National Eelgrass Task Force (NETForce): Building a dynamic, open eelgrass map for Canada

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Les numéros 1 à 456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457 à 714 sont parus à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Les numéros 715 à 924 ont été publiés à titre de Rapports techniques du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 925.

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TABLE OF CONTENTS

ABSTRACT

Guijarro-Sabaniel, J., Thomson, J. A., Vercaemer, B. and Wong, M. C. 2024. National Eelgrass Task Force (NETForce): Building a dynamic, open eelgrass map for Canada. Can. Tech. Rep. Fish. Aquat. Sci. 3583: v + 31 p.

Eelgrass (*Zostera marina*) meadows provide important ecosystem services on all three of Canada's coasts. However, to date, we have lacked comprehensive, national eelgrass maps and a centralized platform for storing, displaying and sharing eelgrass distribution data. The National Eelgrass Task Force (NETForce) was initiated by Fisheries and Oceans Canada in 2019 to address this gap. Here, we present this innovative and inclusive partnership, and the process of creating the national map, which is now publicly accessible and useful for monitoring, research and management. So far, 113 datasets have been contributed by diverse partners, with survey methods ranging from field surveys to benthic sonar, aerial/satellite image analysis, modeling and literature review. At minimum, eelgrass has been mapped in 41,896 ha of Canada's coastal ecosystems. We explore regional differences in data availability and highlight the importance of relationship building and data sharing agreements for the success of the initiative. On-going data gathering will refine our knowledge of eelgrass distribution, facilitate research and feed into key management frameworks such as Marine Planning and Conservation, Integrated Marine Response Planning and *Fisheries Act* assessments. All data can be found on the Government of Canada's Open Data Portal: https://open.canada.ca/data/en/dataset/a733fb88-ddaf-47f8-95bb-e107630e8e62.

RÉSUMÉ

Guijarro-Sabaniel, J., Thomson, J. A., Vercaemer, B. and Wong, M. C. 2024. National Eelgrass Task Force (NETForce): Building a dynamic, open eelgrass map for Canada. Can. Tech. Rep. Fish. Aquat. Sci. 3583: v + 31 p.

Les herbiers de zostères (*Zostera marina*) fournissent d'importants services écosystémiques sur les trois côtes du Canada. Cependant, à ce jour, nous manquons de cartes nationales complètes sur les zostères et d'une plateforme centralisée pour le stockage, la visualisation et le partage des données sur la répartition des zostères. Le Groupe de travail national sur la zostère (NETForce) a été mis en place par Pêches et Océans Canada en 2019 pour combler cette lacune. Nous présentons ici ce partenariat innovant et inclusif, ainsi que le processus de création de la carte nationale, qui est désormais accessible au public et utile pour la surveillance, la recherche et la gestion. Jusqu'à présent, 113 ensembles de données ont été fournis par divers partenaires, avec des méthodes d'enquête allant de la surveillance de terrain au sonar benthique, en passant par l'analyse d'images aériennes/satellitaires, la modélisation et l'examen de la littérature. Au minimum, les zostères ont été cartographiées sur 41,896 ha des écosystèmes côtiers du Canada. Nous soulignons les différences régionales dans la disponibilité des données et l'importance de l'établissement de relations et d'accords de partage de données pour le succès de l'initiative. La collecte continue de données permettra d'affiner nos connaissances sur la répartition des zostères, de faciliter la recherche et de contribuer aux principaux cadres de gestion tels que la planification et la conservation des ressources marines, la planification intégrée des interventions maritimes et les évaluations d'impact en vertu de la loi sur les pêches. Toutes les données peuvent être consultées sur le portail de données ouvertes du gouvernement du Canada: https://ouvert.canada.ca/data/fr/dataset/a733fb88-ddaf-47f8-95bb-e107630e8e62.

1 INTRODUCTION AND METHODS

1.1 BACKGROUND

Seagrasses are marine flowering plants that are widely distributed in shallow, coastal waters throughout the world's temperate and tropical ecosystems (Short et al. 2007). Even with relatively low species diversity – there are about 60 species of seagrass globally – seagrasses generate many valuable ecosystem services, often forming dense meadows that enhance biodiversity, support fisheries, sequester carbon, trap and stabilize sediments, improve water quality and help buffer shorelines from storm-driven erosion (Barbier et al. 2011, Dewsbury et al. 2016).

Despite their well-documented importance, seagrasses are declining rapidly around the world due to a range of anthropogenic and natural threats (Orth et al. 2006; Waycott et al. 2009). The most recent global analysis estimated that 19% of total seagrass area has been lost since 1880, although trends varied significantly within and among bioregions, and data are still lacking for roughly 90% of the world's meadows (Dunic et al. 2021). Primary anthropogenic threats to seagrasses include, but are not limited to, coastal development, nutrient loading, certain fishing and aquaculture activities, poor boat anchoring and mooring practices, invasive species and climate change (Orth et al. 2006).

In Canada, eelgrass (*Zostera marina*) is the dominant seagrass species and is widespread on all three coasts (Green and Short 2003, Murphy et al. 2021), ranging as far north as central British Columbia (and around to western Alaska in the US), James and Hudson Bay, and northern Quebec and Labrador (Short et al. 2010). DFO has identified eelgrass as an Ecologically Significant Species (ESS) because it creates benthic structure that is used preferentially by other species, physically supports other biota by providing settlement substrate or protection, and is adequately abundant and widely distributed to influence the overall ecology of nearshore habitats (DFO 2009). Due to these and other characteristics (e.g., carbon sequestration), eelgrass habitats are of considerable management and conservation interest.

Threats to eelgrass in Canada are varied and can be highly region- and site-specific (Murphy et al. 2019). Temporal trends are not well known for most Canadian eelgrass meadows due to the lack of monitoring data. However, for meadows that do have long-term datasets (n = 105 according to a recent compilation by Environment and Climate Change Canada), 85% showed a stable, increasing or restored trend compared to 15% that showed a decline (Murphy et al. 2021; ECCC 2020). Data availability and trends varied strongly among coasts. On the Pacific coast, 93% of the 61 meadows monitored showed stable, restored or increasing trends compared to 69% of 36 monitored meadows on the Atlantic coast. In the Arctic and sub-Arctic, ten datasets were available and eight of these were considered "in recovery" following major declines associated with hydropower development (Murphy et al. 2021; ECCC 2020).

Reliable and publicly accessible data on the distribution of eelgrass meadows are critical for management decision-making on a wide range of issues from local to national scales. For example, at the local level, knowledge of eelgrass distribution can inform planning processes such as aquaculture siting and the assessment of the impacts of proposed coastal developments (e.g., shoreline hardening) on fish habitat under the Fisheries Act (i.e. harmful alteration, disruption or destruction [HADD]). Other key management frameworks such as Marine Planning and Conservation, and Integrated Marine Response Planning also require up-to-date information on eelgrass distribution and the degree of spatial overlap with possible anthropogenic stressors.

A central challenge associated with incorporating eelgrass meadows into management decision-making in Canada has been the lack of comprehensive, national distribution maps and a centralized platform for storing, displaying and sharing the underlying data. Data describing Canadian eelgrass meadows have been collected by many different organizations and individuals including academic and government scientists, Indigenous and non-Indigenous community groups, non-profit organizations, private industry and citizen scientists. These efforts have used a diverse range of field, remote sensing and/or modeling methods across similarly varied spatial and temporal scales. This has yielded a large amount of valuable biological information; however, to date, it has not been aggregated, organized or made public in an easily accessible way. Doing so would contribute significantly to management processes, reducing the time requirement for data gathering and processing, while also helping to facilitate the testing of key ecological hypotheses through research by various organizations.

The National Eelgrass Task Force (NETForce) was initiated by Fisheries and Oceans Canada in 2019 in response to this gap. The core purpose of NETForce was to bring together as many eelgrass datasets as possible – within the limitations imposed by considerations such as academic publishing and privacy – to produce “evergreen” eelgrass distribution maps and create a public repository that includes information on the associated methods and limitations. By involving colleagues across different sectors and government levels/departments, NETForce also sought to promote collaboration and reduce siloing amongst groups with an interest in the management of eelgrass habitats. Such initiatives had not been undertaken previously due to the challenges associated with storing spatial data over the long term and making datasets publicly available through data sharing agreements. NETForce aimed to support management decision-making and research across the country by addressing these issues. In addition, NETForce sought to help all interested parties locate available datasets that could add value to eelgrass research and mapping projects and/or downstream applications.

This technical report provides a high-level summary of the history of NETForce and its data acquisition, contributors and processing methods, as well as an overview of datasets received from NETForce contributors to date. It also provides a coarse estimate of Canada’s national and bioregional eelgrass coverage based on the compiled datasets and discusses important caveats associated with the interpretation of these estimates. A more detailed description of the data received including maps, metadata and contact information for each dataset by bioregion can be found on the Government of Canada’s Open Data Portal: https://open.canada.ca/data/en/dataset/a733fb88-ddaf-47f8-95bb-e107630e8e62

1.2 NETFORCE ESTABLISHMENT AND WORKFLOW

NETForce began by organizing two national virtual forums in 2020 (Gomez et al. 2021) to engage DFO scientists and external partners. The main goals of these forums were to identify eelgrass datasets and initiate conversations on exchange of eelgrass data and potential data gaps across Canada’s coastline. During the forums, DFO’s NETForce GIS Analyst presented a workflow on the tools that would be used from data collection through to the creation of the online national distribution map (Figure 1).

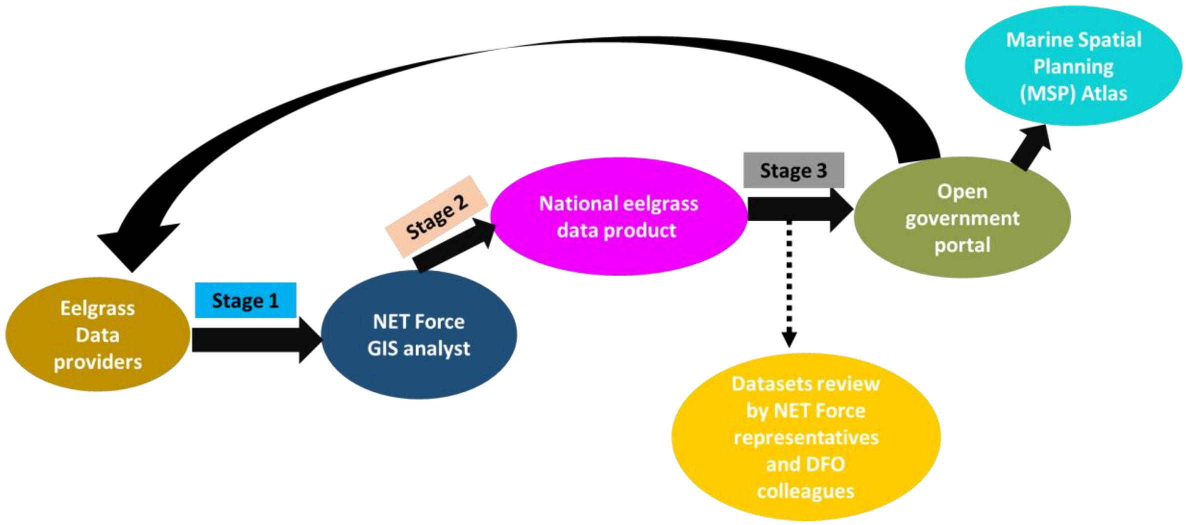

Figure 1. Workflow diagram showing the stages from data collection to the creation of the national eelgrass map in the Open Data Portal.

After the forums, the GIS Analyst started conversations with governmental and non-governmental organizations willing to share eelgrass data. A Data Sharing Agreement (DSA) was proposed in the forum as a tool to ensure that DFO and each of the external partners had a shared understanding about the nature and quality of data that would be provided and how DFO would protect and use the data to produce the publicly accessible map. Some external partners shared data for the map but did not want to have a DSA. In those cases, the GIS Analyst ensured that there was documentation (i.e., email) confirming that the data providers agreed with DFO using and publishing their data in the Open Data Portal to create the map. Once the DSA was signed by both parties (DFO and external partners), or the email confirmation was received, the GIS Analyst started the process of collecting the data.

1.3 DATA COLLECTION

A cloud storage system was used by DFO to facilitate initial data transfer and ensure that the data shared by each provider was only visible to them and the GIS Analyst for any updates or changes that may have been required. The cloud storage setup allowed both parties to have a backup of the original eelgrass data in case either the GIS Analyst or the data provider needed to make edits or add metadata to the original dataset. The original data format and metadata associated with the eelgrass datasets were different depending on the scope of the research projects and the collection methods used.

1.4 DATA PROCESSING AND STANDARDIZATION

In this stage, the goal was to standardize the different datasets to the extent possible since many different data collection techniques and metadata recording approaches were used by providers. Quality control of the datasets was first undertaken to ensure that the format of the fields (e.g., date, latitude and longitude) across each dataset were the same. Subsequently, an automated model was developed using geoprocessing tools in order to edit and manage the data. Model Builder, a visual programming language within ARCGIS 10.7.1 (ESRI 2019), was used to create customized geoprocessing tools to improve project workflows. The datasets from each provider were processed and managed individually because of the different types of metadata among them. As a result, a workspace folder was created for each organization and an Esri file geodatabase added to it to store the original datasets. Key steps of the data standardization process included:

- transforming layers that were provided as rasters (e.g., SDM layers, satellite images) into vector format for calculation of area metrics
- reprojecting all datasets using World Geodetic System 1984 (WGS 1984)
- adding fields to each layer's attribute table for eelgrass metrics (e.g., presence-absence, % cover) and associated metadata (e.g., image classification technique); if metadata were not recorded and shared by the data provider, they were either extracted from an associated technical report or through a direct request to the provider
- adding geometry for polygons (e.g., area, length)

A more detailed workflow showing the steps of data processing and standardization can be found in Appendix I.

1.5 INTERNAL DATA REVIEW

Once the initial datasets were assembled and processed/standardized, a review process was conducted by NETForce representatives and DFO colleagues. This internal review provided the opportunity to contribute with comments or feedback about the datasets before they were submitted to the Open Data Portal. In particular, we were interested in hearing comments on the symbology used for the eelgrass polygons and presence/absence data, the colour palette, the new fields added to the data (metadata) and ways to improve the representation of the spatial data. For this internal review, a web map was created in the DFO Map Viewer portal.

1.6 PUBLICATION OF OPEN MAP AND CONTRIBUTION TO MSP ATLAS

Once all received datasets were processed and standardized, and the internal review was completed, they were submitted to the Open Data Portal and then included in the Canada Marine Planning Atlas: Canada Marine Planning Atlas (dfo-mpo.gc.ca).

1.7 AREA ANALYSIS

In addition to providing a summary of the NETForce program, contributors and datasets, a secondary goal of this technical report was to provide an estimate of the minimum mapped area of eelgrass habitat in Canada and each of its bioregions. These estimates were intended as a first pass that can be refined in the future as more datasets become available, allowing for more in-depth analyses. They therefore must be interpreted cautiously, considering important caveats, which are discussed in Section 3 below.

Eelgrass habitat area estimates were calculated using all data available by the cutoff date of February 28, 2023 for the first version of the NETForce map published on the Open Data Portal. The total area of eelgrass extent was calculated using the Dissolve tool in ArcGIS using the NAD83(CSRS) / Canada Atlas Lambert projection (EPSG: 3979). All layers were dissolved to a single layer so that overlapping data would not be duplicated in the area calculation. The dissolve also meant that areas that were surveyed repeatedly over time were only reflected once in area estimates.

2 DATA OVERVIEW

2.1 GENERAL INFORMATION ON DATA CONTRIBUTED

NETForce received engagement from a wide variety of partner organizations across the country. In total, 113 datasets were contributed by 14 partners by the initial publication cut-off date (Table 1). Contributors included provincial and federal government departments and agencies, academic institutions (both university and community college), non-profit organizations and private companies. Outreach to Indigenous organizations was also initiated and is on-going with several groups that have expressed interest in further exploring participation in the NETForce initiative.

Datasets were contributed from seven of DFO's marine bioregions comprising, from west to east: the Southern Shelf, the Northern Shelf, the Strait of Georgia, all on the Pacific coast; the Hudson Bay Complex; the Estuary and Gulf of St. Lawrence; the Scotian Shelf; and the Newfoundland-Labrador Shelves (Table 1; Figures 2 and 3). Datasets received from the Pacific coast may include some observations of dwarf eelgrass (*Zostera japonica*), which is difficult to differentiate from Z. marina.

The methods underlying the provided datasets were equally varied, ranging from direct observation of eelgrass habitats in the field (e.g., video transects, quadrat sampling, opportunistic surveys) to benthic sonar, aerial and satellite image analysis (Table 1). Output from one large-scale (i.e., regional) species distribution model (SDM) for eelgrass, which covered the Atlantic coast of Nova Scotia, was also contributed (see O'Brien et al. 2022). Some data were also extracted by contributors from already published primary publications.

Note that this summary reflects only contributions that were received and standardized before the cut-off date for publication of the first version of NETForce. We are aware of several additional existing datasets, some with extensive spatial coverage, that we expect to be contributed or finalized in the near future, which are detailed in the appropriate sections below.

It is important to note that areas lacking eelgrass data in Figures 2 and 3 do not necessarily indicate that the area was surveyed and eelgrass is absent. Instead, data gaps may indicate that no surveys have been conducted at those locations, data are available and were contributed to NETForce but were not fully processed and standardized before the cut-off date, or because DSAs for data in those areas are not yet finalized.

Table 1. Summary of mapping techniques, number of datasets and format of data provided by partner organizations, broken down by province.

Mapping technique	Number of datasets	Data format	Province	Organization/Institution
Species distribution modelling (SDM)	3*	Raster	NS	DFO Maritimes Region
Benthic sonar	33	Vector (points and polygons) and text files	NS, NB and PEI	Southern Gulf of St. Lawrence Coalition (co-owned by DFO Gulf Region)
Field surveys (e.g., underwater video, quadrat sampling)	11	Vector (points and polygons) and text files	NS, NB, PEI, QC, BC and NL	DFO Gulf Region, Ecology Action Centre, McGill University, Parks Canada Agency, Fisheries and Marine Institute of Memorial University of Newfoundland, Hakai Institute, NS Department of Natural Resources and Renewables, Mayne Island Conservancy and Moran Coastal and Ocean Resources Inc.
Aerial images and LiDAR	27	Vector (lines and polygons)	NS, NB, BC, NL and PEI	DFO Gulf Region, Nature Conservancy of Canada, Fisheries and Marine Institute of Memorial University of Newfoundland, Moran Coastal and Ocean Resources Inc., Hakai Institute, Department of Natural Resources and Renewables and Applied Geomatics Research Group (Nova Scotia Community College)
Satellite images	14	Raster and vector (polygons)	NS, NB and BC	DFO Gulf and Maritimes Regions, McGill University, Fisheries and Marine Institute of Memorial University of Newfoundland, Parks Canada Agency, Moran Coastal and Ocean Resources Inc. and NS Department of Natural Resources and Renewables
Airborne spectrographic imaging	1	Raster	NS	Defense Research and Development Canada
Unoccupied Aerial Vehicle (UAV) images	23	Vector (polygons)	NS, BC and NL	Parks Canada Agency, Hakai Institute and Fisheries and Marine Institute of Memorial University of Newfoundland
Literature review	1	Vector (polygons)	QC	Open Government License - Canada
TOTAL	**113**			

* SDM data layers contributed included: 1) predicted habitat suitability; 2) prediction uncertainty; and 3) binary predictions of habitat suitability (suitable vs. unsuitable) based on a threshold probability

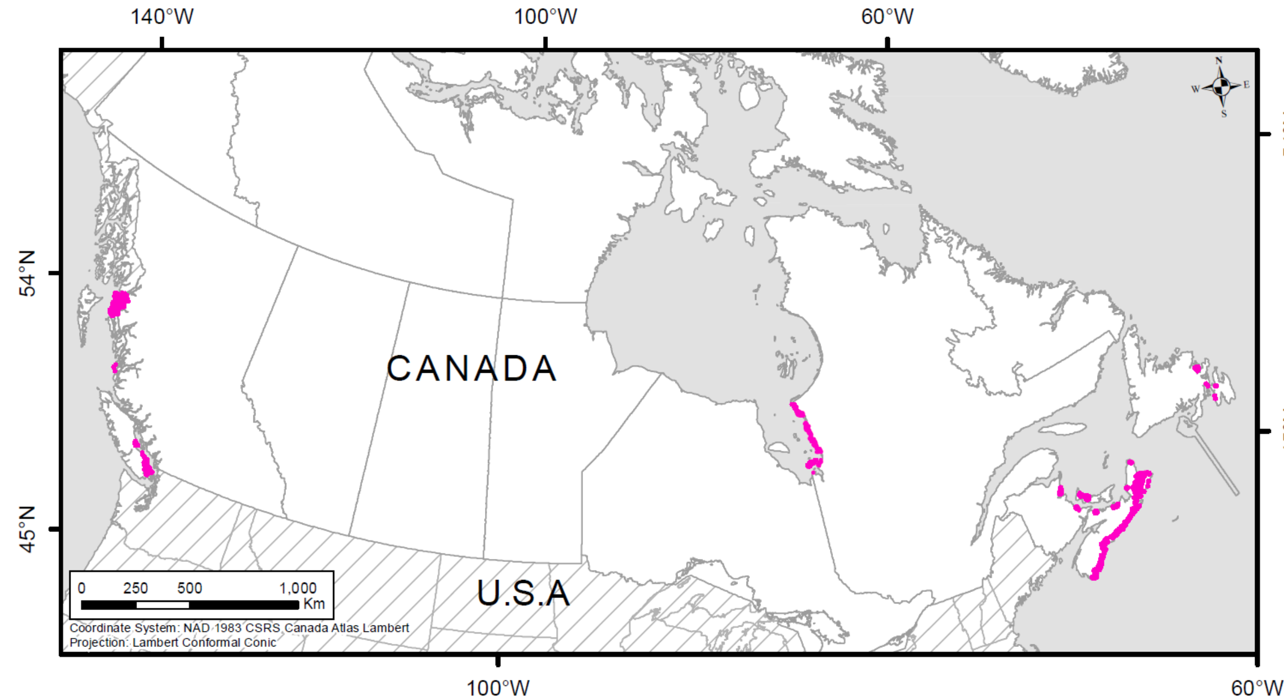

Figure 2. Overview map of eelgrass extent data.

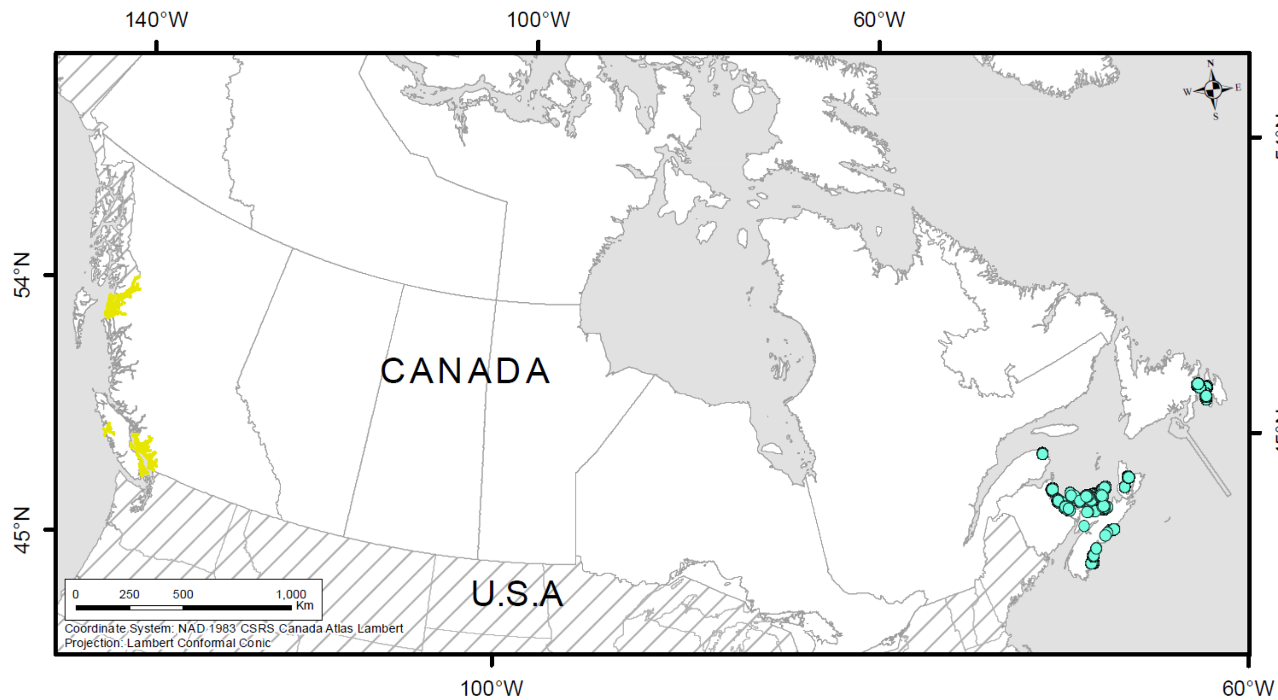

Figure 3. Overview map of eelgrass presence data. Point data are shown as green circles while alongshore eelgrass ShoreZone units on the Pacific coast, as defined by Coastal and Ocean Resources Inc., are shown as yellow lines. For details on ShoreZone units, refer to Section 2.2.4 or the ShoreZone Coastal Imaging & Habitat Mapping Protocol on the Government of Canada's Open Data Portal NETForce page.

2.2 DATA SUMMARY PER BIOREGION

In the following figures, which summarize the eelgrass extent and presence/absence data available for each bioregion, individually numbered boxes correspond to the data layer names provided in Appendix II Tables A2-A8. These data layer names match the corresponding file names on the Open Portal.

2.2.1 ESTUARY AND GULF OF ST. LAWRENCE

A large number of datasets was received for the southern Gulf of St. Lawrence, spread across the coasts of QC, NB, PEI, and NS (Figure 4). Mapping techniques for these datasets (Table A2) included LiDAR, aerial and satellite image analysis, and benthic sonar. Most associated field survey data used for ground-truthing are included in the Open Portal.

Additional pending datasets for this bioregion that have either been contributed but are not yet finalized, or that we expect to be contributed in the near future, include satellite and aerial imagery of the north and south coasts of the St. Lawrence Estuary.

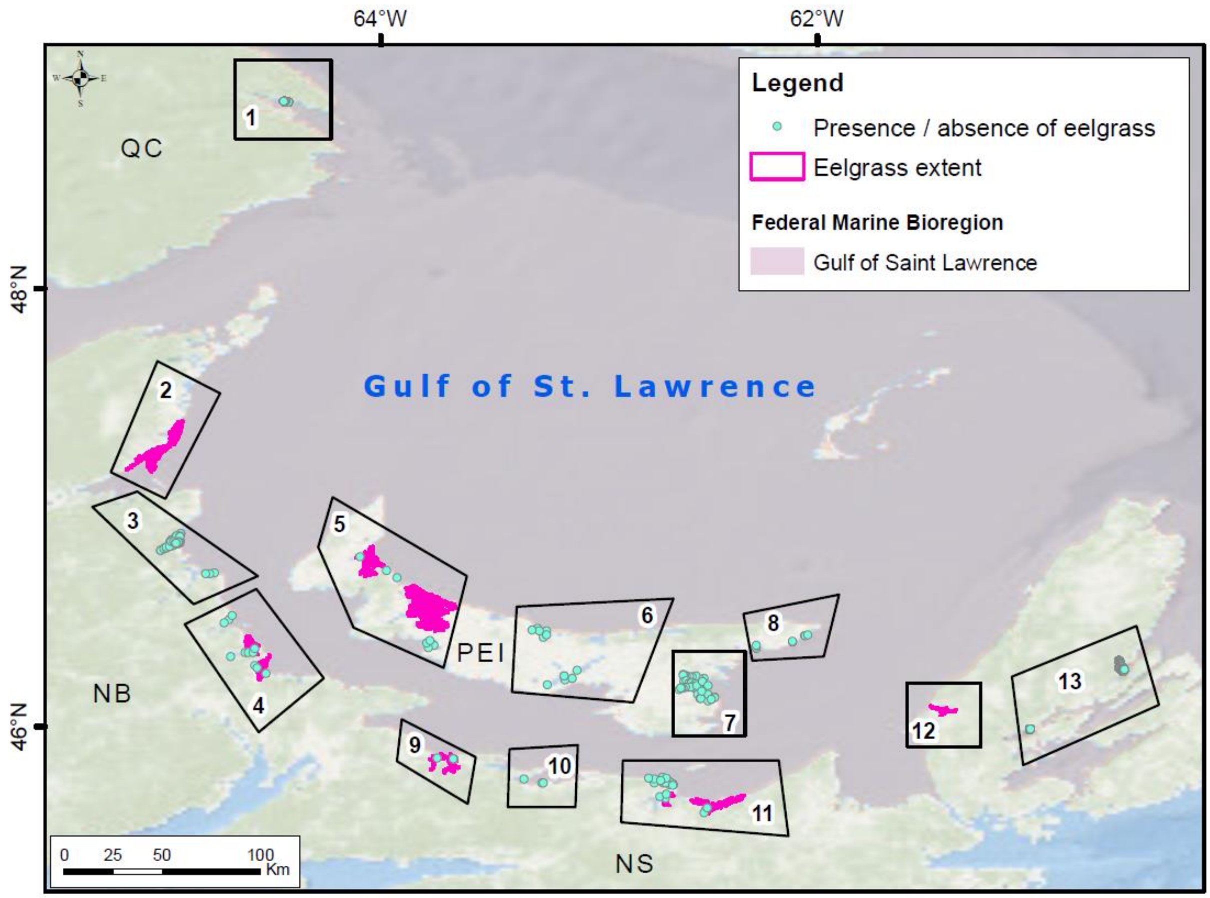

Figure 4. Overview map of eelgrass extent and locations of presence/absence data for the Estuary and Gulf of St. Lawrence bioregion. NB = New Brunswick, PEI = Prince Edward Island, NS = Nova Scotia, QC = Quebec.

2.2.2 SCOTIAN SHELF

A large number of datasets for the Scotian Shelf was contributed, with the Atlantic coast of Nova Scotia being particularly well covered (Figure 5). However, this coverage largely reflected the spatially extensive SDM output layer which, as noted, represents predicted habitat suitability for eelgrass as opposed to actual eelgrass presence (although it is based on a large point eelgrass presence-absence dataset). Other datasets from this region included eelgrass extent determined from LiDAR, aerial and satellite image analysis, benthic sonar and field surveys (Table A3).

Additional pending datasets for the Scotian Shelf bioregion that have either been contributed but are not yet finalized, or that we expect to be contributed in the near future, include satellite imagery from some areas on the southwest coast of Nova Scotia.

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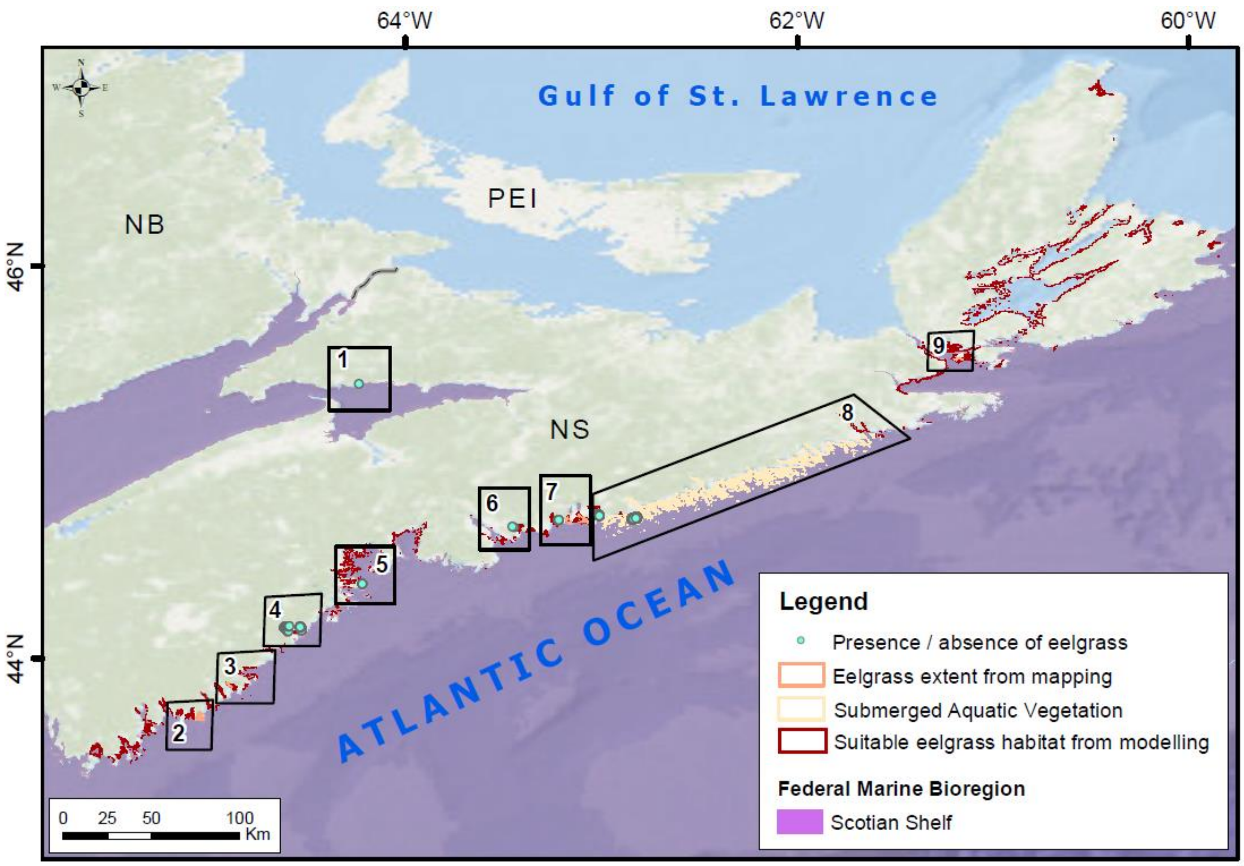

Figure 5. Overview map of eelgrass extent from habitat mapping and modelling and locations of presence/absence eelgrass data for the Scotian Shelf bioregion. NB = New Brunswick, PEI = Prince Edward Island, NS = Nova Scotia. Submerged aquatic vegetation refers to satellite mapping where macrophyte species could not be differentiated (i.e., eelgrass vs macroalgae).

2.2.3 NEWFOUNDLAND AND LABRADOR SHELVES

For this region, datasets were contributed from the southeast coast on Placentia Bay and Trinity Bay (Figure 6). A combination of aerial and satellite image analysis along with field surveys were used to determine eelgrass extent and presence/absence (Table A4).

Additional pending datasets for this bioregion that have either been contributed but are not yet finalized, or that we expect to be contributed in the near future, include aerial imagery of Placentia Bay from the southeast coast of Newfoundland.

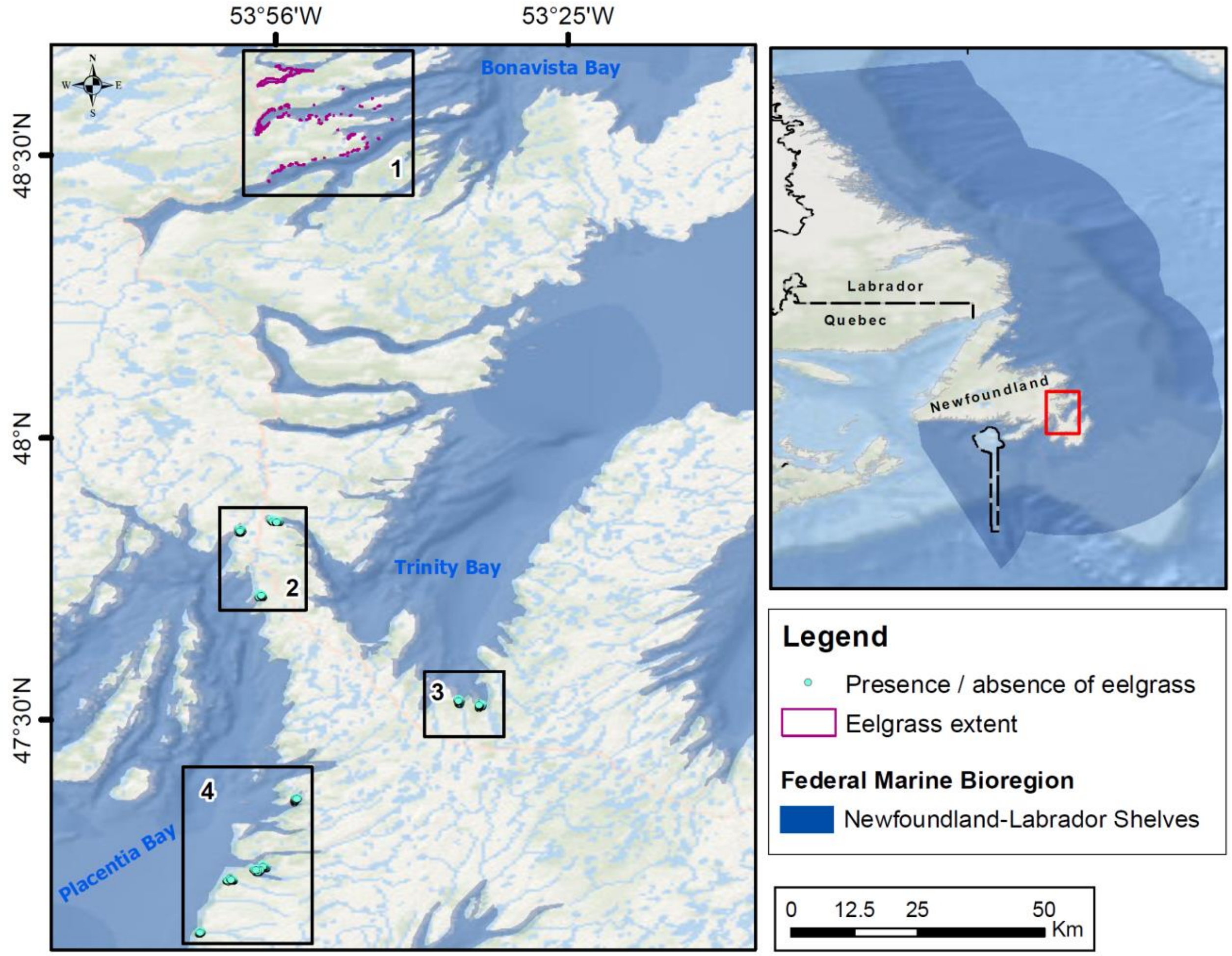

Figure 6. Overview map of eelgrass extent and locations of presence/absence data for the Newfoundland and Labrador Shelves bioregion.

2.2.4 PACIFIC REGION: NORTHERN SHELF, SOUTHERN SHELF, AND STRAIT OF GEORGIA

On the west coast, large datasets were received from the Northern Shelf bioregion in BC, specifically parts of the central coast adjacent to Prince Rupert and Bella Bella (Figure 7). These datasets used a combination of aerial and satellite image analysis along with field surveys to map eelgrass (Table A5). For the Southern Shelf bioregion in BC, a large dataset was contributed for Nootka Sound on the central west coast of Vancouver Island comprising aerial and satellite image analysis combined with field surveys (Figure 8, Table A6). A smaller dataset was received from the waters surrounding D'Arcy Island in the Southern Gulf Islands (Figure 8, Table A6). For the Strait of Georgia bioregion, data were contributed from the coastal waters around Denman Island, the Southern Gulf Islands and much of the mainland coast (Figure 9). These datasets came in the form of aerial and satellite image analysis and field surveys (Table A7).

A significant proportion of the aerial data in the Pacific region are from Coastal and Ocean Resources Inc. and were collected using ShoreZone protocols[1]. ShoreZone is an aerial imaging, coastal habitat classification and mapping system used to inventory alongshore and across-shore geomorphological and biological attributes. It uses aerial imagery to partition a digital representation of the shoreline into relatively homogeneous units. An eelgrass ShoreZone unit is therefore a linear stretch of coastline with a consistent level of eelgrass coverage. Eelgrass ShoreZone units can be broken into higher and lower coverage; here, we show all eelgrass ShoreZone units pooled (i.e., stretches of coast with any eelgrass present).

Additional pending datasets for the Pacific bioregions that have either been contributed but are not yet finalized, or are expected to be contributed in the near future, include aerial imagery and field surveys for significant portions of the BC coast (i.e., Howe Sound, Gulf Islands and North Coast Regional District).

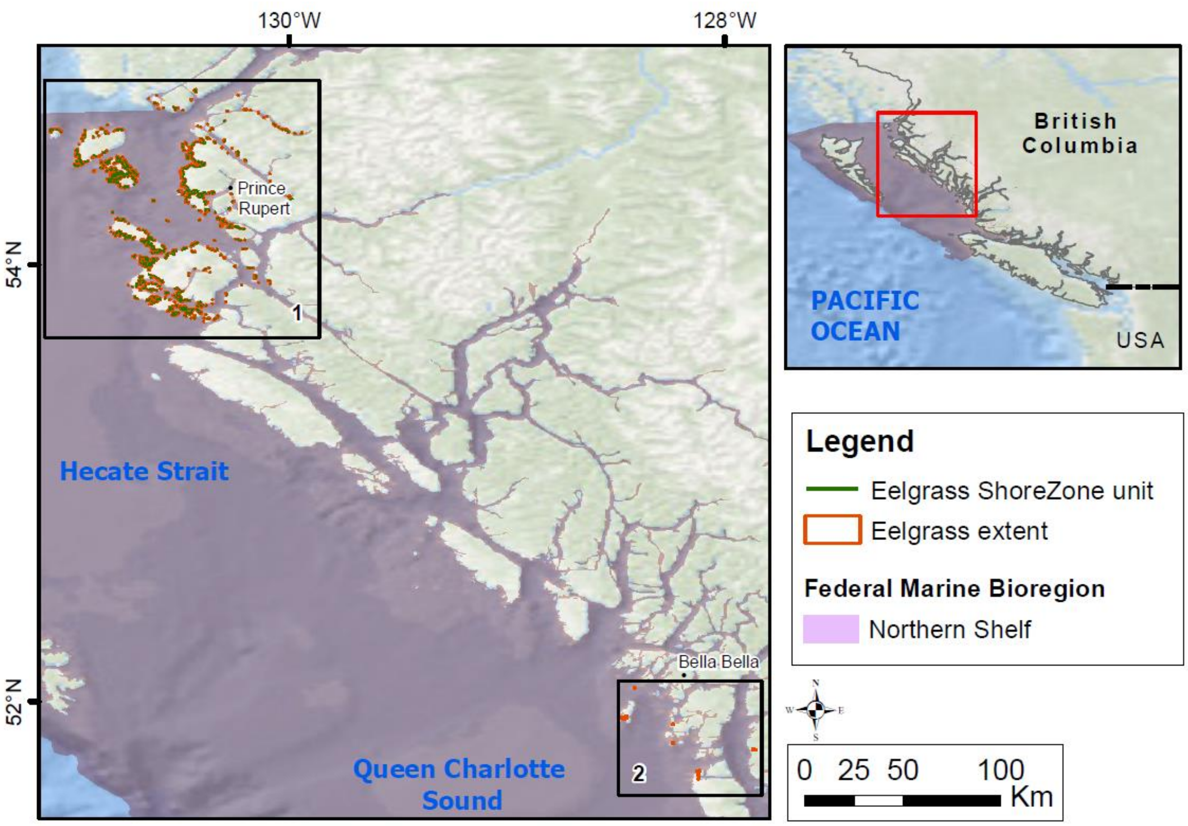

Figure 7. Overview map of eelgrass extent and eelgrass ShoreZone units for the Northern Shelf bioregion.

[1] https://shorezone.org/wp-content/uploads/2023/10/ShoreZone-Protocol-2017.pdf

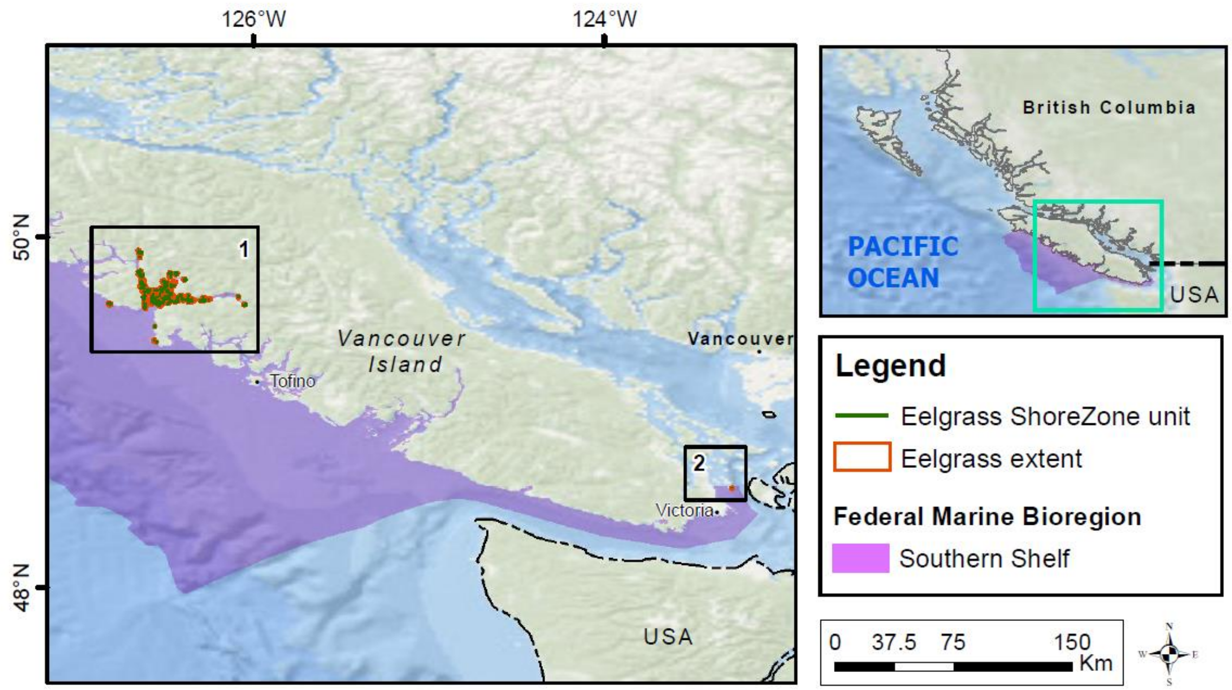

Figure 8. Overview map of eelgrass extent and eelgrass ShoreZone units for the Southern Shelf bioregion.

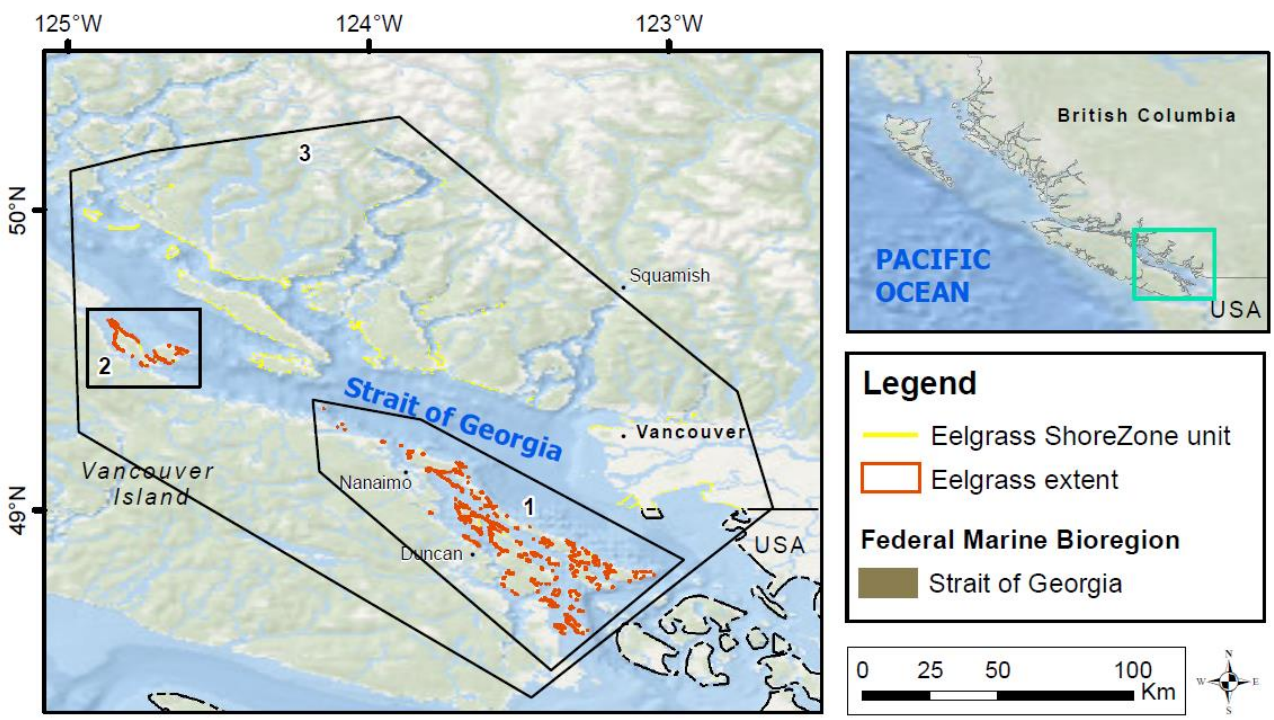

Figure 9. Overview map of eelgrass extent and eelgrass ShoreZone units for the Strait of Georgia bioregion.

2.2.5 HUDSON BAY COMPLEX

For the Arctic, data were compiled for eastern James Bay, located in the Hudson Bay Complex bioregion. These data were obtained from a literature review of documents produced between 1987 and 1992 by DFO Quebec Region (Figure 10, Table A8).

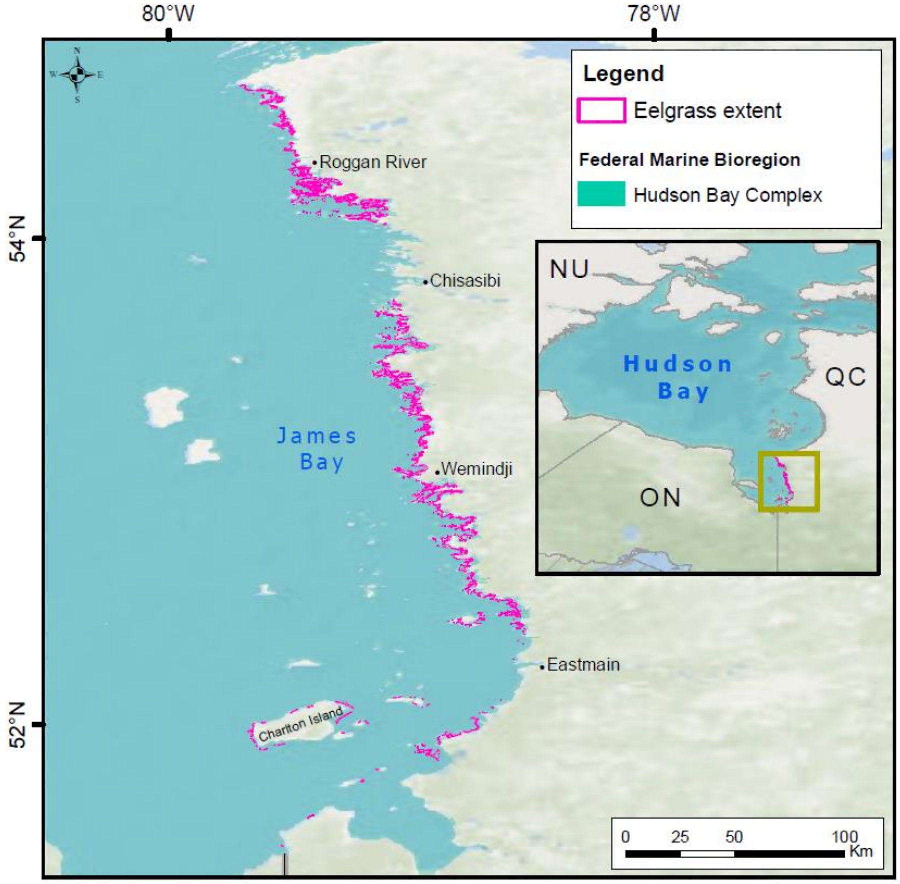

Figure 10. Overview map of eelgrass extent for the Hudson Bay Complex bioregion. QC = Quebec, NU = Nunavut, ON = Ontario.

2.3 DATA GAPS

Most of the coast of Newfoundland and Labrador remains unsurveyed for eelgrass. Additionally, most portions of the Arctic outside of eastern James Bay also remain data poor. These areas lie within the known geographic range of eelgrass (Short et al. 2010), and anecdotal data suggest that eelgrass is present in at least some parts of these areas. While these represent the largest data-poor regions, eelgrass data are also relatively scare for other areas of the Scotian Shelf (e.g., Bay of Fundy, Cape Breton), and St. Lawrence River Estuary (Quebec region).

Because the open data map produced by NETForce is intended to be an evergreen repository, we aim for these gaps to continue to shrink as new data become available, new partnerships are made and existing relationships are strengthened, and in-progress DSAs are completed. These limitations notwithstanding, gaps in the current version of NETForce are useful, in conjunction with other published resources (e.g., ECCC 2020), to identify areas to prioritize for additional eelgrass mapping, monitoring and research.

3 EELGRASS AREA ANALYSIS

The Hudson Bay Complex bioregion had the largest area of eelgrass mapped at 24,029 ha (Table 2) based on information on the distribution of eelgrass beds in James Bay, according to a literature review of documents produced between 1987 and 1992.

The Estuary and Gulf of St. Lawrence had 13,138 ha of mapped eelgrass habitat from a combination of aerial photography, LiDAR and satellite image analysis. Note that we have excluded a dataset of interpolated benthic sonar data from the southern Gulf of St. Lawrence (and one from Port Mouton, NS) from area estimates at this time because these data are in the process of being refined and finalized. These benthic sonar layers are currently included in the Open Data Portal but will be updated in the near future.

Approximately 3,200 ha of mapped eelgrass habitat were reported across three bioregions on the Pacific coast – mostly from the Northern Shelf and Strait of Georgia – consisting primarily of aerial and satellite imagery. However, it is important to note that this estimate excludes ShoreZone surveys, which produce data in linear format as opposed to extent. For the Northern and Southern Shelf bioregions, ShoreZone datasets often had overlapping satellite imagery with corresponding extent data. However, much of the Strait of Georgia bioregion – in particular most of the mainland coast – only had ShoreZone data so these areas are not captured in our area estimate (see Figures 7-9).

The Scotian Shelf and Newfoundland and Labrador Shelves had small areas mapped for eelgrass relative to the other bioregions (1,078 ha and 420 ha, respectively). For Nova Scotia, we excluded the spatially extensive SDM data layer from the area estimate because this layer reflects predicted suitable habitat as opposed to eelgrass presence and is therefore difficult to compare directly with mapping outputs. The SDM, which is based on correlative relationships between environmental variables and eelgrass presence-absence observations, predicts 39,560 ha of suitable habitat[2] in the study area, which includes most of the Atlantic coast of the province as well as the Bras d'Or Lakes in Cape Breton (O'Brien et al. 2022). While we cannot say with confidence how much of the area predicted as suitable for eelgrass is actually occupied (i.e., fundamental vs. realized niche), 76% of the underlying presence-absence observations within the suitable habitat area actually showed eelgrass to be present. Therefore, it is reasonable to infer that: 1) a large proportion of the predicted suitable habitat has at least some eelgrass coverage; and 2) the area directly mapped in this bioregion using other techniques represents a fraction of actual eelgrass habitat present.

For the Scotian Shelf bioregion, several datasets included a Submerged Aquatic Vegetation (SAV) classification, which may or may not include eelgrass mixed in with other macrophytes. For example, in a hyperspectral imagery dataset, both eelgrass and SAV classifications were included and the area denoted as eelgrass was 34 ha compared to 19 ha of SAV. In addition, some satellite imagery analysis from this region (Wilson et al. 2020, 2022) only noted the presence of SAV (i.e., no specific eelgrass category). To be conservative, areas classified as SAV were excluded from eelgrass area estimates.

[2] This value varies slightly from the published area in O'Brien et al. (2022) due to differences in projection.

At the national level, we estimate that a minimum of 41,896 ha of eelgrass habitat have been mapped in Canadian coastal waters[3]. Less than 4% of the area was surveyed by more than one mapping technique (and overlapping areas were only counted once in area estimates).

The area estimates presented here should be interpreted with caution and also considered as conservative estimates of eelgrass coverage that are intended to be refined on an on-going basis as additional datasets become available. Differences among regions should also be interpreted carefully because they reflect a combination of variation in eelgrass habitat area, research effort, methodology, and specific contributed datasets. Important caveats to consider when interpreting the area estimates include, but are not limited to:

1. *The NETForce dataset only includes data contributed by the cutoff date for initial publication*. As noted above, we are aware of other existing and in-progress datasets that we expect to be contributed in the near future. Some existing datasets were not obtained due to the lack of data sharing agreements.
2. *Polygons classified as submerged aquatic vegetation (SAV) in remote sensing datasets were excluded*. This would likely lead to an underestimate of eelgrass area.
3. *Differences in observation and estimation techniques complicate comparisons*. Contributed data were collected using vastly different methodologies, which can have a significant impact on area estimates. Even within a common method such as aerial or satellite image analysis, differences in factors such as image quality (e.g., glare, cloud cover), and analytical methods, can have a strong impact on map outputs.
4. *Variation in survey timing and effort complicate comparisons*. The eelgrass data compiled to date span 1987 to present, and some eelgrass beds were surveyed only once while others were sampled across several years. In addition, factors such as seasonal timing have not been accounted for.
5. *Point and line observation layers without associated extent information were excluded from area calculations*. It was beyond the scope of this report to convert contributed point data layers into polygons due to the wide variety of data properties (e.g., point density, spatial extent). Similarly, linear observations (i.e., ShoreZone units in BC) were not included. As such, significant amounts of eelgrass habitat in surveyed parts of the coast are not reflected in our area estimates.
6. *Only a small proportion of Canada's eelgrass meadows have been the focus of mapping, monitoring and research to date*. As a result, the area estimates presented here almost certainly represent significant underestimates of actual eelgrass extent per bioregion and nationally.
7. *We have not investigated or attempted to account for change of eelgrass extent over time* (e.g., with climate change and other anthropogenic impacts). Observations reflected in the national dataset may not reflect historical baselines, which is a common challenge in eelgrass studies (Dunic et al. 2021).

[3] In an M.Sc. thesis, Christensen (2023) estimated a national eelgrass coverage of 130,349 ha. This estimate was derived in collaboration with members of the DFO NETForce team. The difference between estimates largely reflects: 1) SDM output was included in the thesis estimate but was not included here; and 2) differences in data availability to NETForce at the time of this publication.

Table 2. Total area (ha) of eelgrass extent by mapping technique for all bioregions (UAV = Unoccupied Aerial Vehicle, CASI = Compact Airborne Spectrographic Imager, LiDAR = Light Detection and Ranging). Total area without overlaps represents estimated eelgrass area after overlapping data layers were dissolved into a single layer (see Section 1.7).

	Bioregion							
Mapping technique	**Estuary and Gulf of St. Lawrence****	**Scotian Shelf****	**Newfoundland and Labrador Shelves**	**Northern Shelf**	**Southern Shelf**	**Strait of Georgia**	**Hudson Bay Complex**	**Total area covered (ha)**
Aerial images	4135	115	84	1917	63	219		6533
UAV images		10	265	146				421
Airborne CASI hyperspectral and fieldwork		34						34
Fieldwork***				115		90		205
Aerial images and fieldwork					0.8	684		685
Satellite images	1543	177	270					1990
Satellite images and fieldwork	2294	276						2570
Satellite and aerial images				9	12	42		63
Satellite and aerial images and fieldwork		179				104		283
LiDAR	5851							5851
LiDAR and aerial images	1626	287						1913
Species distribution model		*39560**						*39560**
Literature review							24029	24029
Total area (ha)	15449	1078	619	2187	76	1139	24029	44577
Total area without overlaps (ha)	**13138**	**1078**	**420**	**2042**	**76**	**1113**	**24029**	**41896**

* not included in area totals

** benthic sonar datasets from this region that were received are not yet included in area estimates because they are in the process of being refined

*** fieldwork reflects in-water observations made using methods such as video transects, quadrat surveys and opportunistic surveys

4 APPLICATIONS

The NETForce project stands to benefit management decision-making as well as research by gathering eelgrass distribution datasets in one place and making them openly accessible and easy to explore across the country. It also will help to build a nationwide network of eelgrass specialists whose knowledge can inform various management and science issues when required. Specific applications that may benefit from NETForce include, but are not limited to:

1. *Planning and implementation of spatial protections under the Oceans Act, Fisheries Act and other legislation*. As biogenic habitat that provides many ecosystem services, eelgrass meadows are included as conservation priorities for DFO marine protected areas and other effective area-based conservation measures (e.g., Jeffery et al. 2020). Similarly, the high productivity of eelgrass meadows and its role as fish habitat support the evaluation and classification of Ecologically Significant Areas under the *Fisheries Act*. In both cases, knowledge of eelgrass extent is critical for these spatial protection initiatives.
2. *Fish habitat impact assessments*. DFO's Fish and Fish Habitat Protection Program reviews proposed works, undertakings and activities that may impact fish and fish habitat (e.g., wharf maintenance, shoreline hardening) under the *Fisheries Act* (i.e., HADD assessments). The centralized availability of up-to-date eelgrass maps will help facilitate efficient assessment, and can also be used to evaluate compliance.
3. *Environmental emergency response planning*. NETForce maps and data can provide for up-to-date information on location of valuable fish habitat (eelgrass) to inform environmental emergency response measures for Integrated Marine Response Planning.
4. *Monitoring of ecosystem health*. Since seagrasses tend to be highly sensitive to environmental variability and human impacts (e.g., Hitchcock et al. 2017), and tightly coupled with important aspects of ecosystem function (e.g., habitat creation, fisheries production), they also represent a useful indicator for long-term coastal monitoring (ECCC 2020) including cumulative impact analysis and mapping. Similarly, data on eelgrass distribution are important for socioeconomic models that include ecological indicators such as those compiled by the National Ocean Accounts (Canadian Ocean Accounts: A Pilot Project).
5. *Marine spatial planning.* There are many spatial conflicts within coastal ecosystems related to human activities and uses. Knowledge of the location of seagrass beds can help facilitate integrated management plans that account for cumulative activities and help resolve spatial conflicts while protecting valuable seagrass habitat.
6. *Research by internal and external scientists.* The NETForce repository will facilitate and add value to ecological research projects as the dataset and contributor network continues to grow. For example, models of habitat suitability for eelgrass under climate scenarios (e.g., Wilson and Lotze, 2019) and assessment of other anthropogenic impacts including cumulative effects will be able to draw on NETForce datasets.

5 LESSONS LEARNED

As the first attempt at drawing together and publishing eelgrass datasets from across the country in a publicly accessible platform, NETForce generated some key learnings that can inform future directions for the project and attempts at similar undertakings in other jurisdictions. These include:

1. *Continued engagement of data contributors*. We found that virtual forums were well attended and energized participants to contribute data and continue their involvement in the project. Engagement was necessary throughout the project to maintain momentum and to ensure the final objectives were achieved. Data contributions continue to be received even after the initial project years have been completed, indicating continued interest in the national map. Future engagement is planned to coincide with major updates to the map.
2. *Flexibility in data sharing agreements (DSAs).* We found that while most participants required data sharing agreements, these needed to be flexible to accurately represent the interests of the different parties involved. While the core content of the DSA remained the same for all participants, small adjustments were often made to ensure the needs of different contributors were met. Considerable attention was placed on internal DFO review and signature requirements to ensure efficient completion of DSAs. Experience from this project has contributed to the national DSA framework underway for DFO, and the NETForce DSA continues to evolve as more experience is gained.
3. *Ease of data transfers.* We found that data transfers between DFO and participants had to be easy and efficient to ensure data contributors remained engaged. This was particularly relevant for NETForce because most data files were large and required FTP servers to be transferred. To do this, we used a cloud service that external contributors were able to easily access. This proved important in not only supporting efficient data transfers but also in maintaining good relationships with participants.
4. *Data quality control.* Because contributors spanned such a diversity of organizations, each with unique priorities and resources available, the datasets received required a range of time and effort to ensure quality and move through the standardization and publishing process. The semi-automated workflows developed during this project will improve efficiency moving forward.
5. *Data portal and visualization.* There is considerable interest in the NETForce dataset, and having it freely available through the Open Data Portal is essential for continued engagement of NETForce members and the public at large. The Open Data Portal was considered the best place for the dataset as it can easily handle spatial data, can be regularly and easily updated or revised, will be maintained for in perpetuity and, most importantly, is freely accessible to the public. Visualization through the Open Data Portal will continue to be improved to enhance map loading times and support quick exploration of datasets. Further links to the Marine Spatial Planning Atlas provide additional context for eelgrass habitat in relation to the surrounding physical environment and human stressors.

6 CONCLUDING REMARKS

NETForce was envisioned as an innovative, diverse and inclusive partnership to create a publicly accessible national map of eelgrass beds that can be used to support monitoring and decision-making and facilitate future research. The project has been successful in engaging and consulting with scientists, managers, and partners to collate, to date, 113 eelgrass datasets integrated in a common format. The data collected using diverse mapping techniques was used to create a dynamic national map of eelgrass extent covering seven federal marine bioregions, which is now available on the Open Data Portal. This map is intended to be dynamic and evergreen, allowing easy exploration and addition of new or expanded datasets as they become available. We anticipate that NETForce will be used to help incorporate eelgrass habitat into many management frameworks and decision-making processes ranging from local to national scales. To make the project as successful as possible moving forward, effort should be directed toward attracting as many contributing partners as possible and promoting the use of the tool among researchers and managers across the country. Continued focus on networking and relationship building, including on-going and expanded discussions with Indigenous organizations, is needed to continue growing a national eelgrass resource that is accessible and beneficial to all. Lastly, lessons learned from the NETForce process may be useful for helping to assemble networks and gather datasets for other important coastal taxa using a similar framework in the future.

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8 AUTHOR CONTRIBUTION STATEMENT

JGS: data curation, formal analysis, methodology, project administration, software, validation, visualization, writing – original draft, writing – review and editing

JAT: writing – original draft, writing – review and editing, supervision

BV: writing – original draft, writing – review and editing, supervision

MCW: conceptualization, funding acquisition, methodology, project administration, resources, supervision, writing – review and editing

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10 DATA AVAILABILITY STATEMENT

All data and metadata contributed to NETForce are available on the Government of Canada's Open Data Portal: https://open.canada.ca/data/en/dataset/a733fb88-ddaf-47f8-95bb-e107630e8e62.

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APPENDIX I: SPATIAL DATA PROCESSING AND STANDARDIZATION

Final spatial data processing was performed using vector datasets. For data received as raster datasets, the RASTER CALCULATOR tool from ArcGIS 10.7.1 was used to transform floating points to integer pixel type. Then the RASTER TO POLYGON tool was used to convert rasters to polygon features. Under this tool, the ‘simplify polygons’ parameter was unchecked, which allowed the output polygons to conform exactly to the input raster's cell edges. Once the data were converted to vector format and imported to the Esri file geodatabases as feature classes, the Model Builder (Figure 4) was used using the different Esri file geodatabases as workspace (A). From this model, the PROJECT tool (B) was used to change the projected coordinate system of the data to another coordinate system: all datasets were reprojected to the World Geodetic System 1984 (WGS 1984, EPSG:4326). Then, additional fields were added to the attribute table for each feature class in the dataset using the ADD FIELD tool (C). These fields were included depending on the original metadata provided by the data provider (i.e. eelgrass percent cover, eelgrass density, map reference, image classification technique) (Table 3). Some of the metadata were not included in the original data contribution and had to be extracted from the associated technical report, when available, or by request to the data provider. In Figure 4, the fields added are shown in light blue circles (Year, Mapping techniques, Area [m2] and Province). The CALCULATE FIELD tool (D) was then used to calculate the values for each new field added previously or extracted from a field already present in the attribute table using string or number functions. The area and length fields were calculated using the ADD GEOMETRY tool (E). For this tool, the coordinate system used to generate the area calculations was NAD83(CSRS) / Canada Atlas Lambert projection (EPSG: 3979); areas were calculated in ha and m2, while lengths were calculated in m. After the default fields and values were generated from the ADD GEOMETRY tool, new fields were added (Area m2, Area Ha and Length m). The geometry values from the default fields were used to calculate the new fields. The final set of fields associated with each feature class are shown in Table 3.

The outputs from this model (feature classes) were organized and imported in geodatabases based on the biogeographic region from which the data originated. Some of the datasets are included in more than one geodatabase because of the spatial extent (i.e. Nova Scotia Community College (NSCC) original dataset contains data in the Estuary and Gulf of St. Lawrence and Scotian Shelf bioregions). The layers (feature classes) title followed a name convention rule (‘Institution acronym or name’_’Area or region in which data were collected’_’mapping technique used to collect the data’_’year range of the data’).

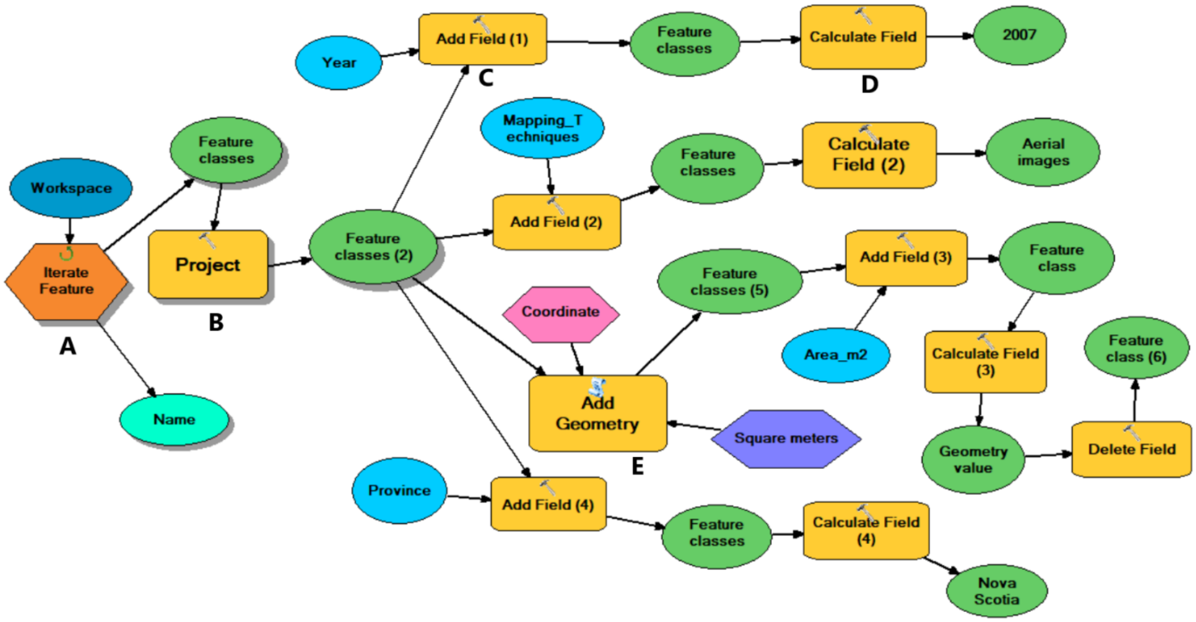

Figure A1. Example of the tools used in the model to generate new fields and add their values for each eelgrass dataset from the data providers. In this figure only four of the twenty-three fields are displayed.

Table A1. List of the fields added to the attribute table of the feature classes and their descriptions.

Field	Description
Latitude	Latitude of sample site in decimal degrees*
Longitude	Longitude of sample site in decimal degrees*
Site	Indicates the name of the location that was surveyed
StationID	Unique identification code for the stations associated with fieldwork
Year	The four-digit year in which the data were collected
Month	The one or two-digit month in which the data were collected
Day	The one or two-digit day in which the data were collected
Class	Name of the cover type classified from the image technique used
Eelgrass observation	Indicates if the class was classified as eelgrass (Presence), not eelgrass (Absence) or Uncertain
Eelgrass percentage cover	Estimated percentage of eelgrass cover / Estimated unit length percentage of eelgrass cover
Probability eelgrass presence	Estimated percentage of eelgrass cover using Ordinary Kriging interpolation method
Eelgrass density	Density class of eelgrass cover
Area m^2	Area of the class in square meters (m^2)**
Area Ha	Area of the class in hectares (ha)**
Length	Length of the ShoreZone unit in meters (m)**
Mapping techniques	Name of the data collection methods
Image classification technique	Type of the image classification technique used to process the images
Water body	Name of the water body in which the data were collected
Province	Name of the province in which the data were collected
Biogeographic region	Federal Marine Bioregions. See the following link: https://open.canada.ca/data/en/dataset/23eb8b56-dac8-4efc-be7c-b8fa11ba62e9
Data provider	Name of the person, group or institution having custody of the data
Institution code	Name and acronym in use by the institution having custody of the data
Dataset URL	Address of the web page from the dataset
Reference	Reference to the dataset in the web page related to the data
Dataset Name	Name of the dataset included in the institution having custody of the data
Map reference	Reference to the figure number in the publication related to the data
Comments / Note	Additional information about the data

* World Geodetic System 1984 (EPSG: 4326)
**Area and length calculations using NAD83(CSRS) / Canada Atlas Lambert projection (EPSG: 3979)

APPENDIX II: DATA LAYERS BY BIOREGION AND AREA

For all tables below, the name of each data layer matches the file name in the Open Data Portal.

Table A2. List of fieldwork, satellite and aerial image datasets per area of the Estuary and Gulf of St. Lawrence bioregion and associated map (figure number). PCA = Parks Canada Agency, NSCC = Nova Scotia Community College, AIS = Aquatic Invasive Species, NCC = Nature Conservancy of Canada, EAC = Ecology Action Centre, DFO = Department of Fisheries and Oceans Canada, SGSL = Southern Gulf of St. Lawrence Coalition.

Area	Province	Layer
1	QC	PCA_Forillon_National_park_Eelgrass_Quadrat_2013_2018
2	NB	DFO_GulfRegion_Tabusintac_Bay_eelgrass_Satellite_Images_2014
		McGill_University_Tabusintac_Bay_Eelgrass_Satellite_Images_FieldWork_2008_2017
		NSCC_Eelgrass_Lidar_Aerial_Images_2014_2021
3	NB	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
4	NB	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
		NSCC_Eelgrass_Lidar_Aerial_Images_2014_2021
5	PEI	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
		DFO_GulfRegion_Malpeque_Foxley_Bay_Eelgrass_Aerial_images_2010
6	PEI	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
7	PEI	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
8	PEI	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
9	NS	NCC_Pugwash_Estuary_Eelgrass_Aerial_Images_2014
		NSCC_Eelgrass_Lidar_Aerial_Images_2014_2021
		DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
10	NS	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
11	NS	DFO_GulfRegion_Eelgrass_AIS_FieldWork_2001_2012
		NSCC_Eelgrass_Lidar_Aerial_Images_2014_2021
12	NS	NSCC_Eelgrass_Lidar_Aerial_Images_2014_2021
13	NS	EAC_BrasdOrLakes_AnnsHarbour_Eelgrass_FieldWork_2019_2020
2-8, 11	PEI, NB	SGSL_Coalition_Eelgrass_BenthicSonar_2018_2020
2-8, 11	PEI, NB	SGSL_Coalition_Eelgrass_InterpolationBenthicSonar_2018_2020

Table A3. List of surveyed areas within the Scotian Shelf bioregion. EAC = Ecology Action Centre, NSCC = Nova Scotia Community College, DNRR = Department of Natural Resources and Renewables, PCA = Parks Canada Agency, DRDC = Defence R and D Canada, SGSL = Southern Gulf of St. Lawrence Coalition.

Area	Layer
1	EAC_ScotianShelfRegion_Eelgrass_FieldWork_2019_2021
2	NSCC_Eelgrass_Lidar_Aerial_Images_2016
3	DNRR_Port_Joli_Eelgrass_Satellite_Images_FieldWork_2009_2010
	PCA_KejimkujikSeaside_Eelgrass_UAV_Images_2018_2022
	SGSL_Coalition_Eelgrass_BenthicSonar_2018_2020
	SGSL_Coalition_Eelgrass_InterpolationBenthicSonar_2018_2020
4	EAC_ScotianShelfRegion_Eelgrass_FieldWork_2019_2021
5	EAC_ScotianShelfRegion_Eelgrass_FieldWork_2019_2021
6	EAC_ScotianShelfRegion_Eelgrass_FieldWork_2019_2021
7	EAC_ScotianShelfRegion_Eelgrass_FieldWork_2019_2021
	DNRR_Musquodoboit_Harbour_Petpeswick_Inlet_Eelgrass_Aerial_Satellite_Images_FieldWork_2002_2014
8	EAC_ScotianShelfRegion_Eelgrass_FieldWork_2019_2021
	DFO_Maritimes_EasternShoreIslands_Submerged_Aquatic_Vegetation_Satellite_Images_2016_2019
9	DRDC_Janvrin_Island_Eelgrass_Airbone_hyperspectral_FieldWork_2005
Atlantic coast of NS and Bras d'Or Lakes	DFO_MaritimesRegion_Eelgrass_Ensemble_Species_Distribution_Model_Binary_PA_2010_2021

Table A4. List of surveyed areas within the Newfoundland and Labrador Shelves bioregion. PCA = Parks Canada Agency, OCEANS Lab = 4D OCEANS Lab - Fisheries and Marine Institute of Memorial University of Newfoundland.

Area	Layer
1	PCA_TerraNova_National_Park_Eelgrass_Satellite_Images_2017
2	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_UnderWaterVideo_2020
	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_Aerial_UAV_Images_2009_2020
	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_UAV_Images_2020
3	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_UnderWaterVideo_2020
	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_Aerial_UAV_Images_2009_2020
	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_UAV_Images_2020
4	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_UnderWaterVideo_2020
	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_Aerial_UAV_Images_2009_2020
	OCEANS_Lab_Placentia_Trinity_Bay_Eelgrass_UAV_Images_2020

Table A5. List of surveyed areas within the Northern Shelf bioregion. CORI = Moran Coastal and Ocean Resources Inc., Hakai = Hakai Institute, BC = British Columbia.

Area	Province	Layer
1	BC	CORI_BritishColumbia_Eelgrass_Aerial_Video_Images_2014_2019
		CORI_BritishColumbia_Eelgrass_Aerial_Satellite_Images_2014_2019
2	BC	Hakai_CentralCoast_Eelgrass_Aerial_UAV_UnderwaterVideo_Images_2012_2020

Table A6. List of surveyed areas within the Southern Shelf bioregion. CORI = Moran Coastal and Ocean Resources Inc. BC = British Columbia.

Area	Province	Layer
1, 2	BC	CORI_BritishColumbia_Eelgrass_Aerial_Video_Images_2021
		CORI_BritishColumbia_Eelgrass_Aerial_Satellite_Images_FieldWork_2021

Table A7. List of surveyed areas within the Strait of Georgia bioregion. CORI = Moran Coastal and Ocean Resources Inc. BC = British Columbia.

Area	Province	Layer
1	BC	CORI_BritishColumbia_Eelgrass_Aerial_Satellite_Images_FieldWork_2021
		MICS_Southern_Gulf_Islands_Eelgrass_FieldWork_2009_2021
2	BC	CORI_BritishColumbia_Eelgrass_Aerial_Satellite_Images_FieldWork_2021
3	BC	CORI_BritishColumbia_Eelgrass_Aerial_Video_Images_2017_2021

Table A8. List of surveyed areas within the Hudson Bay Complex bioregion. OGP = Open Government Licence – Canada, QC = Quebec.

Province	Layer
QC	OGP_JamesBay_Eelgrass_LiteratureReview_1987_1992