The boundaries of the polygons can and should be refined using more detailed site-specific data from both environmental and fishery sources. The analysis is not intended to produce hard boundaries for management decisions, but rather to focus attention on the key areas for identifying significant concentrations of corals and sponges.

We also point out that the KDE polygons are subject to change and are influenced by the search radius used. By optimizing the radius in the way we described earlier, we reduced the subjectivity of this element but in some cases we chose to use smaller or larger values; more often larger values were used in order to perform the aerial analysis on a continuous surface. Over-smoothing will create larger polygons around the data, however if used in combination with SDMs this should not be an issue. Additional data that changes the spatial data extent and/or changes the density structure of the points over the surface will also change the kernel surface even if the search radius is unchanged. This was seen in the figures that compared the results from the 2010 analysis (Kenchington et al., 2010) with the current analysis. This can produce changes to the number and/or shape of the polygons which in some cases may be informative in and of themselves (e.g., Kenchington et al., 2012). A simple sensitivity analysis could be conducted by applying KDE at each given year separately to create an averaged KDE output. While optimal search radius needs to be identified each year, a comparison of average versus aggregated KDE outputs could be used to identify potential shifts in species hotspots.

The random forest (RF) models worked well at interpolating predictions between data observations and extrapolating within the data extent. However, RFs are averaging the decision and regression trees to predict piecewise constant functions, giving a constant value for inputs falling under each leaf. When extrapolating outside their training domain, where different physical environmental conditions from those used to train the model may exist, they predict the same value as they would for the nearest point in the tree at which they had training data

(Breiman et al., 1984). For true extrapolation, the random forest algorithm would need to learn the functional relationship between the response and environmental conditions at those locations. Other models, such as Generalized Additive Models, which can find a relationship between the response and predictors, could provide additional information. Therefore, we are not confident of the model extrapolations to depths outside of our data extent (generally greater than 2000m), as we have no means of validation. Sponges, sea pens and gorgonian corals can be found at such depths and so the model may be helpful in guiding research surveys to perform such validation.

Species distribution models were performed using a 5 km buffer around land from the Gulf and Scotian Shelf regions, and with a 20 km buffer for the Newfoundland and Labrador, Hudson Strait and Eastern Arctic. Consequently coastal areas were not considered in this report. This also applies to the KDE analysis as the trawl surveys that generated the data used in the analysis do not cover coastal areas.

While RF models are more robust against overfitting compared to other machine learning algorithms such as bagging, they have been observed to overfit when data contains very "noisy" classification or regression tasks (Segal, 2004). In the SDM context, random forests make distinct spatial predictions compared to GAMs and GLMs. In this regard, overfitted RF models can make predicted distribution maps very "patchy" at smaller spatial scale and difficult to interpret (Franklin, 2010). Caution should be taken to not over analyze predicted distribution maps at smaller spatial scales.

Species catch distribution data from multispecies surveys may be subject to contamination from one trawl set to the next. Different invertebrate organisms such as sponges and some types of corals can remain hooked to the trawl net or in others parts of the vessel during the sorting process and appear posteriorly in the sorting process of the next trawl set catches. This contamination issue likely does not greatly affect the species distribution models based on biomass response data, but it can be an important issue in the models based on presence-absence data, where a large catch counts the same as a small catch, increasing the distribution area of the species studied.

The use of presence-absence records from different data sources and gear types (trawl and *in situ* camera observations) in random forest modelling may introduce bias and cause poor model performance. In the Maritimes Region, many of DFO’s scientific missions involving benthic imagery collection were designed to target the continental slope and canyons where deep-water corals are known to congregate. These areas are typically not surveyed in the multispecies stock assessment surveys as they are either outside of the survey depth limit or are too rough to deploy bottom-tending gear. The addition of *in situ* camera observations and other sources significantly improved the predictive performance of the presence-absence models, and its inclusion in the models is warranted given the spatial bias in the DFO multispecies trawl surveys. Naturally, the addition of the *in situ* camera observations increased the probability of occurrence of the three coral groups along the Scotian Slope and in several deep canyons. Predictions in areas dominated by *in situ* camera observations should be interpreted with caution, as no null data accompanied those records.

An overview of this process with “Lessons Learned” was presented as a case study and published in the International Council for the Exploration of the Sea (ICES) Working Group on the Ecosystem Effects of Fishing Activities (ICES, 2016).

CONCLUSIONS

KDE analyses produced very similar locations to those previously identified (Kenchington et al., 2010), despite the large increase in the number of data points used in the present analysis.

The KDE method only uses the georeferenced biomass data from the trawl surveys to construct the polygons. The analysis is not intended to produce hard boundaries for management decisions, but rather to focus attention on the key areas for identifying significant concentrations of corals and sponges. The boundaries of the polygons can and should be refined using more detailed site-specific data from both environmental and fishery sources. In some cases it may be important to closely refine the boundaries of the polygons, particularly if they lie over a depth gradient, or to consider whether a species group occurs in an area not sampled by the survey. Species distribution models (SDMs; e.g., Beazley et al., 2016a, c; Murillo et al., 2016; Guijarro et al., 2016) can be used to refine the boundaries of the polygons and to identify potential areas of occurrence and/or high biomass in unsampled areas. For instance, models based on presence-absence response data can be used to ascertain the full range distribution of the taxa considered whereas models based on biomass response data can be used to trim the polygon while maintaining the biomass identified in the KDE analysis.

Machine learning techniques such as RF can also be compared with regression models such as generalized additive models (GAMs). This comparison is elaborated on in Murillo et al. (2016) and in Kenchington et al. (2016). In this instance the RF model seemed a better fit to the data, and offers less scope for trimming the KDE polygon than the GAM output (Kenchington et al. 2016).

We have found that classification random forest models generated using all presence and absence data (i.e. unbalanced species prevalence) and a threshold equal to species prevalence produced the most realistic presence probability prediction surfaces and highest model accuracy in instances when the input data were highly imbalanced and spatially biased across the study area. Random down-sampling of the absence data often resulted in gross extrapolation of high presence probability beyond the location of presence observations. This was likely exacerbated when down-sampling to match a low number of presence observations, as in our *V. pourtalesi*, sea pen, and gorgonian coral models. Our sponge model however, produced nearly identical presence probability surfaces and model accuracy measures between balanced and unbalanced runs, likely due to the high and relatively even number of presence and absence observations across the study extent. These results may help guide future applications of random forest modelling by providing insight into which methods are appropriate based on the properties of the training data.

The species distribution models provided in this study do not consider the effect of disturbance by human activities. Predicted distribution and biomass can therefore be confounded by fishing activities, and areas that are physically suitable but are predicted to have low occurrence or biomass may not necessarily indicate bad model performance. The taxa considered in this report are vulnerable marine ecosystem (VME) indicators (NAFO, 2014) and are highly aggregating, structure-forming megafaunal groups that can be found in ‘significant concentrations’ constituting VMEs (Kenchington et al., 2014). The life- history traits of these species, such as slow growth rates, late age of maturity, or their structural complexity make them very vulnerable to fishing activities (FAO, 2009). In order to consider how anthropogenic pressure has influenced these ecosystems, a measure of this, such as fishing intensity, should be included as a predictor variable in the RF models and the effects of changes in the pressure explored (Bergström et al. 2013). This kind of analysis would point out potential species distribution and could indicate areas for future restoration initiatives.

IDENTIFICATION OF SIGNIFICANT BENTHIC AREAS

A National Advisory Process meeting was held on March 8-10, 2016 to review the work presented above. At that meeting the results of the KDE analyses and SDMs were jointly considered and significant benthic areas (SBAs) were identified. Here we present the results of those decisions, providing more detail than in the associated Science Advisory Report (SAR). The locations of the tow positions that were used to delineate the significant concentrations of corals and sponges are provided in the Appendix 1 and the species codes used to extract the data are provided in Appendix 2. Fisheries Observer Program Data (FOP) was also provided for the meeting and those data were used to validate the prevalence maps where available (Appendix 3).

MARITIMES REGION

There was a high degree of consistency between the KDE-derived polygons and the SDMs for all coral and sponge taxa on the Scotian Shelf. Consequently, none of the KDE-derived polygons were modified. An exception was the KDE polygon for large gorgonian corals. On the southeastern slope, east of the Gully and near the *Lophelia* Coral Conservation Area two KDE polygons were merged. In this area the biogeographic units for the Scotian Shelf and Newfoundland and Labrador Shelves (DFO, 2009) met (Figure 16), resulting in the large gorgonian coral catches made with the Western IIA gear on the Scotian Shelf, being assessed using the data for the Newfoundland and Labrador Shelves biogeographic unit (NL), that was caught with Campelen trawls. The use of the biogeographic unit makes sense as it kept the Laurentian Channel as a single ecological unit, however when comparing the KDE-derived polygons for each region it was apparent that the smaller threshold used in the NL region due to the predominance of the different gear, introduced bias to the size of the polygon on the Scotian Shelf. The biomass model for the large gorgonian corals showed that regions of high biomass extended to the east of the Scotian Shelf biogeographic unit (SS) (Figure 18). Consequently, the threshold value used to create the KDE polygons in the SS was applied to the adjacent area in the NL and a new polygon was created (Figure 80).

In general, there was little overlap between the KDE-derived polygons for each taxon (Figure 81), except for in the St. Ann’s Bank Proposed Closure where SBAs for sponges and sea pens overlapped.

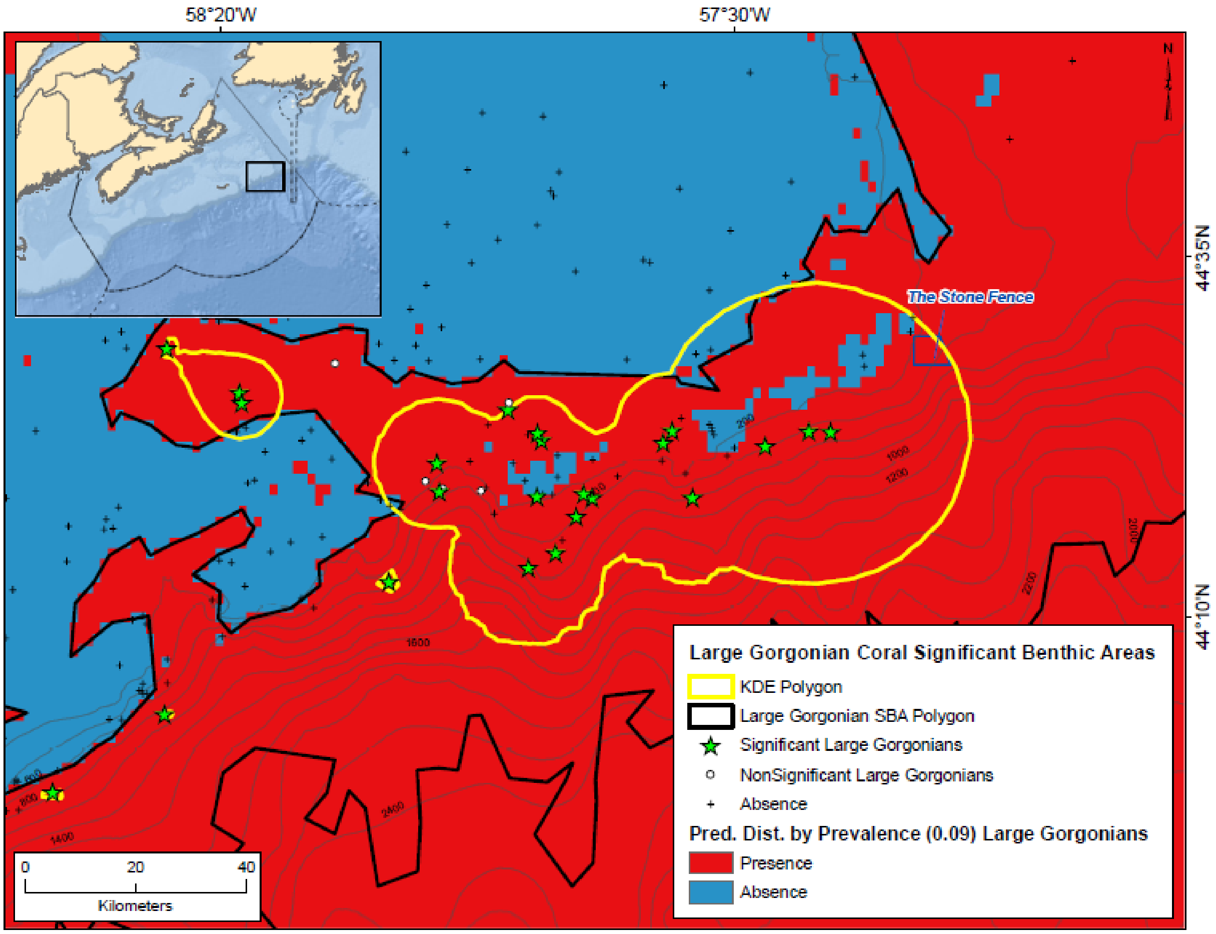


Figure 80. *Location of the new KDE-derived polygon for large gorgonian corals (yellow outline) on the southeastern Scotian Shelf (SS), formed by merging the boundaries of two adjacent polygons, one for the SS and the other from the analysis of the Newfoundland and Labrador Shelves region. For the later, the threshold was changed to match that of the SS where the same gear was used in this area (Western IIA). The polygons are overlain on the random forest prevalence map which was used to create a SBA on the slope in this region (see Figure 83). The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

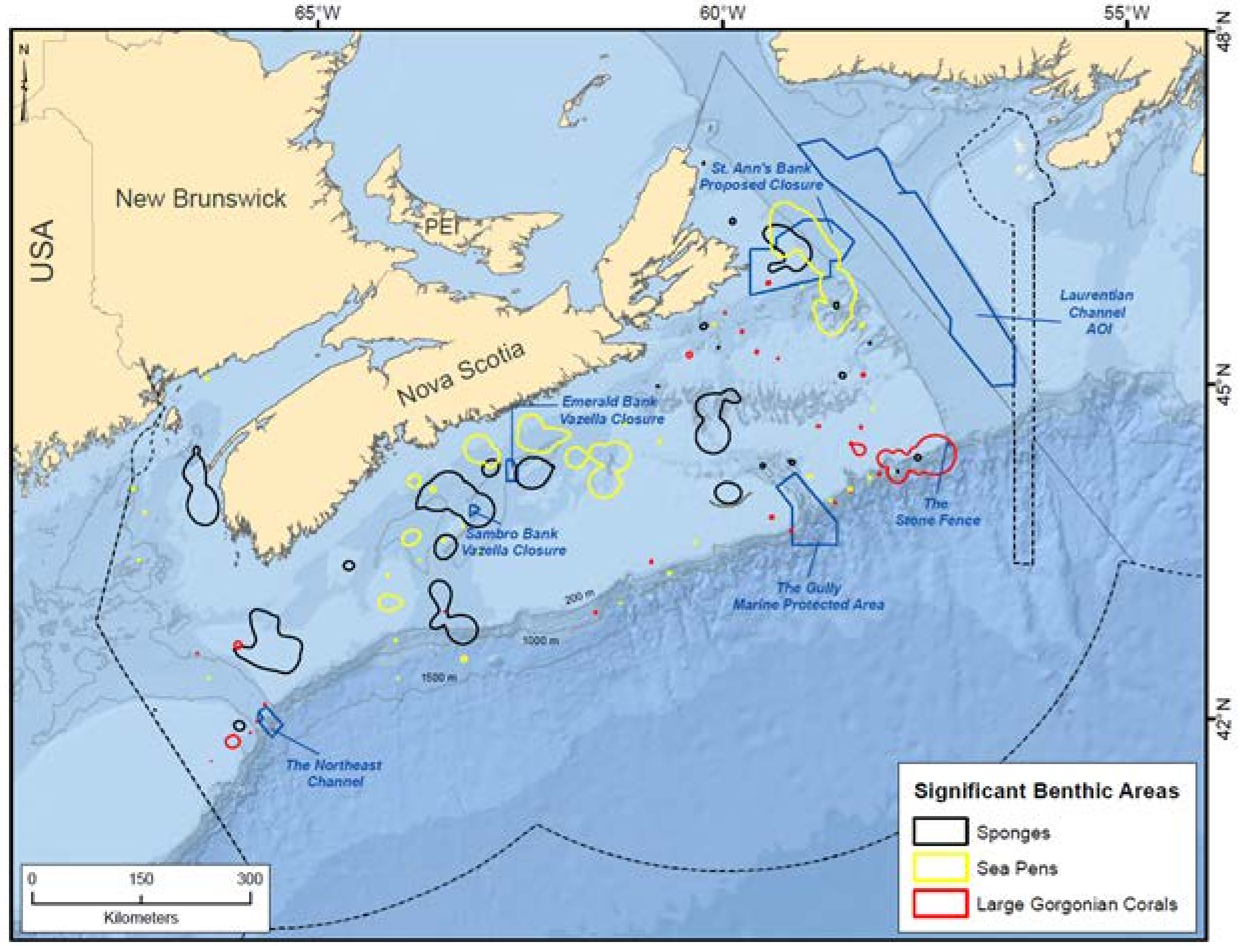


Figure 81. *Location of sponge (black outline), sea pen (yellow outline) and large gorgonian (red outline) SBAs as determined from KDE analyses. Note that there are many small polygons for each taxon that are not readily seen at this scale. The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

The lower slope and deep water areas off the Scotian Shelf were not fully included in the spatial extent of the research vessel trawl surveys and consequently the KDE approach was not able to delineate significant concentrations of benthic taxa in those areas. It was recognized that those areas coincided with the distribution of the large and small gorgonian corals and sea pens and so new SBAs were drawn using the predicted presence area for the appropriate RF SDM for each taxon. These presence-absence models were considered to be more reliable than the KDE-derived polygons in slope areas due to the inclusion of benthic imagery data in the former analyses. Further, RF maps were used to identify all SBAs for the small gorgonian corals as this group could not be modelled using KDE due to its small sample size.

For the small gorgonian corals, the most influential environmental variables in the RF presence-absence model were Depth and Slope, and predicted presence prevalence closely followed the 200m depth contour along the shelf slope. It was recommended that the region of predicted presence between the 200m Canadian Hydrographic Service (CHS) Atlantic Bathymetry Compilation (ABC) depth contour and the random forest extrapolation boundary be considered a SBA for small gorgonian corals (Figure 82). The prevalence was followed to the edge of the regional boundary in the east and included extrapolated area in its northeast extreme. In creating this large SBA it was noted that further research on soft bottom communities in this area could help to refine these boundaries. The RF biomass models did not perform well and so could not assist in this respect.

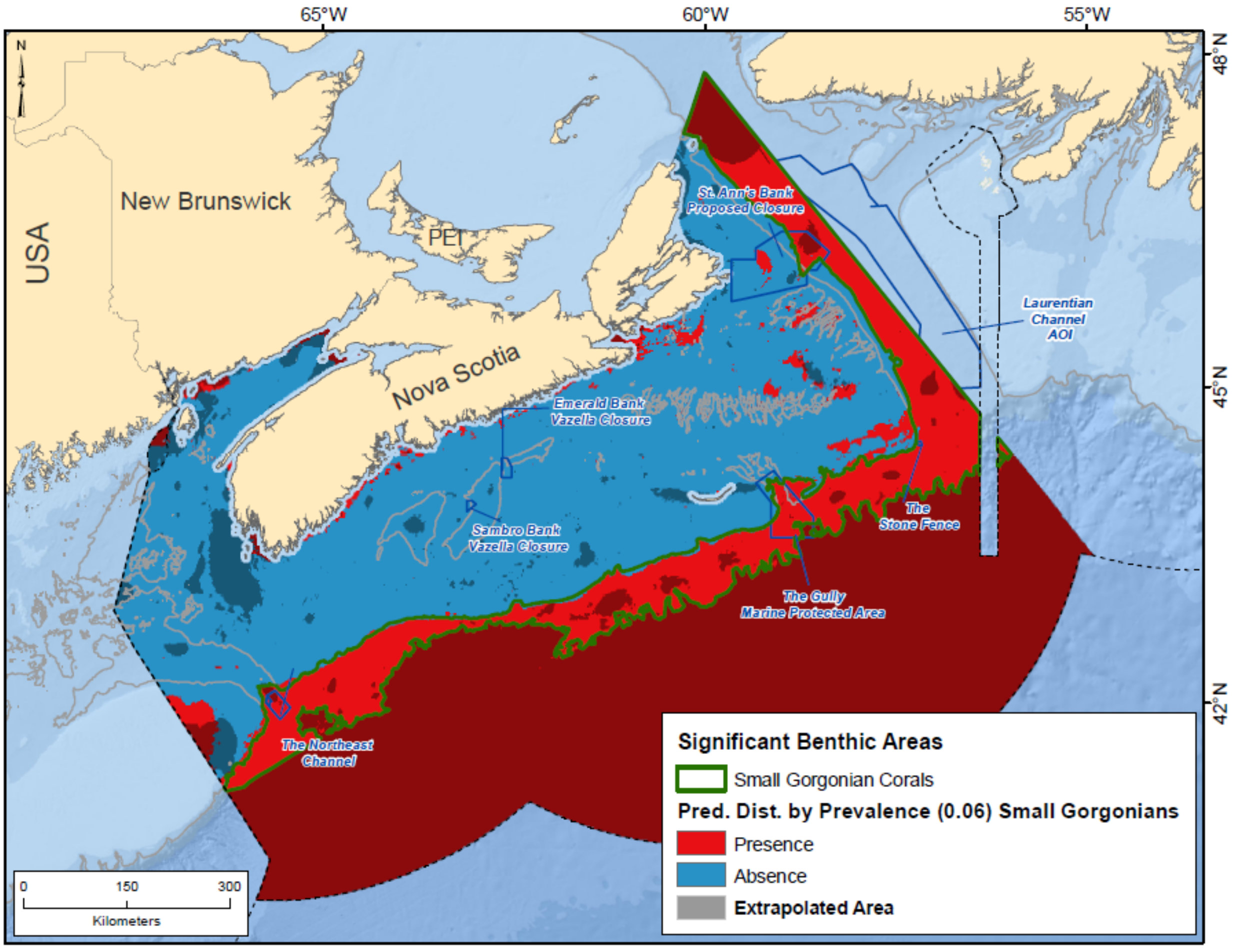


Figure 82. *SBAs (green outline) for small gorgonian corals delineated from the random forest presence-absence SDM and clipped using the 200m depth contour and/or upper prevalence boundary. The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

For the large gorgonian corals, the presence prediction area from the random forest presence-absence model was considered a SBA in the slope areas (Figure 83). It showed good congruence with the ecology of the taxa. Unlike the small gorgonian corals a depth boundary was not recommended as the intrusion of the prediction surface into the Northeast Channel and the extrapolated area on the shelf off southwest Nova Scotia was felt to reflect the known ecology of the species. In two regions the KDE-derived polygons overlapped in distribution with this new SBA. In both cases the polygons fell within the SBA (Figure 84).

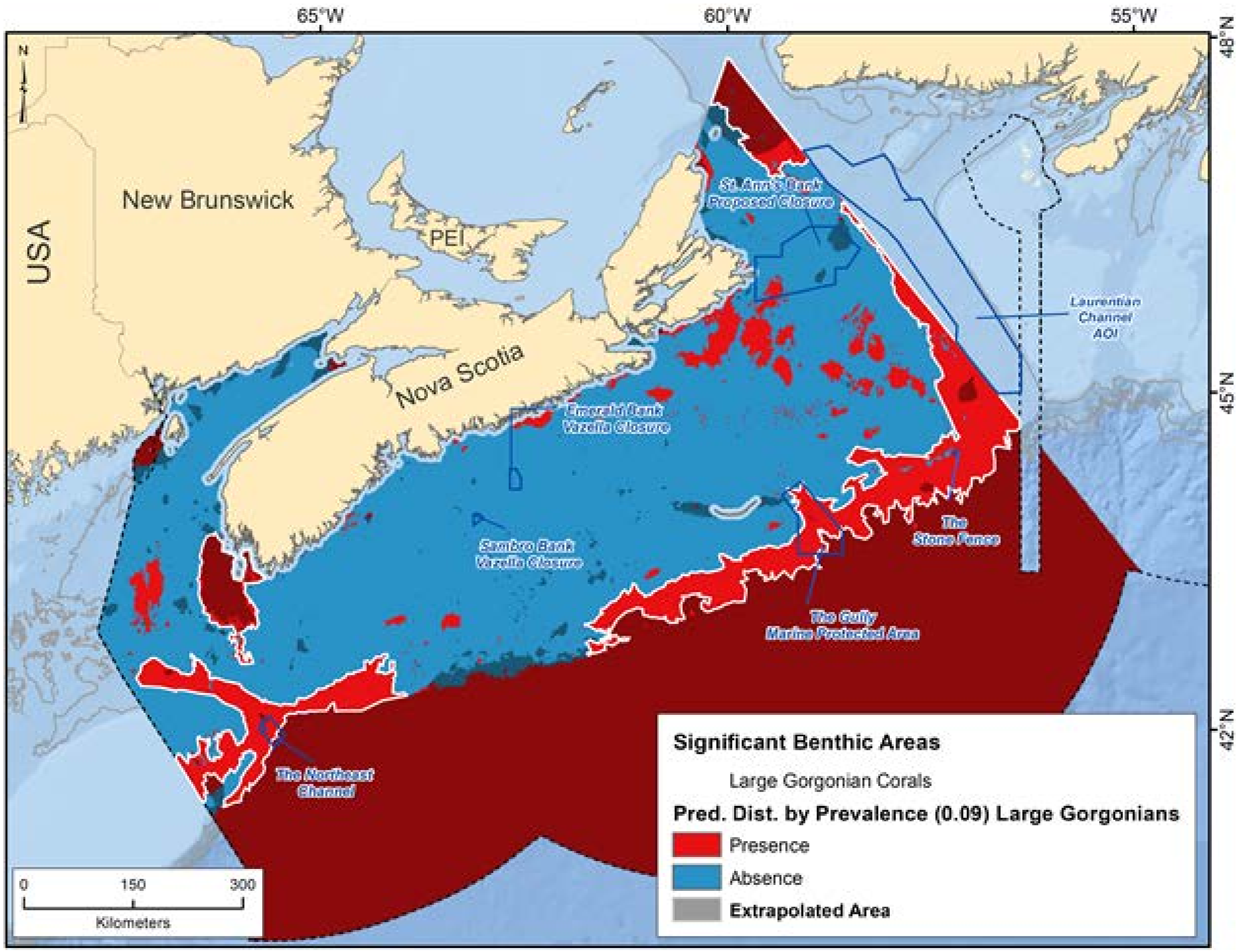


Figure 83. *SBAs (white outline) for large gorgonian corals delineated from the random forest presence-absence SDM. Note that an area of model extrapolation off southwest Nova Scotia was considered by the experts at the meeting to warrant inclusion in the SBA. The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

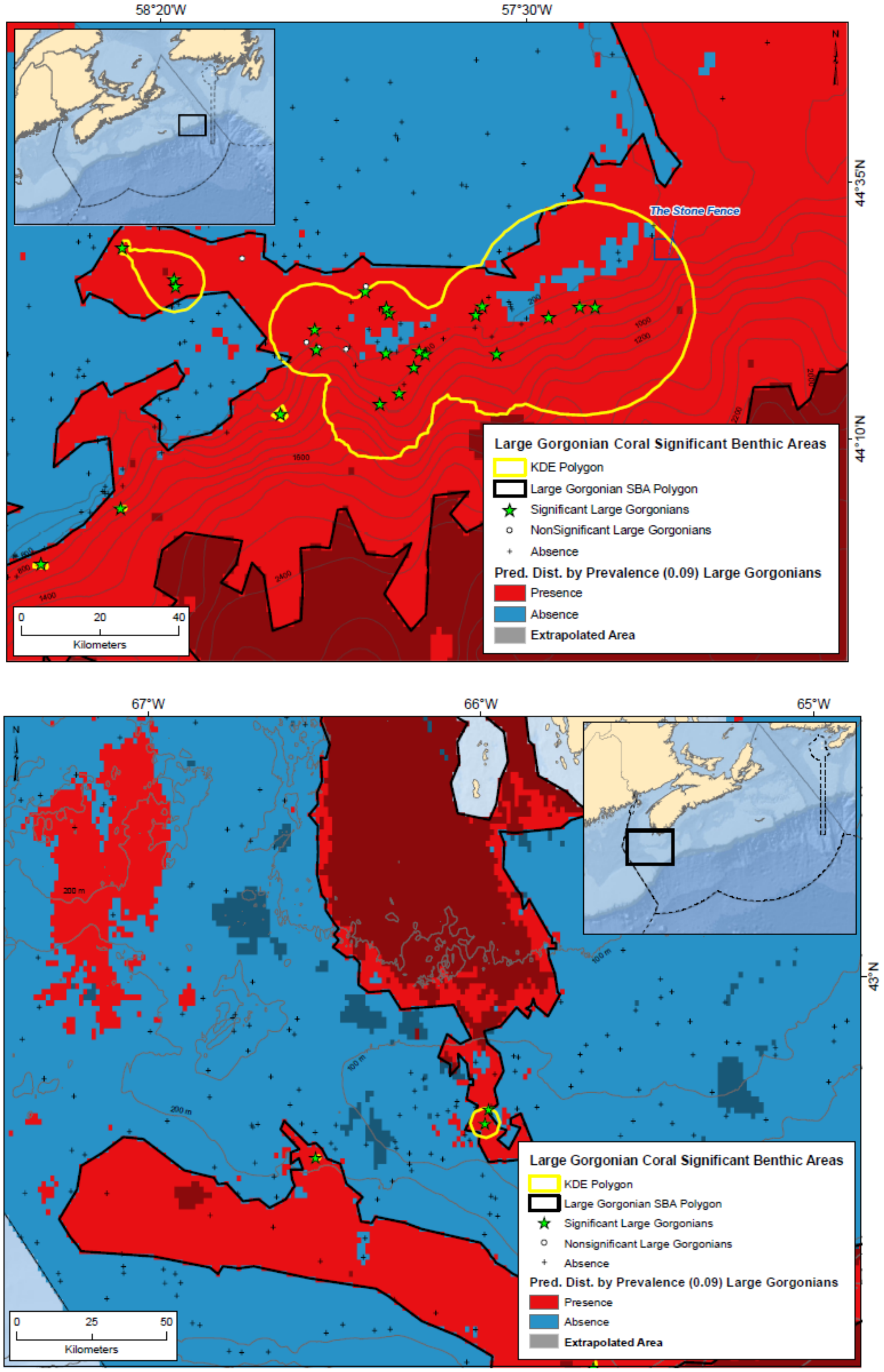


Figure 84. *KDE-derived SBAs (yellow outline) for large gorgonian corals overlain on the SBA delineated from the random forest presence-absence SDM (see Figure 83). The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

For sea pens, a similar slope area determined from the RF predicted presence prevalence was recommended as a SBA (Figure 85). Depth was not the primary predictor in this model and the boundaries were not clipped to depth. One area of overlap occurred to the northeast of the spatial extent. In this area the KDE-derived SBA showed good congruence with the SBA from the random forest prevalence map (Figure 86).

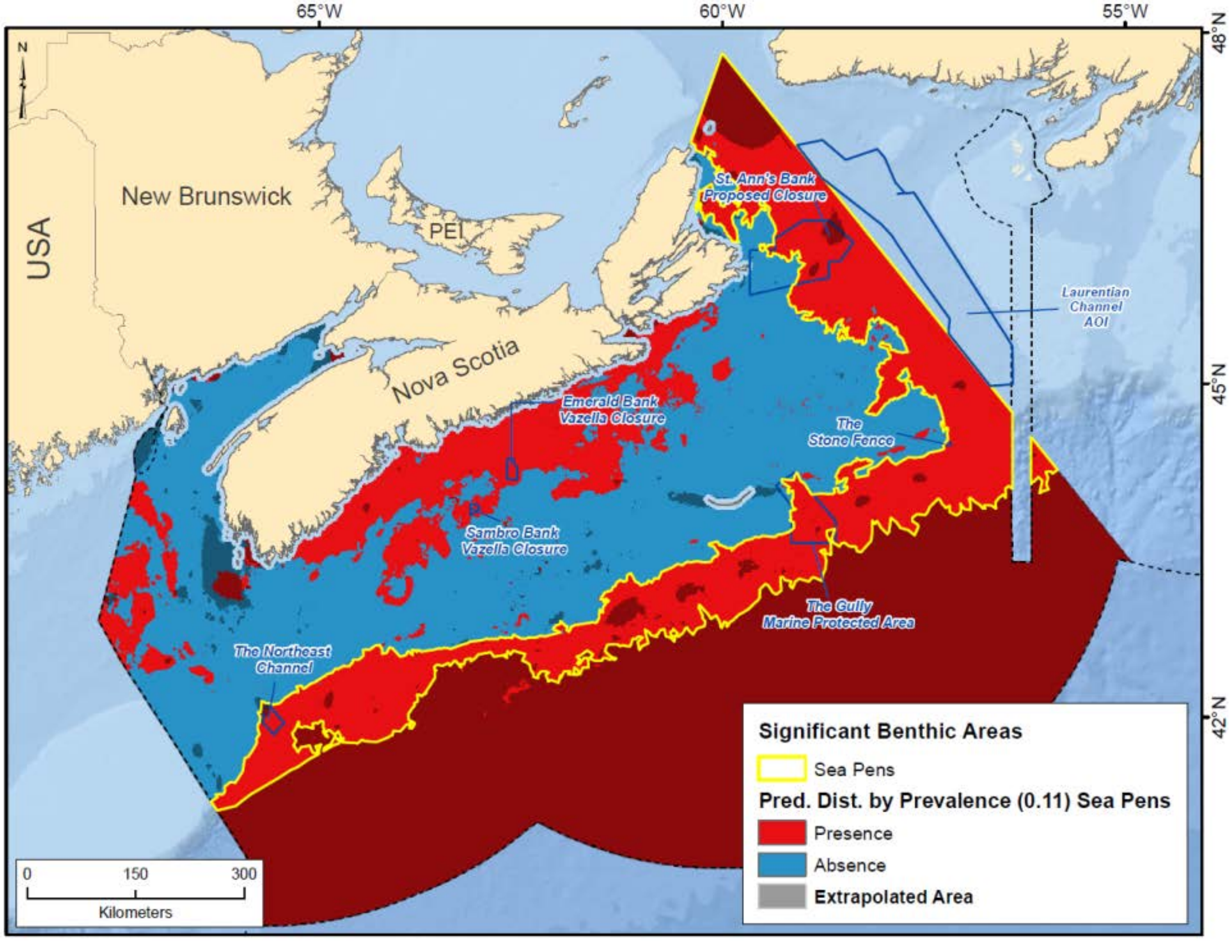


Figure 85. *SBA (yellow outline) for sea pens delineated from the random forest presence-absence SDM. The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

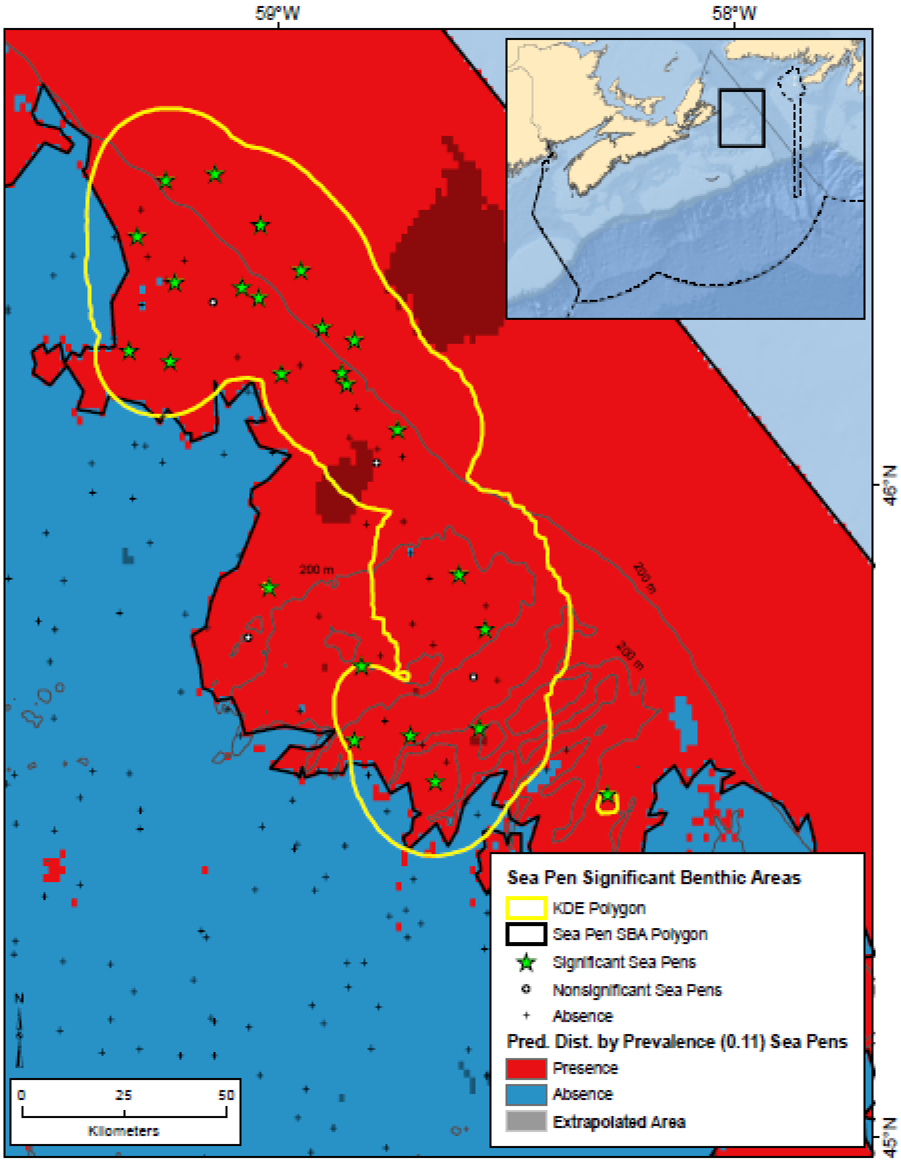


Figure 86. *KDE-derived SBAs (yellow outline) for sea pens overlain on the SBA delineated from the random forest presence-absence SDM (see Figure 85) showing congruence between the modelling approaches. The EEZs of Canada and France (St. Pierre and Miquelon) are in dashed lines.*

GULF OF ST. LAWRENCE

The KDE analysis identified many sponge SBA polygons in the north of the Gulf of St. Lawrence (NGSL) and few and smaller ones in the south (SGSL). Some significant areas in the NGSL were straddling deep channel and shelf areas and these were individually inspected; it appeared that the models may not be doing well for some especially where fine scale (< 1 km) environmental factors may be influencing distribution, while others appeared to be justified. Two KDE-derived sponge polygons were clipped to the underlying RF model probability (Figure 87). Three sponge KDE-derived polygons that were northwest and west of Anticosti Island were slightly modified to remove land in the polygon extents, however these were not clipped to the buffer area along the coast due to high catch records along the periphery of the buffer (Figure 87, lower panel and similar).

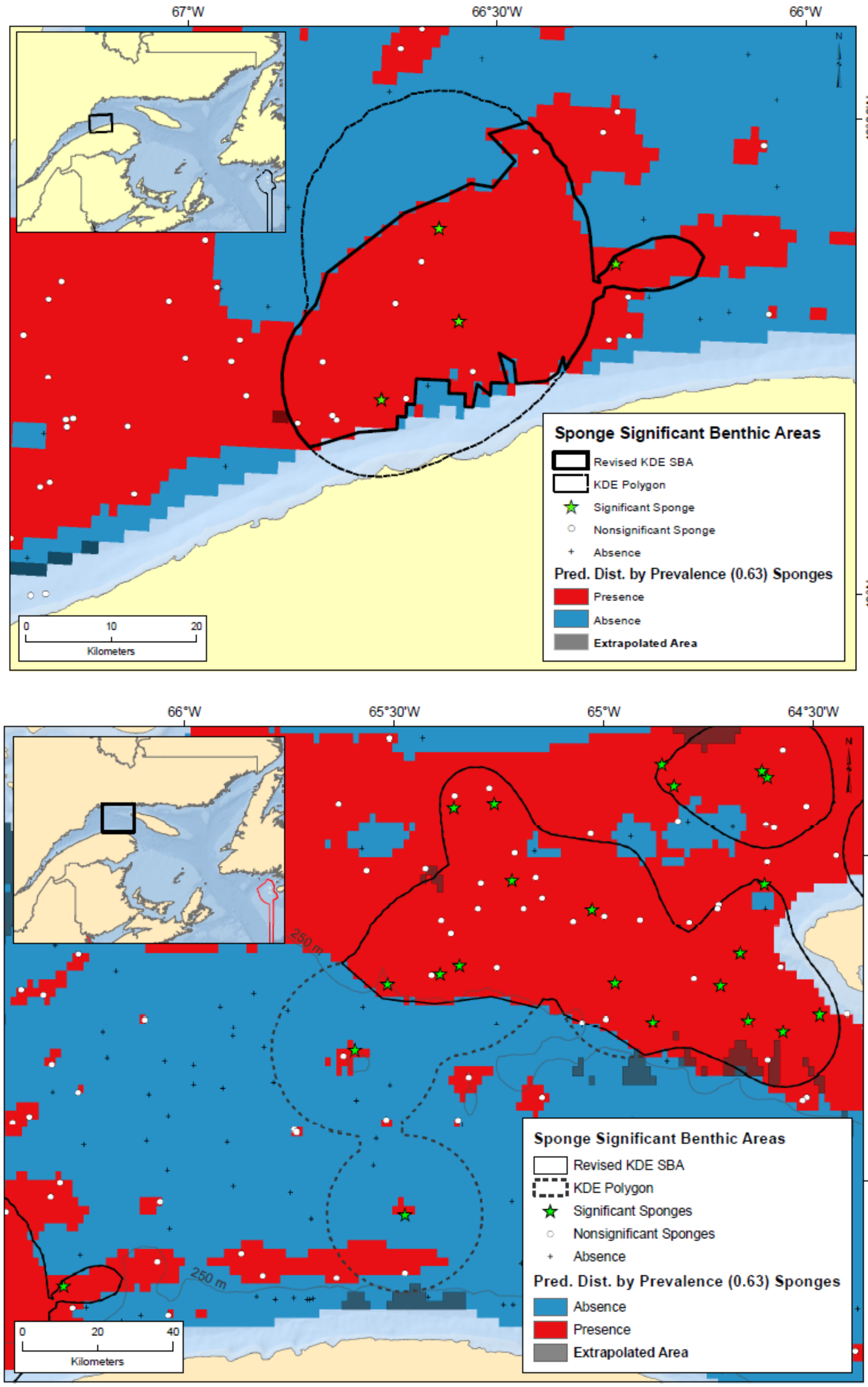


Figure 87. *Two KDE-derived polygons for sponges in the Gulf of St. Lawrence Estuary were trimmed (dashed area removed) to match the sponge prevalence to create new sponge SBAs.*

Two small sponge KDE-derived polygons immediately south of east Anticosti Island at constant depth were grouped together. This was done by using the RF prevalence area bounded by the absence boundary and the 300m depth contour to the north. The latter was estimated using the

CHS-ABC depth contours (Figure 88). To the north of east Anticosti Island a polygon was deleted. This polygon straddled an area of predicted absence from the random forest presence-absence model and linked three large catches across and along this barrier (Figure 89).

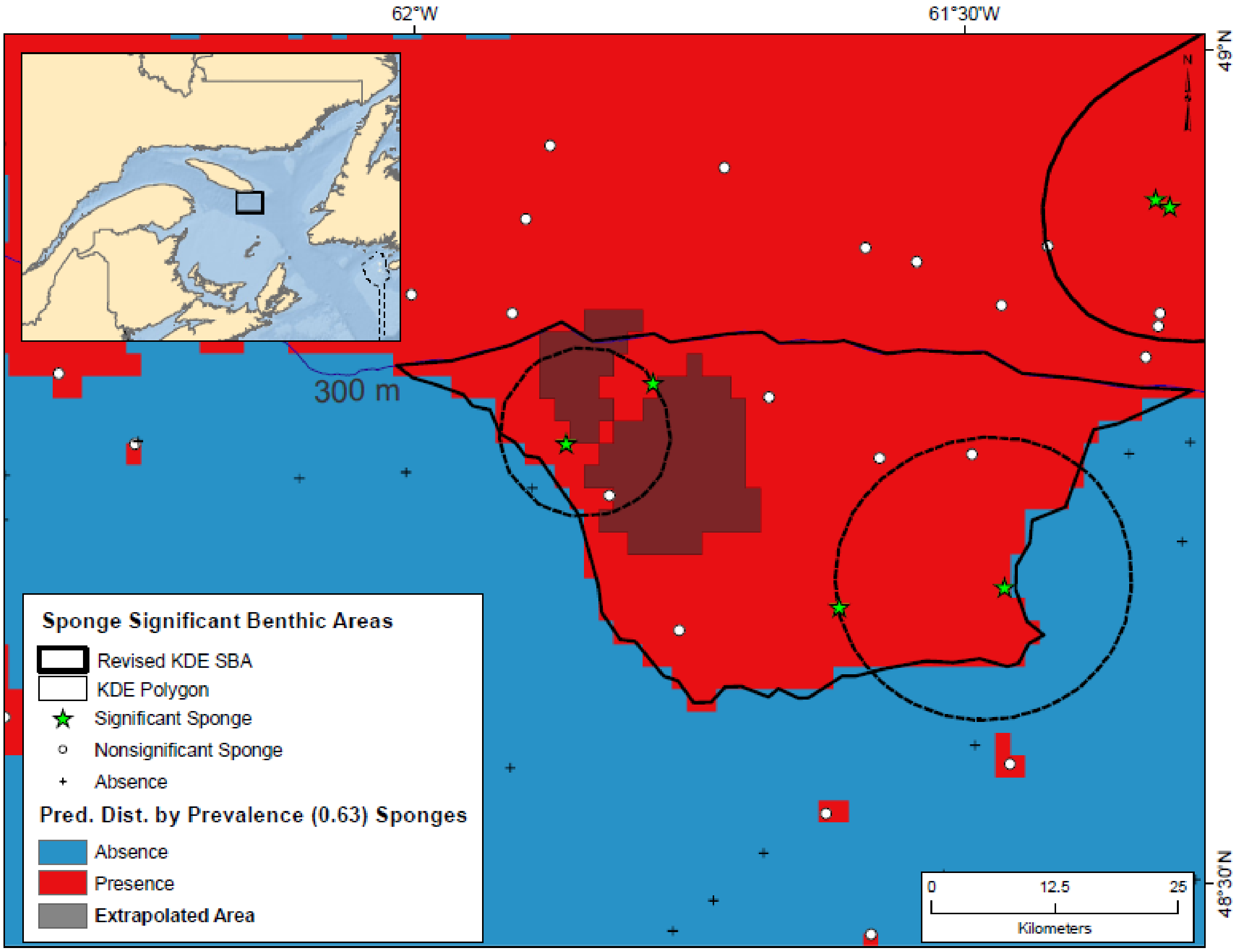


Figure 88. *Two KDE-derived polygons for sponges (dashed lines) in the Gulf of St. Lawrence were replaced with the portion of the RF prevalence area to the 300m depth contour to create a new sponge SBA.*

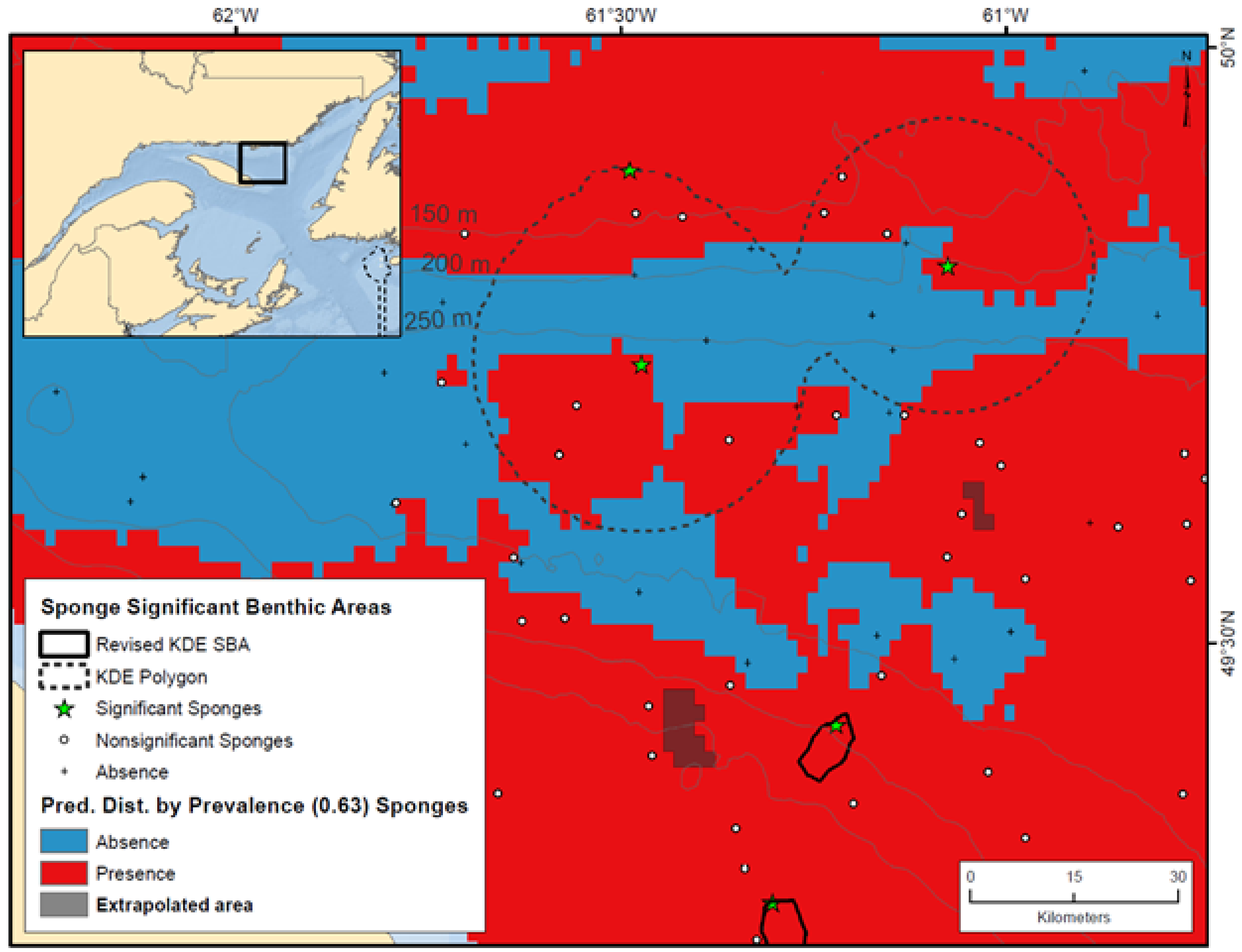


Figure 89. *The location of the KDE-derived polygons for sponges (dashed lines) in the Gulf of St. Lawrence that was deleted because the polygon straddled the absence area of the RF model.*

The KDE-derived polygons for sponges in the southern Gulf of St. Lawrence were small and scattered (Figure 90). A few large catches occurred with many smaller catches interspersed among them. These smaller SBA may be grouped using the prevalence maps.

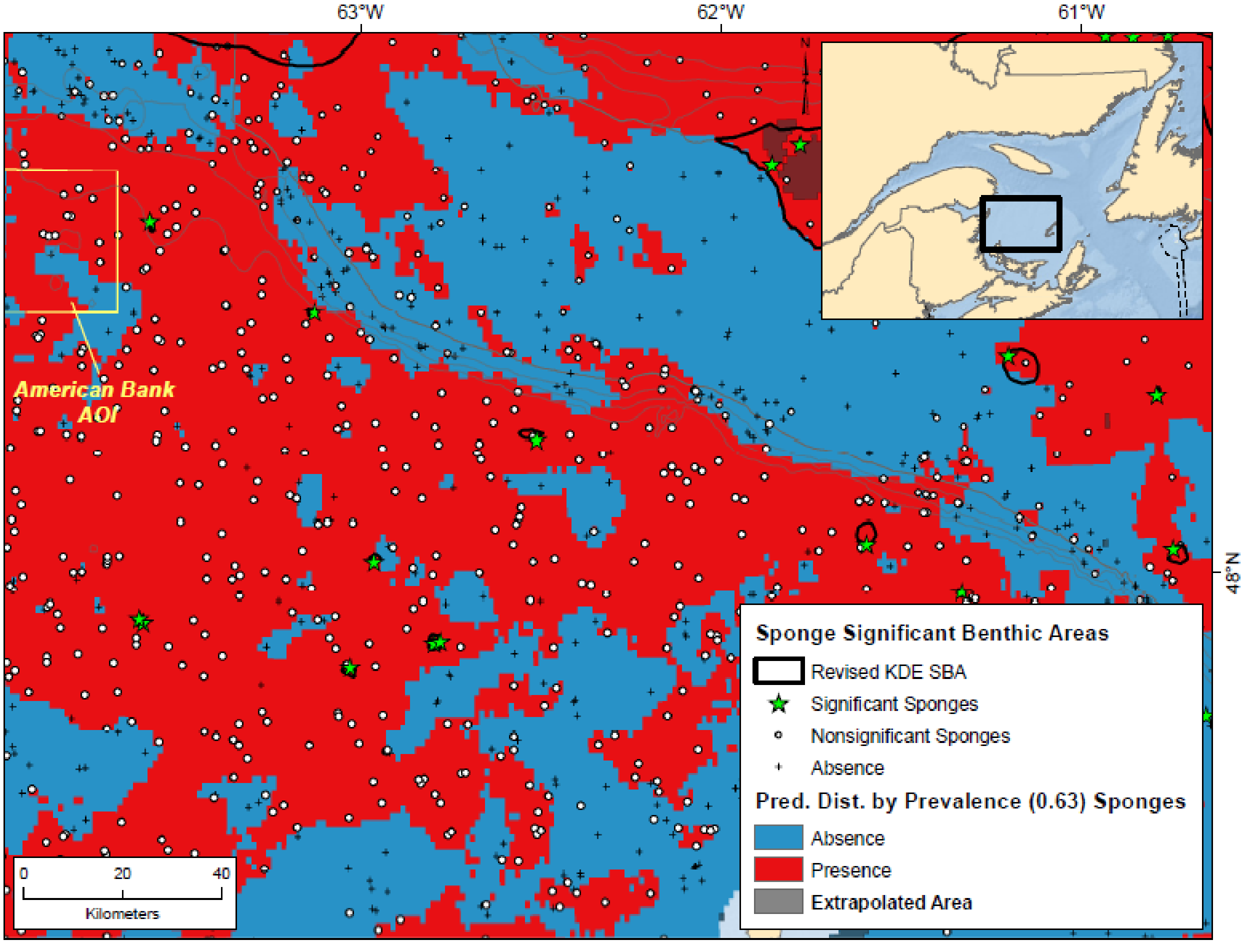


Figure 90. *Location of some of the KDE-derived polygons for sponges in the southern Gulf of St. Lawrence overlain on species prevalence from the random forest presence-absence model, showing their small size and separated distribution.*

Large, elongated sea pen areas in the Laurentian Channel were identified probably connected through strong bidirectional (tidal) current. There was good overlap between concentrations in the south and northern Gulf from the different surveys, overlapping at the shelf break between the two zones. In one region the KDE polygons from the two surveys overlapped and extended over the shelf edge, likely due to contamination in the trawl catches. It was recommended that these polygons be merged and clipped to the 200-m isobaths (using the CHS-ABC depth contours). This new sea pen SBA is shown in Figure 91.

The final sponge and sea pen SBAs are shown in Figure 92; no substantial overlap between areas was observed.

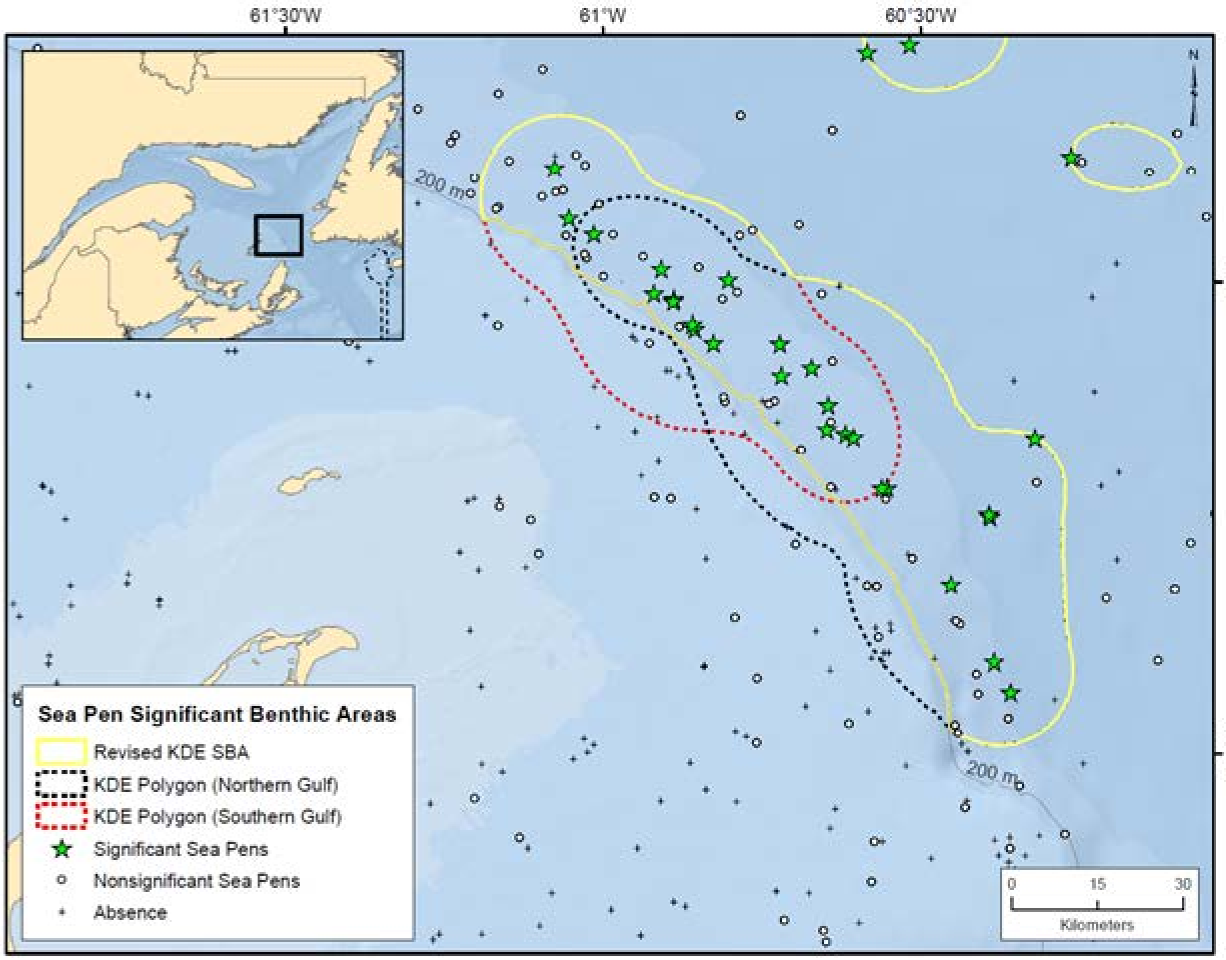


Figure 91. *Location of the sea pen KDE-derived polygons from the northern and southern Gulf surveys. The smaller polygon was subsumed within the larger one and the boundary (dashed lines) clipped to the 200m depth contour. The new sea pen SBA is indicated in yellow.*

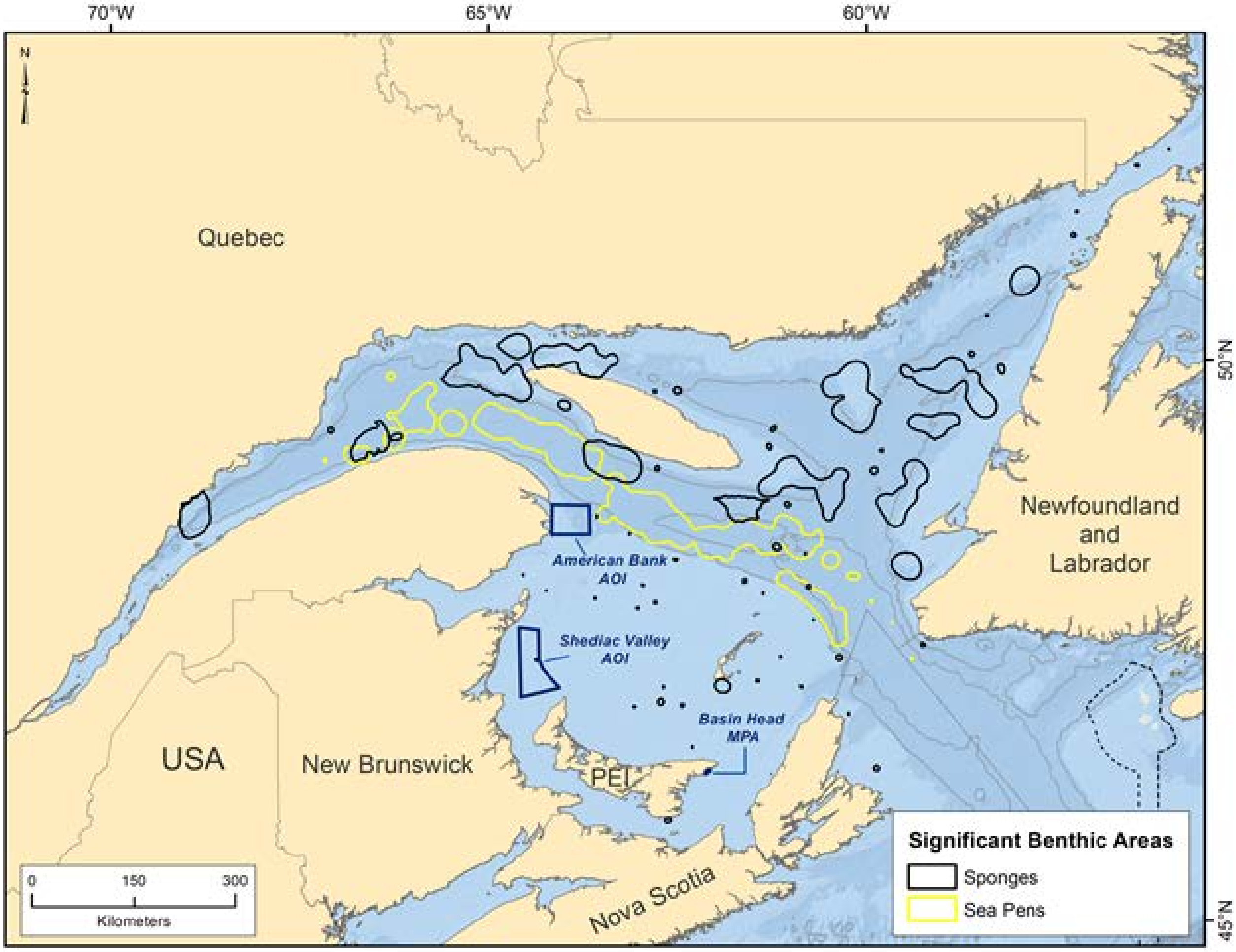


Figure 92. *Location of the sponge and sea pen KDE-derived polygons from the northern and southern Gulf surveys. Boundaries are shown after modifications were made. The EEZs of France (St. Pierre and Miquelon) is shown in dashed lines. Areas closed or proposed to be closed to protect benthic species and habitats are indicated in blue outline.*

NEWFOUNDLAND AND LABRADOR SHELVES

A number of KDE-derived polygons were modified. One sponge KDE-derived polygon was modified from its original boundary. This polygon was located on the edge of Saglek Bank off northern Labrador (Figure 93). The southwestern portion of the polygon was clipped based on the 250m CHS-ABC depth contour to exclude absence areas predicted by the RF presence-absence prevalence model (Figure 93).

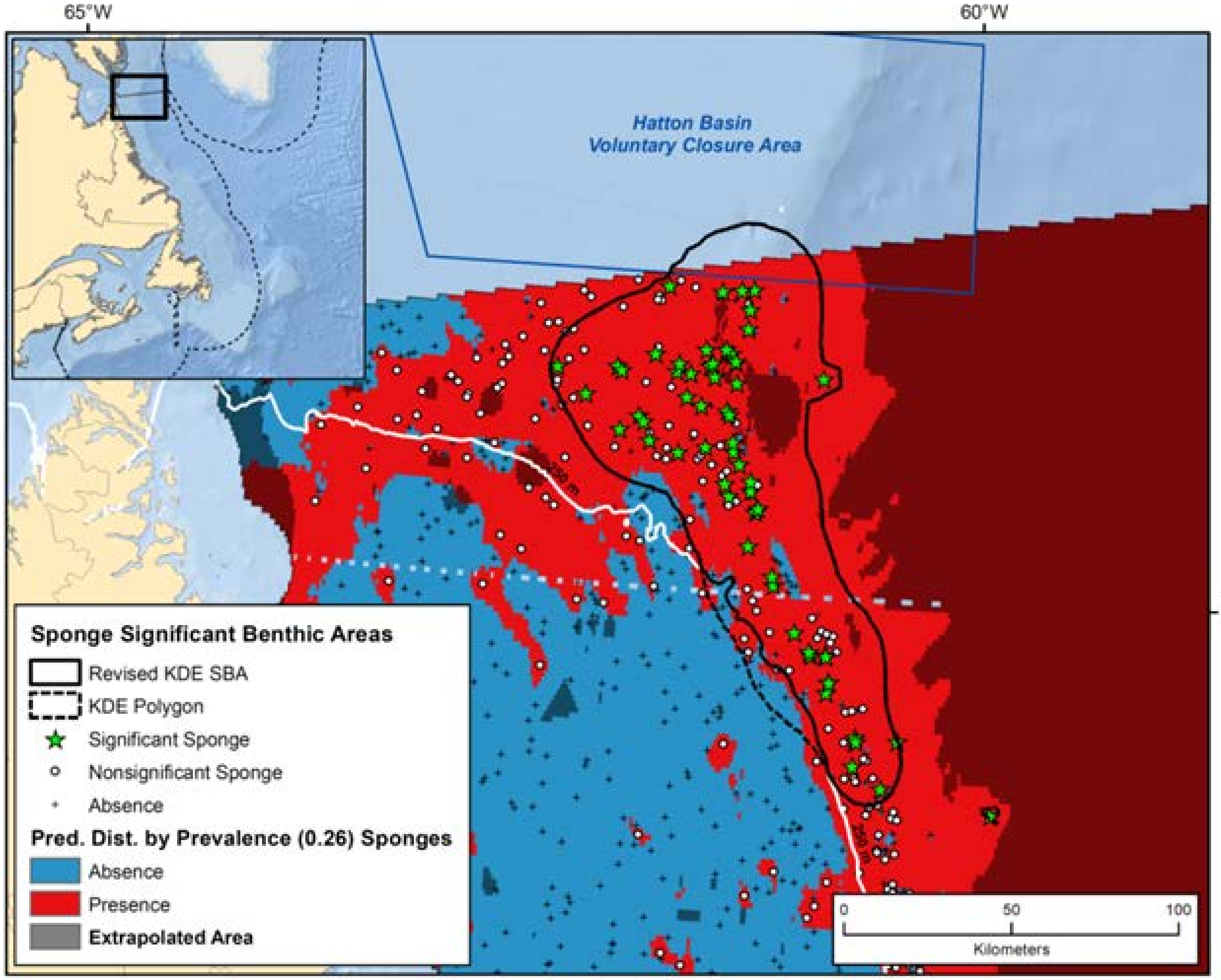


Figure 93. *Location of the sponge KDE-derived polygon from the northern Labrador slope south of the Hatton Basin. This polygon was trimmed (dashed line) to the 250m depth contour (white) to more closely follow the prevalence distribution along the upper slope. EEZs of Canada, Greenland and France are shown by dashed lines in the inset box.*

One sea pen KDE-derived polygon was modified and a new SBA for sea pens was added based on the random forest model output. The modified KDE-derived polygon was located on the northwest boundary of the 3O Coral Protection Zone (Figure 94). The northern portion of the polygon was clipped along the presence-absence boundary excluding the model absence areas.

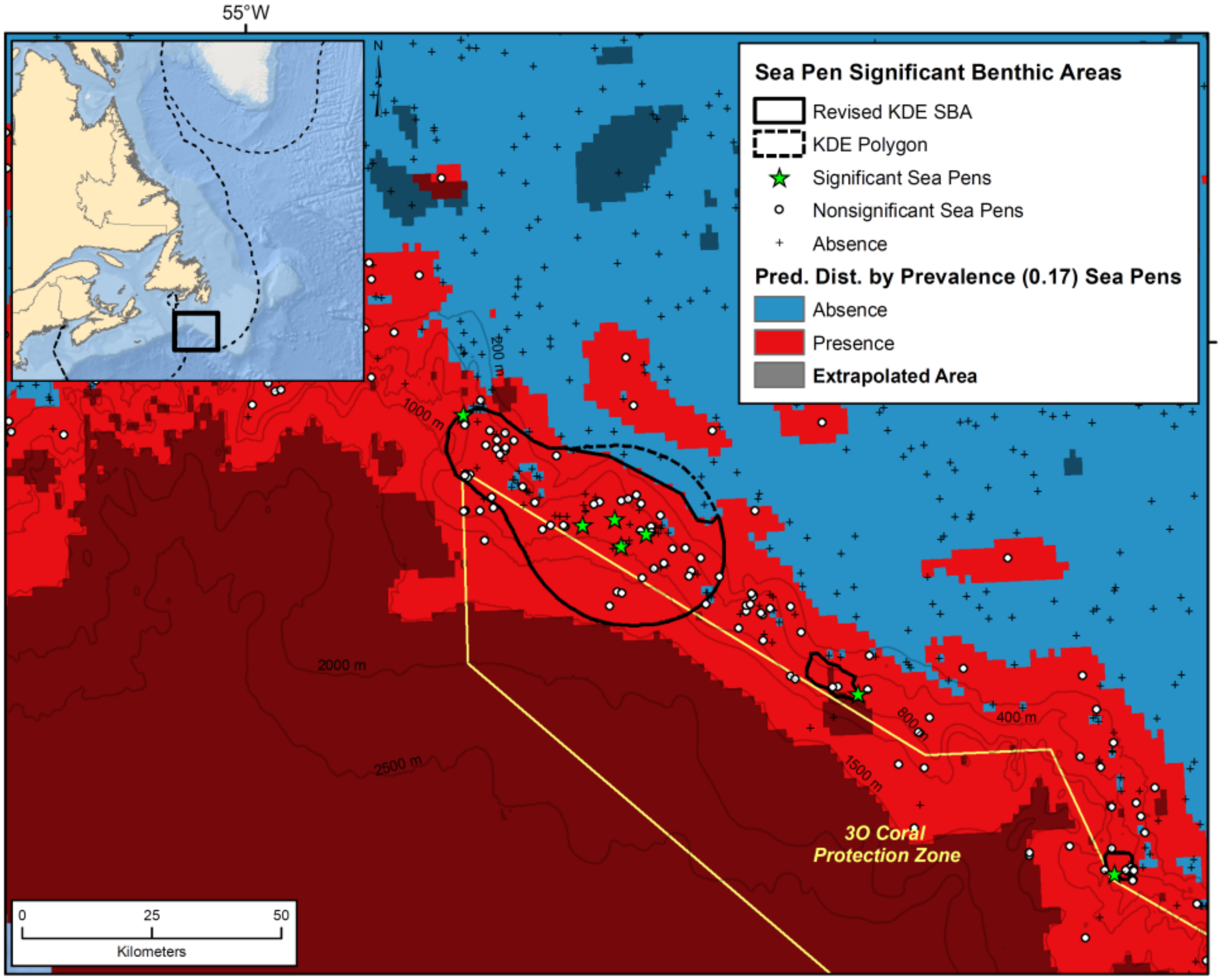


Figure 94. *Location of the sea pen KDE-derived polygon that was trimmed (dashed line) to match the prevalence distribution along the upper slope. EEZs of Canada, Greenland and France are shown by dashed lines in the inset box.*

The new sea pen SBA was located on the slope northeast of Newfoundland (Figure 95). This SBA coincided with an area of sea pen presence predicted by the random forest model. This area also had a high probability of sea pens based on the probability scale, and had good congruence with sea pen records from the Fisheries Observer Program that were used to validate the model. The heavy fishing in this area may be the reason why larger catches were not taken in the RV surveys. The polygon is bounded by the extrapolated area boundary in the deeper portion, and by the presence boundary in the shallow portion. It was clipped to create a single, continuous polygon.

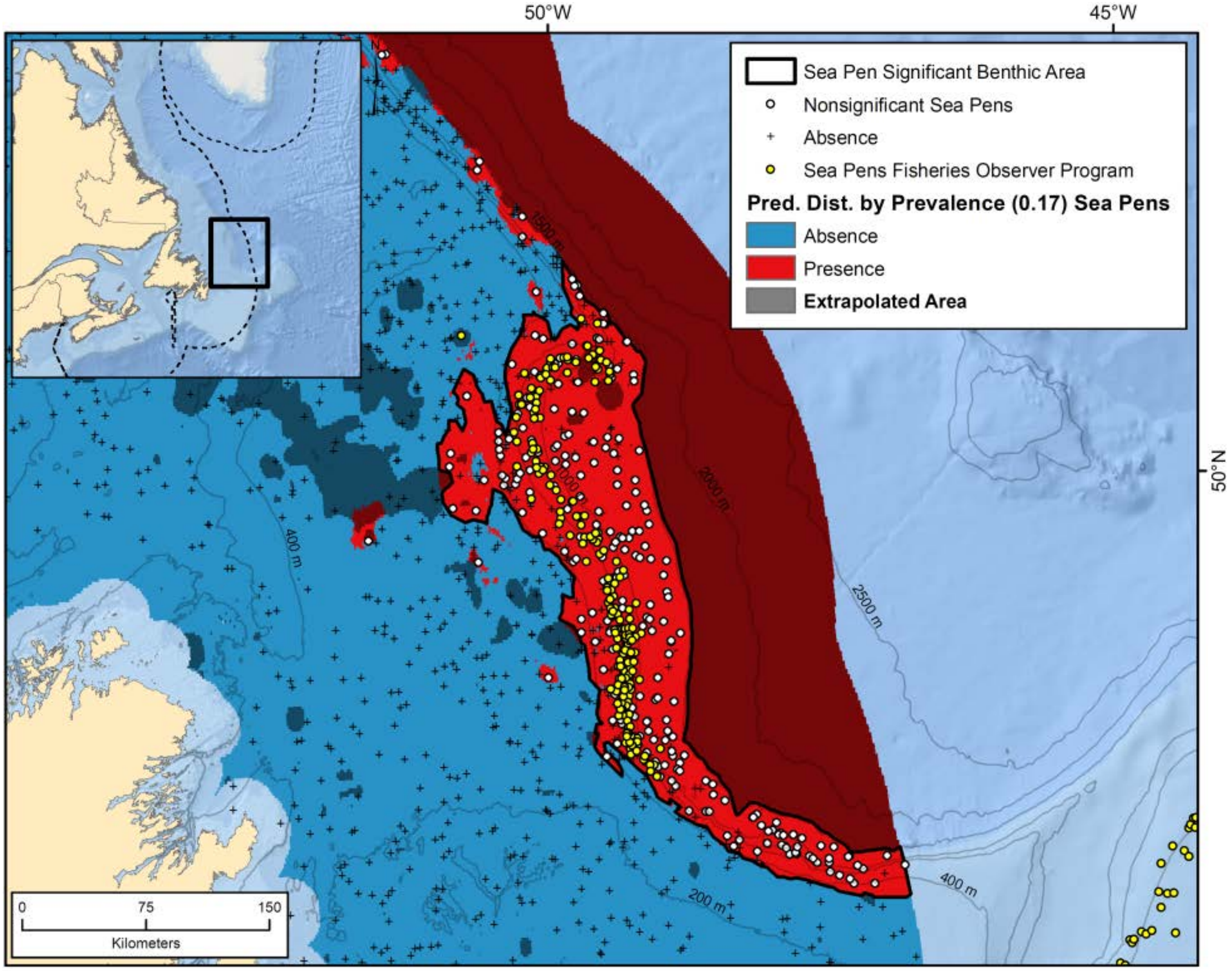


Figure 95. *Location of the sea pen SBA (red area outlined in black) created to match the prevalence distribution along the upper slope and the area of extrapolation to the east. The yellow circles denote data from the Fisheries Observer Program which was used to validate the area. White circles denote sea pen presence from the research vessel catches. EEZs of Canada, Greenland and France are shown by dashed lines in the inset box.*

Three large gorgonian coral KDE-derived polygons were modified from their original extent. All three polygons were clipped to the presence-absence boundary from model prevalence. One polygon was located along the northwest boundary of the 3O Coral Protection Zone (Figure 96). The two other modified large gorgonian coral KDE-derived polygons were located along the slope northeast of Newfoundland (Figure 97). These were clipped based on the presence-absence boundary from model prevalence, although the changes to the smaller polygon were very minor.

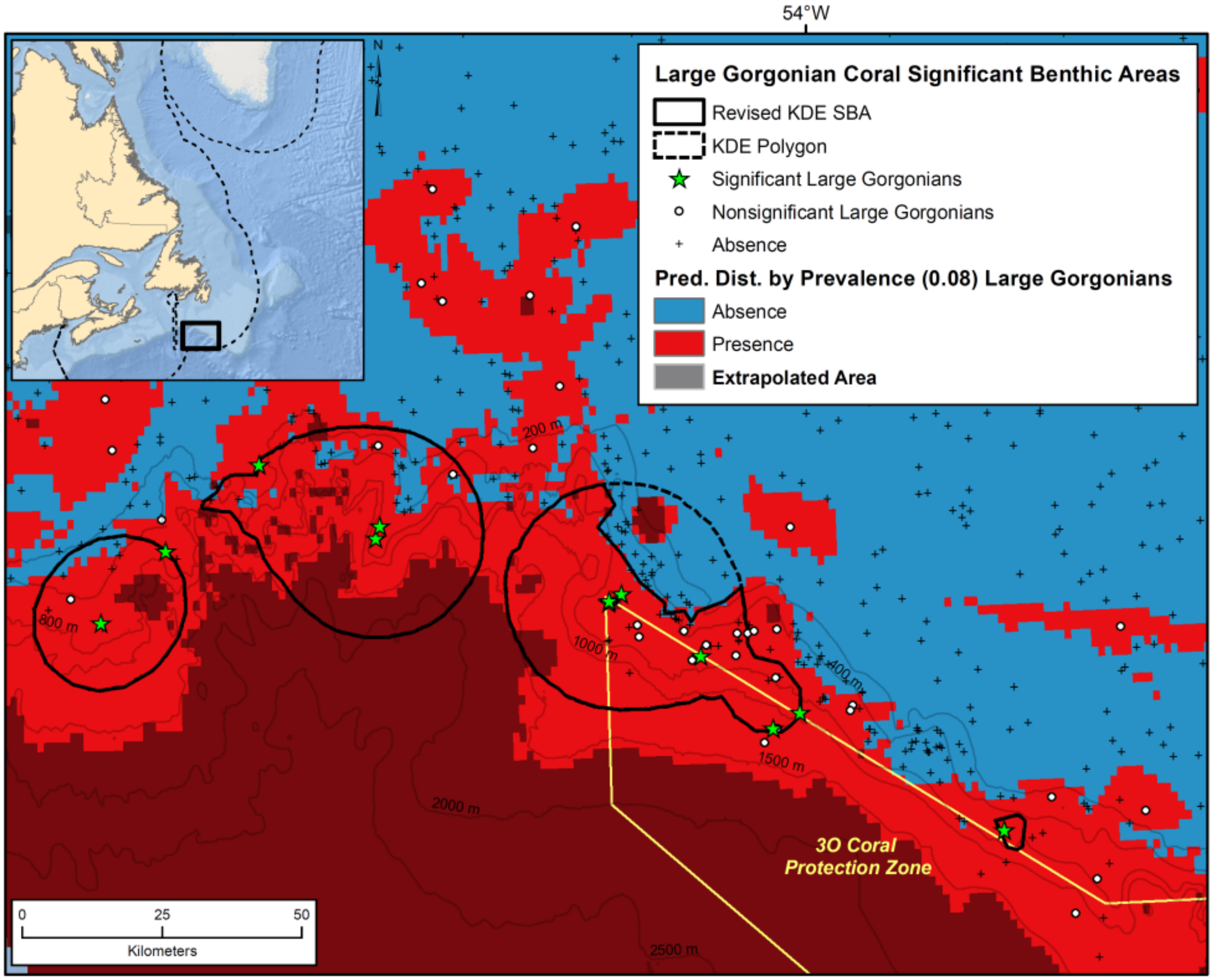


Figure 96. *Location of the large gorgonian KDE-derived polygon that was modified (dashed area clipped) to match the prevalence distribution along the upper slope. The new SBA is indicated in red outlined in black. EEZs of Canada, Greenland and France are shown by dashed lines in the inset box.*

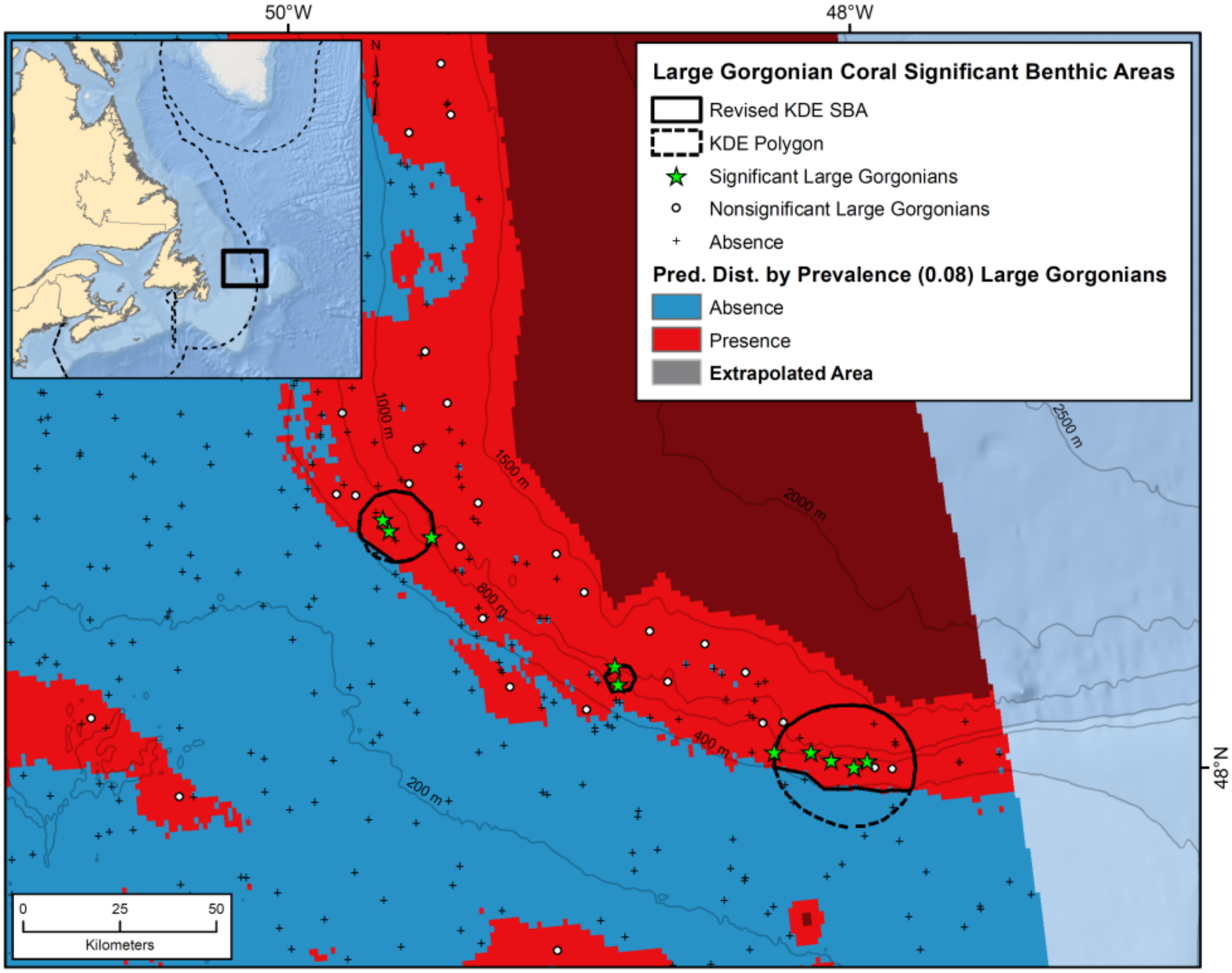


Figure 97. *Location of the large gorgonian KDE-derived polygons that were modified (dashed area clipped) to match the prevalence distribution along the upper slope. The new SBAs are indicated in red outlined in black. EEZs of Canada, Greenland and France are shown by dashed lines in the inset box.*

Three KDE-derived polygons for small gorgonian corals were modified from their original extent. All three were located along the northern boundary of the 3O Coral Protection Zone (Figure 98). The westernmost polygon was clipped based on the 400m CHS-ABC depth contour. This contour closely followed the undulating presence-absence boundary. Most small gorgonian KDE-derived polygons in the Newfoundland and Labrador Region were located below 400m depth.

The location of all coral and sponge SBA are shown in Figure 99. Most of the SBAs fall along the slopes and there is a high degree of overlap amongst the different taxa in some areas.

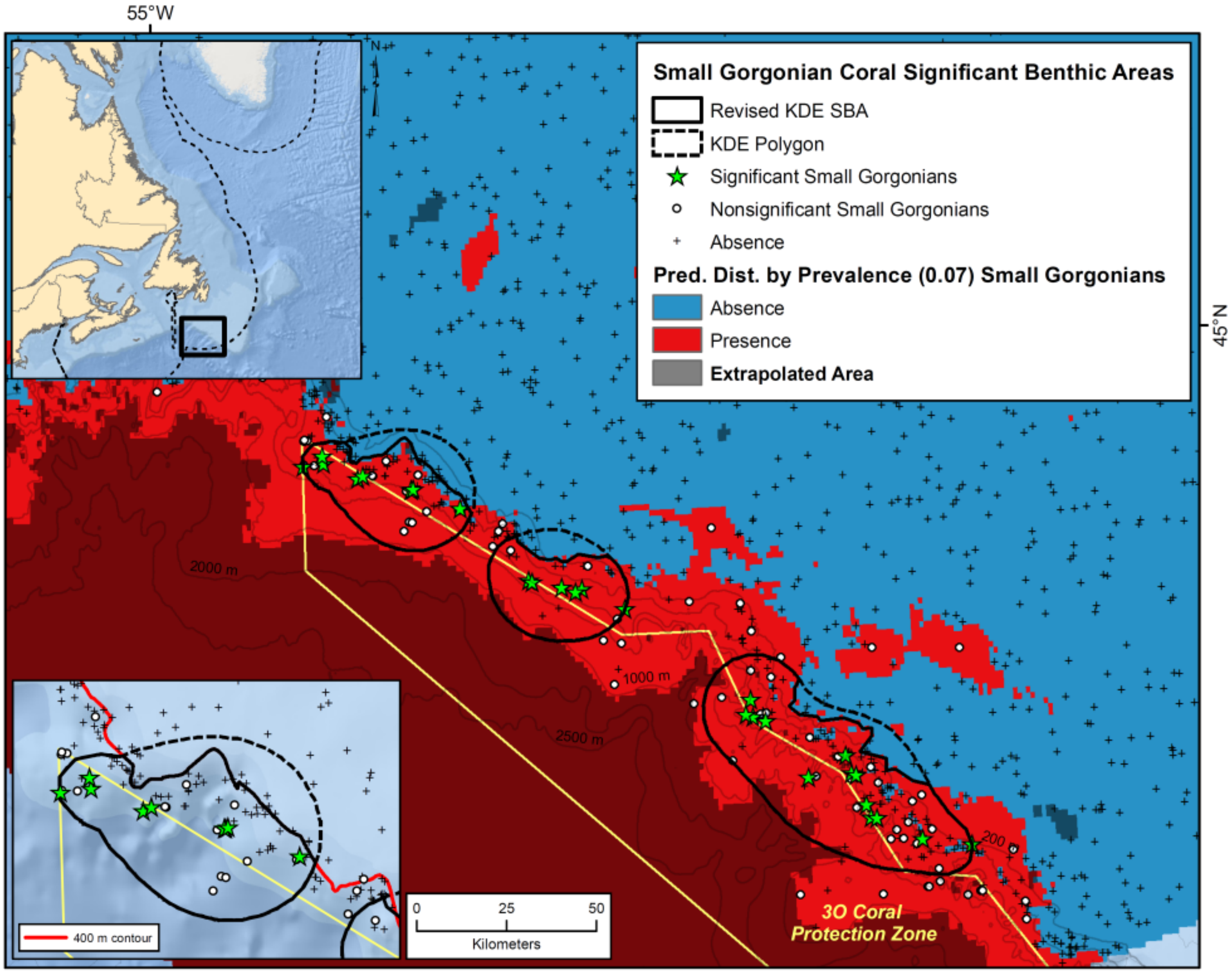


Figure 98. *Location of the small gorgonian KDE-derived polygons that were modified (dashed area clipped) to match the prevalence distribution along the upper slope. The westernmost polygon was clipped using the 400m depth contour. The new SBAs are indicated in red outlined in black. EEZs of Canada, Greenland and France are shown by dashed lines in the inset box.*

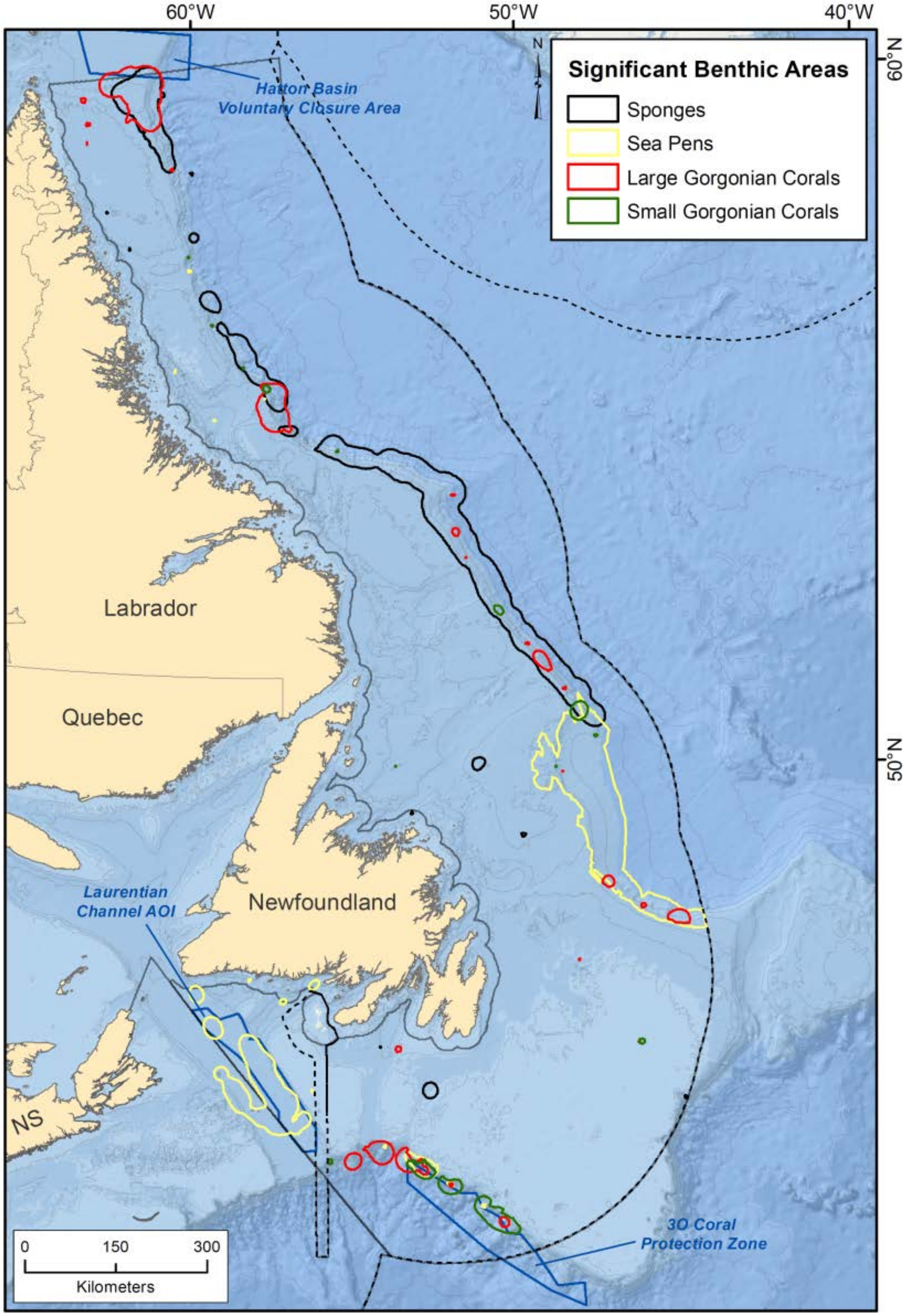


Figure 99. *SBAs for sponges, sea pens, large and small gorgonian corals for the Newfoundland and Labrador Shelves region. All but one of the polygons was derived from the KDE analyses but a number were clipped using the random forest presence-absence prevalence maps and/or depth. One sea pen polygon was created from the latter along the slope east of Newfoundland. Note that there are a number of small SBAs that are not readily seen on this projection. EEZs of Canada, Greenland and France are shown by dashed lines.*

HUDSON STRAIT

In this region KDE polygons were created for sponges only (Figure 100) as the sea pens, large and small gorgonian corals were either not present or present with insufficient data to perform the analyses. The random forest SDM did not perform well (AUC=0.643) and so was not used to alter the KDE polygons. It was felt that modelling in this area could be improved with more survey data to augment the current data series.

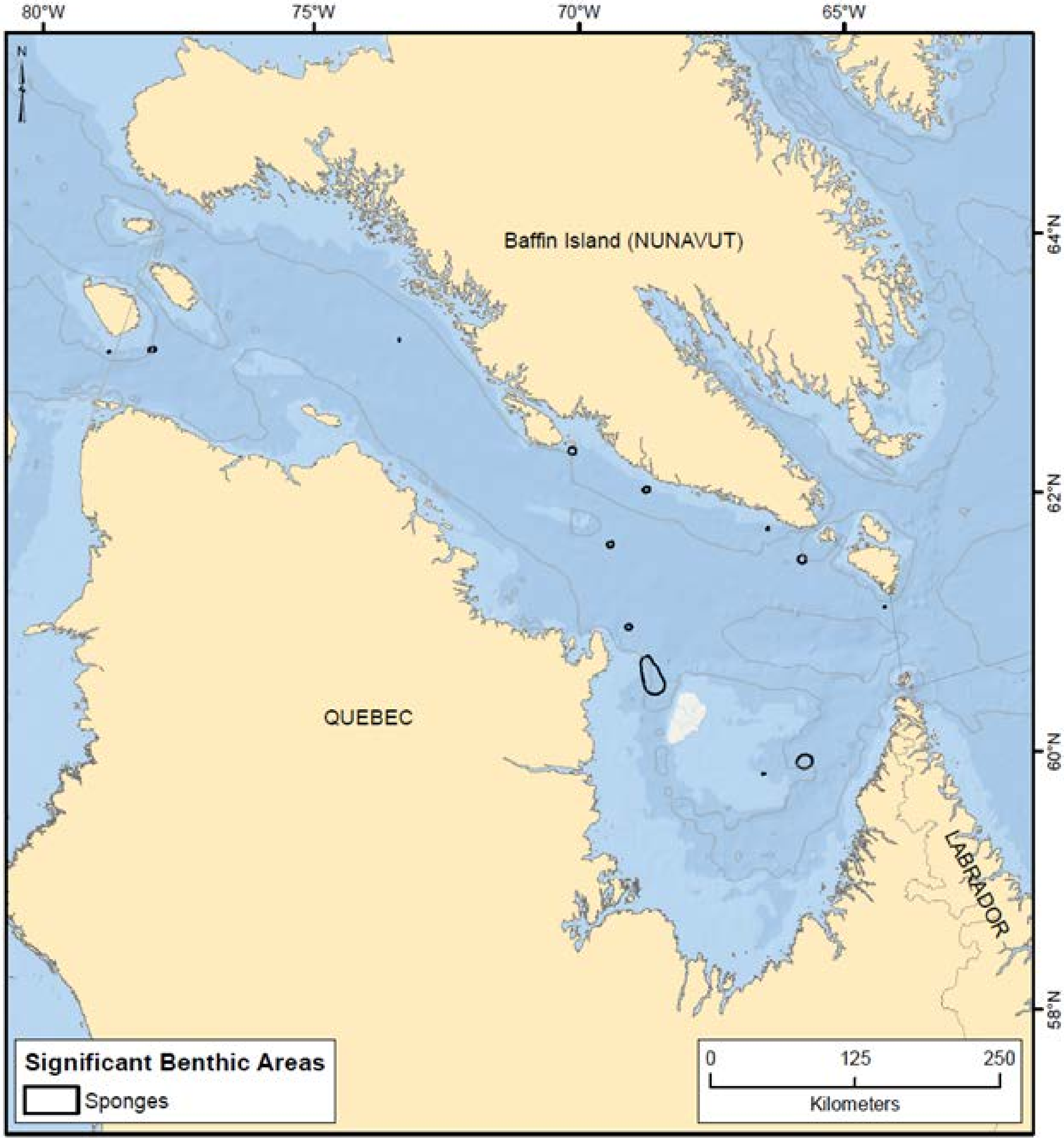


Figure 100. *Location of sponge (black outline) SBAs in Hudson Strait, as determined from KDE analyses. Note that there are many small polygons for each taxon that are not readily seen at this scale.*

EASTERN ARCTIC

There was a high degree of consistency between the KDE-derived polygons and the SDMs for all indicator taxa in the Eastern Arctic. Fisheries Observer data (FOP) that was not used in the analysis overlaid the modelled species presence very well. For one location in the Narwhal Overwintering and Deep-Sea Coral Conservation Area the prevalence map was used to expand the KDE-derived polygon, creating a new SBA for large gorgonian corals (Figure 101). This was based on the overlay of a high catch of the large gorgonian coral *Keratoisis* sp. from the FOP data which gave confidence that the KDE polygon was too small to define the habitat.

The locations of the SBAs in the Eastern Arctic are shown in Figure 102. There is a high degree of overlap amongst taxa in the southern part of the region, along the slope areas. Figure 103 eliminates overlap within taxa from the different gears by dissolving polygons embedded in other polygons of the same type.

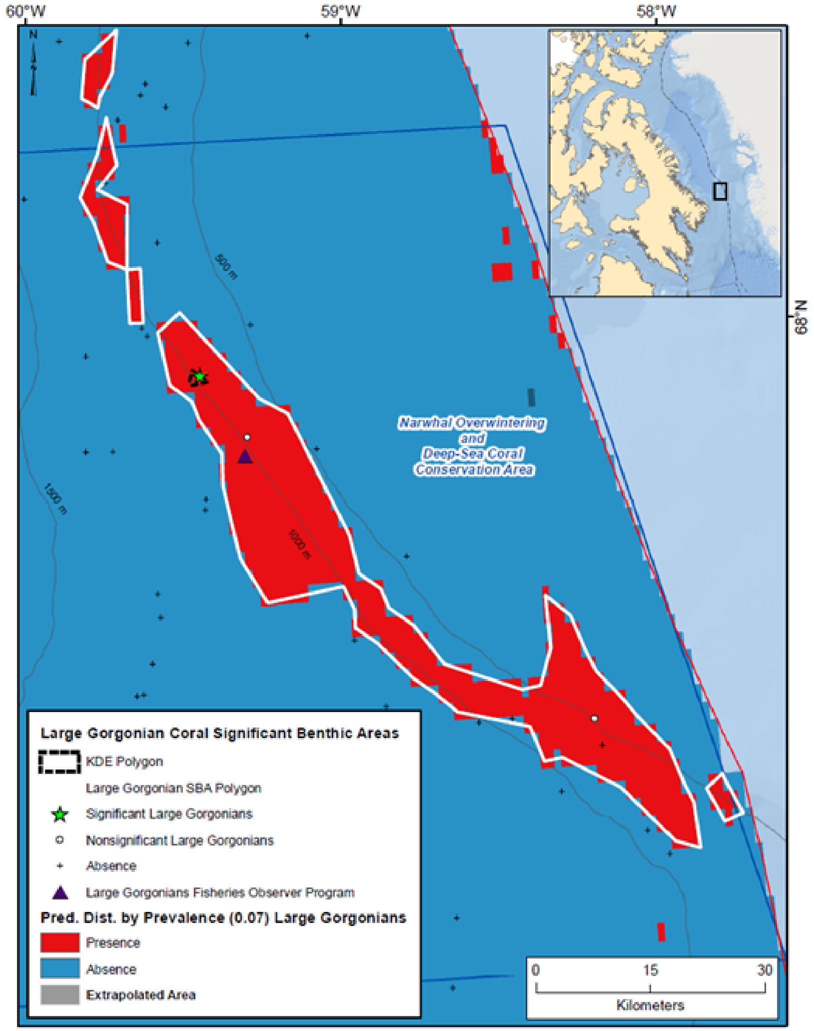


Figure 101. *SBA (red area with white outline) for large gorgonian corals delineated from the random forest presence-absence SDM. The areas are overlain with all of the catch data (presence of large gorgonian corals and absence). A very large catch of large gorgonian corals from the Fisheries Observer Program (triangle) was positioned in this area and provided independent confirmation of the SBA. EEZ of Canada is shown by the dashed line in the inset box.*

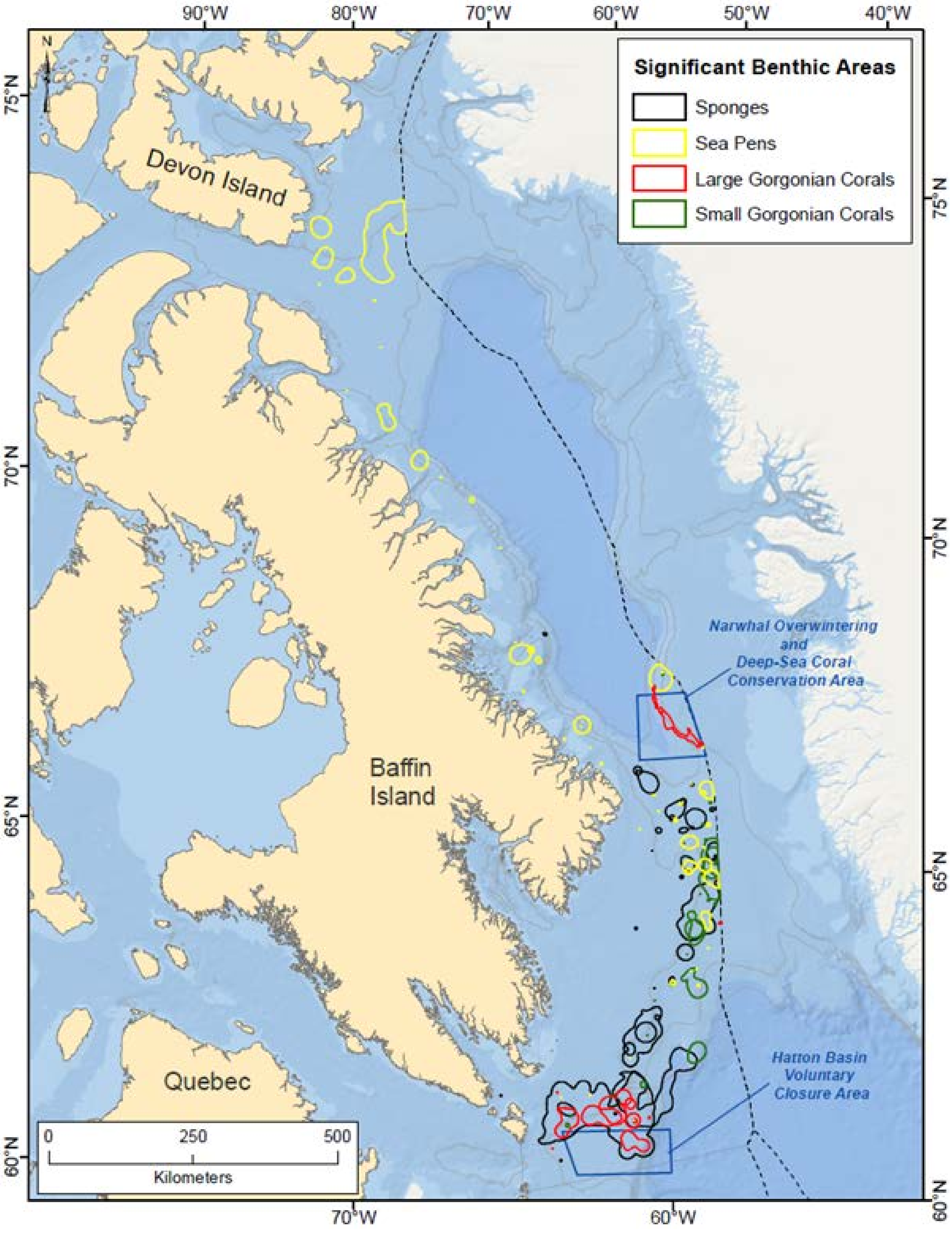


Figure 102. *Location of sponge (black outline), sea pen (yellow outline), large gorgonian (red outline) and small gorgonian coral (green outline) SBAs as determined from KDE analyses and random forest SDM based on presence-absence (large gorgonian coral SBA in the Narwhal Overwintering and Deep-Sea Coral Conservation Area). Note that there are many small polygons for each taxon that are not readily seen at this scale. EEZ of Canada and Greenland are shown by the dashed lines.*

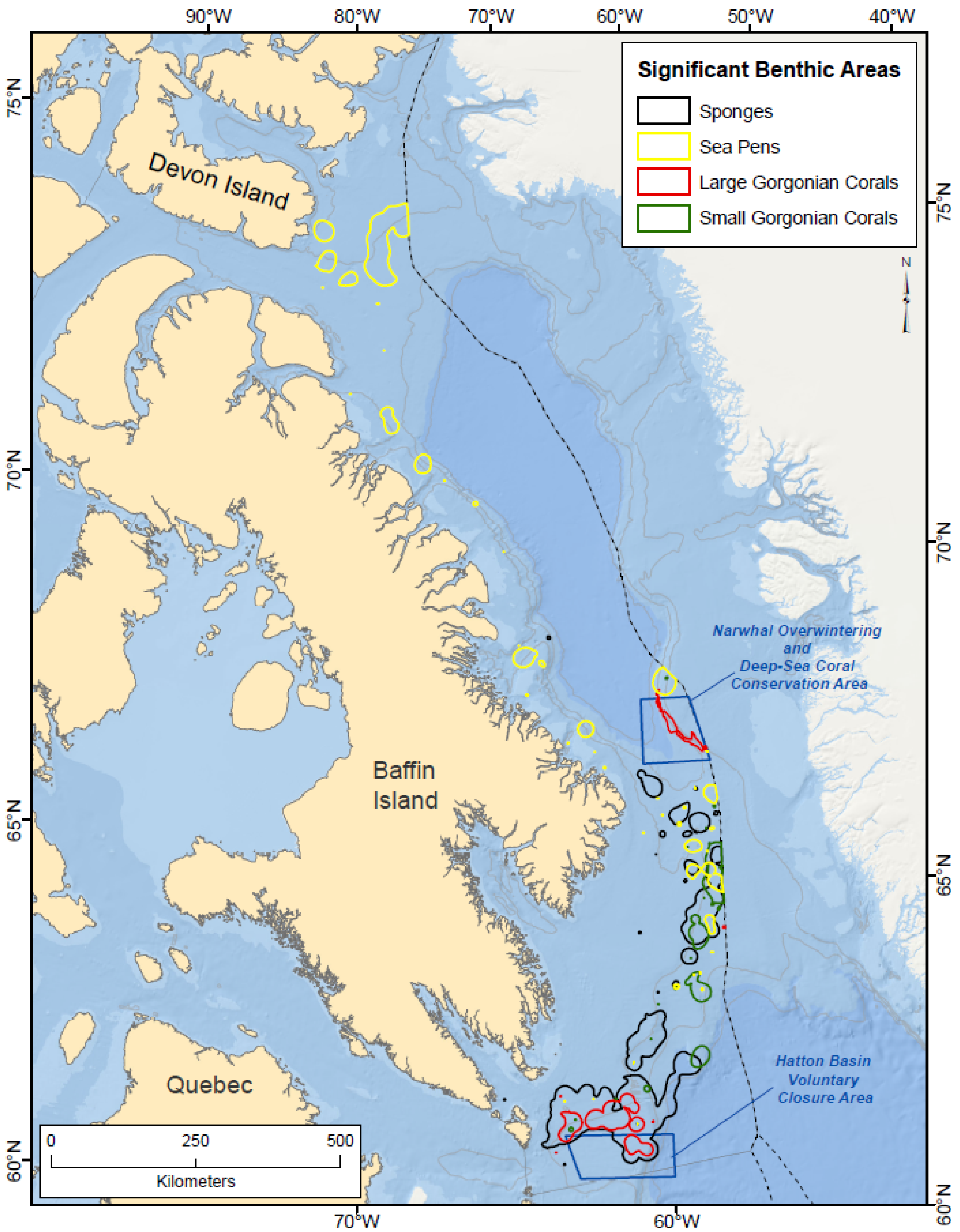


Figure 103. *Location of non-overlapping sponge (black outline), sea pen (yellow outline), large gorgonian (red outline) and small gorgonian coral (green outline) SBAs as determined from KDE analyses and random forest SDM based on presence-absence (large gorgonian coral SBA in the Narwhal Overwintering and Deep-Sea Coral Conservation Area). Note that there are many small polygons for each taxon that are not readily seen at this scale. EEZ of Canada and Greenland are shown by the dashed lines.*

ACKNOWLEDGEMENTS

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APPENDICES

APPENDIX 1. LOCATIONS OF THE TOW POSITIONS THAT WERE USED TO DELINEATE THE SIGNIFICANT CONCENTRATIONS OF CORALS AND SPONGES.

The locations of the tow positions that were used to delineate the significant concentrations of corals and sponges are provided in this Appendix. Tables A1.1 to A1.3 provide locations for sponges, sea pens and large gorgonian corals on the Scotian Shelf where they were fished with a Western IIA trawl. In this region there were insufficient data to perform the analyses on the small gorgonian corals. Tables A1.4 and A1.5 provide the tow positions for the sponges and sea pens respectively in the southern Gulf of St. Lawrence where they were fished with a Western IIA trawl, while Tables A1.6 and A1.7 provide the tow positions for the sponges and sea pens respectively in the northern Gulf where they were fished with a Campelen trawl. Tables A1.8 to A1.11 provide tow locations for sponges, sea pens, large and small gorgonian corals respectively from the Newfoundland and Labrador Shelves Region. Table A1.12 provides the locations for sponges in Hudson Strait. Tables A1.13 to A1.22 provide locations for sponges, sea pens and large gorgonian corals by gear type for the Eastern Arctic.

***Table A1.1** Scotian Shelf Biogeographic Zone: Details of the Location of Research Vessel Sponge Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)	*Vazella pourtalesi*
2011	NED2011025004	43.89233	-63.02217	43.86383	-63.01400	85.54	Yes
2008	TEM2008830046	43.91683	-66.42050	43.93383	-66.45367	56.00	No
2010	NED2010027086	42.81667	-63.21633	42.81483	-63.17633	50.18	Yes
2013	NED2013022174	44.22183	-62.33667	44.20483	-62.36750	36.25	Yes
2013	NED2013028032	44.09600	-63.39900	44.08833	-63.43733	32.89	No
2002	NED2002037002	43.98917	-63.21050	43.96683	-63.18483	30.50	No
2012	NED2012022003	43.98733	-63.21633	43.97217	-63.18200	30.18	Yes
2014	NED2014018144	44.21833	-62.89400	44.19300	-62.91200	29.89	Yes
2014	NED2014101002	44.01417	-63.50150	44.02283	-63.46267	28.10	Yes
2009	NED2009027095	44.31217	-62.77817	44.31500	-62.73833	27.41	No
2009	NED2009027051	43.96833	-66.43217	43.94883	-66.43317	24.80	No
2002	NED2002037026	43.57433	-63.41150	43.59717	-63.38750	23.63	No
2011	NED2011025151	44.55517	-60.12833	44.55133	-60.16817	23.22	No
2014	NED2014002020	42.08183	-67.00633	42.05683	-66.98317	20.89	No
2010	NED2010027041	44.22683	-66.50350	44.20967	-66.51933	16.48	No
2005	TEL2005605004	43.13517	-63.46150	43.14550	-63.42283	15.85	No
2011	NED2011025171	44.27550	-62.92933	44.25983	-62.96267	15.10	Yes
2010	NED2010002071	42.81800	-63.21933	42.81800	-63.18550	14.07	Yes
2014	NED2014018133	44.04300	-59.91267	44.03767	-59.95533	13.63	No
2010	NED2010027029	42.64917	-65.57917	42.62650	-65.57883	13.20	No
2014	NED2014018170	46.27350	-59.29717	46.26983	-59.26817	12.64	No
2009	NED2009027032	42.58783	-65.62533	42.58917	-65.66450	12.42	No
2002	NED2002040055	44.22383	-57.83533	44.23867	-57.86467	11.76	No

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)	*Vazella pourtalesi*
2008	TEM2008830088	42.80617	-63.19967	42.80700	-63.16333	10.15	Yes
2013	NED2013022161	44.03400	-59.93950	44.02667	-59.97900	8.90	No
2010	NED2010027025	42.94317	-65.75833	42.91350	-65.75883	8.85	No
2009	NED2009027055	44.38950	-66.47750	44.41550	-66.45700	8.09	No
2002	NED2002037023	43.20967	-63.53100	43.23367	-63.50700	7.96	No
2002	NED2002040090	46.14550	-59.02533	46.13917	-58.98400	7.66	No
2013	NED2013022020	42.58883	-65.61250	42.60867	-65.62433	7.28	No
2008	TEM2008830034	42.61817	-65.39367	42.63500	-65.42650	7.17	No
2008	TEM2008830037	42.80150	-65.66717	42.77783	-65.68583	7.10	No
2009	NED2009027052	44.07083	-66.41117	44.05133	-66.41117	7.04	No
2014	NED2014101003	43.46317	-63.49967	43.44117	-63.52533	6.95	Yes
2012	NED2012022047	42.54067	-65.44567	42.52550	-65.48000	6.65	No
2008	TEM2008830148	46.31767	-59.49067	46.33050	-59.45233	6.55	No
2002	NED2002037066	43.83617	-66.35067	43.86583	-66.34567	6.53	No
2010	NED2010027194	44.19683	-62.47483	44.17617	-62.49933	6.53	No
2013	NED2013022221	46.04650	-59.11817	46.07517	-59.11133	6.47	No
2011	NED2011025212	45.70767	-58.57083	45.69283	-58.60700	6.28	No
2010	NED2010002058	44.27450	-59.47833	44.25317	-59.44783	6.18	No
2012	NED2012002048	41.92900	-65.92983	41.94883	-65.95917	6.16	No
2011	NED2011025176	44.98017	-60.80200	45.00383	-60.77667	6.14	No
2014	NED2014101001	44.04283	-63.62967	44.05483	-63.59433	6.11	Yes
2008	TEL2008805011	44.05033	-59.97933	44.05267	-59.93967	6.10	No
2010	NED2010002015	44.80217	-60.20467	44.82550	-60.18667	6.07	No
2008	TEM2008830138	45.98867	-59.40467	45.96383	-59.41567	6.05	No
2015	NED2015002026	41.97467	-66.01317	41.94850	-65.99750	5.80	No
2009	NED2009027149	46.19417	-59.08733	46.17750	-59.05267	5.74	No
2008	TEL2008805002	44.26983	-62.08433	44.26800	-62.04383	5.20	No
2011	NED2011025047	43.82917	-66.37133	43.81000	-66.36883	5.20	No
2010	NED2010027030	42.58017	-65.53017	42.57150	-65.55367	5.02	No
2007	TEL2007745030	44.17983	-66.57283	44.19250	-66.55133	4.99	No
2012	NED2012022069	44.00583	-66.41950	44.02833	-66.40000	4.90	No
2010	NED2010027008	43.15467	-63.54933	43.13150	-63.57317	4.80	Yes
2007	TEL2007745068	42.97783	-63.43167	42.97683	-63.39267	4.65	Yes
2014	NED2014018084	42.87550	-63.45250	42.87383	-63.48000	4.53	Yes
2007	TEL2007745069	43.05600	-63.37300	43.08517	-63.37000	4.35	Yes
2006	NED2006030088	42.80267	-63.20167	42.80733	-63.16200	4.32	No
2012	NED2012022191	45.36217	-58.18117	45.35517	-58.14167	4.24	No
2010	NED2010027085	42.94750	-63.43117	42.96433	-63.41883	4.20	Yes
2012	NED2012022051	42.55450	-65.84350	42.58300	-65.85050	4.04	No
2010	NED2010027173	44.06483	-59.77283	44.05400	-59.81167	3.97	No

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)	*Vazella pourtalesi*
2008	TEM2008830087	42.83067	-63.56183	42.82750	-63.52383	3.95	Yes
2007	TEM2007686014	44.30617	-59.11133	44.33483	-59.10267	3.85	No
2002	NED2002040095	45.31683	-60.04567	45.29200	-60.02333	3.84	No
2007	TEL2007745118	44.06217	-60.05633	44.06550	-60.09667	3.70	No
2010	NED2010002030	45.09617	-58.54033	45.12483	-58.52650	3.70	No
2002	NED2002040076	46.23167	-59.19667	46.24933	-59.23117	3.67	No
2010	NED2010027157	45.49567	-60.27600	45.51700	-60.25800	3.61	No
2013	NED2013022009	43.40300	-64.55233	43.41833	-64.53350	3.58	No
2007	TEM2007686089	42.80517	-63.07400	42.80383	-63.11350	3.50	No
2013	NED2013022016	42.74450	-65.30483	42.74633	-65.34333	3.43	No
2007	TEL2007745124	44.84883	-59.78833	44.82033	-59.78950	3.20	No
2005	TEL2005605085	43.91250	-63.72250	43.93467	-63.69300	3.10	No
2013	NED2013028150	44.02300	-59.78100	44.03250	-59.74300	3.05	No
2009	NED2009002041	44.53950	-60.02250	44.56867	-60.01667	3.04	No
2010	NED2010002054	44.34767	-57.61850	44.35233	-57.57833	3.02	No
2013	NED2013022103	42.93117	-63.52100	42.92267	-63.55717	3.01	No

***Table A1.2.** Scotian Shelf Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2012	NED2012022183	45.86450	-58.60300	45.84933	-58.56750	2.560
2014	NED2014018190	45.78183	-58.54517	45.78733	-58.50800	1.140
2008	TEL2008805004	44.13217	-61.47050	44.11200	-61.50200	1.000
2008	TEL2008805005	44.36333	-61.31783	44.33483	-61.32483	1.000
2011	NED2011025206	46.30867	-59.22450	46.31817	-59.26517	0.791
2007	TEL2007745156	46.08533	-58.73683	46.10350	-58.76900	0.500
2010	NED2010027235	42.55233	-63.19467	42.53867	-63.26900	0.418
2009	NED2009027153	45.84567	-59.01867	45.84250	-59.05333	0.286
2012	NED2012022145	44.43217	-63.01983	44.42367	-63.05767	0.236
2012	NED2012022180	46.15383	-58.84900	46.12867	-58.82717	0.224
2012	NED2012022186	45.54900	-58.65483	45.56067	-58.61800	0.172
2011	NED2011025205	46.28517	-59.04067	46.26383	-59.01150	0.122
2007	TEM2007686047	45.63017	-58.55867	45.65600	-58.54150	0.120
2010	NED2010027123	46.46217	-59.24517	46.44367	-59.21400	0.106
2013	NED2013028006	46.30117	-59.07783	46.27983	-59.04967	0.106
2006	NED2006036002	44.62450	-62.37233	44.63933	-62.34317	0.105
2012	NED2012022179	46.32667	-58.94800	46.30450	-58.92217	0.104
2011	NED2011025204	46.39517	-59.03783	46.37583	-59.00600	0.095
2010	NED2010027231	42.37450	-64.00817	42.38367	-64.18600	0.074

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2009	NED2009027097	44.35283	-61.81300	44.35100	-61.77183	0.072
2013	NED2013022007	43.05850	-64.15167	43.06383	-64.11467	0.072
2009	NED2009027096	44.52100	-62.39700	44.53067	-62.35917	0.062
2008	TEM2008775075	44.08467	-67.27617	44.11167	-67.26050	0.060
2010	NED2010027216	43.05567	-61.25917	43.10650	-61.28400	0.058
2008	TEM2008830083	42.72067	-64.03517	42.73150	-64.00000	0.056
2003	NED2003042035	46.22017	-58.83250	46.20217	-58.80017	0.056
2012	NED2012022209	44.17650	-58.18350	44.16100	-58.20517	0.054
2009	NED2009027098	44.39467	-61.53267	44.39450	-61.49133	0.052
2013	NED2013022194	43.97467	-58.66300	43.95950	-58.69667	0.050
2012	NED2012022197	44.77633	-58.14083	44.75950	-58.17383	0.043
2002	NED2002037030	43.06100	-63.95900	43.05767	-63.91883	0.040
2010	NED2010027226	42.52917	-63.18400	42.55483	-63.11567	0.040
2011	NED2011025207	46.18850	-59.23483	46.15917	-59.23183	0.040
2011	NED2011025173	44.51350	-62.19333	44.52433	-62.15550	0.040
2011	NED2011025268	43.60367	-60.33983	43.59333	-60.37750	0.039
2010	NED2010027004	43.74450	-63.21617	43.71517	-63.21667	0.037
2010	NED2010027061	44.07017	-67.29750	44.04883	-67.32567	0.037
2013	NED2013022226	46.37800	-59.30717	46.37067	-59.34833	0.036
2006	NED2006030067	43.87417	-67.14517	43.89717	-67.13450	0.035
2012	NED2012022148	44.64933	-61.20617	44.62150	-61.21800	0.032
2013	NED2013022216	45.51967	-60.11050	45.51200	-60.15133	0.032
2008	TEM2008775078	45.04833	-66.37000	45.06417	-66.33200	0.026
2010	NED2010027005	43.61750	-63.44850	43.58883	-63.44967	0.026
2010	NED2010027074	42.37967	-66.35217	42.37700	-66.31300	0.024
2012	NED2012022146	44.47267	-62.24967	44.46350	-62.28867	0.024
2013	NED2013022008	43.29967	-64.14050	43.32833	-64.13683	0.023
2009	NED2009027099	44.24850	-61.43083	44.27500	-61.41533	0.022
2009	NED2009027159	45.52833	-58.27817	45.54550	-58.24450	0.022
2012	NED2012022147	44.55000	-62.08333	44.53333	-62.11667	0.022
2013	NED2013022004	43.63950	-63.87533	43.61383	-63.85700	0.022
2009	NED2009027100	44.13800	-61.25083	44.10883	-61.24733	0.020
2006	NED2006036001	44.38583	-62.85750	44.39517	-62.81800	0.020
2009	NED2009027148	46.20450	-59.32583	46.18317	-59.29850	0.018
2008	TEL2008805006	44.50267	-60.78400	44.53050	-60.80333	0.016
2009	NED2009027154	45.72550	-58.81683	45.73700	-58.77717	0.016
2013	NED2013022225	46.47267	-59.13733	46.48883	-59.17250	0.016
2010	NED2010027129	45.61900	-58.71017	45.59817	-58.73667	0.016
2011	NED2011025174	44.55633	-61.88483	44.55583	-61.84417	0.016
2011	NED2011025257	44.08950	-58.42083	44.06917	-58.42100	0.015

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2010	NED2010027003	44.09233	-63.56250	44.10933	-63.53917	0.015
2003	NED2003036133	43.32883	-60.65517	43.33433	-60.61650	0.014
2009	NED2009027005	44.17050	-63.82133	44.19033	-63.79217	0.014
2009	NED2009027155	45.61200	-58.83167	45.58900	-58.85650	0.014
2010	NED2010027124	46.17183	-58.85917	46.15067	-58.83867	0.014
2010	NED2010027002	44.17233	-63.75867	44.14617	-63.77700	0.014
2013	NED2013028040	43.44400	-63.74350	43.41400	-63.75233	0.014
2010	NED2010027064	43.44067	-67.21517	43.42033	-67.24300	0.014
2013	NED2013022003	44.11383	-63.86967	44.09217	-63.89600	0.014
2011	NED2011025172	44.26900	-62.87367	44.28250	-62.83783	0.014
2013	NED2013022223	46.23983	-58.90150	46.25867	-58.93433	0.012
2010	NED2010027006	43.68600	-63.74383	43.69750	-63.77983	0.012
2002	NED2002037029	43.07533	-64.08850	43.05467	-64.11733	0.010
2009	NED2009027008	43.51000	-63.02600	43.53117	-62.99883	0.010
2008	TEL2008805016	44.19017	-58.92650	44.17350	-58.88967	0.010
2007	TEL2007745157	46.17000	-58.99167	46.18667	-59.02533	0.010

Table A1.3. *Scotian Shelf Biogeographic Zone: Details of the Location of Research Vessel Large Gorgonian Coral Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2007	TEL2007745058	42.13483	-65.66050	42.14050	-65.62250	27.109
2011	NED2011025229	44.30500	-57.56900	44.29133	-57.59083	26.025
2002	NED2002040055	44.22383	-57.83533	44.23867	-57.86467	6.000
2006	NED2006036061	43.96300	-58.60717	43.94900	-58.64150	2.170
2010	NED2010027216	43.05567	-61.25917	43.10650	-61.28400	1.494
2011	NED2011025232	44.34567	-57.98333	44.31733	-57.99350	0.850
2005	TEL2005633050	44.30533	-57.73167	44.28350	-57.75667	0.570
2011	NED2011025230	44.38333	-57.60183	44.38083	-57.64567	0.538
2009	NED2009027179	44.28350	-57.75800	44.25483	-57.76333	0.460
2015	NED2015002023	41.97783	-65.74633	41.95100	-65.72617	0.326
2012	NED2012022164	45.62250	-59.96500	45.64050	-59.93233	0.203
2009	NED2009027036	42.67533	-65.98717	42.66850	-65.96267	0.160
2007	TEL2007745068	42.97783	-63.43167	42.97683	-63.39267	0.140
2015	NED2015002027	41.79417	-66.04533	41.76650	-66.05217	0.129
2013	NED2013022216	45.51967	-60.11050	45.51200	-60.15133	0.112
2003	NED2003042066	44.05333	-58.42500	44.03817	-58.42500	0.110
2005	TEL2005633051	44.37150	-57.81367	44.37900	-57.85317	0.105

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2005	NED2005034051	44.38050	-57.82000	44.38617	-57.85917	0.096
2015	NED2015002030	41.61183	-66.32217	41.58350	-66.31433	0.082
2011	NED2011025231	44.30683	-57.82133	44.28467	-57.84917	0.078
2014	NED2014018158	45.45783	-59.75917	45.46767	-59.72067	0.059
2012	NED2012022162	45.22467	-59.31400	45.23583	-59.28817	0.052
2013	NED2013022190	44.62067	-58.29100	44.60100	-58.26067	0.041
2013	NED2013022200	44.31000	-57.74550	44.32467	-57.72200	0.041
2013	NED2013022154	44.63100	-58.81617	44.64333	-58.85267	0.040
2014	NED2014018206	44.31233	-57.97950	44.33933	-57.96883	0.035
2011	NED2011025238	44.47817	-58.42183	44.48633	-58.46133	0.032
2011	NED2011025237	44.42700	-58.30400	44.45067	-58.33000	0.032
2015	NED2015002024	41.87467	-65.83533	41.89600	-65.86450	0.030
2014	NED2014018205	44.20783	-58.06183	44.18967	-58.06650	0.029
2015	NED2015002028	41.77850	-66.13650	41.75083	-66.14500	0.028
2013	NED2013022191	44.41517	-58.30017	44.38583	-58.30483	0.028
2009	NED2009027042	42.60000	-66.49667	42.60550	-66.45800	0.026
2005	NED2005034015	45.87867	-59.43333	45.88833	-59.40933	0.025
2008	TEL2008805062	43.42867	-60.88283	43.43967	-60.85833	0.020
2003	NED2003042049	44.24117	-57.79067	44.26433	-57.76750	0.018
2012	NED2012022161	45.28167	-59.57750	45.28217	-59.61800	0.017
2012	NED2012022192	45.07983	-58.26033	45.05050	-58.26583	0.016
2012	NED2012022159	45.25500	-60.40933	45.23233	-60.38317	0.016
2003	NED2003042069	43.82617	-59.39150	43.80850	-59.42300	0.016
2005	NED2005034052	44.40733	-57.86833	44.40767	-57.90867	0.015
2013	NED2013022029	42.70733	-65.97600	42.68733	-66.00483	0.012
2009	NED2009027178	44.36950	-57.61650	44.36817	-57.65700	0.012
2003	NED2003042068	43.70533	-59.15883	43.69167	-59.19383	0.010
2010	NED2010027218	42.97150	-61.56617	42.99050	-61.53467	0.010

Table A1.4. *Southern Portion of the Gulf Biogeographic Zone: Details of the Location of Research Vessel Sponge Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2009	TEL2009992129	47.89625	-62.79942	47.90767	-62.78667	225.000
2010	TEL201074145	47.41075	-61.13158	47.42200	-61.14583	57.202
2010	TEL201074065	47.89917	-62.78342	47.88950	-62.80050	28.600
2009	TEL2009992052	47.14492	-62.69417	47.15700	-62.70750	24.500
2005	TEL2005507093	47.93220	-63.59120	47.93033	-63.63483	23.202
2006	TEL2006678034	47.41130	-60.35780	47.42800	-60.38567	21.023

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2014	TEL2014433089	48.13917	-64.55250	48.12950	-64.56933	19.230
2003	TEL2003352023	47.15580	-61.92430	47.13333	-61.91017	18.940
2005	NED2005542093	47.93970	-63.60180	47.93433	-63.64333	16.788
2006	TEL2006678071	48.49900	-63.12730	48.51067	-63.15300	13.734
2005	TEL2005507146	47.97870	-61.36330	47.97517	-61.33300	13.462
2003	TEL2003352019	47.13570	-60.86070	47.13783	-60.90167	13.151
2006	TEL2006678077	48.66370	-63.58030	48.64167	-63.55167	11.892
2012	TEL2012205042	47.41933	-60.37742	47.43033	-60.37267	11.100
2003	TEL2003352043	46.97250	-63.06820	46.98283	-63.02817	10.200
2007	TEL2007745167	46.39017	-59.88217	46.40550	-59.84633	9.650
2008	TEL2008815186	47.19070	-61.45580	47.16300	-61.47233	9.645
2007	TEL2007749183	46.59280	-62.30870	46.58433	-62.28083	9.385
2014	TEL2014433066	45.94250	-62.66075	45.94033	-62.67700	8.924
2005	NED2005542141	47.74180	-60.70870	47.76900	-60.70633	8.167
2012	TEL2012205058	48.06983	-61.62025	48.07183	-61.63600	8.000
2013	TEL2013318037	45.91625	-62.64692	45.91250	-62.66767	7.750
2003	TEL2003352040	47.02100	-62.73970	47.02250	-62.69683	7.619
2008	TEM2008830142	46.43017	-59.86483	46.45000	-59.83100	7.250
2005	TEL2005507069	47.37680	-64.37530	47.38867	-64.35050	7.070
2008	TEL2008815156	46.97680	-62.42750	46.94783	-62.41633	6.928
2005	NED2005542096	48.00120	-64.24250	48.02033	-64.25033	6.761
2004	NED2004446019	46.99120	-62.70530	46.98767	-62.66250	6.288
2004	TEL2004434032	47.12550	-61.81270	47.09883	-61.82967	6.150
2008	TEL2008815049	47.03330	-62.74400	47.00717	-62.76667	5.994
2010	TEL201074044	47.37942	-60.36458	47.36700	-60.35367	5.848
2007	TEL2007749130	48.26700	-62.51830	48.25717	-62.54617	5.479
2010	NED2010027116	46.90200	-60.23867	46.91733	-60.20233	5.350
2004	TEL2004434094	47.85320	-63.02720	47.83700	-63.06150	5.250
2009	TEL2009992130	48.04550	-62.96333	48.05783	-62.97567	5.150

Table A1.5. *Southern Portion of the Gulf Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2010	TEL2010074142	47.95108	-60.85550	47.96133	-60.87133	108.000
2008	TEL2008815169	47.98270	-60.88820	47.96717	-60.85200	99.432
2009	TEL2009992136	47.97992	-60.88933	47.97317	-60.87100	85.400
2012	TEL2012205054	47.98875	-60.91942	47.98100	-60.90100	78.900
2009	TEL2009992038	48.06825	-61.05358	48.06350	-61.03383	76.100
2011	TEL2011194119	47.95542	-60.85925	47.96583	-60.87467	50.700
2004	TEL2004434054	47.84470	-60.64680	47.86700	-60.67500	48.200

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2006	TEL2006678074	48.67850	-63.45450	48.70350	-63.47867	46.011
2007	TEL2007749034	47.93620	-60.82550	47.95517	-60.85883	42.470
2014	TEL2014433036	48.12125	-61.07600	48.11167	-61.05850	30.300
2006	TEL2006678075	49.13220	-63.97530	49.16067	-63.97317	24.215
2006	TEL2006678166	47.91000	-60.67100	47.90150	-60.64400	20.563
2003	TEL2003352082	48.77320	-63.20230	48.79333	-63.23283	19.787
2007	TEL2007749136	48.27500	-61.88280	48.26300	-61.84350	19.342
2012	TEL2012205066	48.44375	-62.36142	48.45000	-62.37767	18.600
2007	TEL2007749122	48.69730	-63.21720	48.67533	-63.19167	17.394
2008	TEL2008815118	48.79770	-63.29550	48.78067	-63.26167	17.300
2005	TEL2005507122	48.76400	-63.20780	48.74200	-63.17883	15.819
2013	TEL2013318127	48.71483	-63.09617	48.72700	-63.10583	15.400
2013	TEL2013318145	47.93517	-60.72133	47.94417	-60.73983	13.500
2007	TEL2007749033	47.78280	-60.56070	47.75950	-60.53850	12.651
2004	TEL2004434073	48.43270	-62.34070	48.43267	-62.29683	12.458
2010	TEL2010074094	48.72308	-63.20008	48.73433	-63.21517	12.200
2005	TEL2005507123	48.57450	-63.04380	48.54933	-63.02183	11.968
2014	TEL2014433013	48.74192	-63.13892	48.75300	-63.14667	10.500
2013	TEL2013318137	48.28900	-61.87942	48.28367	-61.86067	10.300
2006	TEL2006678104	48.81220	-63.17600	48.78283	-63.16700	10.142

Table A1.6. *Northern Portion of the Gulf Biogeographic Zone: Details of the Location of Research Vessel Sponge Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2015	TEL2015012142	49.36667	-66.57750	49.36017	-66.59300	70.90
2012	TEL2012009171	49.73467	-61.47317	49.73633	-61.45400	56.32
2006	TEL2006003184	49.70117	-65.59417	49.70333	-65.57550	43.91
2011	TEL2011008186	49.83217	-65.34467	49.83700	-65.35900	41.18
2010	TEL2010007111	49.44900	-65.47517	49.44650	-65.49483	29.05
2007	TEL2007004172	48.63867	-68.90083	48.64617	-68.88600	25.30
2008	TEL2008005106	48.85317	-60.47033	48.86517	-60.46817	22.35
2008	TEL2008005181	49.81883	-65.39083	49.82400	-65.40850	20.60
2008	TEL2008005171	49.92367	-63.60450	49.91800	-63.58717	18.20
2006	TEL2006003156	49.81733	-61.07583	49.81783	-61.09550	17.99
2010	TEL2010007164	50.05833	-63.99183	50.05600	-63.97733	17.30
2007	TEL2007004143	50.12100	-64.61000	50.11617	-64.59067	17.10
2010	TEL2010007166	50.00900	-64.29550	50.00800	-64.31000	16.43
2008	TEL2008005139	48.67850	-61.46333	48.67617	-61.44550	15.60
2010	TEL2010007060	49.02700	-59.34233	49.03700	-59.33217	15.57
2012	TEL2012009022	49.51900	-60.09833	49.52650	-60.10967	15.22

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2010	TEL2010007065	48.82950	-59.45333	48.81833	-59.46233	14.96
2010	TEL2010007067	48.70350	-59.62117	48.71533	-59.61633	14.94
2007	TEL2007004201	49.11500	-63.39967	49.10783	-63.38433	13.64
2012	TEL2012009145	49.91833	-65.02883	49.91833	-65.04333	12.90
2007	TEL2007004108	48.76467	-61.86250	48.76617	-61.88083	12.75
2012	TEL2012009033	49.91100	-58.88467	49.91850	-58.87217	12.23
2006	TEL2006003024	48.21767	-59.45800	48.22967	-59.46400	12.10
2013	TEL2013010141	50.08167	-63.67500	50.08667	-63.65667	11.38
2007	TEL2007004181	49.27033	-66.53917	49.27433	-66.52117	11.10
2010	TEL2010007162	49.99550	-64.23383	49.99750	-64.24983	11.05
2008	TEL2008005173	49.96083	-63.74633	49.96367	-63.76617	10.40
2012	TEL2012009026	49.81900	-60.17450	49.80667	-60.17917	9.95
2008	TEL2008005089	50.66300	-57.91983	50.67517	-57.92367	9.45
2012	TEL2012009036	50.37317	-58.41283	50.37883	-58.39550	9.28
2012	TEL2012009200	48.64033	-68.89817	48.64583	-68.88517	8.88
2006	TEL2006003133	49.14600	-63.28767	49.14617	-63.26883	8.35
2010	TEL2010007151	49.12667	-63.50167	49.13167	-63.51500	8.29
2006	TEL2006003175	49.80533	-64.97317	49.80533	-64.95383	8.16
2006	TEL2006003043	49.08050	-59.38900	49.08550	-59.37183	7.91
2008	TEL2008005170	50.00933	-63.36500	50.00267	-63.34833	7.65
2008	TEL2008005038	48.79917	-59.78450	48.81167	-59.78867	7.40
2012	TEL2012009020	49.02133	-60.31317	49.00900	-60.31883	7.37
2015	TEL2015012212	48.91133	-61.32550	48.91150	-61.30583	7.24
2008	TEL2008005154	49.43150	-61.21967	49.41967	-61.21283	7.05
2012	TEL2012009076	49.23050	-59.79033	49.23833	-59.78033	6.74
2010	TEL2010007163	49.98900	-64.11433	49.98850	-64.13517	6.60
2008	TEL2008005165	49.74450	-62.49300	49.75567	-62.48583	6.29
2012	TEL2012009176	49.73117	-62.80300	49.73583	-62.82083	6.23
2006	TEL2006003101	48.66200	-60.51967	48.66933	-60.50317	6.22
2012	TEL2012009032	49.80650	-59.01700	49.79983	-59.03317	6.10
2006	TEL2006003147	49.77500	-60.46317	49.78183	-60.46933	6.02
2014	TEL2014011037	50.69183	-57.84083	50.69117	-57.86300	6.02
2010	TEL2010007050	49.59117	-58.42000	49.58683	-58.42117	5.94
2010	TEL2010007018	49.55500	-60.29117	49.54833	-60.27900	5.82
2008	TEL2008005167	49.72917	-62.53317	49.71667	-62.53000	5.70
2010	TEL2010007066	48.77500	-59.60617	48.78400	-59.59367	5.54
2013	TEL2013010002	49.03183	-63.12983	49.03983	-63.14517	5.40
2014	TEL2014011187	50.10817	-64.83250	50.10817	-64.81150	5.28
2006	TEL2006003099	48.80250	-60.48167	48.81417	-60.47617	5.17
2007	TEL2007004203	49.12200	-63.13367	49.13167	-63.14550	5.10
2007	TEL2007004113	48.93450	-61.19883	48.93367	-61.17983	5.05

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2012	TEL2012009087	48.64900	-59.67167	48.63667	-59.67850	4.99
2007	TEL2007004031	48.56483	-59.62850	48.55250	-59.62917	4.82
2011	TEL2011008189	49.73033	-64.57283	49.72983	-64.55433	4.81
2009	TEL2009006074	49.84917	-59.17783	49.85067	-59.19100	4.80
2008	TEL2008005137	49.09533	-63.24883	49.09967	-63.26283	4.75
2008	TEL2008005166	49.71183	-62.48700	49.72400	-62.48133	4.60
2008	TEL2008005215	48.59717	-68.91133	48.58817	-68.92533	4.58
2006	TEL2006003039	48.75767	-59.79083	48.76933	-59.78450	4.50
2007	TEL2007004165	49.39367	-67.12450	49.40233	-67.11100	4.48
2012	TEL2012009094	48.15400	-59.36833	48.14667	-59.38400	4.42
2009	TEL2009006019	48.32717	-60.81800	48.31583	-60.82367	4.40
2007	TEL2007004087	48.74383	-61.02883	48.73750	-61.01150	4.40
2009	TEL2009006158	49.10817	-60.93283	49.10267	-60.94500	4.40
2014	TEL2014011011	49.05033	-59.86217	49.04367	-59.87967	4.39
2007	TEL2007004086	48.91867	-60.62267	48.92900	-60.60883	4.33
2015	TEL2015012193	49.74533	-62.52133	49.75800	-62.52550	4.27
2014	TEL2014011009	48.98117	-60.75700	48.97133	-60.76833	4.23
2010	TEL2010007038	50.68167	-57.93800	50.67333	-57.93083	4.23
2012	TEL2012009023	49.55200	-60.17950	49.54583	-60.16450	4.21
2010	TEL2010007156	49.80150	-64.72217	49.79083	-64.72200	4.19
2009	TEL2009006199	49.18367	-66.65767	49.18633	-66.63950	4.15
2006	TEL2006003173	50.13067	-64.62250	50.11850	-64.61517	4.10
2010	TEL2010007158	49.96333	-65.21950	49.95800	-65.23783	4.09
2009	TEL2009006120	49.62117	-63.97400	49.62567	-63.99350	3.95
2009	TEL2009006050	49.67900	-58.55167	49.66783	-58.56283	3.95
2014	TEL2014011189	49.99150	-63.35700	49.98717	-63.34483	3.93
2013	TEL2013010166	48.80117	-61.78333	48.80033	-61.80300	3.91
2007	TEL2007004085	48.96433	-60.43467	48.97683	-60.43317	3.76
2009	TEL2009006138	50.14083	-64.86200	50.15317	-64.86500	3.75
2012	TEL2012009182	49.95783	-64.61733	49.97150	-64.61300	3.70
2013	TEL2013010164	49.28017	-61.30250	49.28650	-61.31233	3.65
2006	TEL2006003185	49.80333	-65.51633	49.80117	-65.49750	3.65
2008	TEL2008005145	48.98350	-60.93017	48.98500	-60.91167	3.65
2014	TEL2014011161	48.63783	-68.90450	48.63067	-68.91567	3.64
2014	TEL2014011188	50.12117	-64.26033	50.11917	-64.27367	3.62
2010	TEL2010007167	49.92283	-63.62533	49.90150	-63.60467	3.61
2006	TEL2006003176	49.74600	-64.88317	49.74800	-64.89750	3.56
2012	TEL2012009016	48.83467	-60.47467	48.82267	-60.47650	3.53
2008	TEL2008005061	50.04833	-58.57500	50.04217	-58.59333	3.50
2008	TEL2008005175	50.01983	-64.21733	50.02367	-64.19933	3.45
2011	TEL2011008008	48.66667	-61.61350	48.66267	-61.59467	3.36

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2014	TEL2014011073	48.98933	-59.30500	49.00300	-59.30600	3.27
2012	TEL2012009083	48.81867	-59.45300	48.80883	-59.46450	3.16
2011	NED2011401056	47.52500	-59.24500	47.51500	-59.23500	3.12
2010	TEL2010007184	49.00867	-61.10683	49.01767	-61.09350	3.11
2014	TEL2014011019	49.55933	-60.09133	49.55433	-60.11133	3.09
2011	TEL2011008194	49.19200	-63.44800	49.19467	-63.43067	3.05
2007	TEL2007004049	49.84267	-58.56233	49.85267	-58.57767	3.03
2011	TEL2011008187	49.74850	-64.65567	49.76050	-64.66300	3.00
2007	TEL2007004077	49.62183	-60.08417	49.62200	-60.06467	3.00
2006	TEL2006003187	50.08100	-65.26133	50.08117	-65.24583	2.90
2008	TEL2008005097	49.63233	-59.83517	49.64517	-59.83433	2.90
2007	TEL2007004173	48.47150	-69.01883	48.47950	-69.00350	2.88
2015	TEL2015012008	49.56117	-60.09150	49.55733	-60.10833	2.85
2012	TEL2012009072	49.50483	-58.78350	49.49317	-58.79100	2.82
2011	TEL2011008115	49.08967	-62.76200	49.08667	-62.74600	2.82
2010	TEL2010007155	49.85167	-64.67500	49.84667	-64.69500	2.78
2007	TEL2007004064	51.76500	-55.99517	51.75900	-56.01517	2.74
2006	TEL2006003140	48.92600	-60.89517	48.92983	-60.87983	2.71
2008	TEL2008005086	51.24067	-57.22417	51.25317	-57.21933	2.70
2009	NED2009902068	47.53500	-59.27333	47.52667	-59.25833	2.68
2006	TEL2006003152	49.89817	-61.48833	49.89817	-61.47183	2.68
2014	TEL2014011089	48.31033	-59.34767	48.32283	-59.35183	2.64
2006	TEL2006003141	48.97967	-60.85600	48.97283	-60.87200	2.64
2010	TEL2010007053	49.45350	-59.25150	49.45417	-59.23150	2.62
2007	TEL2007004063	51.63733	-56.40533	51.64800	-56.39733	2.50
2010	TEL2010007152	49.30000	-63.63000	49.29333	-63.61000	2.44
2012	TEL2012009146	50.07450	-65.35817	50.07533	-65.33917	2.30
2008	TEL2008005014	48.04867	-60.78450	48.04183	-60.76867	2.30
2006	TEL2006003143	49.04300	-61.09617	49.05567	-61.09800	2.30
2011	TEL2011008029	49.84700	-58.96083	49.83667	-58.97450	2.30
2007	TEL2007004061	51.06100	-57.26967	51.04767	-57.27683	2.26
2009	TEL2009006045	48.98267	-59.22017	48.97217	-59.23300	2.25
2009	TEL2009006068	50.56067	-58.03900	50.56683	-58.02150	2.25
2012	TEL2012009201	48.60700	-68.90883	48.61433	-68.89283	2.21
2008	TEL2008005111	48.40600	-61.22217	48.41450	-61.20883	2.20
2007	TEL2007004081	49.21550	-59.81050	49.20450	-59.81833	2.20
2010	TEL2010007025	49.94750	-59.52100	49.93600	-59.52950	2.17
2009	TEL2009006049	49.43783	-59.06967	49.42750	-59.08333	2.15
2011	TEL2011008117	48.90683	-61.31300	48.90167	-61.29550	2.09
2015	TEL2015012211	49.16733	-61.04583	49.17217	-61.05717	2.08
2009	TEL2009006080	49.89183	-60.17033	49.89317	-60.15100	2.05

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2012	TEL2012009137	49.59983	-64.06417	49.59367	-64.04750	2.03
2011	TEL2011008188	49.75717	-64.48533	49.76367	-64.50167	2.03
2008	TEL2008005058	49.93800	-58.19167	49.95000	-58.18467	2.00
2008	TEL2008005229	49.33800	-66.28983	49.33450	-66.30850	2.00

Table A1.7. *Northern Portion of the Gulf Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2015	TEL2015012096	47.87083	-60.64533	47.88300	-60.65600	128.520
2008	TEL2008005238	49.33050	-64.27450	49.31733	-64.27633	93.100
2013	TEL2013010068	47.68083	-60.45133	47.66783	-60.44500	85.430
2010	TEL2010007110	49.48433	-64.98183	49.47983	-64.96450	80.400
2010	TEL2010007108	49.45100	-64.68600	49.45150	-64.70633	68.280
2012	TEL2012009135	49.33850	-64.13800	49.32817	-64.14983	67.981
2012	TEL2012009110	47.84017	-60.61800	47.85017	-60.62867	63.904
2009	TEL2009006167	49.45500	-64.78167	49.45517	-64.76283	49.450
2010	TEL2010007111	49.44900	-65.47517	49.44650	-65.49483	48.670
2015	TEL2015012125	49.10983	-63.71917	49.09733	-63.72467	45.333
2013	TEL2013010176	48.79100	-63.26050	48.79983	-63.27517	40.613
2011	TEL2011008095	47.90183	-60.71850	47.89367	-60.70283	36.714
2007	TEL2007004018	47.83667	-60.60500	47.82800	-60.59150	30.350
2008	TEL2008005122	48.54283	-62.78617	48.55067	-62.80150	27.960
2009	TEL2009006100	48.75767	-62.79217	48.76317	-62.81050	24.400
2004	TEL2004001137	48.39500	-62.09117	48.39750	-62.10800	24.100
2012	TEL2012009108	47.59817	-60.38400	47.61117	-60.38383	23.200
2014	TEL2014011180	49.86267	-66.30883	49.85683	-66.32567	21.372
2006	TEL2006003219	49.19483	-63.97217	49.18967	-63.95550	20.850
2011	TEL2011008164	49.27500	-64.08667	49.27000	-64.08500	20.515
2008	TEL2008005135	49.16467	-64.09983	49.16100	-64.08200	20.050
2006	TEL2006003177	49.54733	-64.97450	49.54917	-64.95583	19.850
2010	TEL2010007107	49.40417	-64.45617	49.41250	-64.47117	19.560
2013	TEL2013010080	48.44917	-61.99067	48.45200	-62.00883	17.900
2008	TEL2008005120	48.55183	-62.49133	48.55900	-62.50683	17.244
2008	TEL2008005012	47.78283	-60.55283	47.79283	-60.56550	16.750
2012	TEL2012009124	48.49717	-62.44300	48.50583	-62.45733	16.227
2010	TEL2010007003	48.69083	-62.71167	48.69450	-62.72983	16.050
2012	TEL2012009114	48.38833	-60.89667	48.39667	-60.90983	15.347
2006	TEL2006003124	49.22467	-63.90917	49.21150	-63.90517	15.150
2010	TEL2010007191	48.47150	-61.76500	48.48183	-61.77850	14.700
2012	TEL2012009102	47.89817	-59.94483	47.90000	-59.96233	14.260

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2004	TEL2004001140	48.01433	-60.90850	48.00650	-60.89350	13.800
2012	TEL2012009129	48.61900	-62.98300	48.62683	-62.99900	13.210
2007	TEL2007004017	47.75233	-60.39017	47.75833	-60.40467	12.550
2013	TEL2013010178	48.70667	-62.77000	48.70667	-62.79167	12.185
2013	TEL2013010085	49.07117	-63.72267	49.07367	-63.70200	12.111
2010	TEL2010007109	49.39200	-64.88533	49.38817	-64.90433	12.040
2012	TEL2012009118	48.44800	-61.37800	48.46067	-61.37933	12.010
2010	TEL2010007198	48.71817	-63.22967	48.70983	-63.21450	11.800
2009	TEL2009006165	49.33000	-64.20333	49.33333	-64.22333	11.550
2007	TEL2007004189	49.44217	-64.80533	49.43217	-64.79383	11.200
2009	TEL2009006108	48.74367	-63.15783	48.73617	-63.14200	11.000
2006	TEL2006003181	49.51683	-66.04100	49.52150	-66.02417	10.600
2009	TEL2009006023	48.28017	-60.43117	48.27950	-60.41250	10.000
2007	TEL2007004190	49.34083	-64.49033	49.34750	-64.50767	9.950
2012	TEL2012009119	48.50583	-61.51883	48.51067	-61.53750	9.710
2013	TEL2013010177	48.76150	-63.04433	48.77333	-63.05567	9.543
2010	TEL2010007143	49.14517	-67.16300	49.15450	-67.15200	8.440
2011	TEL2011008094	47.75567	-60.39183	47.74233	-60.39800	8.430
2010	TEL2010007144	49.15433	-66.79017	49.15617	-66.77083	8.390
2015	TEL2015012119	48.66633	-63.17333	48.65917	-63.15283	8.288
2013	TEL2013010067	47.56633	-60.35767	47.55833	-60.34300	8.110
2008	TEL2008005121	48.61833	-62.62333	48.61133	-62.60867	7.974
2008	TEL2008005229	49.33800	-66.28983	49.33450	-66.30850	7.700
2013	TEL2013010109	49.16400	-66.73500	49.15717	-66.75167	7.527
2009	TEL2009006199	49.18367	-66.65767	49.18633	-66.63950	7.500
2013	TEL2013010086	49.18550	-63.59483	49.17650	-63.59067	7.487
2014	TEL2014011145	49.47350	-65.01417	49.46250	-65.02633	7.412
2013	TEL2013010069	47.83600	-60.31933	47.85000	-60.32150	7.350
2015	TEL2015012110	48.45933	-61.98600	48.45367	-61.96683	7.251
2006	TEL2006003103	48.40933	-61.34517	48.41783	-61.35800	7.050
2012	TEL2012009120	48.48983	-61.72817	48.48567	-61.71067	7.050
2012	TEL2012009155	49.76250	-65.75367	49.76550	-65.73550	6.847
2007	TEL2007004198	49.28133	-63.82600	49.27283	-63.81300	6.700
2012	TEL2012009112	48.13233	-60.26233	48.14133	-60.27467	6.670
2011	TEL2011008169	49.49567	-64.83317	49.49650	-64.85267	6.554
2010	TEL2010007112	49.46850	-66.05883	49.47067	-66.07750	6.550
2012	TEL2012009157	49.48267	-65.74700	49.48367	-65.72833	6.492
2006	TEL2006003214	49.30400	-66.23400	49.30867	-66.21633	6.450
2015	TEL2015012111	48.49500	-62.12300	48.49067	-62.10217	6.323
2013	TEL2013010103	49.36900	-64.56333	49.36500	-64.58450	6.310
2009	TEL2009006126	49.56633	-65.54250	49.56817	-65.52367	6.300

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2006	TEL2006003178	49.46917	-65.21850	49.47717	-65.20333	6.150
2011	NED2011401057	47.39500	-59.41000	47.38667	-59.39833	6.000
2012	TEL2012009125	48.62767	-62.66183	48.63450	-62.67750	5.976
2006	TEL2006003125	49.32417	-64.02700	49.32500	-64.04650	5.950
2013	TEL2013010076	48.51850	-61.68250	48.52917	-61.66983	5.890
2010	TEL2010007113	49.64967	-65.97767	49.63983	-65.98867	5.800
2006	TEL2006003182	49.56067	-65.89783	49.55017	-65.91017	5.800
2011	TEL2011008167	49.36617	-64.64700	49.36717	-64.66550	5.629
2015	TEL2015012116	48.65483	-62.80317	48.66783	-62.79483	5.561
2014	TEL2014011140	49.33600	-64.49167	49.32817	-64.50900	5.504
2011	TEL2011008099	48.24983	-60.51683	48.26033	-60.50400	5.377
2006	TEL2006003126	49.37383	-64.23667	49.38300	-64.24917	5.350
2013	TEL2013010100	49.49283	-65.88333	49.47917	-65.88583	5.330
2012	TEL2012009104	47.71517	-59.66083	47.70400	-59.65150	5.271
2009	TEL2009006012	48.00267	-60.80267	47.99517	-60.78883	5.100
2015	TEL2015012106	48.50250	-61.28917	48.50350	-61.26917	5.060
2007	TEL2007004088	48.51800	-60.98500	48.51383	-60.96717	5.000
2015	TEL2015012104	48.42800	-60.84617	48.42617	-60.86817	4.960
2015	TEL2015012105	48.49533	-61.07317	48.50167	-61.09150	4.930
2010	TEL2010007106	49.10217	-64.02617	49.09500	-64.01133	4.920
2015	TEL2015012107	48.54200	-61.62533	48.53950	-61.60450	4.907
2009	TEL2009006101	48.66133	-62.77867	48.66700	-62.79633	4.650
2009	TEL2009006014	48.05133	-61.01450	48.04467	-60.99967	4.600
2013	TEL2013010084	49.05933	-63.90617	49.07017	-63.91933	4.587
2012	TEL2012009113	48.24167	-60.58400	48.24733	-60.60033	4.538
2011	TEL2011008176	49.23900	-66.89000	49.24033	-66.87167	4.511
2014	TEL2014011150	49.49767	-66.29817	49.49267	-66.27933	4.511
2006	TEL2006003108	48.32850	-61.85867	48.33717	-61.87200	4.400
2011	TEL2011008011	48.48367	-60.63383	48.49400	-60.64700	4.390
2008	TEL2008005134	49.12017	-63.94483	49.11383	-63.92900	4.350
2009	TEL2009006130	49.84917	-66.25333	49.83633	-66.25733	4.350
2011	TEL2011008173	49.20050	-66.58417	49.20317	-66.56567	4.312
2007	TEL2007004188	49.43350	-64.85133	49.42450	-64.83717	4.300
2008	TEL2008005109	48.62050	-61.14600	48.62533	-61.16417	4.100
2014	TEL2014011131	48.61767	-62.60883	48.62067	-62.58967	4.062
2008	TEL2008005126	48.96700	-63.21200	48.97467	-63.22683	4.050

Table A1.8. *Newfoundland and Labrador Shelves Biogeographic Zone: Details of the Location of Research Vessel Sponge Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2011	BAL2011106067	60.47233	-61.28593	60.45592	-61.27250	1226.29
2008	BAL2008103072	60.75800	-61.21000	60.74800	-61.21200	1200.00
2008	BAL2008103070	60.37500	-61.25000	60.39500	-61.24300	1043.21
2010	BAL2010105080	60.64632	-61.32495	60.63208	-61.31115	1010.30
1997	TEL1997053051	60.81167	-61.19500	60.81167	-61.19500	1000.00
2012	NED2012415019	46.52000	-55.00000	46.53167	-55.00000	823.68
2008	BAL2008103071	60.61617	-61.27033			800.00
2006	BAL2006101084	60.64300	-61.43300	60.65000	-61.45700	800.00
2010	BAL2010105077	60.22763	-61.09982	60.24343	-61.11322	795.61
2010	TEL2010978067	51.59833	-50.09667	51.59000	-50.08500	779.52
2009	TEL2009896013	54.69000	-52.85833	54.69667	-52.84333	750.00
2010	BAL2010105079	60.57203	-61.37953	60.55917	-61.35598	745.62
2007	TEL2007753044	55.03333	-53.65833	55.02167	-53.65667	602.75
2009	BAL2009104061	60.04833	-61.00250	60.03750	-60.98633	600.00
2014	TEL2014135048	54.78833	-52.98500	54.78500	-52.96500	599.22
2001	TEL2001361039	54.72167	-52.77667	54.71167	-52.79000	591.80
2007	TEL2007753045	55.08167	-53.98833	55.07000	-53.97833	580.90
2007	BAL2007102056	60.02500	-60.99200	60.03500	-61.00200	579.65
2009	BAL2009104068	60.60733	-61.39233	60.61993	-61.38900	550.00
1996	TEL1996039053	54.78167	-52.95667	54.79000	-52.97333	550.00
2012	AQV2012107062	59.84260	-60.77070	59.85222	-60.78702	538.66
2004	TEL2004539034	55.09167	-53.97000	55.08000	-53.97333	521.20
2004	TEL2004539092	52.00000	-50.66000	52.01000	-50.67167	519.05
2005	TEL2005611034	53.93500	-52.54500	53.92500	-52.53667	514.01
2014	TEL2014136024	54.21833	-52.83833	54.20667	-52.82667	500.00
1997	TEL1997053054	60.63667	-61.29667	60.65167	-61.29667	500.00
2006	BAL2006101075	60.48300	-61.30000	60.49700	-61.30800	500.00
1999	TEL1999084043	60.40000	-61.25667	60.41167	-61.26167	500.00
2006	TEL2006681062	54.72667	-52.91500	54.71500	-52.92833	500.00
2001	TEL2001361036	54.11167	-52.74667	54.10000	-52.73833	500.00
2001	TEL2001361038	54.41167	-53.17000	54.39833	-53.16167	500.00
2005	TEL2005542020	51.57667	-50.10000	51.56667	-50.09167	500.00
2005	TEL2005611039	54.63833	-52.74500	54.62667	-52.75167	487.60
2013	TEL2013121046	54.78833	-52.98333	54.79167	-53.00167	465.83
2001	TEL2001361037	54.15667	-52.70833	54.17000	-52.71333	446.65
2007	TEL2007753043	54.94667	-53.53500	54.94833	-53.54833	436.70
2001	TEL2001361041	54.68333	-53.08333	54.67167	-53.09667	400.00
2006	TEL2006681061	54.76000	-52.92667	54.76667	-52.94333	400.00

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2001	TEL2001361040	54.78000	-52.91500	54.77167	-52.90000	400.00
2012	AQV2012107078	60.21723	-61.11555	60.20432	-61.11498	396.73
2013	AQV2013108084	60.43920	-61.74747	60.43775	-61.77600	395.16
2012	AQV2012107084	60.80692	-61.25992	60.81952	-61.25648	394.07
2013	AQV2013108081	60.59977	-61.40927	60.59807	-61.38543	374.32
1996	TEL1996023021	54.54167	-53.13167	54.54667	-53.11000	368.40
1996	TEL1996039052	54.66333	-53.10500	54.67500	-53.11333	360.00
2010	BAL2010105084	60.58233	-61.91133	60.59050	-61.93028	357.72
2004	TEL2004539035	55.06833	-54.02833	55.05500	-54.03333	350.00
2009	TEL2009896019	55.21167	-54.33000	55.22000	-54.34333	338.95
2009	TEL2009896006	54.12000	-52.68333	54.11000	-52.67500	320.25
2004	TEL2004539093	51.85667	-50.46500	51.86833	-50.47500	320.00
2012	TEL2012108030	54.21667	-52.84167	54.20833	-52.83000	318.30
2010	BAL2010105061	59.90217	-60.86700	59.89300	-60.85767	311.97
2011	TEL2011096039	54.73000	-52.75833	54.71833	-52.76000	305.82
2009	TEL2009896015	54.84833	-53.27333	54.84167	-53.25667	300.00
2014	TEL2014136051	53.23000	-51.99667	53.21667	-51.98833	300.00
2012	TEL2012109033	53.43167	-51.99500	53.44333	-51.99667	293.55
1996	TEM1996188012	45.86000	-53.95667	45.86500	-53.97500	275.88
2005	TEL2005611040	54.62667	-52.96000	54.61667	-52.96000	265.70
1998	TEL1998072071	55.44833	-55.80333	55.44500	-55.81833	257.60
2003	TEL2003509014	53.23333	-52.00000	53.24500	-52.01167	256.00
2013	AQV2013108080	60.55852	-61.25612	60.57257	-61.25610	253.71
2012	TEL2012108037	53.56667	-52.12000	53.55833	-52.10000	253.19
1998	TEL1998073076	54.34833	-52.96667	54.36167	-52.96833	250.00
2006	TEL2006681063	54.45500	-53.00167	54.44333	-53.00833	250.00
2012	AQV2012107076	60.12607	-61.14112	60.13403	-61.16133	249.20
2009	TEL2009897037	52.27667	-50.92833	52.26667	-50.91500	246.20
2014	TEL2014135040	55.07667	-53.98000	55.06833	-53.97333	242.00
1996	TEL1996037053	60.58333	-60.78333	60.58500	-60.80833	239.53
2013	TEL2013121041	54.38000	-52.93333	54.39000	-52.94000	238.60
2007	TEL2007753050	55.23833	-54.94667	55.23833	-54.93167	235.70
2013	TEL2013121044	54.44833	-53.08333	54.45833	-53.09500	235.33
2003	TEL2003457036	54.58000	-53.27000	54.59333	-53.26833	230.75
2010	TEL2010975021	56.20833	-57.25500	56.20333	-57.24333	224.30
2011	TEL2011096028	53.91833	-52.50833	53.90667	-52.50500	219.90
2009	TEL2009896018	55.08500	-54.13667	55.09000	-54.15500	219.45
2014	TEL2014135047	54.95833	-53.46333	54.96667	-53.46500	217.93
2011	TEL2011096014	53.17000	-51.94667	53.16000	-51.93833	216.96
2014	TEL2014137036	51.70667	-50.31167	51.69833	-50.29500	215.80
2008	TEL2008820013	53.38667	-52.06333	53.39833	-52.07167	215.50

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2001	TEL2001362015	51.89000	-50.45667	51.87833	-50.44500	215.20
2002	TEL2002415045	53.50167	-52.14000	53.49000	-52.13000	214.55
2014	TEL2014137037	51.60833	-50.10833	51.61667	-50.12000	212.28
2008	TEL2008820010	53.07833	-51.79667	53.09167	-51.80667	210.40
2007	TEL2007753009	53.03500	-51.75000	53.04333	-51.75500	207.90
2014	KIN2014109082	60.29810	-61.14847	60.30688	-61.15910	203.70
2012	TEL2012107071	54.76000	-53.16667	54.76500	-53.18833	200.63
2010	TEL2010975026	56.50167	-57.83500	56.49667	-57.84667	200.00
2014	TEL2014136040	53.78333	-52.43167	53.77167	-52.41833	200.00
2014	TEL2014136038	54.09000	-52.71333	54.10000	-52.71333	200.00
2012	TEL2012107067	55.13667	-54.03333	55.13000	-54.02000	200.00
2007	BAL2007102079	60.61200	-61.27000	60.62500	-61.27500	200.00
1999	TEL1999085055	56.95000	-58.24667	56.96000	-58.25833	200.00
2006	TEL2006681060	54.73333	-53.12500	54.72333	-53.11333	200.00
2000	TEL2000340078	54.19167	-52.80167	54.20167	-52.82667	200.00
1999	TEL1999086073	54.10833	-52.68333	54.12167	-52.69000	200.00
2003	TEL2003509016	53.34833	-51.95667	53.33667	-51.94833	200.00
2000	TEL2000340098	53.08667	-51.80667	53.09500	-51.81833	200.00
2000	TEL2000340067	54.52500	-53.11500	54.51333	-53.11833	200.00
2011	TEL2011096013	53.10500	-51.83500	53.09000	-51.82333	193.84
2010	TEL2010975020	56.15000	-57.26000	56.14333	-57.25500	178.40
1996	TEL1996039046	53.98833	-52.57333	54.00000	-52.57833	177.50
1999	TEL1999086042	54.86000	-53.13500	54.86333	-53.15500	177.20
2010	TEL2010975047	57.56500	-59.12667	57.55667	-59.11167	175.11
1997	TEL1997054021	56.71833	-58.07667	56.73000	-58.08667	175.00
2013	TEL2013121051	55.07000	-53.71833	55.06167	-53.70333	174.33
1996	TEL1996037056	60.45333	-61.77500	60.45000	-61.80167	173.44
2011	TEL2011097035	55.07500	-53.80000	55.06667	-53.78833	171.41
2013	AQV2013108082	60.57968	-61.58652	60.57465	-61.55745	170.98
1997	TEL1997055050	54.08333	-52.70833	54.07167	-52.69667	170.35
2011	TEL2011097032	55.16167	-54.30000	55.16167	-54.28167	169.65
2014	TEL2014136022	54.62500	-53.15333	54.63667	-53.14667	165.25
2012	TEL2012107069	54.97833	-53.67000	54.97333	-53.65500	162.11
2011	TEL2011096027	53.87000	-52.58167	53.86000	-52.57500	158.70
2008	TEL2008820011	53.25833	-51.91333	53.27000	-51.92000	157.00
2007	BAL2007102070	60.62300	-61.70800	60.62300	-61.68000	156.94
2011	BAL2011106056	59.85215	-60.78207	59.86042	-60.79050	156.40
2014	TEL2014135039	55.18833	-54.29667	55.18167	-54.28500	156.40
2013	TEL2013121043	54.49167	-53.24167	54.50167	-53.24333	155.50
2011	TEL2011096037	54.52000	-53.23167	54.50667	-53.22333	152.30
2013	AQV2013108063	59.84552	-60.69705	59.85598	-60.71150	151.68

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2002	TEL2002415038	52.27833	-50.94167	52.26833	-50.92667	150.00
1996	TEL1996023019	54.74500	-53.08000	54.73667	-53.06167	150.00
2006	TEL2006681068	53.92333	-52.53333	53.91333	-52.52333	150.00
2003	TEL2003457041	55.10167	-53.84500	55.10667	-53.82833	150.00
2007	BAL2007102054	59.77300	-60.67000	59.76200	-60.65300	150.00
2014	TEL2014136052	53.22833	-51.90667	53.21833	-51.89500	150.00
2010	TEL2010975031	56.75667	-58.07000	56.76333	-58.05333	150.00
2009	BAL2009104055	59.77233	-60.66683	59.76133	-60.65083	150.00
2003	TEL2003509048	54.68000	-52.99167	54.66833	-53.00000	143.20
2012	TEL2012109041	52.39333	-51.19500	52.40167	-51.20500	142.30
1999	TEL1999086067	54.42333	-53.06833	54.41333	-53.06000	140.95
2013	TEL2013121040	54.27667	-52.78000	54.28667	-52.78667	139.53
2011	TEL2011094025	56.26500	-57.26333	56.27833	-57.26167	133.90
2014	KIN2014109060	59.84283	-60.69052	59.85405	-60.70373	133.62
2013	TEL2013122021	52.73833	-51.53833	52.72833	-51.53000	131.18
2003	TEL2003509013	53.14667	-51.96500	53.13500	-51.95833	129.75
2014	TEL2014136026	54.30333	-53.15667	54.31000	-53.17000	126.81
1997	TEL1997053055	60.57667	-61.51167	60.58833	-61.50167	126.65
2010	TEL2010977038	53.95333	-52.55833	53.96667	-52.56167	123.93
2009	TEL2009896007	54.23500	-52.87167	54.22667	-52.85667	122.10
2013	TEL2013122017	53.21500	-51.89167	53.20667	-51.87667	120.00
2009	TEL2009896012	54.51667	-52.96500	54.52667	-52.95500	118.35
2012	TEL2012108029	54.21500	-52.75500	54.20500	-52.74333	117.69
1999	TEL1999086084	53.29500	-52.02667	53.28500	-52.02167	117.30
1996	TEL1996039045	53.93500	-52.53000	53.94667	-52.53333	116.75
1999	TEL1999086068	54.63667	-52.87500	54.64500	-52.86000	116.45
2004	TEL2004537005	56.50833	-57.64167	56.51833	-57.64333	116.40
2001	TEL2001361024	53.36333	-52.07667	53.35000	-52.07000	115.00
2010	BAL2010105035	58.28460	-61.43172	58.28708	-61.45308	114.85
2001	TEL2001362020	51.73333	-50.25833	51.72333	-50.24333	114.60
1996	TEL1996037059	60.25667	-61.26000	60.27000	-61.26667	112.35
2012	TEL2012110039	51.26667	-49.85000	51.26000	-49.83500	111.60
1997	TEL1997055041	54.93167	-53.43500	54.93667	-53.45333	108.65
2011	BAL2011106066	60.34152	-61.21635	60.35422	-61.22807	108.11
1999	TEL1999088028	51.26333	-49.72000	51.27333	-49.73167	107.65
2014	TEL2014137038	51.37500	-49.94833	51.38500	-49.94833	107.09
2006	TEL2006681065	54.18667	-52.92333	54.19833	-52.93500	106.50
2003	TEL2003509059	55.17500	-54.55333	55.16667	-54.53833	106.50
1996	TEL1996039066	55.09833	-53.87833	55.09333	-53.89167	106.30
1996	TEL1996036066	57.44833	-58.84333	57.45333	-58.85333	105.40
2011	TEL2011096009	52.77500	-51.47000	52.76333	-51.45167	103.10

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2013	TEL2013121042	54.38333	-53.24667	54.39333	-53.25833	102.88
1997	TEL1997055067	53.28500	-51.91667	53.29667	-51.92333	102.80
2005	TEL2005611023	52.97667	-51.78333	52.96667	-51.77167	102.00
1997	TEL1997055044	54.63667	-53.05500	54.64833	-53.05000	102.00
2006	TEL2006679020	56.31500	-57.36500	56.32500	-57.36500	101.85
1999	TEL1999086031	55.28667	-55.32167	55.28000	-55.30167	101.70
2001	TEL2001361012	52.46667	-51.23167	52.47500	-51.24333	101.50
2003	TEL2003509047	54.70667	-52.76000	54.72000	-52.76167	101.45
1996	TEL1996039044	53.89667	-52.60000	53.90333	-52.61500	101.15
2010	TEL2010978064	52.02167	-50.66333	52.01167	-50.65167	100.98
1997	TEL1997055042	54.82000	-53.27833	54.83000	-53.29333	100.80
2012	AQV2012107083	60.70608	-61.21222	60.69643	-61.21550	100.40
2007	TEL2007755041	51.56500	-50.14833	51.56000	-50.13500	100.00
2001	TEL2001361010	52.43167	-51.23667	52.44167	-51.24500	100.00
2000	TEL2000340068	54.41667	-53.16667	54.43000	-53.16500	100.00
2006	TEL2006681066	54.19500	-52.82500	54.20667	-52.83500	100.00
1997	TEL1997053026	60.28667	-61.28667	60.29500	-61.31333	100.00
2012	TEL2012107072	54.68333	-53.08000	54.67333	-53.09333	100.00
2012	TEL2012110040	51.32500	-49.91333	51.31500	-49.90333	98.83
1999	TEL1999086043	54.85167	-53.44333	54.84833	-53.42500	98.75
2006	TEL2006680017	57.24167	-58.76833	57.25167	-58.75833	98.20
1997	TEL1997054062	55.42667	-55.77000	55.43833	-55.77167	97.05
2001	TEL2001361029	53.78000	-52.52833	53.79833	-52.50333	96.60
1999	TEL1999087048	52.45167	-51.25833	52.46167	-51.27000	95.95
2005	BAL2005100038	58.79200	-62.12300	58.80000	-62.13500	95.06
2013	TEL2013120006	56.72167	-58.13333	56.71000	-58.13167	93.81
1997	TEL1997055043	54.60667	-53.15833	54.59500	-53.16000	93.00
2010	TEL2010977037	53.92667	-52.61500	53.93833	-52.61167	91.38
1997	TEL1997055046	54.50833	-53.22167	54.52167	-53.22333	91.00
1999	TEL1999085028	58.46667	-59.70333	58.45500	-59.70167	88.80
2008	TEL2008821010	52.15333	-50.71500	52.14167	-50.70667	87.00
2004	TEL2004539027	54.40000	-52.97000	54.41167	-52.97000	86.40
2012	AQV2012107081	60.51368	-61.52357	60.51998	-61.53758	84.85
1999	TEL1999086114	52.93333	-51.76000	52.94333	-51.76667	84.60
2010	TEL2010977018	53.17167	-51.91667	53.18333	-51.92167	83.98
2006	TEM2006707067	49.55833	-51.65167	49.56167	-51.66833	82.05
1999	TEL1999085029	58.45500	-59.54500	58.45833	-59.56667	80.00
2014	TEL2014136023	54.37167	-52.93000	54.38333	-52.93333	79.51
2012	TEL2012107073	54.61667	-53.04667	54.60333	-53.04833	79.15
1999	TEL1999086028	55.39833	-55.76500	55.39667	-55.78333	78.30
1998	TEL1998071027	59.43667	-59.78167	59.44833	-59.77500	77.10

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2010	TEL2010975033	57.00333	-58.44000	56.99500	-58.42500	76.46
1997	TEL1997054029	56.24667	-57.31500	56.25667	-57.32333	76.30
1998	TEL1998071010	58.56667	-59.59500	58.57667	-59.61000	75.80
2007	TEL2007753038	54.50167	-52.99833	54.49667	-53.01500	75.05
2003	TEL2003509020	53.83500	-52.53500	53.84667	-52.53667	75.00
1996	TEL1996039048	54.18000	-52.97333	54.19000	-52.98833	75.00
2006	TEL2006681049	55.08667	-53.82167	55.09833	-53.83333	75.00
1998	TEL1998071034	59.62833	-60.51167	59.64000	-60.51333	75.00
1998	TEL1998073079	54.08500	-52.82500	54.07333	-52.81500	74.15
2014	TEL2014135046	54.90000	-53.56833	54.90833	-53.58333	73.35
2001	TEL2001362011	52.15167	-50.81333	52.16333	-50.82167	73.25
2001	TEL2001397015	50.73500	-52.46000	50.73167	-52.47833	72.60
2010	TEL2010977030	53.44500	-52.12833	53.43167	-52.12000	72.45
2008	BAL2008103048	59.74500	-60.68000	59.75700	-60.69200	72.14
2008	TEL2008818026	57.10667	-58.76167	57.09667	-58.75667	71.25
2011	TEL2011096008	52.53167	-51.31167	52.54167	-51.32167	71.20
1996	TEL1996036018	56.00500	-57.13167	56.00667	-57.11000	69.70
2008	TEL2008821009	52.10833	-50.74167	52.09833	-50.73000	69.40
1999	TEL1999084023	59.55167	-60.52000	59.56500	-60.52500	67.35
1996	TEL1996037060	60.38167	-61.40500	60.39500	-61.40833	66.62
2010	TEL2010976032	54.40500	-52.97500	54.41667	-52.97167	66.49
2007	BAL2007102081	60.80700	-61.66000	60.81700	-61.67500	65.63
2002	TEL2002415037	52.13167	-50.76500	52.14167	-50.77667	65.40
2011	BAL2011106055	59.61822	-60.50757	59.62790	-60.52223	64.94
1997	TEL1997056070	51.25333	-49.74000	51.24333	-49.72667	64.60
2005	BAL2005100073	60.49300	-61.44300	60.48000	-61.43700	64.60
1996	TEM1996198070	49.97167	-54.11500	49.98333	-54.11000	63.32
1997	TEL1997053060	59.62333	-60.28833	59.62833	-60.28833	63.05
2011	TEL2011096038	54.44500	-53.09333	54.43667	-53.07333	61.76
1998	TEL1998074042	51.85333	-50.49167	51.86167	-50.50333	60.70
2003	TEL2003509054	55.08833	-53.82333	55.10000	-53.83333	60.60
1996	TEL1996023015	55.03000	-54.05500	55.03500	-54.06500	60.00
1995	TEM1995177107	45.47667	-48.57833	45.48333	-48.56333	59.41
2013	AQV2013108086	60.57042	-62.23882	60.57502	-62.26290	59.18
1996	TEL1996039054	54.69000	-53.18000	54.70167	-53.18500	58.80
1999	TEL1999086074	53.97667	-52.81000	53.98667	-52.82167	58.75
2003	TEL2003509046	54.37833	-52.96333	54.36833	-52.95167	58.40
1996	TEL1996036028	56.28833	-57.40000	56.29500	-57.41667	58.35
2007	TEL2007752034	52.42333	-51.24000	52.43167	-51.24667	57.95
2009	BAL2009104069	60.80050	-61.36567	60.80000	-61.33817	56.68
1997	TEL1997053029	60.39000	-61.71167	60.39167	-61.73833	55.75

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2010	TEL2010977039	53.95667	-52.78167	53.94667	-52.76833	55.65
1999	TEL1999086083	53.38333	-52.00167	53.37500	-51.98833	55.00
2006	BAL2006101024	58.80800	-62.13200	58.79500	-62.12800	55.00
2013	TEL2013121054	55.07000	-54.08333	55.07667	-54.10167	54.80
1996	TEL1996040033	51.97000	-50.61000	51.97833	-50.61500	54.70
2003	TEL2003457052	55.27667	-55.23167	55.28167	-55.25167	54.70
1998	TEL1998072022	56.56000	-58.10167	56.56333	-58.11833	54.45
2010	TEL2010977031	53.52000	-52.18500	53.51000	-52.17667	53.75
2009	TEL2009897062	51.43000	-49.98000	51.42000	-49.97000	53.20
2010	BAL2010105055	59.49500	-60.36617	59.50500	-60.38000	52.83
1999	TEL1999086069	54.44000	-53.01500	54.45167	-53.00667	52.70
2011	TEL2011096026	53.76667	-52.41833	53.75667	-52.40833	52.28
2009	TEL2009897016	53.71333	-52.44167	53.70333	-52.42667	51.00
2009	BAL2009104070	60.60117	-61.57650	60.59217	-61.55600	50.89
2014	KIN2014109089	60.57313	-61.88760	60.57918	-61.90172	50.85
2013	TEL2013122022	52.55833	-51.30000	52.54667	-51.29000	50.56
2002	TEL2002415040	52.77833	-51.50333	52.76833	-51.49167	50.00
1998	TEL1998073081	54.01667	-52.65833	54.00333	-52.65333	50.00
2006	TEL2006681067	54.13333	-52.76667	54.14500	-52.77500	50.00
1999	TEL1999085085	55.99167	-57.12000	55.98500	-57.10000	50.00
2009	BAL2009104065	60.36383	-61.55050	60.36250	-61.52450	50.00
2009	BAL2009104071	60.41367	-61.87533	60.40650	-61.85317	50.00
2010	TEL2010977011	52.56000	-51.30000	52.54833	-51.29000	49.35
1996	TEL1996036072	56.85833	-58.24500	56.86833	-58.25333	49.00
1997	TEL1997056039	52.11667	-50.76167	52.12833	-50.76333	48.60
2014	KIN2014109081	60.27243	-61.14712	60.26552	-61.13567	47.65
2005	TEL2005611033	53.72833	-52.50667	53.72000	-52.49500	47.50
2005	TEL2005611018	52.29500	-51.07333	52.30333	-51.08667	47.45
1998	TEL1998072018	56.86333	-58.30500	56.87333	-58.31333	46.25
2002	TEL2002415044	53.23000	-51.91000	53.21833	-51.89833	45.75
2008	TEL2008817001	55.35000	-55.54000	55.34667	-55.52167	45.50
2012	TEL2012109034	53.26167	-51.99833	53.27167	-52.01000	45.46
1998	TEL1998072069	55.36667	-56.21833	55.36833	-56.24000	44.85
2005	TEL2005611032	53.68333	-52.36667	53.68000	-52.34833	44.85
1996	TEL1996039022	52.47500	-51.24833	52.48500	-51.26000	44.45
2012	TEL2012107068	54.99833	-53.57833	55.00833	-53.57500	44.04
2006	TEL2006682025	52.55500	-51.29833	52.54500	-51.28667	44.00
2004	TEL2004536015	55.66333	-56.72833	55.65500	-56.72000	43.90
2008	TEL2008821008	51.72500	-50.39500	51.73500	-50.40667	43.85
2003	TEL2003510031	51.65000	-50.23667	51.64167	-50.22500	43.60
2000	TEM2000319003	45.73167	-53.96167	45.72333	-53.97333	43.55

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2005	TEL2005611020	52.57000	-51.27167	52.56167	-51.25667	43.20
2014	TEL2014137039	51.26833	-49.75667	51.27833	-49.75500	41.80
2004	TEL2004539012	52.93833	-51.75333	52.92667	-51.74500	41.45
2004	TEL2004539008	52.37000	-51.18833	52.38000	-51.20167	40.85
2010	TEL2010976020	55.28167	-55.21333	55.28667	-55.22500	40.85
2002	TEL2002415029	51.23000	-49.71833	51.22000	-49.71000	40.10
2007	TEL2007755042	51.47000	-49.97833	51.46333	-49.96000	40.00
2006	BAL2006101082	60.50200	-62.07200	60.51200	-62.09300	40.00

Table A1.9. *Newfoundland and Labrador Shelves Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.C=Campelen trawl; W=Western IIA trawl.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)	Gear Type
2010	NED2010931042	46.22500	-57.52000	46.21500	-57.53000	40.00	C
2013	NED2013022211	45.74617	-58.00417	45.77033	-58.02667	30.62	W
2014	TEL2014134050	56.51333	-60.00500	56.50333	-59.98667	28.60	C
2010	NED2010931044	45.96667	-57.38500	45.95500	-57.38833	24.40	C
2009	NED2009027158	45.90567	-58.14283	45.88283	-58.11650	21.22	W
2009	NED2009903065	46.14833	-57.54667	46.14167	-57.54000	19.50	C
2010	NED2010931041	46.27333	-57.53167	46.27333	-57.55000	17.36	C
2009	NED2009903066	45.98000	-57.39167	45.97000	-57.37833	13.00	C
2010	NED2010942015	44.69333	-54.11833	44.68833	-54.12833	10.65	C
2010	NED2010002043	45.31233	-57.18950	45.29150	-57.16433	10.36	W
2012	NED2012022182	46.13517	-58.42833	46.15217	-58.46317	10.22	W
2015	NED2015451089	45.65167	-57.04167	45.64333	-57.04000	10.20	C
2014	TEL2014130040	46.18500	-57.50833	46.17333	-57.49833	9.59	C
2010	NED2010931092	45.04000	-54.96833	45.03000	-54.97667	9.40	C
2008	TEM2008830153	45.58317	-57.89633	45.56067	-57.87167	8.65	W
2011	NED2011402026	46.70667	-58.53833	46.69667	-58.52833	8.10	C
2010	NED2010931043	46.03333	-57.43333	46.02167	-57.42667	8.10	C
2005	NED2005656107	46.48167	-57.77333	46.49500	-57.77167	7.60	C
2011	NED2011402036	46.15167	-57.49333	46.16167	-57.50000	7.50	C
2010	NED2010931047	45.76500	-56.96500	45.75500	-56.95333	6.70	C
2008	TEM2008835015	44.71333	-54.05667	44.72167	-54.04833	6.40	C
2007	TEM2007758057	46.37000	-57.62000	46.37333	-57.60333	5.55	C
2010	NED2010002041	45.47883	-57.60100	45.46000	-57.58467	5.49	W
2007	TEM2007686041	45.52283	-57.64250	45.51583	-57.68083	5.45	W
2012	NED2012416075	46.70500	-58.58833	46.70500	-58.60500	5.38	C
2013	NED2013431047	46.30833	-57.57500	46.29500	-57.57167	5.36	C

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)	Gear Type
2008	TEM2008826058	45.95500	-57.40667	45.96667	-57.40167	5.10	C
2011	NED2011403054	44.73167	-54.21000	44.72667	-54.22000	4.92	C
2005	NED2005656075	45.48167	-56.60500	45.47833	-56.62333	4.70	C
2010	NED2010002042	45.39167	-57.31283	45.37383	-57.28617	4.54	W
2014	TEL2014130030	46.87667	-58.63500	46.87500	-58.65000	4.42	C
2014	TEL2014134015	56.13500	-57.59000	56.12667	-57.60667	4.38	C
2007	TEM2007686039	45.34950	-57.50700	45.36150	-57.54317	4.35	W
2011	NED2011402050	45.36000	-56.71833	45.37000	-56.72833	4.20	C
2014	TEL2014130031	46.83500	-58.69333	46.83500	-58.71333	4.10	C
2008	TEM2008826055	45.65333	-57.01333	45.66667	-57.01667	4.05	C
2007	TEL2007745155	46.11767	-58.32483	46.14483	-58.34483	3.95	W
2015	NED2015451076	46.37667	-57.70167	46.38333	-57.71167	3.92	C
2007	TEM2007758048	46.78167	-58.70167	46.78000	-58.68500	3.90	C
2013	NED2013431032	47.26167	-58.91333	47.26167	-58.90167	3.86	C
2013	NED2013431038	46.82500	-58.56000	46.82167	-58.54833	3.82	C
2011	NED2011401062	46.92000	-58.65333	46.92833	-58.64333	3.77	C
2007	TEM2007759043	45.24833	-56.88167	45.24333	-56.89833	3.75	C
2009	NED2009903060	46.35833	-57.68667	46.35167	-57.69167	3.75	C
2015	NED2015451090	45.47167	-57.04333	45.46500	-57.04000	3.72	C
2008	TEM2008826056	45.73500	-57.03000	45.74167	-57.04667	3.70	C
2011	NED2011401035	47.23167	-57.03000	47.22833	-57.04333	3.50	C
2011	NED2011402048	45.45667	-57.08000	45.44833	-57.06667	3.50	C
2012	NED2012419025	44.09000	-52.96000	44.08500	-52.95000	3.41	C
2010	NED2010932044	44.42167	-53.55833	44.41833	-53.54167	3.40	C
2008	TEM2008826057	45.84333	-57.44500	45.84667	-57.46333	3.40	C
2007	TEM2007759036	45.70833	-57.38667	45.70833	-57.37000	3.30	C
2009	NED2009902077	46.88167	-58.49667	46.88333	-58.47833	3.30	C
2014	NED2014018189	45.89117	-58.15417	45.91567	-58.17683	3.26	W
2008	TEM2008826024	46.82167	-58.71333	46.81000	-58.71500	3.20	C
2013	NED2013431043	46.64833	-57.93500	46.65667	-57.94500	3.00	C
2007	TEM2007759033	46.07167	-57.54833	46.06500	-57.51833	2.95	C
2014	TEL2014130041	45.89500	-57.26833	45.90667	-57.28000	2.83	C
2011	NED2011402022	46.55333	-57.84667	46.56000	-57.86000	2.72	C
2015	NED2015451083	46.09000	-57.75000	46.08167	-57.74833	2.70	C
2007	TEM2007686040	45.51600	-57.48517	45.54400	-57.48467	2.70	W
2004	TEL2004537065	55.80667	-58.92667	55.80000	-58.94500	2.55	C
2008	TEM2008826032	46.41500	-57.69167	46.41833	-57.77333	2.55	C
2013	NED2013433004	44.93000	-54.49167	44.92167	-54.50500	2.52	C
2011	NED2011401061	46.92833	-58.75833	46.93833	-58.74833	2.50	C

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)	Gear Type
2011	NED2011402049	45.28333	-56.95333	45.27667	-56.94000	2.50	C
2011	NED2011402053	45.87833	-56.46667	45.87000	-56.45333	2.50	C
2008	BAL2008103004	57.99167	-59.71350	58.00050	-59.73050	2.49	C
2009	NED2009913029	44.74000	-54.13167	44.72833	-54.12500	2.46	C
2005	NED2005656108	46.55833	-57.87833	46.56333	-57.89333	2.40	C
2010	NED2010931033	46.77000	-58.45500	46.77333	-58.43667	2.40	C
2009	NED2009903067	45.98833	-57.29000	45.98000	-57.27500	2.38	C
2014	TEL2014130035	46.55000	-57.74333	46.54333	-57.75833	2.34	C
2007	TEM2007759034	45.92000	-57.31500	45.91333	-57.28500	2.30	C
2013	NED2013431039	46.69000	-58.62167	46.68500	-58.61167	2.29	C
2011	NED2011401058	47.37833	-59.11500	47.37167	-59.09833	2.27	C
2015	NED2015451011	47.38333	-56.42500	47.37667	-56.41833	2.22	C
2007	TEM2007759035	45.86000	-57.12667	45.85833	-57.11000	2.20	C
2011	NED2011402047	45.64667	-57.38000	45.63667	-57.37167	2.20	C
2010	NED2010931046	45.73167	-57.39000	45.72000	-57.38833	2.20	C
2007	TEM2007759031	46.11333	-57.59500	46.11167	-57.61333	2.15	C
2007	TEM2007758031	47.52000	-57.81333	47.51333	-57.79833	2.15	C
2012	NED2012417011	46.36333	-57.67833	46.37333	-57.67000	2.10	C
2010	NED2010930065	45.89500	-56.99500	45.88333	-56.98833	2.07	C
2012	NED2012417004	45.97833	-57.34667	45.97000	-57.33333	2.00	C
2011	NED2011402035	46.09333	-57.50500	46.08500	-57.49333	2.00	C

Table A1.10. *Newfoundland and Labrador Shelves Biogeographic Zone: Details of the Location of Research Vessel Large Gorgonian Coral Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2013	AQV2013108080	60.55852	-61.25612	60.57257	-61.25610	866.90
2011	BAL2011106067	60.47233	-61.28593	60.45592	-61.27250	412.65
2010	BAL2010105080	60.64632	-61.32495	60.63208	-61.31115	307.02
2008	BAL2008103072	60.75817	-61.21017	60.74900	-61.21183	200.00
2010	BAL2010105079	60.57203	-61.37953	60.55917	-61.35598	173.85
2008	BAL2008103070	60.37483	-61.25067	60.39567	-61.24267	156.67
2012	AQV2012107083	60.70608	-61.21222	60.69643	-61.21550	154.39
2006	BAL2006101073	60.49333	-61.39000	60.50333	-61.40000	150.00
2007	3LCANZEE07009	48.09950	-48.28667	48.09767	-48.24733	66.25
2012	AQV2012107084	60.80692	-61.25992	60.81952	-61.25648	58.67

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2006	NED2006036055	44.38183	-57.34517	44.38483	-57.39633	54.20
2006	BAL2006101075	60.48333	-61.30000	60.49667	-61.30833	50.19
2007	BAL2007102079	60.61200	-61.27067	60.62500	-61.27517	40.00
2013	TEL2013119019	55.86500	-57.33333	55.87500	-57.34500	35.70
2010	BAL2010105085	60.68282	-62.30657	60.68615	-62.33322	35.00
2011	NED2011409009	44.83667	-54.46333	44.84500	-54.45000	33.40
2010	BAL2010105077	60.22763	-61.09982	60.24343	-61.11322	32.00
2010	TEL2010975017	56.02500	-57.43833	56.01167	-57.43833	25.00
2012	NED2012022203	44.36533	-57.45100	44.35150	-57.47183	23.95
2007	BAL2007102080	60.77350	-61.22000	60.78600	-61.22483	22.05
2013	AQV2013108082	60.57968	-61.58652	60.57465	-61.55745	21.14
2009	BAL2009104069	60.80050	-61.36567	60.80000	-61.33817	20.73
2011	BAL2011106071	59.79310	-62.87933	59.80647	-62.87872	20.11
2008	3LCANZEE08011	48.15467	-48.55483	48.17267	-48.57883	19.00
2013	NED2013432041	44.93667	-55.01667	44.92833	-55.01667	16.88
2007	BAL2007102081	60.80583	-61.65950	60.81717	-61.67567	14.55
2009	NED2009904037	44.81000	-55.64167	44.80667	-55.66000	13.70
2010	NED2010931088	44.95667	-55.00667	44.96333	-54.99833	12.10
2013	AQV2013108081	60.59977	-61.40927	60.59807	-61.38543	11.14
2010	NED2010027138	44.38250	-57.37967	44.37583	-57.40217	11.04
2010	BAL2010105082	60.81687	-61.83453	60.80713	-61.85832	10.86
2006	TEL2006682045	50.44667	-50.59500	50.46000	-50.59667	10.00
2010	BAL2010105055	59.49500	-60.36617	59.50500	-60.38000	9.77
2012	AQV2012107085	60.77850	-61.71733	60.78015	-61.74267	9.44
2010	BAL2010105078	60.35708	-61.43043	60.37093	-61.45083	9.00
2010	TEL2010978063	52.16167	-50.92667	52.16167	-50.91500	8.96
2008	TEL2008820016	53.71167	-52.53000	53.72333	-52.53833	8.40
2006	TEM2006707032	48.75667	-49.81000	48.74500	-49.80167	8.25
2010	BAL2010105084	60.58233	-61.91133	60.59050	-61.93028	6.06
2009	3LCANZEE09022	48.34967	-49.06700	48.36133	-49.09267	6.00
2010	NED2010931089	45.06000	-55.27667	45.07333	-55.27833	5.23
2008	3LCANZEE08010	48.11067	-48.23950	48.11350	-48.20350	4.80
2006	BAL2006101084	60.64333	-61.43333	60.65000	-61.45667	4.61
2015	NED2015452053	44.92333	-55.49333	44.93333	-55.50167	4.11
2009	BAL2009104068	60.60733	-61.39233	60.61993	-61.38900	4.00
2005	BAL2005100066	60.18167	-61.72167	60.19333	-61.73833	3.75
2014	TEL2014137018	51.98833	-50.73833	52.00000	-50.74833	3.50
2004	TEL2004539008	52.37000	-51.18833	52.38000	-51.20167	3.40

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2013	TEL2013123041	51.67500	-50.39333	51.68333	-50.39833	3.36
2009	NED2009913026	44.82333	-54.49333	44.83167	-54.49500	3.29
2007	TEM2007760037	43.87167	-52.58833	43.88000	-52.60000	2.96
2009	BAL2009104061	60.04833	-61.00250	60.03750	-60.98633	2.86
2012	NED2012420097	48.78333	-49.82833	48.77333	-49.82333	2.81
2006	BAL2006101077	60.17000	-61.78833	60.18167	-61.79000	2.80
2009	TEL2009895020	48.39167	-49.07167	48.38833	-49.05833	2.75
2012	NED2012424030	44.63667	-54.07000	44.63500	-54.08667	2.68
2007	TEL2007755037	51.94833	-50.71500	51.95833	-50.72833	2.63
2010	TEL2010975021	56.20833	-57.25500	56.20333	-57.24333	2.53
2005	TEM2005618061	44.82667	-54.49167	44.83333	-54.47667	2.52
2010	TEL2010979032	48.73167	-49.66333	48.74167	-49.67667	2.50
2005	TEL2005611039	54.63833	-52.74500	54.62667	-52.75167	2.42
2008	BAL2008103074	60.77600	-62.12500	60.77533	-62.14283	2.25
2010	NED2010930014	46.51500	-54.61833	46.50167	-54.61833	2.22
2005	TEM2005627035	44.73333	-54.28833	44.73333	-54.27167	2.02
2012	NED2012424033	44.43500	-53.62000	44.43833	-53.63000	1.96
2009	TEL2009894002	44.61333	-54.13167	44.61167	-54.11333	1.83
2012	NED2012424044	43.78833	-52.48167	43.78667	-52.49500	1.79
2009	TEL2009898039	48.12167	-48.36167	48.12000	-48.38000	1.79
2014	KIN2014109090	60.79007	-61.38135	60.79203	-61.41993	1.62
2007	3LCANZEE07008	48.14517	-48.42867	48.14133	-48.39350	1.54
2009	BAL2009104070	60.60117	-61.57650	60.59217	-61.55600	1.53
2011	BAL2011106073	60.38985	-63.08163	60.39235	-63.10705	1.46
2011	BAL2011106068	60.40958	-61.71427	60.41343	-61.69083	1.43
2009	TEL2009896006	54.12000	-52.68333	54.11000	-52.67500	1.40
2007	BAL2007102082	60.74200	-61.90500	60.75500	-61.90983	1.36
2008	TEL2008817011	55.71333	-56.97167	55.71833	-56.99167	1.35
2011	BAL2011106072	60.07970	-62.89383	60.09428	-62.89113	1.32
2010	TEL2010978064	52.02167	-50.66333	52.01167	-50.65167	1.30
2014	TEL2014134016	56.33833	-57.66667	56.32667	-57.65167	1.24
2006	TEM2006707011	47.65000	-50.58167	47.64333	-50.56833	1.03
2008	TEM2008838013	46.36000	-49.45333	46.35833	-49.43667	1.00

Table A1.11. *Newfoundland and Labrador Shelves Biogeographic Zone: Details of the Location of Research Vessel Small Gorgonian Coral Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Small Gorgonian Coral Weight (kg)
2005	NED2005656066	44.82667	-56.10333	44.83000	-56.09333	2.80
2010	NED2010942015	44.69333	-54.11833	44.68833	-54.12833	2.60
2009	TEL2009894010	43.93167	-52.77667	43.94167	-52.78667	1.75
2005	TEM2005619047	43.93667	-52.62833	43.94000	-52.64167	1.45
2008	TEL2008817027	56.26667	-57.53500	56.27500	-57.54833	1.40
2015	NED2015453013	44.45667	-53.72000	44.46500	-53.73000	1.18
2008	TEM2008836018	43.85667	-52.58167	43.84667	-52.58833	1.05
2011	NED2011409013	44.69333	-54.12167	44.68667	-54.13167	0.98
2011	BAL2011106018	58.21113	-59.75405	58.22243	-59.74613	0.83
2005	TEM2005588009	51.30833	-50.11667	51.30000	-50.11167	0.76
2012	NED2012417093	44.42833	-53.53500	44.43500	-53.52500	0.71
2009	TEL2009894001	44.76167	-54.49833	44.76833	-54.51500	0.70
2013	NED2013438018	44.43500	-53.60667	44.43833	-53.59000	0.64
2014	TEL2014138042	50.91833	-49.74333	50.92667	-49.73167	0.60
2011	NED2011403066	44.13333	-52.96500	44.13500	-52.98167	0.60
2007	TEM2007760031	44.69500	-54.11333	44.69667	-54.10167	0.56
2008	TEM2008827044	43.74333	-52.22500	43.74833	-52.23833	0.52
2012	NED2012419025	44.09000	-52.96000	44.08500	-52.95000	0.50
2010	NED2010932067	44.07833	-52.91667	44.07167	-52.90167	0.50
2007	TEL2007755066	50.52000	-50.75167	50.53167	-50.75333	0.45
2009	NED2009905023	43.76333	-52.39333	43.77500	-52.40333	0.44
2010	NED2010947022	50.67167	-54.47500	50.67667	-54.49167	0.40
2010	NED2010932044	44.42167	-53.55833	44.41833	-53.54167	0.40
2013	TEL2013119001	55.36833	-55.69667	55.37333	-55.70833	0.39
2015	NED2015453027	43.98167	-52.64500	43.97667	-52.63167	0.38
2008	TEL2008817028	56.33833	-57.57333	56.34667	-57.58667	0.37
2013	NED2013433010	44.09667	-52.98333	44.09000	-52.99833	0.31
2009	NED2009905022	43.82333	-52.56667	43.82833	-52.58000	0.29
2007	TEM2007771025	44.72667	-54.30833	44.72667	-54.32000	0.28
2011	TEL2011096011	52.84333	-51.72667	52.83500	-51.71333	0.26
2007	TEM2007771027	44.37500	-53.38833	44.36833	-53.37167	0.26
2008	TEM2008827040	43.93167	-52.61167	43.92500	-52.59833	0.23
2014	TEL2014139048	43.82167	-52.54833	43.82500	-52.53000	0.23
2005	TEM2005627035	44.73333	-54.28833	44.73333	-54.27167	0.22
2008	TEM2008835019	44.64333	-53.95000	44.64000	-53.96333	0.21
2013	NED2013433008	44.45167	-53.70833	44.45000	-53.69667	0.20

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Small Gorgonian Coral Weight (kg)
2008	TEM2008835013	44.76667	-54.42667	44.75833	-54.41333	0.20
2008	TEM2008838013	46.36000	-49.45333	46.35833	-49.43667	0.20
2006	TEL2006680016	57.21500	-59.07000	57.22667	-59.08167	0.20
2006	TEL2006679029	56.60000	-58.18833	56.61000	-58.20167	0.20
2013	TEL2013123039	51.43333	-49.95833	51.42333	-49.94500	0.20
2007	TEM2007759046	44.80667	-56.14500	44.80500	-56.16167	0.20
2007	TEM2007759077	44.78500	-54.43000	44.78333	-54.41667	0.20

Table A1.12. *Hudson Strait and Ungava Bay: Details of the Location of Research Vessel Sponge Catches used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2011	PAA2011117102	59.95787	-66.96861	59.96161	-66.94982	8.754
2009	PAA2009007119	62.97383	-77.95183	62.96467	-77.95167	4.613
2009	PAA2009007056	61.64667	-66.23383	61.65683	-66.23550	4.221
2011	PAA2011117045	61.59906	-66.23395	61.59450	-66.25588	3.404
2009	PAA2009007045	60.63767	-68.60300	60.64683	-68.59017	3.252
2009	PAA2009007147	63.29083	-73.04150	63.28367	-73.02450	3.147
2009	PAA2009007091	62.49350	-70.06833	62.49317	-70.08883	2.781
2009	PAA2009007046	60.88850	-68.76117	60.89517	-68.77450	2.754
2011	PAA2011117069	61.74660	-69.40123	61.73596	-69.40771	2.545
2007	PAA2009007037	62.20333	-68.72517	62.20305	-68.74778	2.542
2011	PAA2011117046	61.86658	-66.76842	61.85627	-66.76769	2.479
2007	PAA2009007073	61.21032	-64.91152	61.21210	-64.89832	2.444
2007	PAA2009007038	61.11483	-69.11263	61.11278	-69.08972	2.224
2007	PAA2009007010	61.59747	-66.21477	61.58678	-66.21282	2.184
2007	PAA2009007062	60.01433	-66.42883	60.01767	-66.42550	2.112
2009	PAA2009007120	63.02850	-77.30883	63.01783	-77.30433	2.055

Table A1.13. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Sponge Catches from Alfredo Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2014	PAA2014007142	63.02763	-60.67272	63.01992	-60.62243	1088.322
2013	PAA2013008137	61.70485	-60.65048	61.71987	-60.65288	528.998
2012	PAA2012007155	66.91700	-60.16643	66.89253	-60.15118	419.700
2013	PAA2013008136	61.68727	-61.12232	61.68443	-61.08505	413.100

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2014	PAA2014007134	61.89890	-60.13640	61.86890	-60.13235	399.425
2000	PAA2000002017	61.79000	-60.59000	61.77000	-60.60000	350.000
2011	PAA2011117121	61.94133	-61.27989	61.92167	-61.26488	301.500
2008	PAA2008007067	67.06183	-60.64783	67.03675	-60.63187	250.000
2011	PAA2011117022	62.52859	-59.20289	62.54439	-59.23940	233.150
2013	PAA2013008056	61.87438	-63.37695	61.85992	-63.40908	215.750
2013	PAA2013008135	61.76735	-61.72832	61.74850	-61.70205	172.950
2012	PAA2012007194	66.82927	-58.50340	66.83135	-58.56127	168.224
2010	PAA2010009115	66.84350	-59.99717	66.82003	-59.98455	168.050
2011	PAA2011117023	62.55180	-59.52723	62.57452	-59.53568	162.900
2014	PAA2014007092	66.14090	-58.61472	66.16238	-58.64475	153.424
2010	PAA2010009161	66.55412	-58.96755	66.53023	-58.98213	152.750
2000	PAA2000002026	61.94000	-61.27000	61.92000	-61.25000	150.000
2011	PAA2011117114	61.90894	-63.63715	61.92445	-63.59632	140.579
2006	PAA2006008011	66.92167	-60.18567	66.94050	-60.21500	133.450
2013	PAA2013008052	62.04287	-61.47677	62.02062	-61.50008	132.364
2011	PAA2011117037	61.75708	-63.17784	61.74090	-63.18217	131.768
2013	PAA2013008045	62.98347	-60.30927	62.95920	-60.31075	126.473
2014	PAA2014007004	66.78685	-60.09917	66.76540	-60.11338	124.100
2010	PAA2010009155	66.81430	-58.45597	66.80987	-58.39535	123.850
2011	PAA2011117124	62.17897	-61.21684	62.20351	-61.21690	123.826
2000	PAA2000002033	62.33000	-61.00000	62.35000	-61.00000	120.000
2014	PAA2014007088	66.82693	-58.49283	66.82817	-58.55197	117.793
2013	PAA2013008147	62.62903	-59.67562	62.60567	-59.68063	115.396
2011	PAA2011117132	63.24716	-60.16543	63.26452	-60.19422	107.525
2011	PAA2011117119	62.06004	-61.74539	62.03883	-61.72220	107.149
2013	PAA2013008145	62.43510	-59.78475	62.41438	-59.77095	104.750
2008	PAA2008007049	66.82817	-58.47145			100.000
2000	PAA2000002028	62.11000	-60.85000	62.12000	-60.86000	100.000
2000	PAA2000002030	62.20000	-60.86000	62.23000	-60.88000	100.000
2011	PAA2011117028	62.28608	-59.91905	62.26182	-59.91587	98.903
1999	PAA1999001012	66.82000	-60.28000	66.84000	-60.28300	98.590
2014	PAA2014007124	62.52203	-59.39858	62.54528	-59.40400	94.400
1999	PAA1999001004	66.29000	-59.36000	66.31000	-59.36200	90.500
2011	PAA2011117169	65.66646	-57.76882	65.64293	-57.76118	88.852
2000	PAA2000002016	62.09000	-60.10000	62.06000	-60.12000	88.250
2013	PAA2013008047	62.76543	-61.43020	62.74237	-61.44598	87.950
2010	PAA2010009168	66.42807	-57.70140	66.40437	-57.71060	85.943
2006	PAA2006008044	69.23160	-64.35775	69.24890	-64.39367	83.124
2013	PAA2013008141	62.05390	-60.09182	62.03137	-60.09517	83.030

Table A1.14. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Sponge Catches using Campelen Trawls used to identify the Significant Area Polygons. *Set number is last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2006	BAL2006101090	61.27300	-60.87200	61.27667	-60.89833	2000.000
2005	BAL2005100220	63.03700	-60.60300	62.02333	-60.61500	1500.000
2008	BAL2008103076	61.57200	-60.96000	61.56383	-60.97267	1027.120
2008	BAL2008103095	62.98200	-60.61300	62.97133	-60.62733	1000.000
2007	BAL2007102104	63.02300	-60.64200	63.01467	-60.66667	900.000
2009	BAL2009104254	63.02933	-60.62983	63.02150	-60.65283	800.000
2005	BAL2005100236	61.76300	-60.99300	61.76000	-60.97000	800.000
2007	BAL2007102083	61.64000	-61.33200	61.64133	-61.36017	550.700
2008	BAL2008103158	64.58500	-58.89800	64.57167	-58.91033	504.130
2008	BAL2008103078	61.76700	-62.27500	61.76817	-62.25767	500.000
2007	BAL2007102210	61.63000	-63.33700	61.63333	-63.30933	500.000
2008	BAL2008103096	63.13800	-60.66300	63.15117	-60.67317	500.000
2006	BAL2006101097	62.03000	-60.86200	62.04000	-60.87667	500.000
2010	BAL2010105263	63.05415	-60.42313	63.06728	-60.41015	305.973
2006	BAL2006101102	61.76500	-62.31700	61.77167	-62.29000	300.000
2006	BAL2006101095	61.77000	-61.22700	61.78167	-61.22667	300.000
2007	BAL2007102089	61.90200	-62.37200	61.89250	-62.39350	300.000
2007	BAL2007102100	62.91200	-61.07200	62.90267	-61.09333	300.000
2010	BAL2010105282	61.67685	-61.12683	61.68637	-61.10273	255.099
2010	BAL2010105280	61.86642	-60.77252	61.85375	-60.78200	250.830
2008	BAL2008103077	61.65000	-60.81300	61.64317	-60.82500	225.940
2005	BAL2005100237	61.46300	-61.51000	61.45333	-61.52833	200.000
2007	BAL2007102086	61.72800	-61.96000	61.72100	-61.98600	200.000
2005	BAL2005100234	61.89300	-61.22000	61.88167	-61.20167	200.000
2012	AQV2012107094	61.84818	-60.89045	61.85788	-60.90613	191.127
2010	BAL2010105180	61.68970	-63.07025	61.67440	-63.06718	156.751
2007	BAL2007102209	61.59800	-63.72800	61.60650	-63.70600	156.460
2007	BAL2007102152	64.59200	-58.77700	64.57883	-58.79383	155.190
2009	BAL2009104255	62.83983	-60.74117	62.83317	-60.72283	151.788
2013	AQV2013108142	61.51842	-63.50073	61.52433	-63.48210	151.226
2006	BAL2006101096	61.95200	-61.29000	61.96333	-61.27833	150.000
2007	BAL2007102211	61.57700	-63.30000	61.58217	-63.27933	150.000
2005	BAL2005100184	65.59200	-58.81200	65.60167	-58.83500	144.000
2011	BAL2011106177	63.08680	-60.64975	63.07665	-60.66527	130.000
2011	BAL2011106081	61.72250	-60.78743	61.73640	-60.79367	129.525
2013	AQV2013108280	61.75342	-62.51582	61.76013	-62.49653	125.000
2008	BAL2008103175	65.47300	-57.97300	65.45867	-57.97267	120.000
2005	BAL2005100235	61.84800	-61.23000	61.83500	-61.21833	120.000

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2007	BAL2007102150	64.25500	-59.15500	64.24067	-59.15100	117.330
2007	BAL2007102125	63.70700	-60.31800	63.69383	-60.32867	115.520
2010	BAL2010105276	61.77282	-61.64453	61.77517	-61.61680	110.891
2010	BAL2010105275	61.83857	-62.30048	61.84452	-62.27562	110.205
2005	BAL2005100112	61.92800	-62.81500	61.91333	-62.81500	108.920
2005	BAL2005100226	62.63300	-61.20800	62.62333	-61.19000	102.000
2010	BAL2010105181	61.70067	-63.21193	61.69040	-63.23290	101.521
2008	BAL2008103179	66.15000	-59.87200	66.16317	-59.87717	101.240
2013	AQV2013108281	61.73862	-61.74940	61.73373	-61.73178	100.013
2007	BAL2007102149	64.20700	-59.09000	64.19417	-59.10650	100.000
2006	BAL2006101089	61.20200	-61.38800	61.21333	-61.38000	100.000
2006	BAL2006101241	61.94200	-63.58000	61.95333	-63.56833	100.000
2006	BAL2006101091	61.37700	-61.34500	61.39000	-61.33833	100.000
2008	BAL2008103094	62.98700	-60.95000	63.00067	-60.94683	100.000
2005	BAL2005100232	62.11300	-61.45200	62.10500	-61.47500	97.200
2008	BAL2008103161	64.96500	-58.53300	64.95317	-58.54783	90.370
2008	BAL2008103080	61.93800	-62.58500	61.93300	-62.56583	90.000
2012	AQV2012107128	61.63120	-63.56428	61.63842	-63.55283	81.892
2013	AQV2013108275	62.21497	-60.97392	62.20260	-60.96267	80.968
2014	KIN2014109227	65.10053	-58.03595	65.09007	-58.05082	76.533
2013	AQV2013108147	61.85337	-63.64582	61.85857	-63.62120	76.337
2014	KIN2014109322	61.64850	-63.39537	61.65008	-63.37752	75.566
2010	BAL2010105279	62.11082	-60.87435	62.09663	-60.87160	75.000
2009	BAL2009104267	61.95067	-61.09050	61.94483	-61.11550	72.000
2013	AQV2013108145	61.77457	-63.44222	61.77690	-63.42167	70.626
2012	AQV2012107129	61.59720	-63.44695	61.58620	-63.45150	68.445
2012	AQV2012107112	61.83763	-62.60432	61.82493	-62.60127	67.450
2005	BAL2005100188	65.70200	-59.07200	65.68833	-59.06167	65.000
2010	BAL2010105278	62.17430	-61.06937	62.16078	-61.06268	62.030
2014	KIN2014109327	61.98615	-63.52990	61.98562	-63.55547	60.755
2012	AQV2012107093	61.87795	-61.37597	61.88265	-61.35173	60.061
2008	BAL2008103160	64.95200	-58.31800	64.93917	-58.33333	60.020
2006	BAL2006101226	61.70800	-63.15300	61.70000	-63.13167	60.000
2010	BAL2010105283	61.60972	-61.39430	61.62113	-61.37622	55.316
2013	AQV2013108148	61.94148	-63.53653	61.93975	-63.56218	55.122
2010	BAL2010105119	65.81220	-57.79882	65.82828	-57.82098	54.748
2011	BAL2011106082	61.85785	-61.16688	61.86450	-61.19130	54.351
2007	BAL2007102205	61.92800	-63.48500	61.92600	-63.51267	52.900
2006	BAL2006101124	65.12500	-58.46000	65.13667	-58.44333	51.440
2011	BAL2011106209	61.65390	-63.24807	61.64677	-63.27683	51.082
2013	AQV2013108146	61.82147	-63.45443	61.82335	-63.43530	50.534

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2009	BAL2009104265	61.71700	-62.05250	61.71833	-62.07983	50.000
2007	BAL2007102207	61.90700	-63.51700	61.91933	-63.52300	50.000
2007	BAL2007102136	64.65500	-60.86700	64.64183	-60.86883	49.900
2013	AQV2013108278	61.83920	-62.87523	61.84065	-62.89378	48.564
2006	BAL2006101123	65.09700	-58.19800	65.11000	-58.18667	48.240
2014	KIN2014109326	61.94608	-63.24693	61.95503	-63.26385	46.505
2007	BAL2007102163	65.84200	-60.16500	65.82850	-60.16733	45.000
2012	AQV2012107091	61.59868	-61.40358	61.61232	-61.40747	44.250
2009	BAL2009104142	61.80667	-63.27900	61.80083	-63.30233	43.450
2014	KIN2014109228	65.16237	-58.18915	65.15158	-58.20615	43.130
2012	AQV2012107130	61.62578	-63.27643	61.61315	-63.27718	41.164
2011	BAL2011106085	61.90190	-62.53327	61.91340	-62.54883	40.713
2009	BAL2009104143	61.95217	-63.20067	61.94017	-63.20650	40.000
2006	BAL2006101092	61.48700	-61.80500	61.48833	-61.83333	40.000
2007	BAL2007102103	62.96800	-60.91800	62.95883	-60.94200	40.000
2007	BAL2007102170	65.46500	-57.77800	65.45433	-57.78567	40.000
2011	BAL2011106211	61.64957	-63.28268	61.63992	-63.29675	39.818
2013	AQV2013108282	61.63312	-61.39322	61.62663	-61.37905	39.428
2012	AQV2012107162	61.93382	-63.54263	61.92348	-63.52807	38.172
2005	BAL2005100109	62.17300	-63.55300	62.16500	-63.53500	38.170
2005	BAL2005100096	61.91700	-63.78800	61.96167	-63.79667	38.000
2009	BAL2009104094	61.44767	-63.78283	61.44517	-63.80683	37.920
2013	AQV2013108143	61.68915	-63.25678	61.69895	-63.23732	37.330
2005	BAL2005100111	62.18500	-62.79300	62.18167	-62.82167	36.720
2011	BAL2011106083	61.93805	-61.22777	61.93783	-61.25597	36.613
2005	BAL2005100219	63.23300	-60.41200	63.22000	-60.41833	35.800
2014	KIN2014109328	62.07612	-63.45265	62.07938	-63.42868	35.703
2008	BAL2008103162	64.91800	-58.97300	64.90717	-58.98767	35.630
2006	BAL2006101249	62.04800	-65.54200	62.04500	-65.57167	35.490
2013	AQV2013108187	65.14513	-58.46183	65.15052	-58.43057	35.478
2010	BAL2010105190	61.05393	-63.50533	61.06978	-63.51442	35.332
2008	BAL2008103178	66.14000	-58.75200	66.15167	-58.73650	35.310
2006	BAL2006101119	64.73700	-58.80700	64.74167	-58.78333	35.000
2006	BAL2006101100	62.15700	-61.54500	62.16667	-61.52833	35.000
2007	BAL2007102141	64.65700	-59.20500	64.64283	-59.20250	35.000
2014	KIN2014109296	62.82545	-61.01403	62.81982	-61.03055	34.981
2010	BAL2010105179	61.84830	-63.41650	61.84480	-63.44587	33.307
2011	BAL2011106214	62.03220	-63.56828	62.01968	-63.59543	32.994
2007	BAL2007102203	62.12200	-63.51000	62.11000	-63.49433	32.730
2013	AQV2013108144	61.76610	-63.13112	61.77300	-63.11617	32.023
2010	BAL2010105182	61.65632	-63.90457	61.64277	-63.90173	32.000

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2008	BAL2008103086	62.18700	-61.31800	62.17367	-61.32000	31.780
2009	BAL2009104229	64.65683	-58.67217	64.64450	-58.67283	31.170
2007	BAL2007102171	65.72300	-57.72200	65.73667	-57.71233	30.000
2006	BAL2006101099	62.29800	-61.13300	62.30833	-61.15667	30.000
2011	BAL2011106178	63.12572	-60.52065	63.14502	-60.51268	29.620
2005	BAL2005100218	63.29500	-60.25200	63.28167	-60.25333	29.400
2005	BAL2005100175	64.83000	-58.56300	64.81500	-58.57167	29.060
2013	AQV2013108150	62.01840	-63.53528	62.03017	-63.52385	28.817
2012	AQV2012107092	61.73517	-61.70585	61.74272	-61.68183	28.460
2014	KIN2014109323	61.68208	-63.28177	61.67958	-63.26197	27.872
2014	KIN2014109220	66.17215	-59.96897	66.16020	-59.96252	27.868
2005	BAL2005100094	61.74000	-63.40200	61.74833	-63.37667	26.590
2014	KIN2014109325	61.81207	-63.27278	61.82170	-63.25645	26.500
2011	BAL2011106181	63.38635	-60.25640	63.40647	-60.24525	26.476
2006	BAL2006101118	64.64500	-58.66700	64.65833	-58.65333	26.000
2013	AQV2013108279	61.66170	-62.75550	61.66228	-62.73485	25.695
2005	BAL2005100231	62.17700	-61.33800	62.16333	-61.34667	25.600
2011	BAL2011106176	62.92792	-60.75652	62.92450	-60.78548	25.338
2009	BAL2009104141	61.64617	-63.29183	61.64800	-63.26717	25.000
2007	BAL2007102090	61.95800	-62.61500	61.95383	-62.64250	25.000
2008	BAL2008103111	63.36000	-60.77200	63.36733	-60.75050	25.000
2007	BAL2007102085	61.94300	-62.15800	61.94000	-62.17867	24.490
2014	KIN2014109251	64.74195	-58.52618	64.72930	-58.53008	24.428
2008	BAL2008103151	63.77200	-59.72200	63.77100	-59.75267	24.100
2005	BAL2005100229	62.39800	-61.54300	62.40000	-61.51500	24.000
2007	BAL2007102084	61.82800	-60.87800	61.83100	-60.90700	23.760
2011	BAL2011106084	61.72997	-62.61718	61.72807	-62.64845	22.665
2014	KIN2014109158	62.20405	-62.22047	62.21132	-62.19990	22.500
2006	BAL2006101120	64.89500	-58.40300	64.90833	-58.40667	22.500
2005	BAL2005100114	62.10800	-62.14200	62.12167	-62.13500	21.780
2008	BAL2008103153	64.20800	-59.42200	64.19517	-59.42967	21.300
2005	BAL2005100185	65.38700	-59.11800	65.37333	-59.11000	21.200
2012	AQV2012107174	63.06620	-60.46115	63.08075	-60.45282	21.000
2013	AQV2013108149	62.08545	-63.44520	62.09708	-63.43630	20.981
2008	BAL2008103176	65.65500	-58.11700	65.64233	-58.09933	20.880
2009	BAL2009104262	61.91633	-62.94850	61.92867	-62.94400	20.000
2009	BAL2009104268	61.68450	-61.85283	61.68267	-61.88050	20.000
2007	BAL2007102213	61.36800	-64.02200	61.35883	-64.04500	20.000
2006	BAL2006101239	62.14200	-63.45300	62.13500	-63.42833	20.000

Table A1.15. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Sponge Catches with Cosmos Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sponge Weight (kg)
2006	PAA2006005100	66.29000	-58.42350	66.29617	-58.40617	603.800
2006	PAA2006005093	66.41777	-59.23245	66.40853	-59.22227	195.900
2010	PAA2010009104	67.03782	-60.50720	67.02837	-60.50612	168.100
2008	PAA2008007066	67.13367	-60.71033	67.12432	-60.69650	147.600
2008	PAA2008007048	66.61433	-58.83467	66.62427	-58.82730	139.400
2008	PAA2008007035	66.47083	-59.12767	66.45945	-59.11825	76.500
2006	PAA2006005092	66.43463	-59.57798	66.42828	-59.55770	70.315
2006	PAA2006005089	67.12583	-60.56483	67.11567	-60.56217	53.145
2010	PAA2010009167	66.39263	-57.82317	66.38230	-57.81568	43.121
2008	PAA2008007040	66.40765	-58.71933	66.39547	-58.71592	40.850

Table A1.16. *Eastern Arctic Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches with Alfredo Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2000	PAA2000002	65.38000	-57.95000	65.37000	-57.91000	5.000
2012	PAA2012007	67.81010	-62.79388	67.82403	-62.81360	3.201
2011	PAA2011007	65.19384	-57.71988	65.17259	-57.69835	3.150
2000	PAA2000002	64.28000	-58.32000	64.26000	-58.31000	3.000
2010	PAA2010009	74.65587	-75.00450	74.66215	-75.05523	2.385
2000	PAA2000002	65.49000	-58.92000	64.00000	-58.76000	2.000
2000	PAA2000002	63.97000	-58.78000	65.47000	-58.91000	2.000
2006	PAA2006008	68.55854	-59.37512	68.57033	-59.36755	1.790
2008	PAA2008007	68.46967	-59.43933	68.49353	-59.42368	1.782
2000	PAA2000002	65.48000	-58.73000	65.48000	-58.66000	1.500
2000	PAA2000002	65.36000	-58.24000	65.35000	-58.19000	1.500
2010	PAA2010009	75.30722	-75.25663	75.32952	-75.21998	1.386
2012	PAA2012007	74.84357	-75.02408	74.86072	-75.05397	1.132
2010	PAA2010009	75.53365	-73.96020	75.53740	-73.86885	1.119
2012	PAA2012007	74.98952	-78.48975	74.96445	-78.46423	1.051
2012	PAA2012007	68.88413	-65.37500	68.87165	-65.42833	0.960
2012	PAA2012007	73.40008	-73.70258	73.37697	-73.70988	0.900
2008	PAA2008007	68.62585	-59.45592	68.64652	-59.42268	0.883
2010	PAA2010009	75.47390	-74.69687	75.48268	-74.61155	0.815
2012	PAA2012007	74.58103	-74.74010	74.59807	-74.79483	0.805
2010	PAA2010009	74.93317	-75.05700	74.94053	-75.02583	0.800
2010	PAA2010009	75.10010	-75.32772	75.12150	-75.37388	0.769

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2010	PAA2010009	75.33230	-73.86925	75.30960	-73.83802	0.710
2014	PAA2014007	68.88805	-65.61208	68.86973	-65.65382	0.696
2012	PAA2012007	67.78205	-62.84420	67.76097	-62.80668	0.680
2014	PAA2014007	71.73143	-70.83840	71.71362	-70.78648	0.600
2012	PAA2012007	72.25118	-72.64468	72.23482	-72.58478	0.596
2012	PAA2012007	75.01362	-75.30227	75.02585	-75.34005	0.583
2008	PAA2008007	67.59070	-63.52675	67.56693	-63.53820	0.441
2012	PAA2012007	74.61217	-77.83188	74.59587	-77.91213	0.411
2012	PAA2012007	74.40155	-76.32752	74.38072	-76.34735	0.408
2010	PAA2010009	68.49103	-59.51873	68.51490	-59.51288	0.397
2012	PAA2012007	72.49310	-72.85548	72.50843	-72.79293	0.384
2012	PAA2012007	74.08485	-74.53025	74.09380	-74.61137	0.366
2012	PAA2012007	67.58938	-63.51998	67.56548	-63.52448	0.364
2010	PAA2010009	74.48638	-74.43188	74.50177	-74.46012	0.354
2012	PAA2012007	72.64118	-75.02295	72.63848	-74.94125	0.335
2014	PAA2014007	67.80163	-62.78588	67.78265	-62.75893	0.331
1999	PAA1999001	68.49000	-59.94000	68.51000	-59.94200	0.330
2014	PAA2014007	71.19832	-68.02155	71.18180	-67.96880	0.324
1999	PAA1999001	68.53000	-59.94000	68.55000	-59.92500	0.320
2014	PAA2014007	69.02915	-65.11960	69.01260	-65.16563	0.302
2013	PAA2013008	63.69600	-58.77515	63.67358	-58.79937	0.296
2008	PAA2008007	66.27150	-59.17333	66.24912	-59.17898	0.294
2010	PAA2010009	66.55412	-58.96755	66.53023	-58.98213	0.288
2012	PAA2012007	74.25942	-76.87812	74.26850	-76.80220	0.281
1999	PAA1999001	68.40000	-59.48000	68.42000	-59.46800	0.280
1999	PAA1999001	71.25000	-68.14000	71.26000	-68.14800	0.280
2012	PAA2012007	66.70117	-59.99098	66.72455	-59.99708	0.280
2012	PAA2012007	72.39897	-73.27557	72.41617	-73.32800	0.278
2012	PAA2012007	66.82925	-58.50355	66.83135	-58.56127	0.274
2012	PAA2012007	74.14480	-77.74493	74.12582	-77.68670	0.257
2006	PAA2006008	66.43538	-59.84717	66.44628	-59.85102	0.252
2010	PAA2010009	66.70383	-58.03158	66.68167	-58.03720	0.243
2006	PAA2006008	67.93475	-62.78317	67.94400	-62.80317	0.240
2006	PAA2006008	68.45698	-59.35718	68.49567	-59.36267	0.240
2012	PAA2012007	74.44627	-78.43235	74.44770	-78.51802	0.221
2012	PAA2012007	74.42153	-77.62690	74.42537	-77.71058	0.220
2012	PAA2012007	75.10380	-79.05275	75.08118	-79.08113	0.209
2010	PAA2010009	74.51815	-73.74495	74.49935	-73.74788	0.203
2014	PAA2014007	71.90353	-70.75372	71.88498	-70.69808	0.201

Table A1.17. *Eastern Arctic Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches with Campelen Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2007	BAL2007102099	62.63017	-61.22600	62.64233	-61.24167	0.840
2014	KIN2014109223	65.93757	-58.62283	65.92753	-58.60342	0.720
2013	AQV2013108198	65.92978	-58.94392	65.91648	-58.95840	0.450
2012	AQV2012107187	63.94058	-59.00437	63.95277	-58.99335	0.250
2014	KIN2014109225	65.53643	-58.18128	65.52528	-58.17115	0.250
2012	AQV2012107189	64.58932	-58.30567	64.60140	-58.29512	0.246
2005	BAL2005100184	65.59167	-58.81167	65.60167	-58.83500	0.230
2008	BAL2008103151	63.77083	-59.72167	63.77100	-59.75267	0.200
2013	AQV2013108180	64.79022	-58.47428	64.80283	-58.46762	0.181
2008	BAL2008103173	65.53050	-58.80200	65.51800	-58.79050	0.180
2009	BAL2009104263	62.07617	-62.58033	62.08583	-62.56100	0.160
2010	BAL2010105124	66.17960	-60.61675	66.16695	-60.62358	0.150
2014	KIN2014109224	65.58023	-58.35412	65.56937	-58.33823	0.150
2005	BAL2005100212	63.80833	-59.61667	63.80333	-59.58833	0.140
2010	BAL2010105117	65.84233	-58.20957	65.83007	-58.22080	0.140
2006	BAL2006101094	61.67167	-61.16167	61.68500	-61.15667	0.137
2008	BAL2008103176	65.65467	-58.11733	65.64233	-58.09933	0.130
2013	AQV2013108179	64.72523	-58.23185	64.73892	-58.23940	0.110
2007	BAL2007102154	64.82800	-58.20467	64.81433	-58.21133	0.110
2005	BAL2005100176	64.77167	-58.24500	64.76833	-58.21500	0.100
2005	BAL2005100193	66.17333	-58.04667	66.16500	-58.02167	0.100
2009	BAL2009104144	62.03883	-63.54367	62.02917	-63.54467	0.100
2011	BAL2011106144	65.99653	-58.98448	66.00747	-58.96613	0.100

Table A1.18. *Eastern Arctic Biogeographic Zone: Details of the Location of Research Vessel Sea Pen Catches with Cosmos Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2008	PAA2008007178	67.45488	-62.43787	67.44733	-62.41765	0.780
2008	PAA2008007168	68.31975	-65.24255	68.31313	-65.26900	0.603
2008	PAA2008007177	67.58698	-63.51835	67.59750	-63.51365	0.424
2008	PAA2008007002	68.58700	-59.41783	68.59717	-59.40950	0.382
2010	PAA2010009157	66.74613	-57.92630	66.73622	-57.93393	0.240
2008	PAA2008007179	67.19417	-62.06750	67.20033	-62.09008	0.217
2008	PAA2008007169	68.32315	-65.29628	68.32547	-65.26808	0.184
2008	PAA2008007183	67.79115	-62.84827	67.78270	-62.83172	0.137
2006	PAA2006005056	70.51923	-66.58125	70.51262	-66.56238	0.129
2006	PAA2006005065	69.00732	-65.07908	69.01463	-65.09782	0.122

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Sea Pen Weight (kg)
2006	PAA2006005021	69.07450	-65.68300	69.06700	-65.69900	0.118
2010	PAA2010009147	67.38282	-57.92137	67.39148	-57.93733	0.114
2006	PAA2006005068	68.77447	-64.55833	68.78333	-64.54683	0.112
2008	PAA2008007043	66.57533	-57.77705	66.58362	-57.76262	0.105
2006	PAA2006005042	71.54143	-69.67102	71.53887	-69.63908	0.104

Table A1.19. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Large Gorgonian Coral Catches from Alfredo Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
1999	PAA1999001	67.98000	-59.51000	67.96000	-59.49500	2000.000
2011	PAA2011007	61.88867	-61.93881	61.87287	-61.97377	139.800
2013	PAA2013008	61.76735	-61.72832	61.74850	-61.70205	120.250
2013	PAA2013008	61.87438	-63.37695	61.85992	-63.40908	19.800
2013	PAA2013008	62.04287	-61.47677	62.02062	-61.50008	19.550
2013	PAA2013008	61.70485	-60.65048	61.71987	-60.65288	6.400
2011	PAA2011007	61.94133	-61.27989	61.92167	-61.26488	5.100
2013	PAA2013008	62.11742	-63.68068	62.12995	-63.72565	2.498
2014	PAA2014007	64.65027	-57.82775	64.66595	-57.87232	1.900
2013	PAA2013008	61.68727	-61.12232	61.68443	-61.08505	1.809
2011	PAA2011007	61.63815	-61.10504	61.63938	-61.14792	1.720

Table A1.20. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Large Gorgonian Coral Catches from Campelen Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2006	BAL2006101094	61.67167	-61.16167	61.68500	-61.15667	500.059
2007	BAL2007102086	61.72750	-61.95933	61.72100	-61.98600	500.030
2011	BAL2011106084	61.72997	-62.61718	61.72807	-62.64845	409.940
2009	BAL2009104265	61.71700	-62.05250	61.71833	-62.07983	385.490
2013	AQV2013108280	61.75342	-62.51582	61.76013	-62.49653	375.440
2012	AQV2012107126	61.24570	-63.79993	61.24343	-63.82497	300.000
2006	BAL2006101091	61.37667	-61.34500	61.39000	-61.33833	260.000
2013	AQV2013108142	61.51842	-63.50073	61.52433	-63.48210	240.900
2006	BAL2006101090	61.27333	-60.87167	61.27667	-60.89833	225.000
2013	AQV2013108281	61.73862	-61.74940	61.73373	-61.73178	175.150
2010	BAL2010105181	61.70067	-63.21193	61.69040	-63.23290	139.060

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Large Gorgonian Coral Weight (kg)
2006	BAL2006101089	61.20167	-61.38833	61.21333	-61.38000	120.146
2011	BAL2011106085	61.90190	-62.53327	61.91340	-62.54883	103.300
2013	AQV2013108147	61.85337	-63.64582	61.85857	-63.62120	101.720
2006	BAL2006101096	61.95167	-61.29000	61.96333	-61.27833	100.000
2008	BAL2008103078	61.76683	-62.27483	61.76817	-62.25767	100.000
2009	BAL2009104141	61.64617	-63.29183	61.64800	-63.26717	100.000
2012	AQV2012107092	61.73517	-61.70585	61.74272	-61.68183	90.100
2010	BAL2010105283	61.60972	-61.39430	61.62113	-61.37622	82.470
2007	BAL2007102087	61.76883	-62.29983	61.76300	-62.32533	76.000
2010	BAL2010105180	61.68970	-63.07025	61.67440	-63.06718	57.740
2005	BAL2005100239	61.38500	-61.18500	61.37333	-61.17167	50.000
2011	BAL2011106082	61.85785	-61.16688	61.86450	-61.19130	41.101
2009	BAL2009104142	61.80667	-63.27900	61.80083	-63.30233	39.670
2012	AQV2012107112	61.83763	-62.60432	61.82493	-62.60127	38.240
2011	BAL2011106083	61.93805	-61.22777	61.93783	-61.25597	35.635
2011	BAL2011106208	61.76455	-63.27865	61.75598	-63.31055	32.220
2010	BAL2010105275	61.83857	-62.30048	61.84452	-62.27562	32.000
2014	KIN2014109322	61.64850	-63.39537	61.65008	-63.37752	31.360

Table A1.21. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Small Gorgonian Coral Catches from Alfredo Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Small Gorgonian Coral Weight (kg)
2011	PAA2011007005	65.19384	-57.71988	65.17259	-57.69835	0.240
2013	PAA2013008005	64.52757	-58.66903	64.55183	-58.66767	0.104
2013	PAA2013008157	63.62998	-58.82358	0.00000	0.00000	0.081
2011	PAA2011007144	64.81870	-58.86771	64.84048	-58.88082	0.076
2014	PAA2014007155	65.31822	-58.17720	65.33980	-58.20542	0.069
2011	PAA2011007169	65.66646	-57.76882	65.64293	-57.76118	0.066
2014	PAA2014007150	64.35795	-58.92525	64.37662	-58.88850	0.064
2013	PAA2013008158	63.69600	-58.77515	63.67358	-58.79937	0.053
2011	PAA2011007021	62.69001	-58.94275	62.66701	-58.95473	0.052
2014	PAA2014007156	65.76307	-57.89552	65.78340	-57.86378	0.052
2013	PAA2013008159	63.97803	-58.84367	63.95478	-58.85777	0.051
2013	PAA2013008035	63.84002	-59.20585	63.81870	-59.18218	0.044
2013	PAA2013008008	65.02363	-58.17635	65.04692	-58.16848	0.044
2013	PAA2013008009	65.21562	-57.90177	65.21527	-57.95778	0.040

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Small Gorgonian Coral Weight (kg)
2011	PAA2011007037	61.75708	-63.17784	61.74090	-63.18217	0.037
2013	PAA2013008010	65.44800	-58.18323	65.46518	-58.20398	0.035
2014	PAA2014007151	64.56132	-58.68083	64.54835	-58.70443	0.033
2014	PAA2014007161	66.52778	-57.81260	66.50298	-57.79922	0.029
2011	PAA2011007032	62.17080	-60.78182	62.14774	-60.77752	0.026
2006	PAA2006008069	68.55854	-59.37512	68.57033	-59.36755	0.025
2013	PAA2013008006	64.71255	-58.72272	64.73360	-58.69530	0.022
2011	PAA2011007022	62.52859	-59.20289	62.54439	-59.23940	0.021
2013	PAA2013008011	65.65702	-58.14032	65.67890	-58.12725	0.021

Table A1.22. *Eastern Arctic Biogeographic Zone, Davis Strait: Details of the Location of Research Vessel Small Gorgonian Coral Catches from Campelen Trawls used to identify the Significant Area Polygons. *Set number is the last 3 digits of the string.- indicates unknown value*

Year	Mission Number and Set*	Start Lat. (DD)	Start Long. (DD)	End Lat. (DD)	End Long. (DD)	Small Gorgonian Coral Weight (kg)
2007	BAL2007102152	64.59100	-58.77683	64.57883	-58.79383	1.500
2007	BAL2007102149	64.20617	-59.09017	64.19417	-59.10650	0.340
2010	BAL2010105119	65.81220	-57.79882	65.82828	-57.82098	0.270
2009	BAL2009104210	65.74317	-57.92983	65.75450	-57.94433	0.140
2006	BAL2006101094	61.67167	-61.16167	61.68500	-61.15667	0.122
2006	BAL2006101124	65.12500	-58.46000	65.13667	-58.44333	0.110
2013	AQV2013108197	66.20552	-58.20248	66.21768	-58.19113	0.090
2008	BAL2008103175	65.47283	-57.97383	65.45867	-57.97267	0.080
2013	AQV2013108198	65.92978	-58.94392	65.91648	-58.95840	0.070
2006	BAL2006101119	64.73667	-58.80667	64.74167	-58.78333	0.050
2010	BAL2010105150	64.66138	-58.68850	64.66753	-58.66127	0.050
2008	BAL2008103095	62.98217	-60.61400	62.97133	-60.62733	0.040
2008	BAL2008103151	63.77083	-59.72167	63.77100	-59.75267	0.040
2010	BAL2010105120	66.20172	-58.20583	66.19037	-58.21910	0.040
2008	BAL2008103117	63.51667	-60.31050	-	-	0.039
2008	BAL2008103176	65.65467	-58.11733	65.64233	-58.09933	0.030
2013	AQV2013108196	65.95875	-58.10960	65.96787	-58.12153	0.025
2006	BAL2006101101	62.07000	-61.84833	62.07833	-61.82667	0.020
2006	BAL2006101121	64.95000	-57.91000	64.96167	-57.90500	0.020
2007	BAL2007102210	61.63050	-63.33600	61.63333	-63.30933	0.020
2007	BAL2007102211	61.57683	-63.29967	61.58217	-63.27933	0.020

APPENDIX 2. AT-SEA IDENTIFICATIONS OF SPECIES WITHIN EACH OF THE FOUR TAXONOMIC GROUPS ANALYZED.

The at-sea identifications of species within each of the four groups analyzed, that is, sponges, sea pens, large and small gorgonian corals, have not been validated consistently within and across regions. The Quebec and Gulf Regions have undertaken identification of all benthic invertebrates in the RV trawls as part of ecosystem surveys (Nozères et al., 2015) and Newfoundland and Labrador Region have put significant effort into identifying corals. The latter has provided taxonomic identifications in their own region and in Central and Arctic Region which should make those regions consistent with each other. Maritimes Region has identified the sponges collected during the Central and Arctic Region surveys of Davis Strait and southern Baffin Bay (not yet in the coding system) and the (southern) Gulf Region have codes for a number of sponge taxa, but in general, identification of the sponge fauna is poor. Consequently we did not perform the SDMs at the species level. Nevertheless the codes provided below (Tables A2.1-A2.4) allow users to extract the same data that we did from the surveys and to get a sense of the types of species that may be present within each taxonomic group within each region. Note that these same data and codes were used for the KDE analyses (Kenchington et al., 2016).

Table A2.1. *Species composition in each of the four taxonomic groups in Maritimes Region modelled using random forest and KDE. Also shown are the Virtual Data Centre (VDC) codes used for data entry into the VDC (after Beazley et al, 2016a).*

Taxonomic Group	**Species/Taxon**	**VDC Taxon Code**
Sponges (Porifera)	Phylum Porifera	8600
	Geodia spp.	8364
	Polymastia sp.	8610
	Rhizaxinella sp.	8356
	Vazella pourtalesi	8601
Sea Pens (Pennatulacea)	Order Pennatulacea	8318
	Anthoptilum grandiflorum	8361
	Funiculina quadrangularis	8359
	Halipteris sp.	8363
	Pennatula borealis	8360
Large Gorgonian Corals	*Acanthogorgia armata*	8326
	Keratoisis ornata	8325
	Paragorgia arborea	8323
	Primnoa resedaeformis	8322
Small Gorgonian Corals	*Acanella arbuscula*	8329
	Chrysogorgia agassizii	8338
	Radicipes gracilis	8330

Table A2.2. *Taxon name and species code included in each of the taxonomic groups modeled for SDM and KDE for the northern and southern Gulf regions (after Murillo et al., 2016).*

Taxonomic Group	Region	Taxon Name	Species Code
Sponges (Porifera)	Northern Gulf	Porifera	1101
		Stylocordila borealis	1112
	Southern Gulf	*Asconema foliata*	8365
		Biemna variantia	8617
		Geodia spp.	8364
		Halichondria panicea	8623
		Halichondria sitiens	8620
		Haliclona oculata	8621
		Haliclona sp.	8618
		Iophon sp.	8614
		Mycale lingua	8616
		Phakellia spp.	8366
		Phakellia ventilabrum	8624
		Polymastia mammillaris	8611
		Polymastia sp.	8610
		Porifera	8600
		Suberites ficus	8613
		Tentorium semisuberites	8612
Sea Pens (Pennatulacea)	Northern Gulf	*Anthoptilum grandiflorum*	2218
		Halipteris finmarchica	2217
		Pennatula aculeata	2203
		Pennatula grandis	2210
		Pennatulacea	2201
	Southern Gulf	*Anthoptilum grandiflorum*	8631
		Pennatulacea	8318

Table A2.3. *Species composition in each of the four taxonomic groups modelled using random forest and KDE. Also shown are the species/taxon codes associated with data entry of the DFO multispecies and northern shrimp survey records (after Guijarro et al., 2016). * Indicates taxon listed in Spanish/EU surveys.*

Taxon	**Species/Taxon**	**Taxon Code**
Sponges	Porifera	1101
Sea Pens (Pennatulacea)	*Anthoptilum**	5117
	Anthoptilum grandiflorum	8937
	Distichoptilum gracile	8932
	Funiculinia quandrangularis	8938
	Halipteris finmarchica	8936
	Pennatula aculeata	8934
	Pennatula cf. *aculeata*	8934
	Pennatula grandis	8935
	Pennatula cf. *grandis*	8935
	Pennatula phosphorea	8933
	Pennatula cf. *phosphorea*	8933
	Pennatula sp.	8954
	Pennatulacea	8901
	Sea pen sp.	8901
	Umbellula sp.	8972
Large Gorgonian Corals	*Acanthogorgia**	5073
	Acanthogorgia armata	8907
	Acanthogorgia cf. *armata*	8907
	*Keratoisis**	5070
	Keratoisis grayi	8906
	Paragorgia arborea	8903
	Paragorgia cf. *arborea*	8903
	Paramuricea sp.	8912
	Paramuricea placomus	8940/5114
	Paramuricea cf. *placomus*	8940
	Plexauridae*	5054
	Parastenella atlantica	8944
	Primnoa resedaeformis	8902
Small Gorgonian Corals	*Acanella arbuscula*	8909
	Anthothela grandiflora	8915
	Chrysogorgia cf. *agassizii*	8924
	Chrysogorgia sp.	8965
	Radicipes gracilis	8910
	Swiftia sp.	8959

Table A2.4. *Species composition in each of the four taxonomic groups modelled using random forest and KDE (after Beazley et al., 2016c). The asterisk (*) was used to indicate species/taxa recorded in both the Eastern Arctic and Hudson Strait – Ungava Bay Regions.*

Taxonomic Group	**Species/Taxon**	**Taxon Code**
Sponges (Porifera)	Porifera P.	1101
Sea Pens (Pennatulacea)	Pennatulacea O.	8901
	Anthoptilum grandiflorum	8937
	Halipteris finmarchica	8936
	Pennatula grandis	8935
	Pennatula sp.	8954
	Umbellula sp.*	8972
	Sea pen sp.	8901
Large Gorgonian Corals	*Acanthogorgia armata**	8907
	*Paragorgia arborea**	8903
	Keratoisis ornata	8906
	Paramuricea sp.	8912
	Paramuricea placomus [28S-b]	8940
	*Primnoa resedaeformis**	8902
Small Gorgonian Corals	*Acanella arbuscula*	8909
	Anthothela cf. *grandiflora*	8915
	Radicipes gracilis	8910

APPENDIX 3. CONGRUENCE BETWEEN FISHERIES OBSERVER DATA AND SPECIES PREVALENCE.

During the National Advisory Process meeting held on March 8-10, 2016 to review the work presented above, Fisheries Observer Program Data (FOP) was provided to the meeting (for more details contact V. Wareham, DFO, NWAFC, St. John's, NL; pers. comm.) and those data were used to validate the prevalence maps where available. As they were part of the decision making process of the meeting they are presented here. However, this type of data requires considerable quality control evaluation and that was not done prior to the meeting. Therefore, the data should only be considered preliminary.

Newfoundland and Labrador

The overlay of FOP data in Newfoundland and Labrador had showed good congruence with the presence prevalence of sponges (Figure A3.1), sea pens (Figure A3.2), large (Figure A3.3) and small (Figure A3.4) gorgonian corals. For sponges, several FOP records occurred in deep water off the Labrador Slope in an area considered extrapolated and may help to validate the presence prevalence there. FOP records for sea pens, and large and small gorgonians were concentrated along the slopes of Newfoundland and Labrador, particularly on the slope off southwest Grand Bank in the 3O Coral Protection Zone. Several large gorgonian coral records were located on the shelf in areas not consistent with prevalence. Sea Pen FOP records were also concentrated on the slope northeast of Newfoundland. This area was identified as an SBA (see Figure 95) based on the RF model results and the high presence probability predicted in this area.

Eastern Arctic

The overlay of FOP data in the Eastern Arctic had remarkable congruence with the presence prevalence for sponges (Figure A3.5), sea pens (Figure A3.6), large (Figure A3.7) and small (Figure A3.8) gorgonian corals. In two areas the FOP showed catches that were not consistent with prevalence. This was seen for sea pens immediately north of the Hatton Basin Voluntary Closure Area (Figure A3.6). Closer examination of this area showed that the area was very patchy and that given the long tow lengths of the commercial fleets, it was feasible that they could overlap with nearby presence predictions. The other area was for small gorgonian corals (Figure A3.8). The FOP data showed small gorgonian catches in the absence area surrounding the Narwhal Overwintering and Deep Sea Coral Conservation Area.

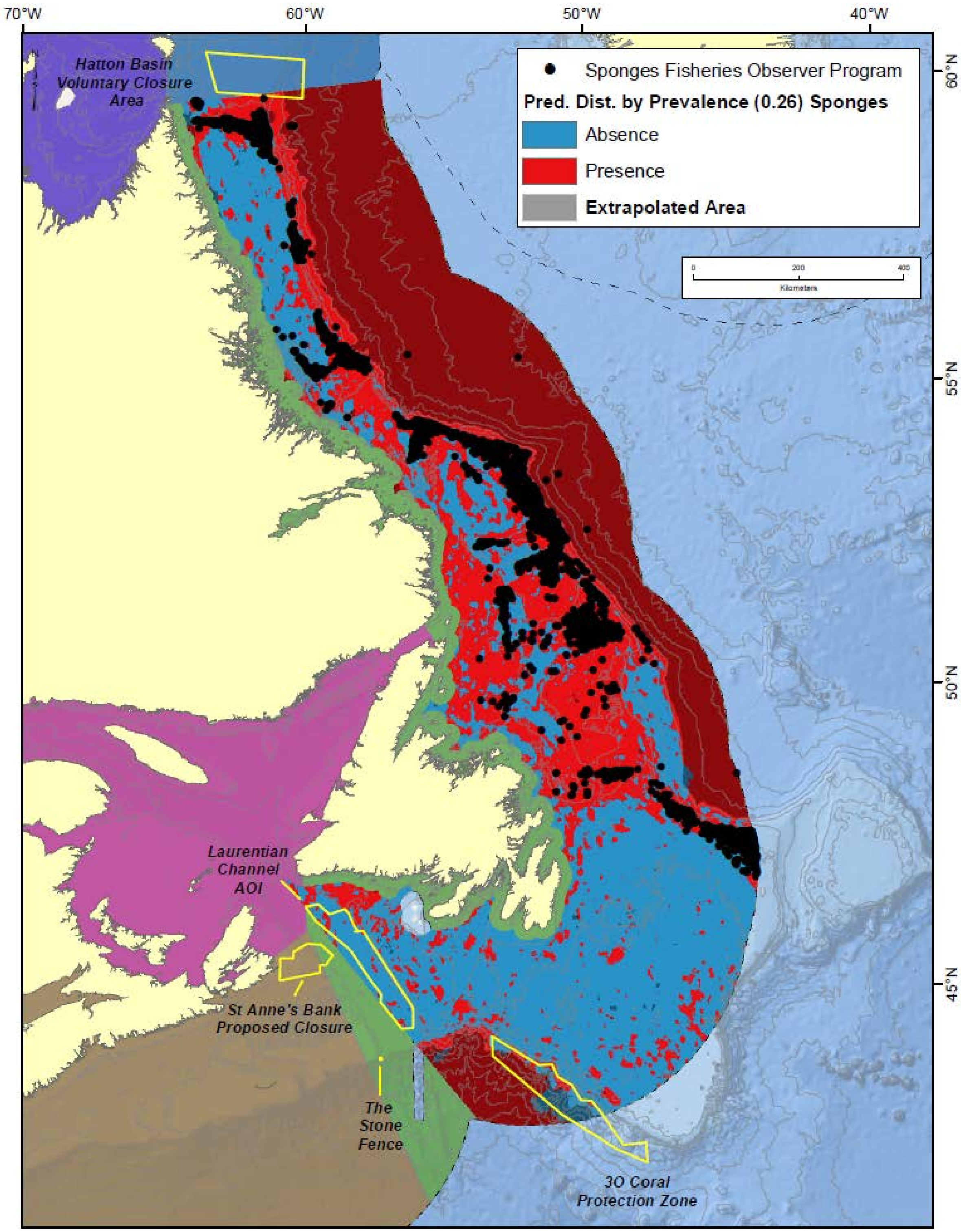

Figure A3.1. *Location of the start positions of commercial tows with sponge catches from the Fisheries Observer Program (1996-2015) in the Newfoundland and Labrador Region overlain on the sponge RF prevalence map. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

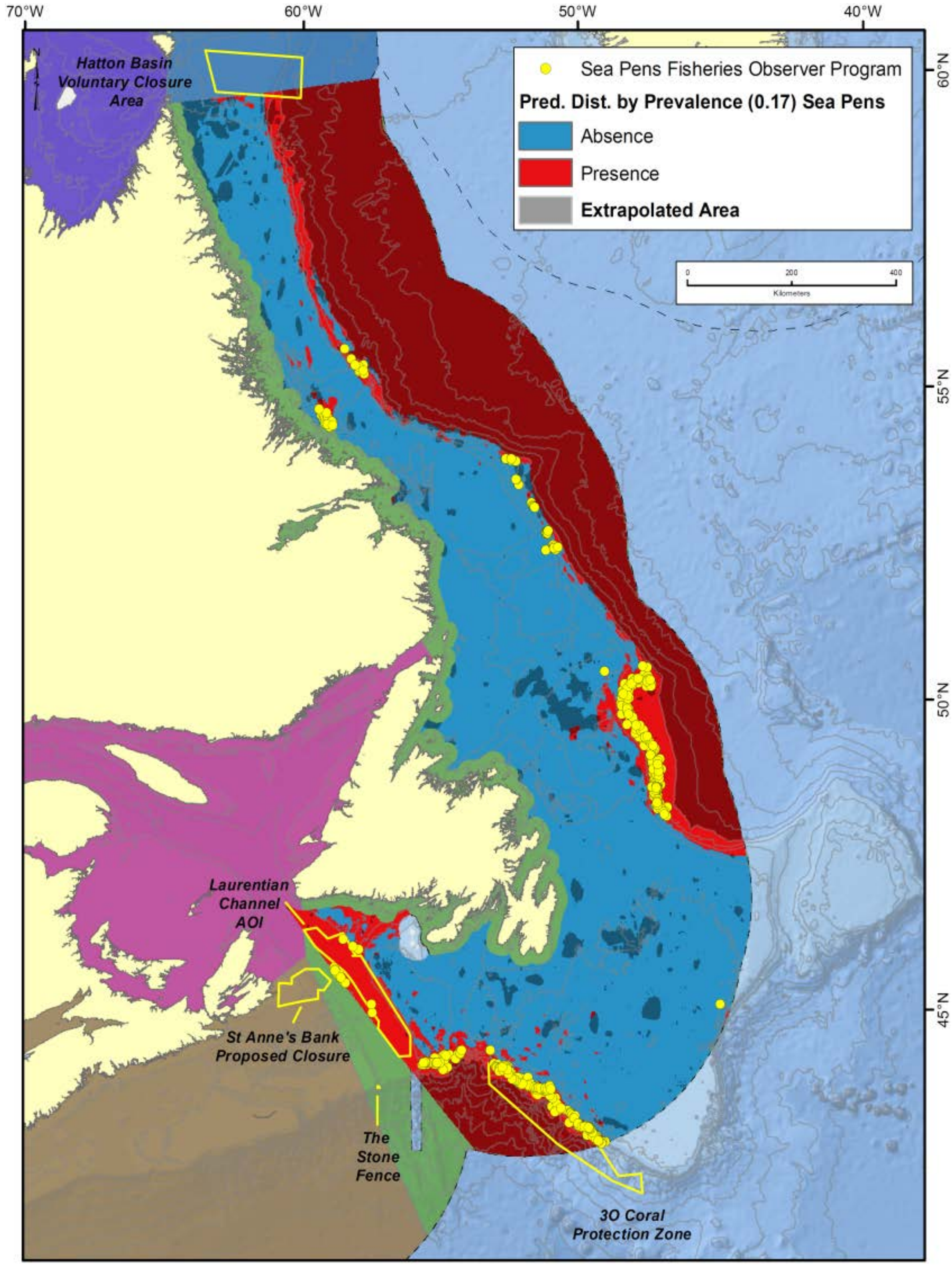

Figure A3.2. *Location of the start positions of commercial tows with sea pen catches from the Fisheries Observer Program (2004-2013) in the Newfoundland and Labrador Region overlain on the sea pen RF prevalence map. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

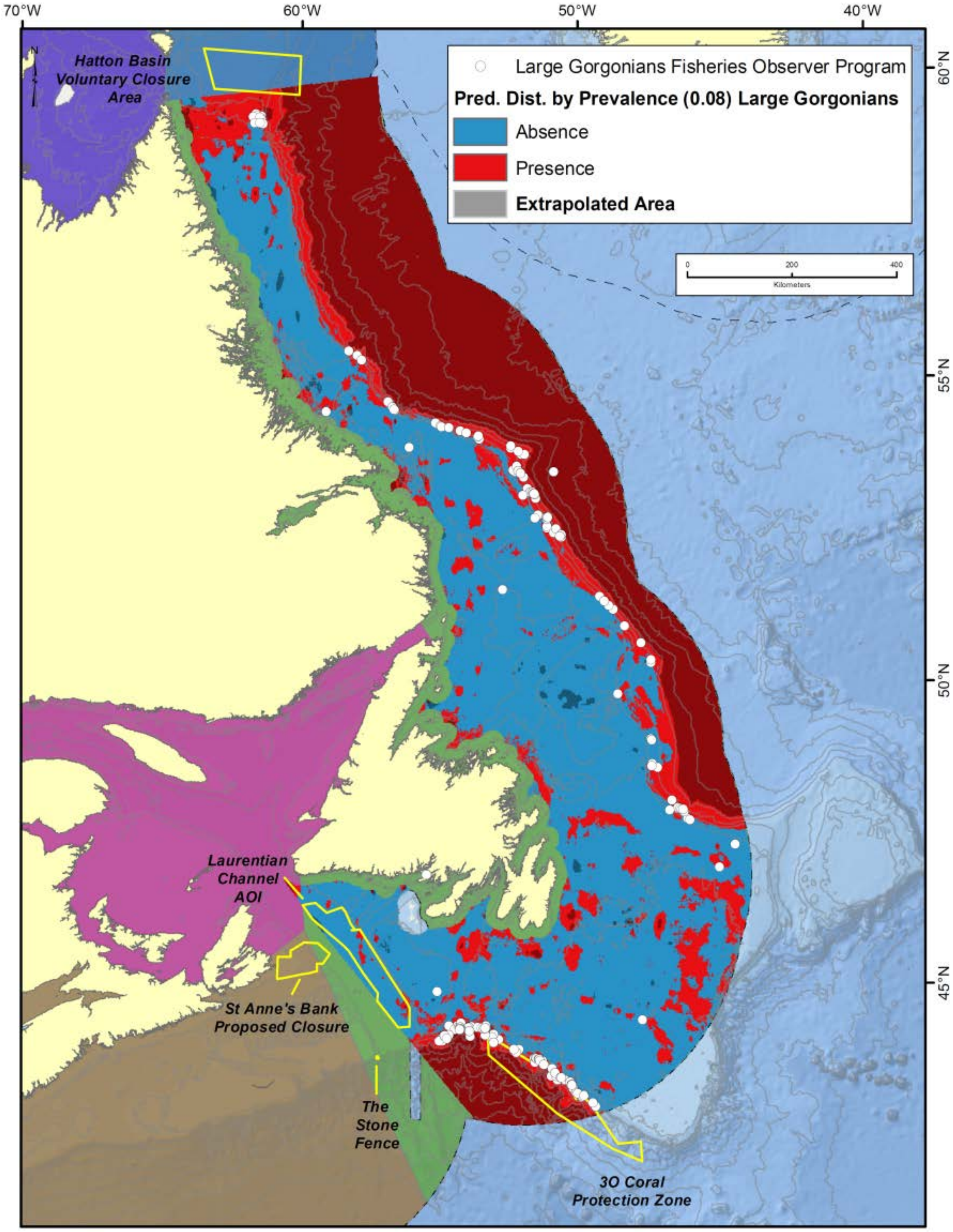

Figure A3.3. *Location of the start positions of commercial tows with large gorgonian coral catches from the Fisheries Observer Program (2004-2013) in the Newfoundland and Labrador Region overlain on the large gorgonian coral RF prevalence map. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

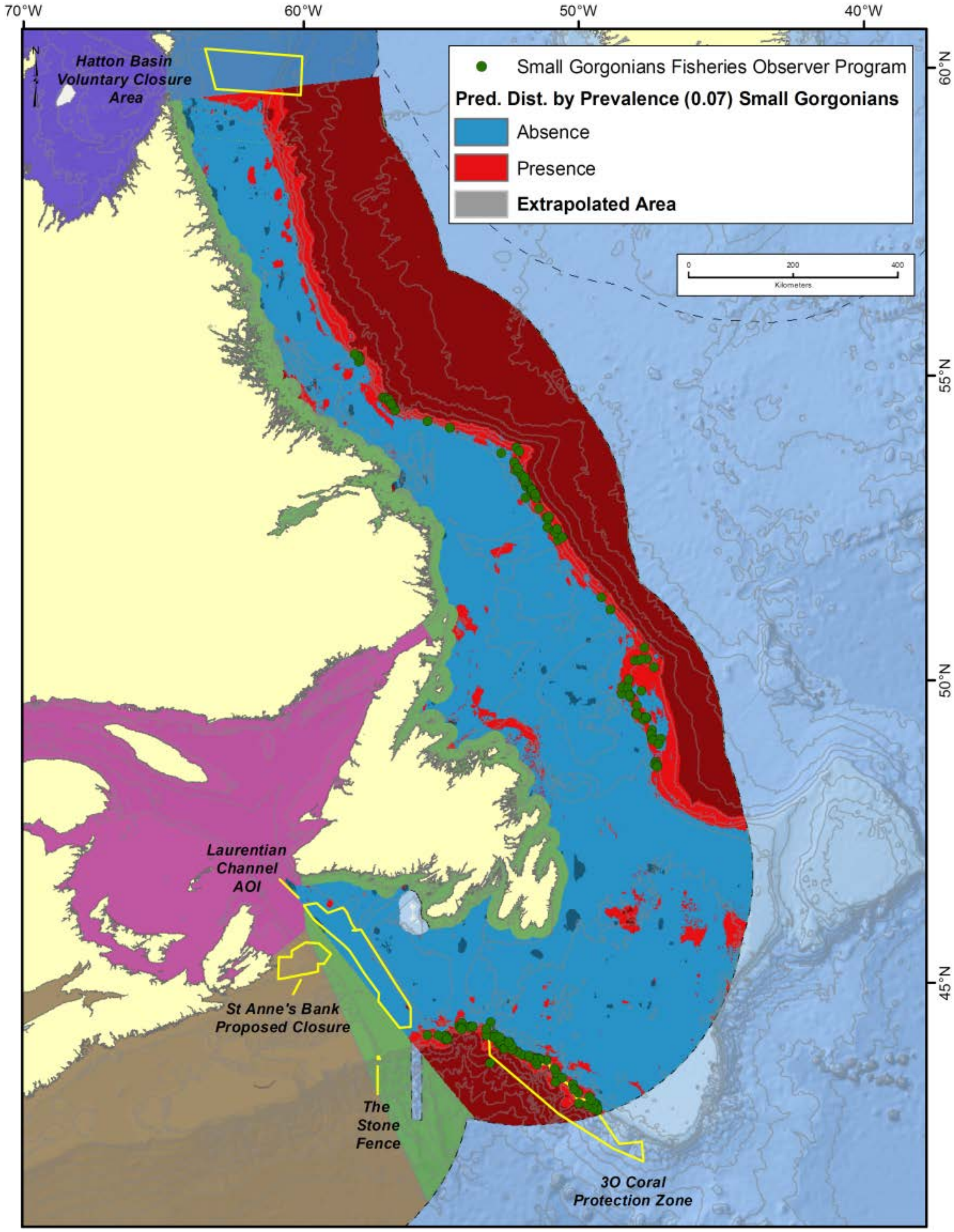

Figure A3.4. *Location of the start positions of commercial tows with small gorgonian coral catches from the Fisheries Observer Program (2004-2013) in the Newfoundland and Labrador Region overlain on the small gorgonian coral RF prevalence map. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

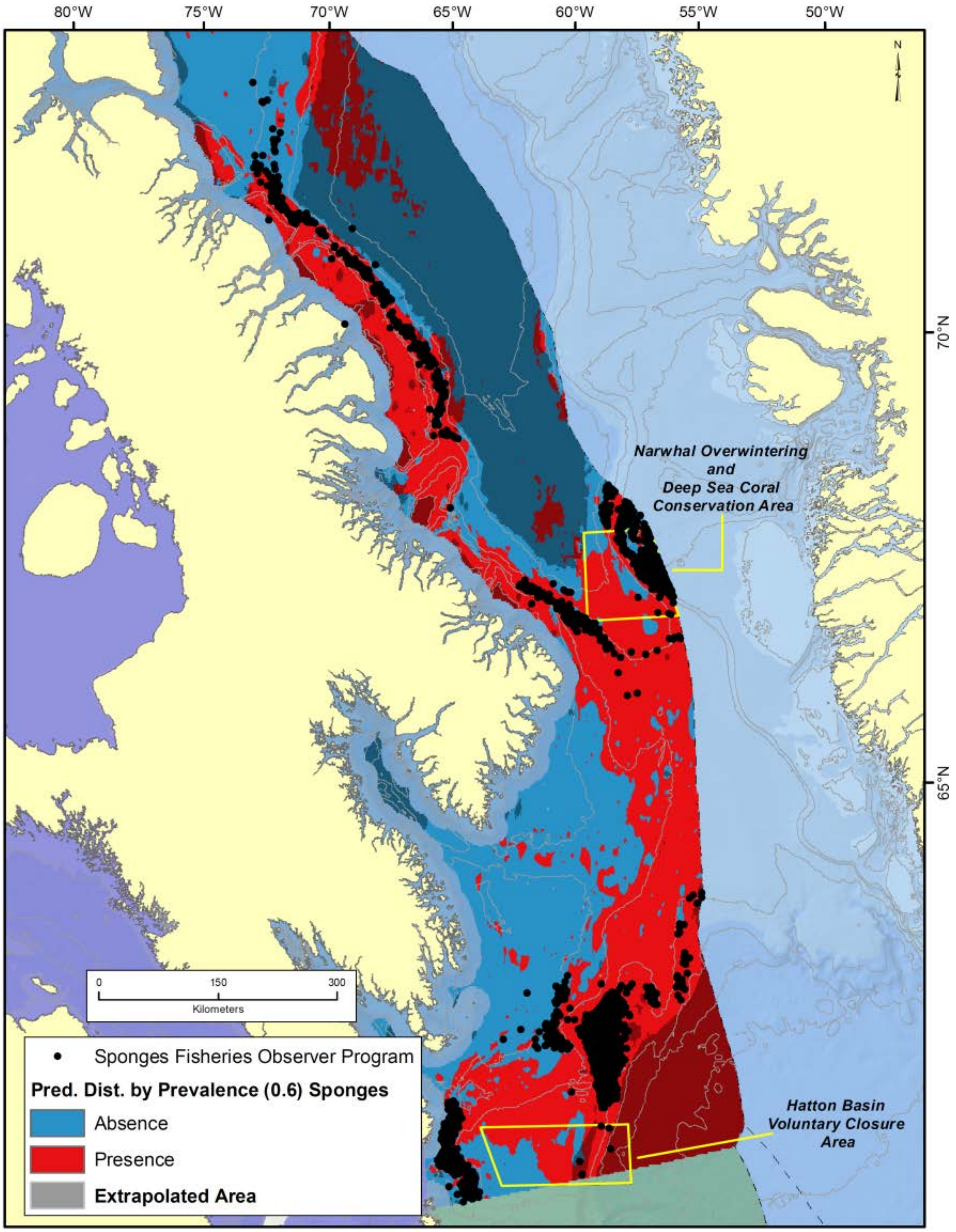

Figure A3.5. *Location of the start positions of commercial tows with sponge catches from the Fisheries Observer Program (1998-2013) in the Eastern Arctic overlain on the sponge RF prevalence map. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

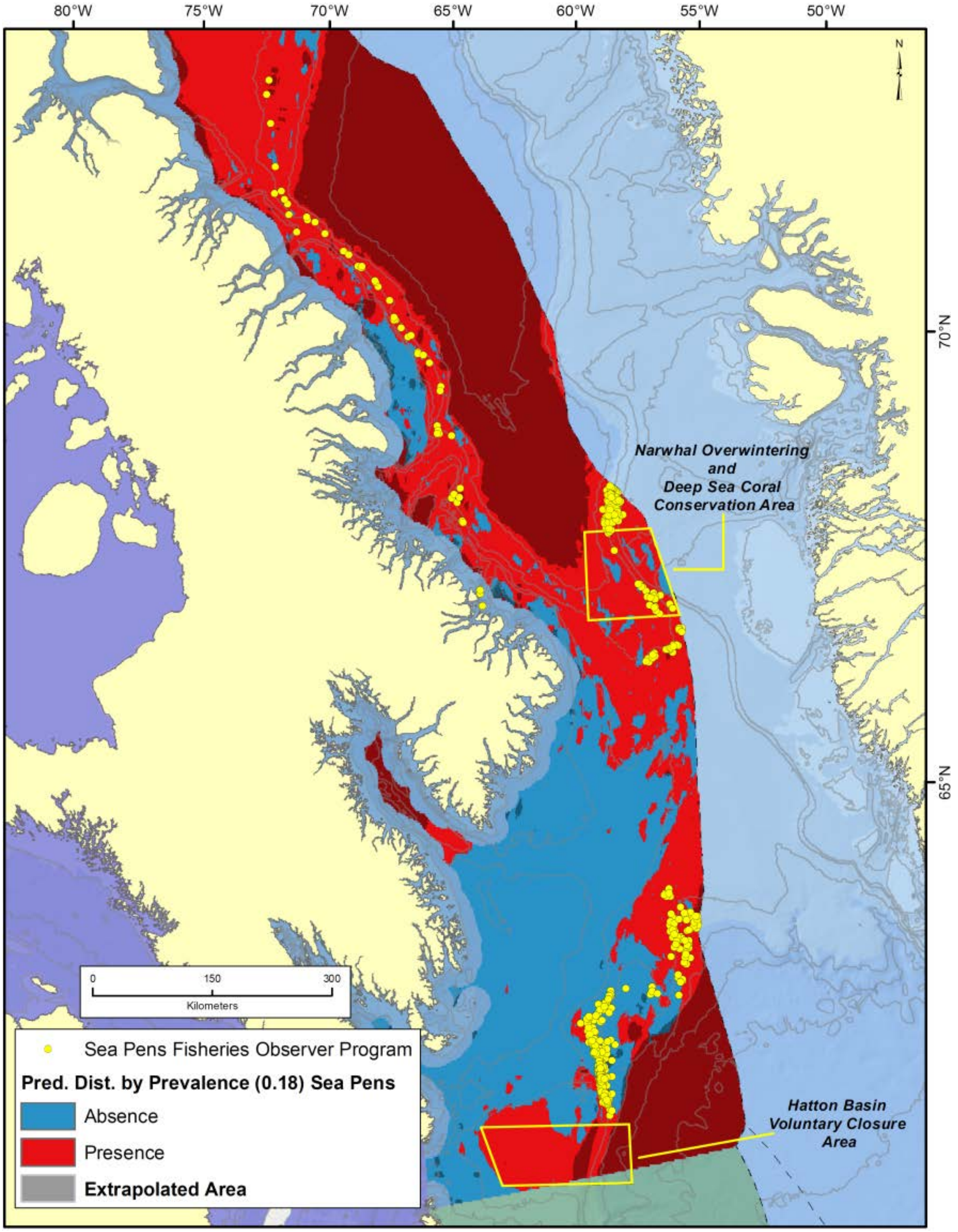

Figure A3.6. *Location of the start positions of commercial tows with sea pen catches from the Fisheries Observer Program (2004-2013) in the Eastern Arctic overlain on the sea pen RF prevalence map. The area immediately to the north of the Hatton Basin Voluntary Closure Area was the only area where the FOP data showed catches in areas where absence was prevalent. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

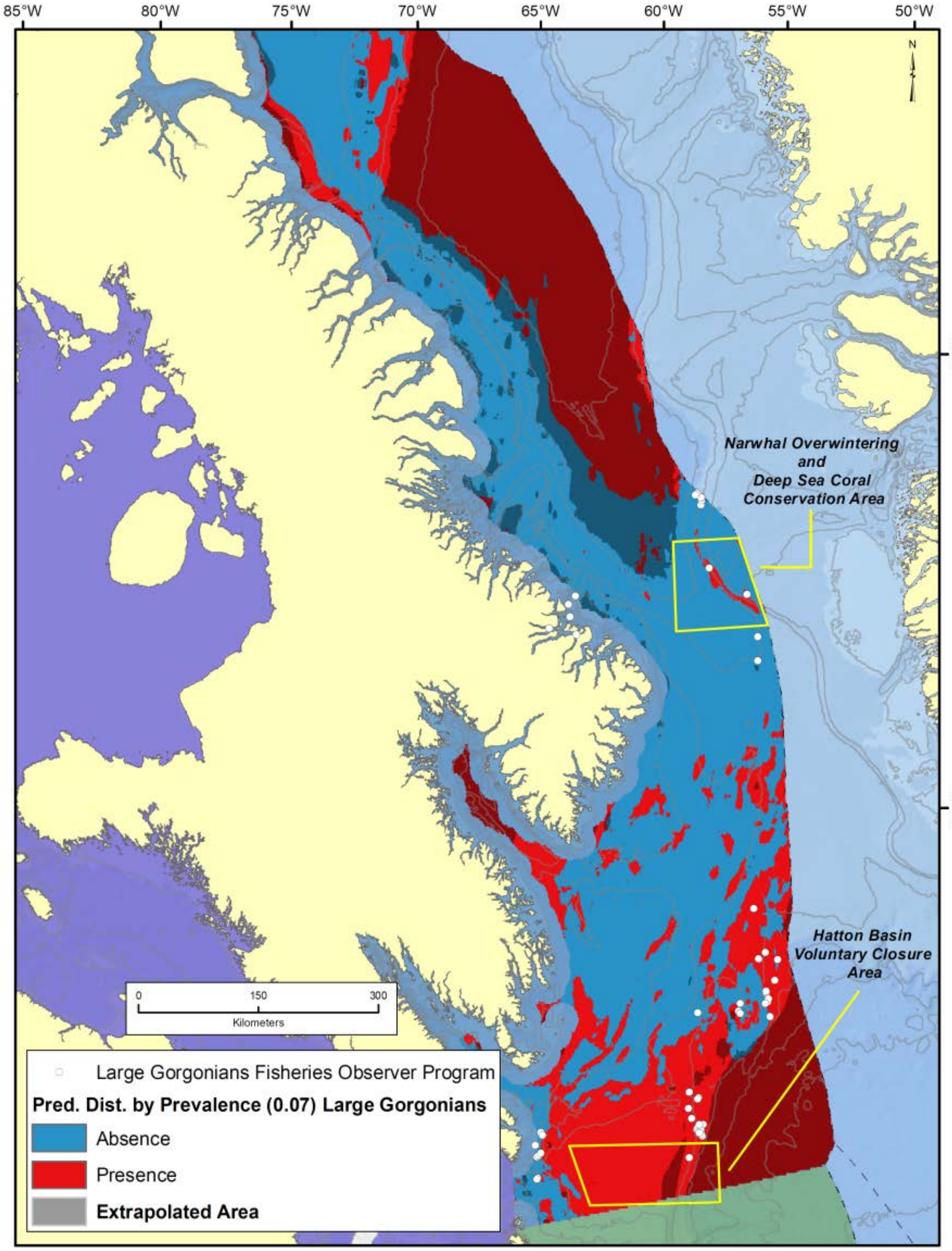

Figure A3.7. *Location of the start positions of commercial tows with large gorgonian coral catches from the Fisheries Observer Program (2004-2013) in the Eastern Arctic overlain on the large gorgonian coral RF prevalence map. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*

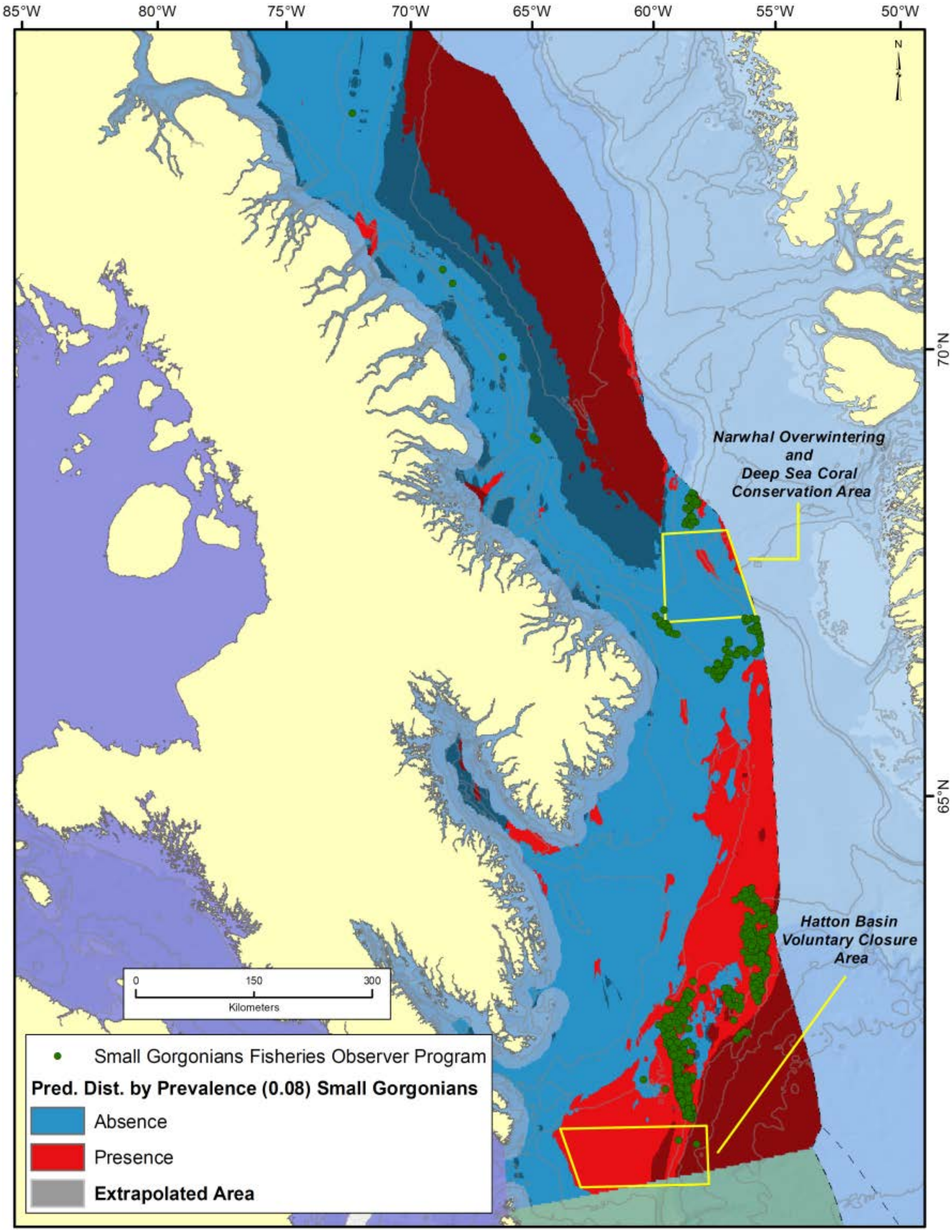

Figure A3.8. *Location of the start positions of commercial tows with small gorgonian coral catches from the Fisheries Observer Program (2004-2013) in the Eastern Arctic overlain on the small gorgonian coral RF prevalence map. The records immediately around the Narwhal Overwintering and Deep Sea Coral Conservation Area was the only area where the FOP data showed catches in areas where absence was prevalent. Also shown are the grey areas of model extrapolation, which appear dark red or blue when overlain on the presence-absence surface.*