

Using shoreline characteristics, relative exposure, depth, and freshwater inputs as surrogate measures to identify areas potentially suitable for eelgrass (*Zostera marina*) in Newfoundland

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Using shoreline characteristics, relative exposure, depth, and freshwater inputs as surrogate measures to identify areas potentially suitable for eelgrass (*Zostera marina*) in Newfoundland

by

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Abstract

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Seagrasses support multiple key ecosystem functions (e.g., sediment stabilization, carbon storage, nursery habitat) in nearshore environments across all three Canadian coastlines. Eelgrass (*Zostera marina*) is a seagrass species that has been designated as an Ecologically Significant Species (ESS) and is the most widely distributed and abundant seagrass in Canada. Given the considerable conservation and management interest in eelgrass habitats, large-scale data aggregation efforts have been initiated to generate comprehensive distribution maps of eelgrass coverage in Canadian coastal waters. However, extensive portions of the Newfoundland coastline have not yet been surveyed for the presence of eelgrass. We combine spatial data layers describing shoreline characteristics, relative exposure index (REI), depth, and freshwater inputs to delineate areas potentially suitable for eelgrass growth in Newfoundland. We determined that many nearshore environments could potentially support eelgrass habitats but confirming eelgrass presence will require further validation and ground-truthing. Incorporating distribution models that use environmental covariates to estimate probabilities of occurrence in nearshore areas could help to strengthen these predictions. Mapping eelgrass distributions provides baseline data essential to eelgrass monitoring and implementation of coastal marine conservation, informing emergency response, and is particularly important considering the consequences associated with the potential loss of ecosystem functions in the event of eelgrass decline.

Résumé

King, B.G.C., Gullage, L., Butt, K., Warren, M., Allard, K., Gregory, R.S., and Byrne, M.A. 2026. Using shoreline characteristics, relative exposure, depth, and freshwater inputs as surrogate measures to identify areas potentially suitable for eelgrass (*Zostera marina*) in Newfoundland. Can. Tech. Rep. Fish. Aquat. Sci. 3737: vii + 22 p.
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Les herbes marines soutiennent de multiples fonctions écosystémiques clés (p. ex. stabilisation des sédiments, stockage de carbone, habitat d'alevinage) dans les environnements littoraux des trois côtes canadiennes. La zostère marine (*Zostera marina*) a été désignée à titre d'espèce d'importance écologique (EIE), et elle est l'espèce d'herbe marine la plus abondante et dont l'aire de répartition est la plus vaste au Canada. Compte tenu de l'intérêt considérable qui est démontré pour la conservation et la gestion des habitats de la zostère marine, des efforts de regroupement des données à grande échelle ont été déployés en vue de produire des cartes complètes des zones où l'espèce est présente dans les eaux côtières canadiennes. Cependant, de vastes parties du littoral de Terre-Neuve n'ont pas encore fait l'objet de relevés visant à recenser la présence de la zostère marine. Nous combinons des couches de données spatiales qui décrivent les caractéristiques du littoral, l'indice d'exposition relative (IER), la profondeur et les apports d'eau douce pour délimiter les zones pouvant convenir à la croissance de la zostère marine à Terre-Neuve. Nous avons déterminé que de nombreux milieux littoraux pourraient comporter des habitats convenables, mais la confirmation de la présence de l'espèce nécessitera une validation et une vérification sur le terrain. L'intégration de modèles de distribution qui utilisent des covariables environnementales pour estimer les probabilités de présence dans des zones littorales pourrait aider à renforcer les prédictions. La cartographie de l'aire de répartition de la zostère marine fournit des données de référence essentielles au suivi de l'espèce et à la mise en œuvre de mesures de conservation marine côtière qui s'avèrent utiles pour orienter les interventions d'urgence, et elle est particulièrement importante compte tenu des conséquences pouvant découler de la perte de fonctions écosystémiques en cas de déclin de la zostère marine.

Introduction

Seagrasses are perennial marine flowering plants that form productive habitats in shallow coastal waters and estuaries within tropical, temperate, and subarctic ecosystems (Hemminga and Duarte 2008; Short et al. 2007). Seagrasses support several ecosystem functions, including carbon sequestration, nutrient cycling, sediment stabilization, and primary productivity, and serve as habitat for fish and invertebrates and as a food source for herbivores (Barbier et al. 2011; Dewsbury et al. 2016; Orth et al. 2006; Orth et al. 2020). The coastal distribution of seagrasses renders them particularly vulnerable to numerous anthropogenic pressures which have contributed to global declines in meadow areas (Dunic et al. 2021; Orth et al. 2006; Tomasko et al. 2018; Waycott et al. 2009). Mapping seagrass habitats forms a central component of conservation initiatives to support and protect meadows globally (Unsworth et al. 2019).

In Canada, eelgrass (*Zostera marina*) is a seagrass species that is widespread throughout nearshore coastal environments (Murphy et al. 2021). Through the Atlantic Canada distribution range, eelgrass meadows serve as valuable foraging areas for waterfowl (Kollars et al. 2017) including Canada geese (*Branta canadensis*; Leblanc et al. 2023; Seymour et al. 2002) and Atlantic Brant (*Branta bernicla hrota*; Ladin et al. 2014; Leblanc et al. 2022), provide critical nursery habitat to small-bodied and juvenile fishes including commercial species like Atlantic cod (*Gadus morhua*; Gorman et al. 2009; Laurel et al. 2003; Warren et al. 2010), and stabilize fish community composition (Cote et al. 2013). Fisheries and Oceans Canada (DFO) has identified eelgrass as having the characteristics of an Ecologically Significant Species (ESS) – a species whose loss would carry greater impact on the provision of ecosystem services than other components within the ecosystem (DFO 2009). Given that eelgrass habitats are of considerable conservation and management interest in Canada, large-scale data aggregation efforts have been initiated to generate comprehensive national distribution maps of eelgrass extent in Canadian nearshore coastal waters (ECCC 2020; Guijarro-Sabaniel et al. 2024).

The large and complex coastlines of Atlantic Canada, particularly Newfoundland and Labrador, makes *in situ* sampling for eelgrass beds in these areas time-, resource-, and labour-intensive. The delineation of eelgrass habitats with remote sensing techniques in optically complex temperate coastal waters (i.e., areas with high coloured dissolved organic matter (CDOM), suspended particulate matter, and phytoplankton concentrates) also comes with unique challenges (Wilson et al. 2020). Consequently, extensive portions of the Newfoundland and Labrador coastline have not been surveyed for the presence of eelgrass (Guijarro-Sabaniel et al. 2024). A preliminary coarse-scale, composite map of eelgrass locations in Newfoundland and southern Labrador was previously produced by combining disparate data sources including local ecological knowledge, aerial photography, satellite imagery, and visual ground-truthing surveys (Rao et al. 2014). Further delineation of eelgrass locations will help guide eelgrass monitoring and improve delivery of related conservation efforts moving forward.

Surrogate measures can be used to determine locations that could be suitable for eelgrass growth, and in doing so, help to prioritize conservation planning, monitoring, ground-truthing, and restoration or enhancement efforts. Shoreline characteristics, exposure, depth, and presence of freshwater inputs are all environmental variables that strongly correlate and reliably predict

eelgrass distributions (Bekkby et al. 2008; O'Brien et al. 2022b; O'Leary et al. 2021; Yang et al. 2023). As a photosynthesizing plant, eelgrass grows in shallow (0.5 – 5.5 m) salty and brackish waters with adequate light penetration (Hemminga and Duarte 2008; Murphy et al. 2021). In Newfoundland, eelgrass is not typically distributed in waters < 1 m as rhizome and shoot systems can become damaged from winter storms and ice scour (Rao et al. 2014). Eelgrass meadows are also limited to areas with fine-grain substrates (Wilson et al. 2019; Wong 2018) as rhizomes can only grow through soft sediments, including those trapped in the interstices of coarser substrates. These shallow, soft sediment environments are typically associated with gently sloping, low exposure locations along coastlines (Bekkby et al. 2008; O'Brien et al. 2022b; Yang et al. 2023).

Methods

In this report, we used shoreline characteristics for the lower intertidal zone and backshore, relative exposure index (REI), bathymetry, and linear water flow features (i.e., freshwater inputs) as predictor variables to support the identification of potentially suitable eelgrass habitat within 100 m of the Newfoundland coastline. Newfoundland is near the northern limit of typical eelgrass growth along the eastern seaboard of North America. Although eelgrass does grow in some small areas along the coast of Labrador - most notably brackish Lake Melville - we were not confident that the data available for our predictor variables would adequately capture growing conditions along the Labrador coast. Additionally, we would not easily be able to verify such areas in the near future. Therefore, we confined our analysis to Newfoundland, avoiding extrapolation beyond our existing knowledge and unsupported speculation. Known eelgrass observation records were used to validate the potentially suitable habitat predictions. These records existed as point observations as well as polygons delineating eelgrass beds.

Data Preparation

Shoreline classification data derived from aerial surveys of Newfoundland provide details of lower intertidal zone and backshore form and material for individual shoreline segments. These data are available as polyline features from Environment and Climate Change Canada (ECCC). Shoreline classifications were generated following guidelines in the ECCC Shoreline Cleanup Assessment Technique (SCAT) manual (ECCC 2018). The shoreline classification layer was filtered to extract lower intertidal zone and backshore materials most commonly associated with eelgrass growth as outlined in the literature or observed in Newfoundland. Sites where the materials were recorded as bedrock, bedrock resistant, or bedrock unresistant in both the lower intertidal zone and backshore were excluded, as such a combination would limit availability of smaller particle sizes which form the soft substrate required to support eelgrass growth. The filtered shoreline classifications used in the analysis are provided in Figure 1 and Figure 2.

To correct misalignment between the shoreline classification layer and the coastline, and split up expansive shoreline features into more manageable units, the 'Buffer' tool in ArcGIS Pro Version 3.3.2 (ESRI 2024) was used to create a 100 m buffer (full buffer with flat ends) for the filtered shoreline classification layer. The coastline from the CanVec 1:50,000 shapefile produced by Natural Resources Canada (NRCan; NRCan 2019a) was converted to a polyline feature and subdivided into 5 km segments. The 'Clip' tool was then used to extract segments of the coastline

that intersected the filtered shoreline classification layer. The clipped and segmented coastline layer was used as a proxy for the filtered shoreline classification layer in all subsequent analyses.

Relative exposure index (REI) quantifies exposure of a given area to wind-driven waves. The resolution (250 m) of publicly available REI data for Newfoundland (DFO 2022) was not sufficient for the purposes of this analysis. Consequently, an updated REI layer was generated at a 50 m resolution following the methodology outlined by O'Brien et al. (2022a). The threshold used to filter the REI data was based on O'Brien et al. (2022b), who found that eelgrass distributions in Nova Scotia are reliably predicted in water with REI values < 0.1 . The filtered REI layer used in the analysis is provided in Figure 3.

Bathymetric data spanning the Newfoundland coastline was provided by the Canadian Hydrographic Service (CHS) in the form of Electronic Navigational Charts (ENCs). Bathymetric contours were extracted from the charts as shapefiles and were subsequently filtered to include depths of 0 – 5.5 m, falling within the range typically occupied by eelgrass in Newfoundland (Murphy et al. 2021). The filtered bathymetry layer used in the analysis is illustrated in Figure 4.

Linear water flow features representing watercourses (e.g., rivers, streams) were retrieved from the CanVec 1:50,000 hydrographic features layer produced by NRCan (2019b) and used to characterize freshwater inputs along the coastline as differences in salinity and nutrient inputs from freshwater sources can influence eelgrass distributions (Murphy et al. 2021). The layer was filtered to extract data for Newfoundland and merged into a single shapefile using R Version 4.4.3 (R Core Team 2025). The filtered linear water flow features used in the analysis are provided in Figure 5.

All data layers described above were projected to WGS84 UTM Zone 21N (EPSG:32621) to support further analysis.

Analysis

In contrast to the other predictor variables, linear water flow features were terrestrial in origin. To ensure we could incorporate them into the analysis, a 100 m buffer (full buffer with round ends) was applied to the filtered shoreline classification layer using the 'Buffer' tool in ArcGIS Pro Version 3.3.2 (ESRI 2024). Following this procedure, the 'Spatial Join' tool was used to overlay predictor variables with the buffered shoreline classification layer to identify potentially suitable eelgrass habitat. The overlay analysis was conducted in succession based on the decreasing spatial coverage of predictor variables (i.e., REI, bathymetry, and linear water flow features). To account for uncertainty introduced by data gaps (i.e., poor spatial coverage), three qualitative classes of habitat suitability were defined according to the number of intersecting predictor variables at each stage of the analysis (Figure 6). Areas, or segments of the coastline, where the first two variables (e.g., shoreline classification and REI) co-occurred were defined as '*moderately suitable*' habitat, those where the first three variables (e.g., shoreline classification, REI, and bathymetry) co-occurred were defined as '*suitable*' habitat, and those where all four variables (e.g., shoreline classification, REI, bathymetry, and linear water flow features) co-occurred were defined as '*highly suitable*' habitat.

To eliminate overlap with land, the ‘Erase’ tool in ArcGIS Pro Version 3.3.2 (ESRI 2024) was used to clip the areas delineated as potentially suitable eelgrass habitat, as defined during the overlay analysis, to the coastline. Polygons for each of the three individual habitat suitability classes were aggregated using the ‘Dissolve’ tool. Predictor variables were overlaid in succession when delineating potentially suitable eelgrass habitat resulting in some locations where multiple habitat suitability classes co-occurred (Figure 6). In these instances, the ‘Erase’ tool was used to retain the polygon with the highest suitability classification (i.e., ‘*highly suitable*’ > ‘*suitable*’ > ‘*moderately suitable*’). The ‘Merge’ tool was used to combine the non-overlapping polygons into a single layer to illustrate the coverage of potentially suitable eelgrass habitat classes for Newfoundland.

Validation

Eelgrass observation records (provided as polygons) from the Community-Based Coastal Resource Inventory (CCRI; DFO 2023), satellite and aerial imagery (Rao et al. 2014), and the National Eelgrass Dataset for Canada (NETForce; Guijarro-Sabaniel et al. 2024) were used to validate the accuracy of potentially suitable eelgrass habitat predictions. Observation records from all sources were combined using the ‘Merge’ tool in ArcGIS Pro Version 3.3.2 (ESRI 2024). The ‘Clip’ tool was then used to keep only those records occurring within 100 m of the coastline. This ensured that the assessment would not be influenced by eelgrass observations beyond the extent of the filtered predictor variables. The eelgrass observation records used for validation are illustrated in Figure 7.

Overlap between eelgrass observation records and the individual marine-based predictor variables was assessed to determine how data gaps may have impacted the quality of habitat suitability predictions. Linear water flow features were excluded from this exercise as they were land-based and did not directly overlap any of the eelgrass observation records. Validation was conducted by comparing the total number of eelgrass observations occurring within 100 m of the coastline to the number intersecting each of the predictor variables. Similarly, to assess the accuracy of the habitat suitability predictions, the total number of eelgrass observation records occurring within 100 m of the coastline were compared to the number intersecting potentially suitable eelgrass habitats across all habitat suitability classes, as well as within each habitat suitability class.

A predicted-expected ratio was computed to assess whether the frequency of occurrence of eelgrass observation records was higher for potentially suitable eelgrass habitat than would be expected by chance. The predicted number of eelgrass observations was equal to the number of eelgrass observation records that overlapped potentially suitable eelgrass habitat. The expected number of eelgrass observation records were determined by multiplying the proportion of the total area (within 100 m of the coastline) occupied by potentially suitable eelgrass habitat by the total number of eelgrass observation records. These values were then used to calculate a ratio (predicted/expected), with values > 1 indicative of eelgrass observation records occurring more frequently than expected by chance.

Results

In Newfoundland, an area of 1,832 km² lies within 100 m of the coastline, extending seaward. The shoreline characteristic classes, REI, and bathymetry deemed suitable for supporting eelgrass growth occur in 32% (580 km²), 63% (1,150 km²), and 42% (769 km²) of this area, respectively (Figure 8). Eelgrass observations were recorded at 202 sites in Newfoundland. Of these, 189 occurred within 100 m of the coastline (Figure 8) and were used to assess performance of the predictor variables.

The filtered shoreline classification layer intersected 152 (80%) of the 189 sites with eelgrass observations (Figure 8). Of the 37 sites that were not captured, two had no shoreline classification information, and the remaining 35 occurred in areas where both the lower intertidal zone and backshore materials were recorded as bedrock resistant. The filtered REI layer was in good agreement with eelgrass observation records, intersecting 184 (97%) of the 189 sites (Figure 8). Of the five sites that were not captured, REI was above the filtered threshold at three sites and was not available at the remaining two. Spatial coverage of the filtered bathymetry layer was sporadic along much of the coastline intersecting 143 (76%) of the 189 areas with eelgrass observation records (Figure 8).

The overlay analysis delineated 560 km² of the Newfoundland coastline as potentially suitable eelgrass habitat, of which 54% (304 km²) was defined as '*highly suitable*' habitat, 22% (121 km²) was defined as '*suitable*' habitat, and 24% (135 km²) was defined as '*moderately suitable*' habitat (Figure 8). The distribution of potentially suitable eelgrass habitat by habitat class is illustrated in Figure 10. In total, the analysis delineated 791 polygons representing '*highly suitable*' habitat, 921 polygons representing '*suitable*' habitat, and 356 polygons representing '*moderately suitable*' habitat. Details on the spatial coverage of polygons by habitat suitability class are provided in Table 1.

Validation against the 189 eelgrass observation records within 100 m of the coastline found that 151 (80%) sites intersected potentially suitable eelgrass habitat (Figure 8). Of the intersecting eelgrass observation records, 49 were polygons representing eelgrass beds which spanned multiple habitat suitability classes (Figure 8). When assessed by class, 110 (73%) intersected '*highly suitable*' habitat, 53 (35%) intersected '*suitable*' habitat, and 37 (25%) intersected '*moderately suitable*' habitat (Figure 8). In some cases, eelgrass observation records were polygons which spanned multiple habitat suitability classes. As a result, the number of eelgrass observation records overlapping the potentially suitable eelgrass habitat classes (n = 200) was greater than the number of eelgrass observation records overlapping potentially suitable eelgrass habitat (n = 151).

The predicted-expected ratios computed for potentially suitable eelgrass habitat (2.61), '*highly suitable*' habitat (3.51), '*suitable*' habitat (4.25), and '*moderately suitable*' habitat (2.66) were all greater than one, suggesting that eelgrass observation records intersected potentially suitable eelgrass habitat more frequently than would be expected by chance (Figure 9).

Discussion

Mapping eelgrass habitats and predicting areas suitable for eelgrass growth form critical components of coastal marine conservation, particularly given the importance of eelgrass in current spatial management and protection efforts in Atlantic Canada (DFO 2017, 2018). The

results of this report focused on identifying potentially suitable eelgrass habitat for nearshore areas to fill data gaps in Newfoundland, guide ongoing research, and contribute to national efforts mapping eelgrass meadows across Canada (Guijarro-Sabaniel et al. 2024). While the areas identified as potentially suitable eelgrass habitat require further validation and ground-truthing, agreement with eelgrass observation records suggests that this work has identified coastal areas which may support eelgrass growth but have not yet been surveyed. Validation also suggested that the absence of potentially suitable eelgrass habitat did not always reflect true absences, but rather gaps in the coverage or resolution of underlying data layers.

Misalignment between the shoreline classification layer and the coastline, which was addressed by using the coastline as a proxy for the filtered shoreline classification layer, led to the exclusion of otherwise suitable shoreline classification records in areas where unique or fine-scale coastline feature had not been digitized (e.g., Frenchman's Cove Barachois). As a result, there were a limited number of cases where the habitat was likely suitable for supporting eelgrass growth but was not identified in the analysis. Restricting the analysis to within 100 m of the shoreline likely also led to the underrepresentation of potentially suitable eelgrass habitat, which is known to extend beyond 100 m from the shoreline in other regions (e.g., Nova Scotia).

Spatial overlays suggested that eelgrass observation records are found across a broader range of shoreline classifications than described in existing literature (Bekkby et al. 2008; O'Brien et al. 2022b; Yang et al. 2023); however, this is likely an artefact of underlying data quality rather than a reflection of eelgrass habitat suitability preferences. There were eelgrass observation records in areas where materials in both the lower intertidal zone and backshore were recorded as bedrock and/or bedrock resistant. Filtering the shoreline classification layer likely led to the underrepresentation of potentially suitable eelgrass habitat for Newfoundland. This could be due to sampling bias if eelgrass observations were more concentrated in easily accessible areas (such as those supporting anthropogenic activities (e.g., fishing, recreation)) as compared to more remote parts of the coastline. Alternatively, the coarse resolution of the digitized eelgrass observations may not have accurately reflected the boundaries of eelgrass distributions at individual sites (Rao et al. 2014), and potentially resulted in overlap with areas of the coastline where shoreline classifications are considered less suitable for eelgrass growth. It is also possible that the resolution of the shoreline classification layer was unable to accurately capture fine-scale changes in sediment throughout the lower intertidal zone and backshore. Nonetheless, the potentially suitable eelgrass habitat delineated in the analysis captured all but one eelgrass observation record ($n = 151$) that intersected the filtered shoreline classification layer, suggesting that the analysis performed well in areas where data were available. It is anticipated that the accuracy of the habitat suitability predictions would increase as underlying data coverage throughout the Newfoundland coastal area improves. Time spent ground-truthing the habitat suitability predictions presented here could also serve to ground-truth the accuracy of the shoreline classification. A validation study (jointly through DFO and the Memorial University of Newfoundland (MUN)) comparing field observations of eelgrass presence against the predictions presented here will take place in 2025-26 (R. Gregory and P Snelgrove, pers. comm.). Using drone imagery, the validation study will evaluate sites in each of the eelgrass habitat suitability categories identified in this analysis. Results are expected within two years.

Spatial coverage of the REI layer was extensive, and it is unlikely that it substantially impacted the quality of habitat suitability predictions. However, as the threshold used to filter the REI layer was adopted from a species distribution modelling exercise for the Atlantic coast of Nova Scotia (O'Brien et al. 2022b), it might not accurately represent habitat preferences for eelgrass in Newfoundland. Meanwhile, gaps in bathymetric data coverage inflated the proportion of habitat that was classified as '*moderately suitable*' that would have otherwise been classified as '*suitable*' or '*highly suitable*' had additional data been available for use in the analysis.

Overall, this work provides a static present-day representation of potentially suitable eelgrass habitat locations in Newfoundland. However, suitability and eelgrass extent may expand or contract over time. In Newman Sound, Bonavista Bay, eelgrass beds have locally expanded and colonized shorelines that were previously devoid of eelgrass (Warren et al. 2010). Contrastingly, in Placentia Bay, the presence of invasive European Green Crab (*Carcinus maenas*) has contributed to eelgrass decline (Matheson et al. 2016). Coastal developments and activities are likely to affect eelgrass distributions (DFO 2012; Murphy et al. 2021; Orth et al. 2006). The interplay between temperature and light can be significant drivers of spatial and temporal variability in eelgrass productivity whereby warming can reduce tolerance to low-light conditions (Krumhansl et al. 2021; Lefcheck et al. 2017). More broadly, eelgrass distributions are expected to shift northward in line with projected climate-related temperature changes (Wilson and Lotze 2019) with the potential to increase habitat suitability in some parts of Newfoundland. Given this variability and the consequences associated with the potential loss of ecosystem functions in the event of eelgrass decline, continual survey efforts will be critical for monitoring changes in eelgrass extent in Newfoundland moving forward.

While this work supported the identification of areas potentially suitable for eelgrass habitats through overlay analysis, mapping and conservation efforts may also benefit from incorporating modelling approaches. Implementing predictive techniques like ensemble modelling (O'Brien et al. 2022b; Yang et al. 2023), which integrate environmental variables, average model predictions, climate change scenarios, and assign probabilities of occurrence to given areas, could further aid in focusing monitoring surveys and supporting marine spatial planning processes and informing environmental emergency response plans (e.g., oil spills). The potentially suitable eelgrass habitats highlighted in this report, when accompanied with occurrence probabilities, would strengthen the guidance for ground-truthing and mapping efforts moving forward.

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Tables

Table 1: Summary statistics for polygons delineating the individual habitat suitability classes.

Habitat suitability class	Number of polygons	Polygon coverage (km²)		
		Range	Mean	Median
Highly suitable	791	<1 – 8	0.38	0.16
Suitable	921	<1 – 2	0.13	0.05
Moderately suitable	356	<1 – 10	0.38	0.11

Figures

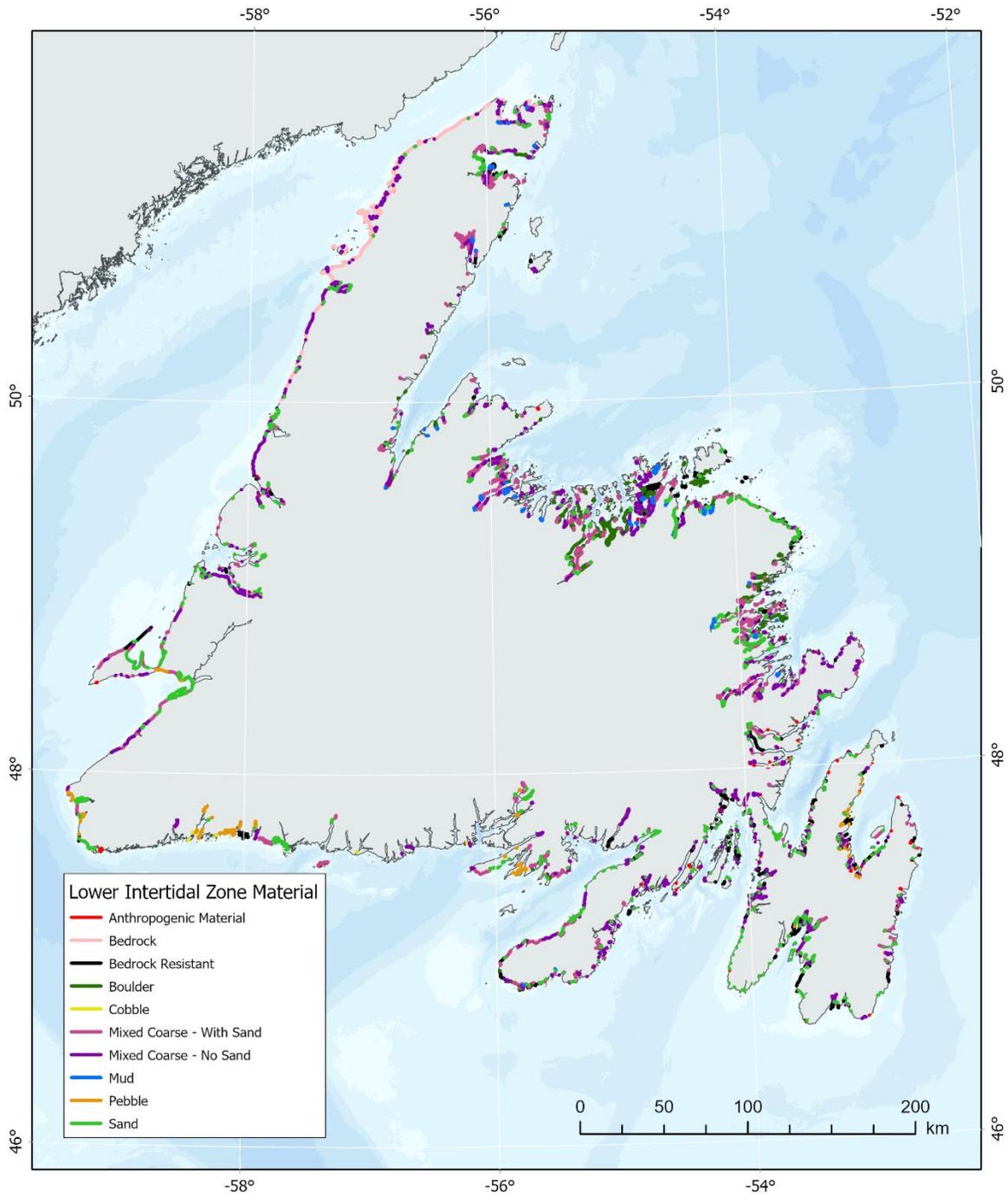


Figure 1: Distribution of lower intertidal shoreline materials in the filtered shoreline classification layer for the Newfoundland coastline.

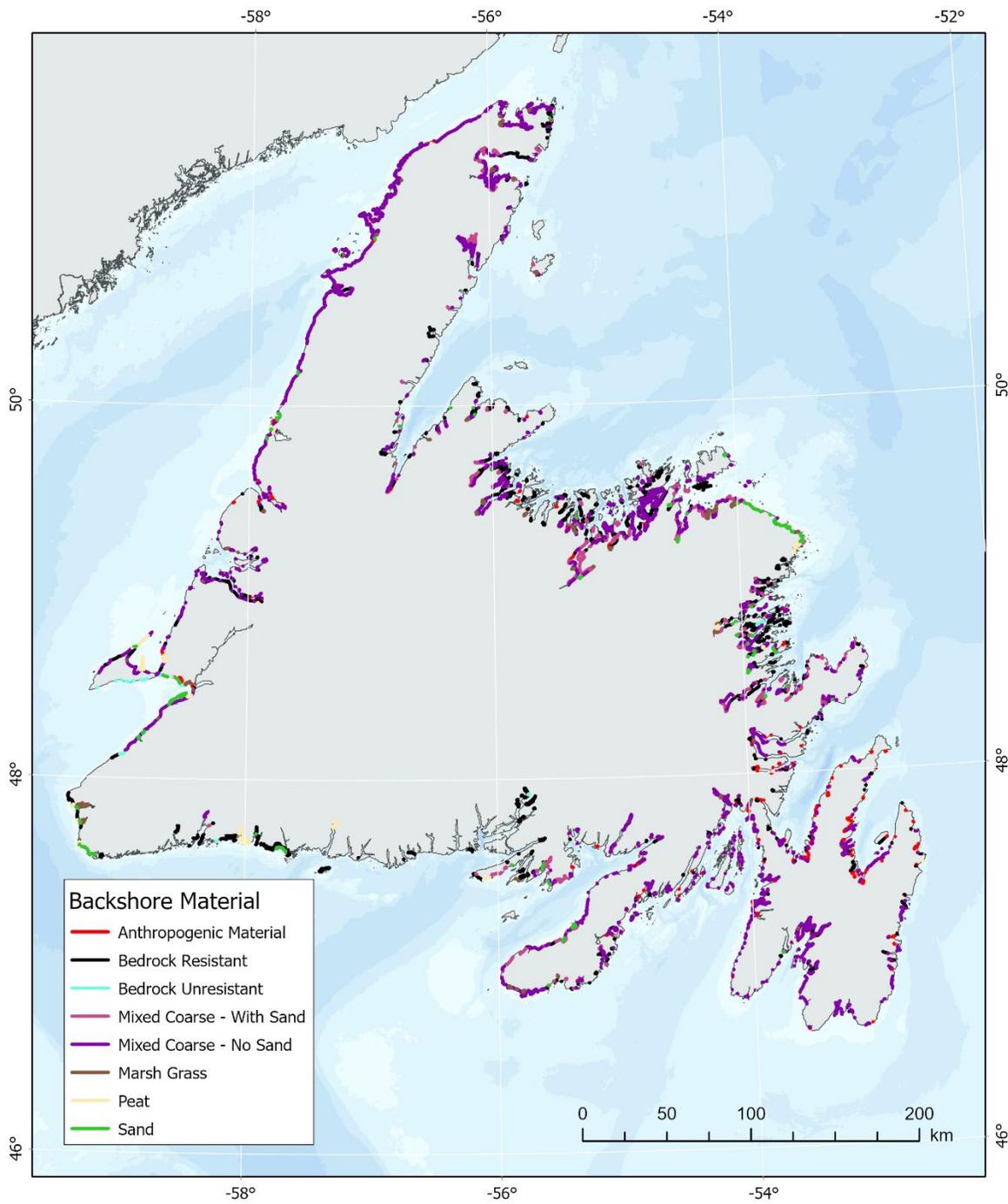


Figure 2: Distribution of backshore shoreline materials in the filtered shoreline classification layer for the Newfoundland coastline.

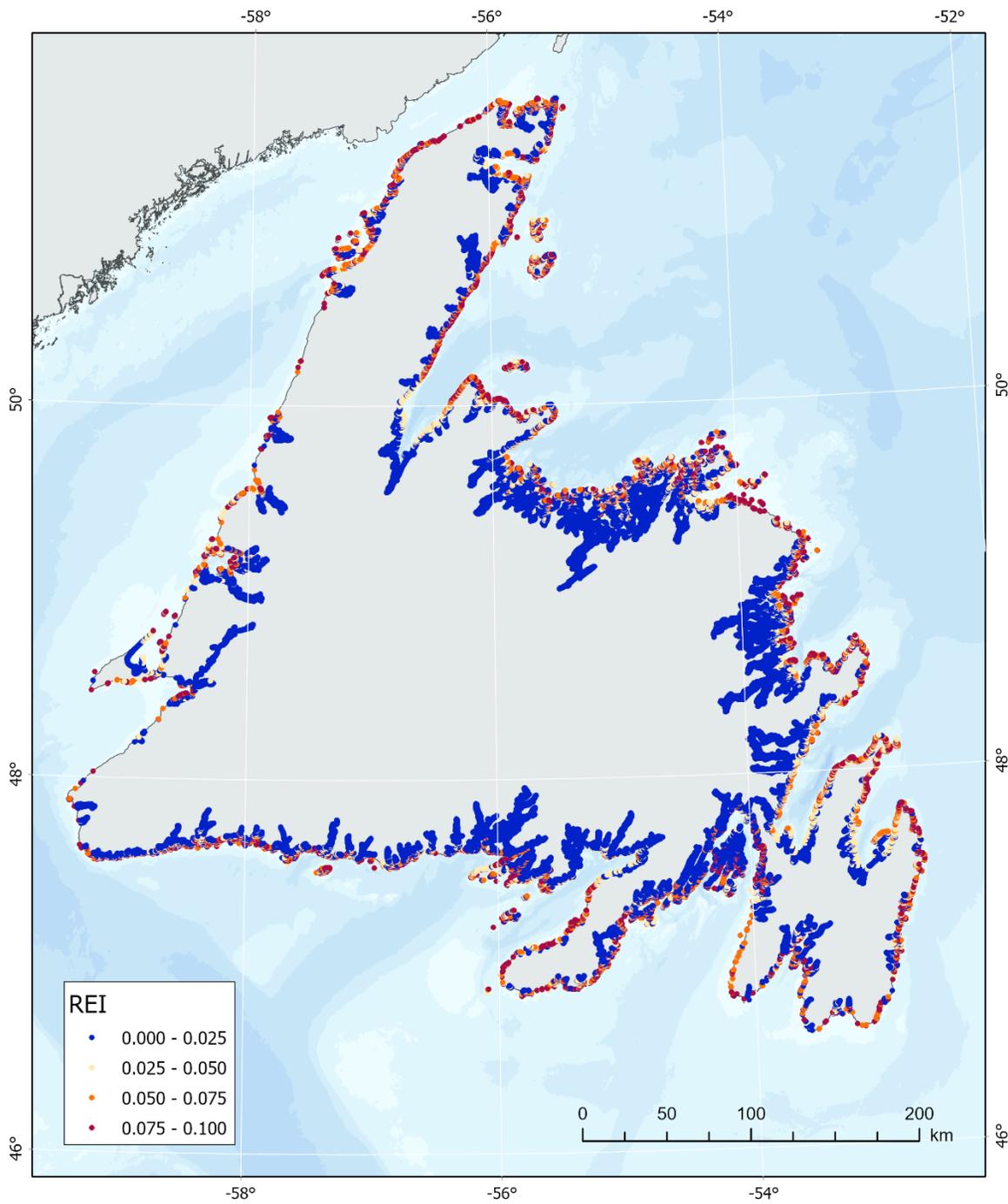


Figure 3: Relative exposure index (REI) values (< 0.1) occurring within 100 m of the Newfoundland coastline.

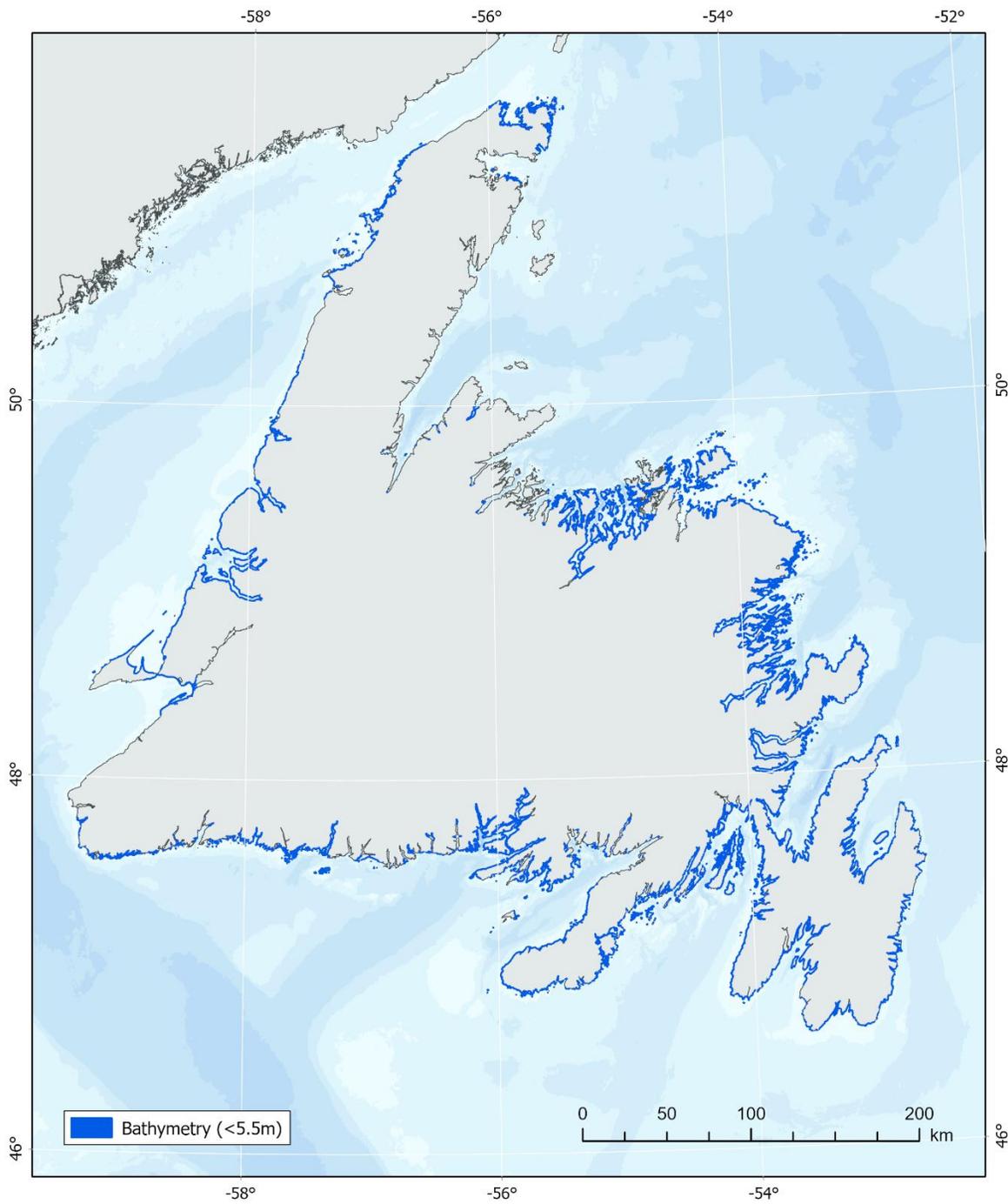


Figure 4: Coverage of bathymetric data (< 5.5 m) occurring within 100 m of the Newfoundland coastline.

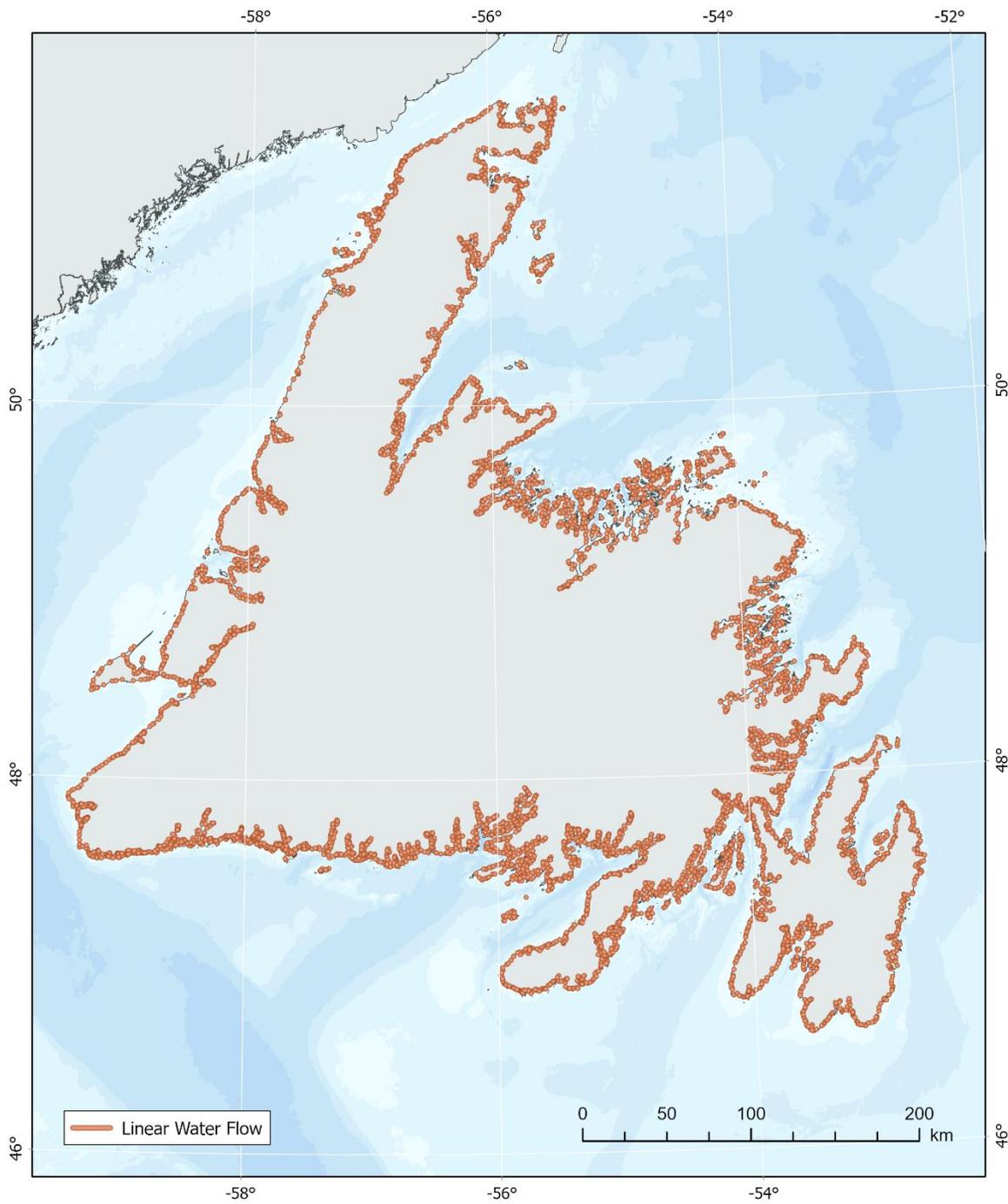


Figure 5: Linear water flow features occurring within 100 m of the Newfoundland coastline.

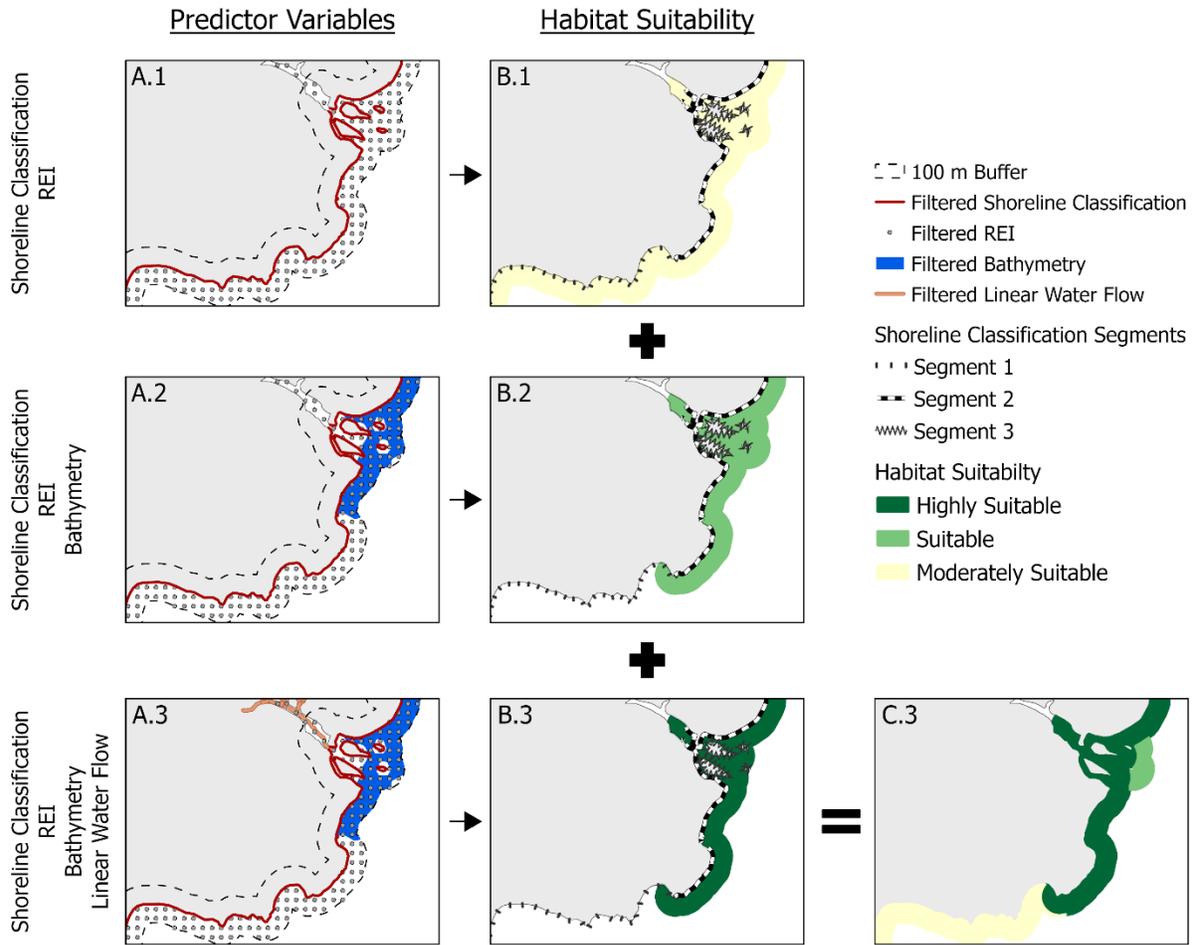


Figure 6: The sequential overlay of predictor variables (A.1 – A.3) used to delineate individual habitat suitability classes (B.1 – B.3). Individual habitat suitability classes (B.1 – B.3) were merged and the highest habitat suitability classification was prioritized in areas of overlap to delineate the potentially suitable eelgrass habitat layer (C.3).

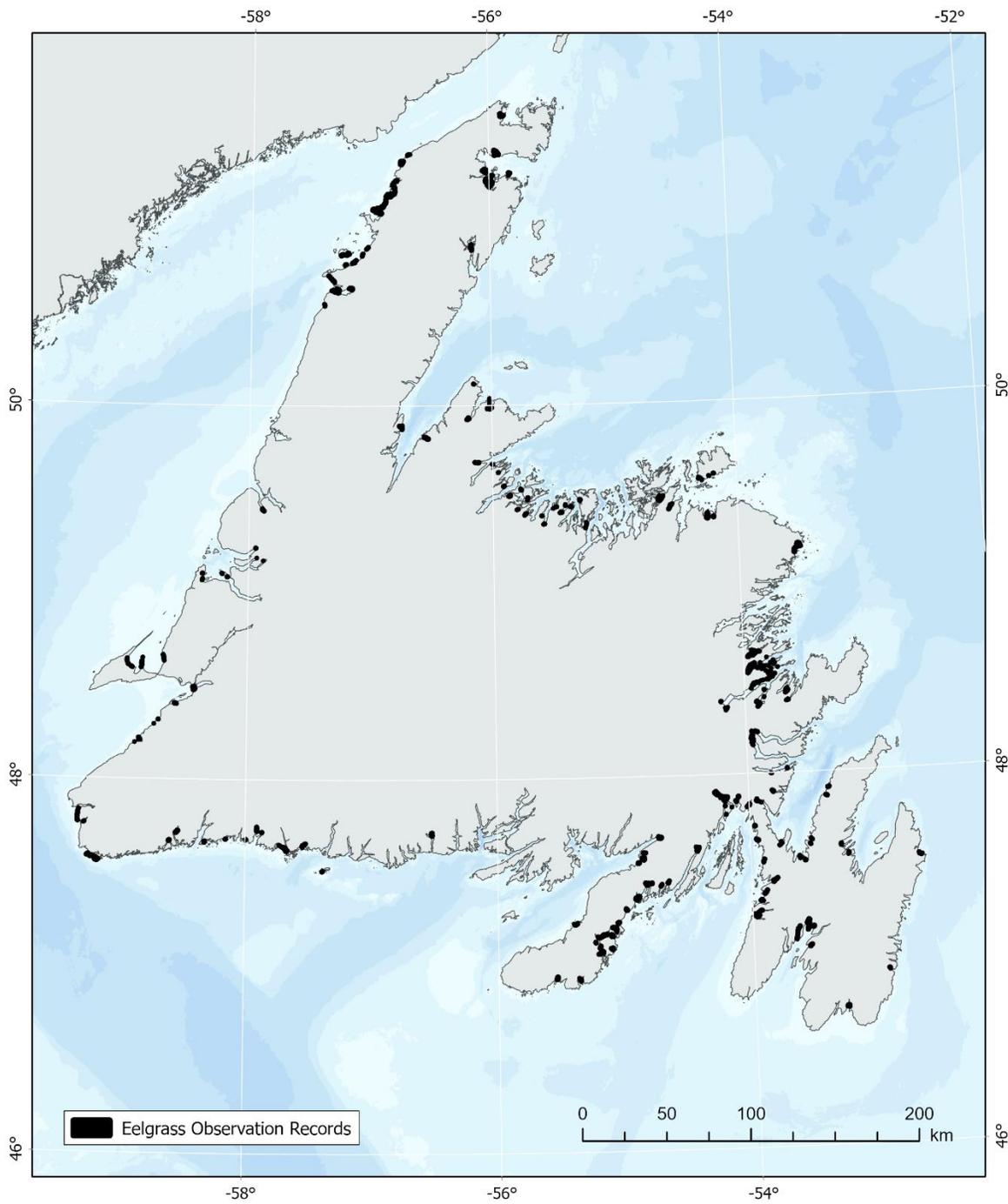


Figure 7: Distribution of eelgrass observation records (n = 189) within 100 m of the Newfoundland coastline.

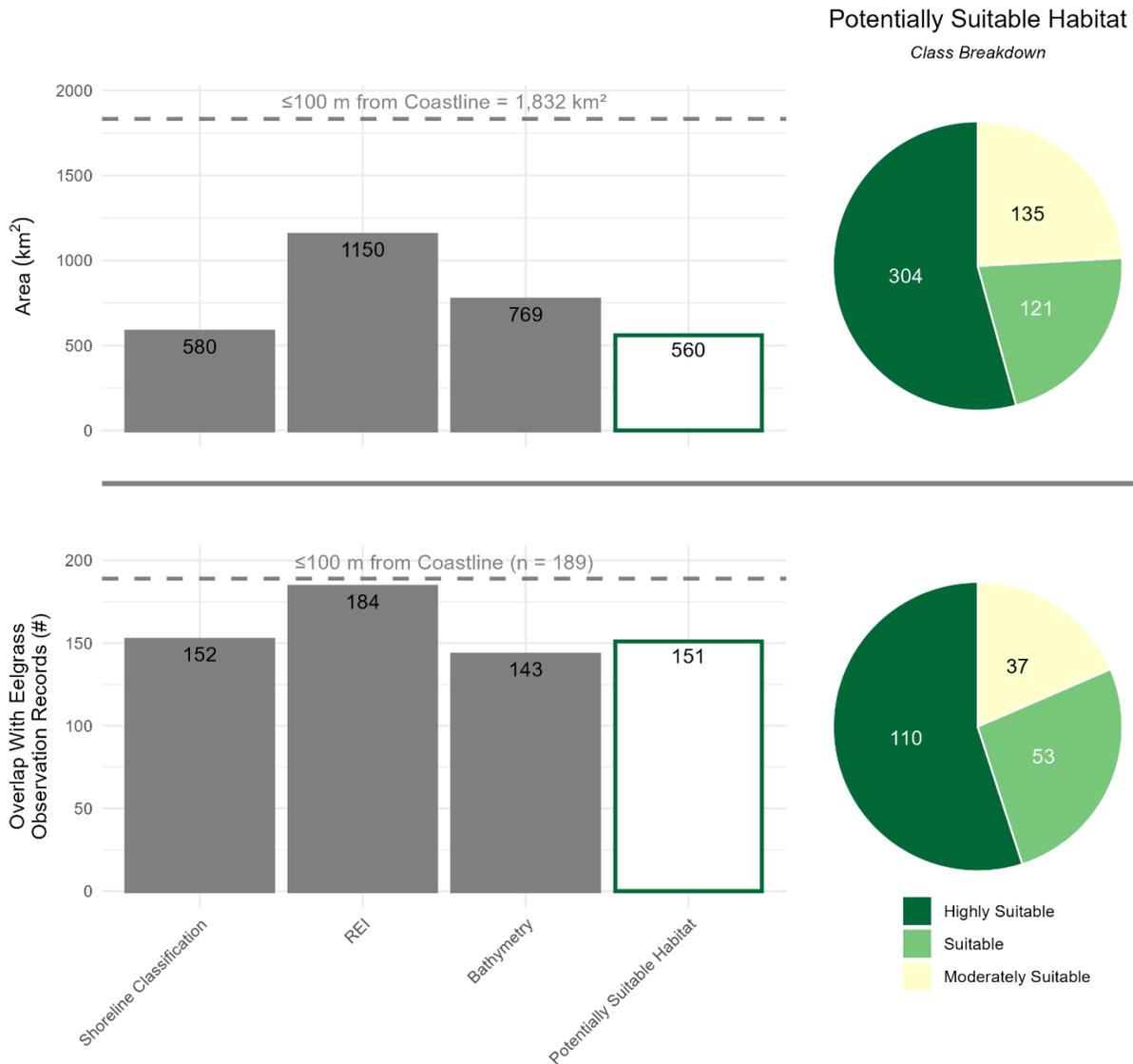


Figure 8: Spatial coverage (top) and overlap with eelgrass observation records (bottom) of filtered marine-based predictor variables (solid grey bars) and potentially suitable eelgrass habitat (white bars). The dashed grey line illustrates the area (top) and number of eelgrass observation records (bottom) occurring within 100 m of the Newfoundland coastline. A breakdown of the spatial coverage and overlap with eelgrass observation records by potentially suitable eelgrass habitats class (e.g., ‘highly suitable’, ‘suitable’, ‘moderately suitable’) is provided to the right of the bar plots. In some cases, eelgrass observation records spanned multiple habitat suitability classes (e.g., polygons). As a result, the number of eelgrass observation records overlapping the potentially suitable eelgrass habitat classes (n = 200) (bottom right) is greater than the number of eelgrass observation records overlapping potentially suitable eelgrass habitat (n = 151).

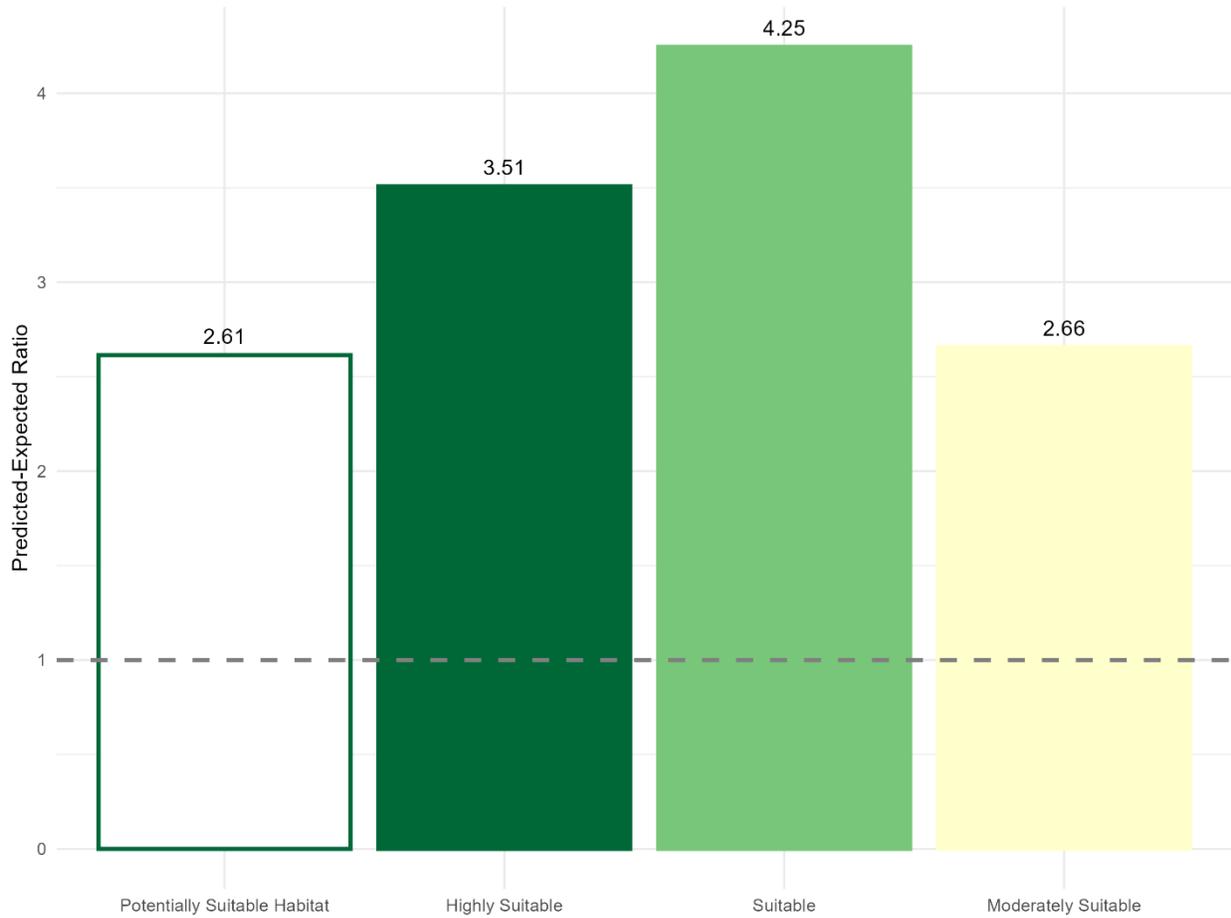


Figure 9: Predicted-Expected ratios computed for potentially suitable eelgrass habitat, as well as each of the underlying habitat suitability classes (e.g., ‘*highly suitable*’, ‘*suitable*’, ‘*moderately suitable*’). The dashed grey line illustrates the ratio at which the frequency of eelgrass observation records would be occurring by chance. Ratios exceeding this are indicative of eelgrass observation records occurring more frequently than expected by chance.

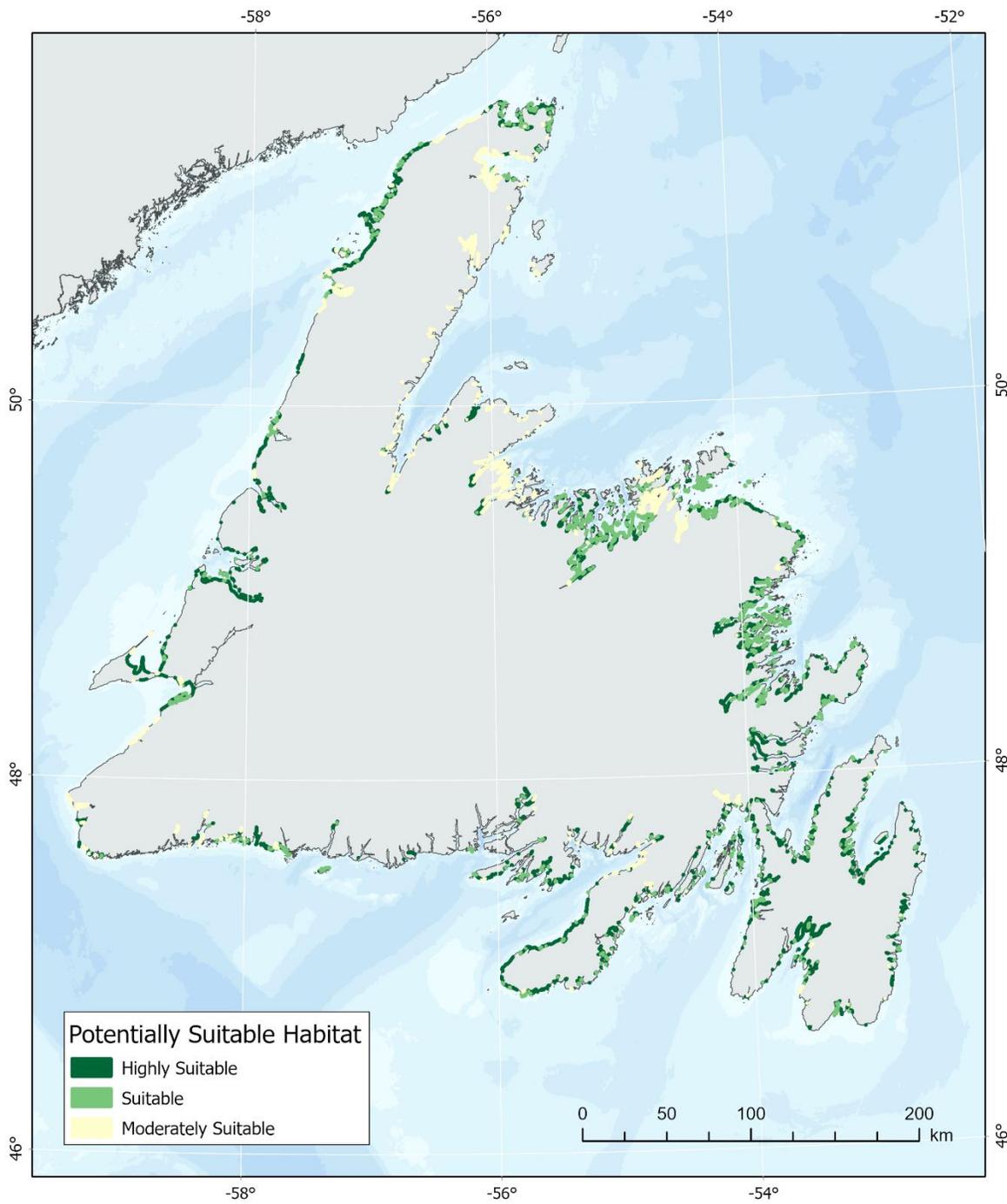


Figure 10: Distribution of potentially suitable eelgrass habitat categorized by suitability class (e.g., ‘highly suitable’, ‘suitable’, ‘moderately suitable’) for the Newfoundland coastline.