

North America Blue Carbon Maps

Cartographic Integration Process

Commission for Environmental Cooperation

North America Seagrasses Map update process

This document describes the processes conducted to update the North America Seagrasses distribution map published by the Commission for Environmental Cooperation (CEC) in 2015. The overall process comprises data search of new or updated mapping sources describing the spatial distribution of Seagrasses across North America, data review, data selection and cartographic integration of the selected data.

An initial review of the datasets used in the 2017 North America Seagrasses distribution map and an exhaustive search for data updates or new datasets available was conducted by the Mexican Carbon Program, that reviewed 46 seagrasses datasets ranging from global to regional scale (Table 1).

Table 11. Initial seagrasses datasets collected and reviewed.

| | Dataset | Geometry | Source |
|----|---|----------|--|
| 1 | WCMC Seagrass Distribution Map | Polygon | World Conservation Monitoring Center-United Nations Environment Programme |
| 2 | Seagrass location in Estero el Soldado, Sonora | Polygon | Benítez-Valenzuela et al. 2020 |
| 3 | Estero EL Soldado Orthophoto | Polygon | Encinas-Lara et al. 2019 |
| 4 | Washington state, GPS transects | Polygon | Washington State Department of Natural Resources Submerged Vegetation Monitoring Program |
| 5 | Seagrass distribution in the south coast of Texas | Polygon | Texas Parks and Wildlife, Coastal Fisheries Division |
| 6 | Atlantic coast seagrass distribution | Polygon | National Oceanic and Atmospheric Administration |
| 7 | Baja California Seagrass distribution | Polygon | Frederick T. Short (University of New Hampshire) |
| 8 | British Columbia Eelgrass Distribution | Polygon | Hakai Institute |
| 9 | Campeche Seagrass distribution | Polygon | |
| 10 | Nova Scotia seagrass distribution | Polygon | |
| 11 | Seagrass distribution in the coast of Washington state | Polygon | Washington State Department of Natural Resources Submerged Vegetation Monitoring Program |
| 12 | Aquatic submerged vegetation communities in the Gulf of Mexico | Polygon | National Commission for the Knowledge and Use of Biodiversity |
| 13 | Spatial distribution of seagrasses and macroalgae in the eastern coast of Yucatan's state | Polygon | National Commission for the Knowledge and Use of Biodiversity |
| 14 | Veracruz distribution of seagrasses | Polygon | National Commission for the Knowledge and Use of Biodiversity |
| 15 | Dzilam, Yuc, Seagrass Distribution | Polygon | Mendoza-Martínez et al. 2018 |
| 16 | Veracruz reef system, seagrass distribution | Polygon | Mendoza-Martínez et al. 2019 |
| 17 | Aquatic submerged vegetation, Yucatan | Polygon | National Commission for the Knowledge and Use of Biodiversity |

| | | | |
|----|---|---------|---|
| 18 | Seagrass and aquatic submerged vegetation distribution in Los Petenes, Campeche | Polygon | National Commission for the Knowledge and Use of Biodiversity |
| 19 | British Columbia Eelgrass Distribution | Polygon | Ministry of Forests, Lands, Natural Resource Operations and Rural Development - GeoBC. Open Government License - British Columbia |
| 20 | Seagrass Distribution Christmas Bay, Texas | Polygon | Texas Parks and Wildlife, Coastal Fisheries Division |
| 21 | James Bay Seagrass Distribution (1996) | Polygon | Melanie Leblanc (McGill University) |
| 22 | New Brunswick Eelgrass Distribution | Polygon | Melanie Leblanc (McGill University) |
| 23 | Laguna de Términos, Campeche, seagrass distribution | Polygon | INECC-PNUD México, 2017 |
| 24 | Petenes, Campeche, Seagrass distribution | Polygon | INECC-PNUD México, 2017 |
| 25 | Bahía de la Ascensión, QROO, Seagrass distribution | Polygon | INECC-PNUD México, 2017 |
| 26 | Sistema Arrecifal Veracruzano, seagrass distribution | Polygon | Herrera-Silveira et al. 2018 |
| 27 | Densisty of Eelagras in the USA Northeast Atlantic | Polygon | SeaPlan |
| 28 | Dzilam-Bravo, Yuc, Seagrass Distribution | Polygon | Laboratorio Producción Primaria of Cinvestav-Unidad Mérida |
| 29 | Nichupte Lagoon seagrass distriution | Polygon | Herrera-Silveira et al. 2020 |
| 30 | Yalahau-Holbox seagrass distribution | Polygon | Herrera-Silveira et al. 2018 |
| 31 | Chelem Lagoon seagrass distribution | Polygon | Laboratorio Producción Primaria of Cinvestav-Unidad Mérida |
| 32 | Isla de Todos los Santos, Seagrass | Polygon | José Miguel Sandoval Gil |
| 33 | British Columbia ShoreZone | Polygon | Carol Ogborne |
| 34 | British Columbia Seagrass distribution | Polygon | British Columbia-Marine Conservation Analysis (BCMCA) |
| 35 | Habitat benticos del Parque Nacional Arrecifes de Xcalak | Polygon | National Commission for the Knowledge and Use of Biodiversity |
| 36 | San Francisco Bay seagrass distribution | Polygon | Frederick T. Short (University of New Hampshire) |
| 37 | Seagrass distribution in the coast of Washington state | Polygon | Washington State Department of Natural Resources |
| 38 | Seagrass distrubution in Southeast Alaska and the Aleutians | Polygon | United States Geological Survey |
| 39 | St. Lawrence Wetlands | Polygon | Environment Canada |
| 40 | Pacific Northwest seagrass locations | Point | Prentice et al. 2020 |
| 41 | USA Seagrasses distribution from the National Greenhouse Gasses Inventory | Point | Environmental Protection Agency |
| 42 | North Pacific coast seagrass locations | Point | Kauffman et al. 2020 |
| 43 | James Bay seagrass locations | Point | Melanie Leblanc (McGill University) |
| 44 | New Brunswick seagrass locations | Point | Frederick T. Short (University of New Hampshire) |
| 45 | Nova Scotia seagrass locations | Point | Frederick T. Short (University of New Hampshire) |
| 46 | Prince Edward Island seagrass locations | Point | Frederick T. Short (University of New Hampshire) |

In a second review of the seagrass datasets, each of them was evaluated and identified for suitability in the update process. Based on this second review, a final list of seagrass datasets was defined to be used

in the mapping integration process representing the spatial distribution of seagrass ecosystems across North America. The following list offers a summary of the second review of seagrasses datasets.

1. WCMC Seagrass Distribution Map

This layer was initially provided by PMC but there is an updated version (version 7) that shows global distribution of seagrasses. The new layer was acquired from the source URL.

2. Seagrass location in Estero el Soldado, Sonora

This dataset displays one single seagrass sample in estero El Soldado, Sonora.

3. Estero EL Soldado Orthophoto

This dataset is an orthophoto without any values associated to seagrass with the image frame, no further vector information related to seagrass distribution is delivered.

4. Washington state, GPS transects

This geodatabase contains points records of exhaustive transects. The points represent more than 11 million GPS tracking stamps. The updated information of this layer is already in the SVMP updated database published in 2020.

5. Seagrass distribution in the south coast of Texas

The area covered by the polygons in this dataset are already mapped in the newest WCMC global distribution map.

6. Atlantic coast seagrass distribution

The area covered by the polygons in this dataset are already mapped in the newest WCMC global distribution map.

7. Baja California Seagrass distribution

This dataset was restored from CEC files. However, this dataset does not have any clear metadata associated, there is no scale, year or source reported. It was delivered by Fred Short, but attributes and some other important data are still uncertain.

8. British Columbia Eelgrass Distribution

This dataset refers to a website from Hakai institute, no files were delivered by PMC.

9. Campeche Seagrass distribution

This dataset was restored from CEC files: The area covered by this dataset has been updated in the areas mapped by two new layers from CONABIO and INEECC-PNUD.

10. Nova Scotia seagrass distribution

This layer was reviewed by PMC, but no file was delivered. The file was downloaded using the link provided. This dataset does not contain any information related to seagrasses distribution.

11. Seagrass distribution in the coast of Washington state

The polygons and points representing the distribution of seagrasses have been identified and extracted as individual spatial layers from the delivered geodatabase.

12. Aquatic submerged vegetation communities in the Gulf of Mexico

Polygon features in this dataset are very generalized and the area covered by this layer is already mapped in higher detail by another dataset.

13. Spatial distribution of seagrasses and macroalgae in the eastern coast of Yucatan's state

This dataset is suitable for integration in the new North America seagrasses distribution map.

14. Veracruz distribution of seagrasses

This dataset shows seagrass polygons that are mapped in higher detail by another dataset.

15. Dzilam, Yuc, Seagrass Distribution

This data set cover the same area as Dzilam-Bravo, Yuc, Seagrass Distribution dataset and the methodology for both datasets is similar, but Dzilam-Bravo, Yuc reports higher accuracy (89%) than this dataset (81%).

16. Veracruz reef system, seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

17. Aquatic submerged vegetation, Yucatan

This dataset is suitable for integration in the new North America seagrasses distribution map.

18. Seagrass and aquatic submerged vegetation distribution in Los Petenes, Campeche

This dataset is suitable for integration in the new North America seagrasses distribution map.

19. British Columbia Eelgrass Distribution

Polygons in this layer are already mapped by the WCMC global seagrass distribution map.

20. Seagrass Distribution Christmas Bay, Texas

This dataset is suitable for integration in the new North America seagrasses distribution map.

21. James Bay Seagrass Distribution (1996)

This layer was integrated in a first map draft, but based on direct communication with Brigitte Lebron, this data might not be used as it comes from point data.

22. New Brunswick Eelgrass Distribution

This layer was integrated in a first map draft, but based on direct communication with Brigitte Lebron, this data should not be used as it comes from point data.

23. Laguna de Términos, Campeche, seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

24. Petenes, Campeche, Seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

25. Bahía de la Ascensión, QROO, Seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

26. Sistema Arrecifal Veracruzano, seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

27. Density of Eelgrass in the USA Northeast Atlantic

The PMC delivered geodatabase file and a polygon shapefile with the same ID, although no preprocess is reported, the layer corresponding Eelgrass bed within the geodatabase was exported to generate a new spatial layer out of the geodatabase.

28. Dzilam-Bravo, Yuc, Seagrass Distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

29. Nichupte Lagoon seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

30. Yalahau-Holbox seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

31. Chelem Lagoon seagrass distribution

This dataset is suitable for integration in the new North America seagrasses distribution map.

32. Isla de Todos los Santos, Seagrass

This dataset is suitable for integration in the new North America seagrasses distribution map.

33. British Columbia ShoreZone

This dataset was restored from CEC files. However, there is a newest dataset published in 2018 that must be used.

34. British Columbia Seagrass distribution

Polygons in this layer are already mapped by the WCMC global seagrass distribution map.

35. Habitat benticos del Parque Nacional Arrecifes de Xcalak

This dataset was restored from CEC files. However, it was also downloaded from the sources to confirm all metadata information and preprocesses originally performed prior integration in the North American map. The downloaded map is version 2 of this dataset.

36. San Francisco Bay seagrass distribution

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

37. Seagrass distribution in the coast of Washington state

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

38. Seagrass distribution in Southeast Alaska and the Aleutians

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

39. St. Lawrence Wetlands

This is a layer used in the 2015 Blue Carbon Map, Guy Letourneau from Environment Canada has delivered this dataset.

40. Pacific Northwest seagrass locations

This dataset is suitable for integration in the new North America seagrasses distribution map.

41. USA Seagrasses distribution from the National Greenhouse Gases Inventory

This layer was delivered by PMC; however, it is not clear what was the source file they used. The database was later identified from the source URL and reprocessed to generate a shape file of the distribution of points representing different Blue Carbon Ecosystems. Points possibly incorrectly georeferenced over the ocean and further inland were deleted manually to keep only the records along the coast of the United States.

42. North Pacific coast seagrass locations

This dataset is suitable for integration in the new North America seagrasses distribution map.

43. James Bay seagrass locations

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

44. New Brunswick seagrass locations

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

45. Nova Scotia seagrass locations

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

46. Prince Edward Island seagrass locations

This dataset was restored from CEC files and is suitable for integration in the new North America seagrasses distribution map.

Derived from the second review of the initially identified and reviewed seagrasses datasets covering the North American region, a final list of datasets was defined to be used as main inputs in the new

North America Seagrass distribution map. Some of the datasets were acquired later than the initial data collection, Table 2.

Table 12. Final datasets for the North America Seagrasses Map update.

| | CODE | Name | Version | Resolution/ Scale | Spatial Reference | Year of Origin | Year of Publication | Coverage | Source |
|----------|-------|--|---------|-----------------------|----------------------|-------------------|------------------------|----------|--|
| Polygons | SG_01 | SG_01 Global Distribution of Seagrasses | 7 | 1:12,000 - 1:80,000 | Mollwide (WGS84) | 2020 | 2010 | Global | UN World Conservation Monitoring Centre |
| | SG_02 | BC Howe Sound Eelgrass distribution | 1 | N/A | WGS 1984 | 2012 - 2018 | 2020 | Regional | Howe Sound/Átl'ka7tsem Marine Reference Guide |
| | SG_03 | British Columbia ShoreZone Observed Habitat Polygons | N/A | 1:2,000 - 1:50,000 | Albers (NAD83) | 2011 | 2020 | Regional | BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development |
| | SG_04 | East Canada Eelgrass Inventory | N/A | N/A | NAD83 | 1987 - 2009 | 2009 | Regional | Fisheries and Oceans Canada (DFO) |
| | SG_05 | New Brunswick Eelgrass Distribution | N/A | 30 meters | UTM 20N (WGS84) | 2017 | 2017 | Regional | Melanie Leblanc (McGill University) |
| | SG_06 | St. Lawrence wetlands classification | N/A | 10 meters | UTM 19N (NAD83) | 1991 | N/A | Regional | Environment and Climate Change Canada |
| | SG_07 | Alaska and the Aleutians seagrass distribution | N/A | N/A | UTM 4N (WGS84) | 2002 - 2008 | 2012 | Regional | United States Geological Survey and Fish and Wildlife Service |
| | SG_08 | Washington coast seagrass distribution | N/A | 1:50,000 - 1:625,000 | LAEA | 2000 - 2019 | 2020 | Regional | Washington State Department of Natural Resources Submerged Vegetation Monitoring Program |
| | SG_09 | Washington ShoreZone seagrass distribution | N/A | 1:24,000 | NAD83 | 2001 | 2006 | Regional | Washington State Department of Natural Resources |
| | SG_10 | Density of Eelgrass in the USA Northeast Atlantic | N/A | 1:5,000 - 1:3,000,000 | NAD83 | 2014 | 2014 | Regional | Northeast Ocean Data |
| | SG_11 | San Francisco Bay seagrass distribution | N/A | N/A | NAD83 | 2009 | 2009 | Regional | Frederick T. Short (University of New Hampshire) |
| | SG_12 | Texas Christmas Bay seagrass distribution | N/A | N/A | NAD83 | 2016 | 2018 | Regional | Texas Parks and Wildlife, Coastal Fisheries Division |
| | SG_13 | Seagrass distribution, Veracruz reef system | N/A | 2 meters | UTM 14N (WGS84) | 2017 | 2020 | Regional | Mendoza-Martínez et al. 2019 |
| | SG_14 | Seagrass distribution, Veracruz reef system 2 | 1 | 2 meters | UTM 14N (WGS84) | 2017 | 2017 | Regional | Herrera-Silveira et al. 2018 |
| | SG_15 | Distribution of seagrasses in eastern Yucatan | 1 | 1:20,000 | WGS 1984 | 2018 - 2019 | 2020 | Regional | National Commission for the Knowledge and Use of Biodiversity |
| | SG_16 | Seagrass distribution, Dzilam, Yucatan | N/A | 6 meters | UTM 16N (WGS84) | 2017 | 2018 | Regional | Mendoza-Martínez et al. 2018 |
| | SG_17 | Aquatic submerged vegetation, Yucatan | 1 | 1:450,000 | WGS 1984 | 2010 - 2012 | 2018 | Regional | National Commission for the Knowledge and Use of Biodiversity |
| | SG_18 | Chelem seagrass distribution | N/A | 10 meters | UTM 15N (WGS84) | 2019 | 2019 | Regional | Laboratorio Producción Primaria, Cinvestav-Unidad Mérida |

| | | | | | | | | | |
|--------|-------|---|-----|-----------|-----------------|-------------|------|---------------|--|
| Points | SG_19 | Aquatic submerged vegetation, Campeche | 1 | 1:350,000 | WGS 1984 | 2011 - 2017 | 2020 | Regional | National Commission for the Knowledge and Use of Biodiversity |
| | SG_20 | Laguna de Términos seagrasses distribution | 1 | 30 meters | UTM 15N (WGS84) | 2017 | 2017 | Regional | INECC-PNUD México, 2017 |
| | SG_21 | Los Petenes, Campeche, seagrasses distribution | 1 | 30 meters | UTM 15N (WGS84) | 2017 | 2017 | Regional | INECC-PNUD México, 2017 |
| | SG_22 | Bahía Ascención, Q Roo, seagrasses distribution | 1 | 30 meters | UTM 16N (WGS84) | 2017 | 2017 | Regional | INECC-PNUD México, 2017 |
| | SG_23 | Nichupte Lagoon seagrass distribution | N/A | 10 meters | UTM 16N (WGS84) | 2019 | 2019 | Regional | Herrera-Silveira et al. 2020 |
| | SG_24 | Yalahau-Holbox seagrass distribution | N/A | 10 meters | UTM 16N (WGS84) | 2017 | 2017 | Regional | Herrera-Silveira et al. 2018 |
| | SG_25 | Catoche-Xcalak seagrasses distribution | 2 | 1:8,000 | WGS 1984 | 2017 | 2018 | Regional | National Commission for the Knowledge and Use of Biodiversity |
| | SG_26 | Isla de Todos los Santos seagrass distribution | N/A | N/A | WGS 1984 | 2020 | 2020 | Regional | Botánica Marina del Instituto de Investigaciones Oceanológicas, UABC |
| | SG_27 | Global Distribution of Seagrasses | 7 | N/A | WGS 1984 | 2020 | 2020 | Global | UN World Conservation Monitoring Centre |
| | SG_28 | Canada Eelgrass Locations | N/A | N/A | WGS 1984 | 1969 - 2019 | 2020 | Canada | Environment and Climate Change Canada |
| | SG_29 | Canada Eelgrass Locations 2 | N/A | N/A | WGS 1984 | 1882 - 2013 | 2020 | Canada | Matt Christensen (University of British Columbia) |
| | SG_30 | BC Howe Sound Eelgrass locations | N/A | N/A | WGS 1984 | 2012 - 2018 | 2020 | Regional | Howe Sound/Átl'ka7tsem Marine Reference Guide |
| | SG_31 | New Brunswick seagrass locations | N/A | N/A | NAD27 | 1980 - 1985 | 1996 | Regional | Frederick T. Short (University of New Hampshire) |
| | SG_32 | Prince Edward Island seagrass locations | N/A | N/A | NAD27 | 1974 | 1996 | Regional | Frederick T. Short (University of New Hampshire) |
| | SG_33 | Nova Scotia seagrass locations | N/A | N/A | NAD27 | 1974 - 1978 | 1996 | Regional | Frederick T. Short (University of New Hampshire) |
| | SG_34 | National Greenhouse Gases Inventory | 1 | N/A | WGS 1984 | 2016 | 2017 | United States | Environmental Protection Agency |
| | SG_35 | Pacific Northwest seagrass locations | N/A | N/A | WGS 1984 | 2015 - 2019 | 2020 | Regional | Prentice et al. 2020 |
| | SG_36 | North Pacific coast seagrass locations | N/A | N/A | WGS 1984 | 2020 | 2020 | Regional | Kauffman et al. 2020 |
| | SG_37 | Washington coast seagrass locations | N/A | N/A | LAEA | 2000 - 2019 | 2020 | Regional | Washington State Department of Natural Resources Submerged Vegetation Monitoring Program |
| | SG_38 | Pastos marinos en la Península de Yucatán | N/A | N/A | WGS 1984 | 2013 - 2018 | 2021 | Regional | National Commission for the Knowledge and Use of Biodiversity (CONABIO) - UAM-I |

Preprocessing by dataset

SG_01. Global Distribution of Seagrasses

A “selection by attributes process” was performed to isolate all seagrasses polygons corresponding to Canada, the United States and Mexico territories. All polygons located in the USA territories over the Pacific Ocean as well as Puerto Rico were deselected. A final seagrass layer was exported from the remaining polygons selection.

SG_02. BC Howe Sound Eelgrass distribution

The original data is available in a geodatabase that contains different polygon layers with seagrass distribution and a layer that merges all of them. The “Eelgrass_HoweSound_Merged” was selected and exported to a new polygons spatial layer.

SG_03. British Columbia ShoreZone Observed Habitat Polygons

This is an updated layer from the BC_ShoreZone dataset used in the CEC 2015 Blue Carbon map. The data was downloaded from the BC Geographic Warehouse Custom Download. By means of a selection by attributes, all polygons with SPECIES_NM equal to “Zostera marina” were exported to a final BC seagrasses layer.

SG_04. East Canada Eelgrass Inventory

Based on feedback from different experts (Brigitte Leblon, University of New Brunswick; Javier Guijarro-Sabaniel, Fisheries and Oceans Canada; Melanie Leblanc, McGill University) in relation the high uncertainty in the seagrasses distribution in James Bay derived from previous mapping efforts; all polygons in the region were removed from this dataset.

SG_05. New Brunswick Eelgrass Distribution

Classes corresponding to seagrass habitats were extracted from the field "CLASS NAME": Class1 "LOW", Class2 "MED", Class3 "DENSE".

SG_06. St. Lawrence wetlands classification (seagrass)

The layers used to generate the St. Lawrence seagrasses distribution were delivered by Environment and Climate Change Canada. The files were delivered in raster format, containing pixels of eelgrass distribution in 1991. Eelgrass data is only available in the area between Isle Verte and Trois Pistole. Base on feedback from Guy Letourneau from Environment and Climate Change Canada, data from “Map_13.tif” must be impose over “Map_14.tif”.

1. A mosaic to new raster process was performed to generate a single raster file for the region of interest.
2. Conversion from raster to vector polygons preserving pixel edges shape.
3. Values corresponding to “Fucus and Eelgrass == 14” and “Eelgrass == 15” were selected and exported to a new spatial layer.
4. A new attribute field describing g the year of origin of the data was added to the attribute table and filled with “1991”.

A new attribute field describe the class name was added to the attribute table and filled with “14 == Fucus and Eelgrass” and “15 == Eelgrass”

SG_07. Alaska and the Aleutians seagrass distribution

Three input layers were merged into a new polygon spatial layer.

SG_08. Washington coast seagrass distribution

All polygons classified as different than “no_grass” class in the “generalized_eelgrass_poly” layer withing the source geoDataset were selected and exported to a new polygons spatial layer.

SG_09. Washington ShoreZone seagrass distribution

The polygons different than “absent” in the layer eelpoly.shp was exported to a new polygons spatial layer from the source geodatabase.

SG_10. Density of Eelgrass in the USA Northeast Atlantic

No preprocessing was needed for this dataset.

SG_11. San Francisco Bay seagrass distribution

No preprocessing was needed for this dataset.

SG_12. Texas Christmas Bay seagrass distribution

No preprocessing was needed for this dataset.

SG_13. Seagrass distribution, Veracruz reef system

Classes corresponding to seagrass habitats were extracted from the field "CLASE": Class 2 "low cover of seagrasses <30%"; Class 3 "medium cover of seagrasses 20-70%"; Class 4 "high cover of seagrass >70%".

A new field “Coverage” was created to describe the percentage of seagrass coverages indicated by each value in the field “CLASE”.

SG_14. Seagrass distribution, Veracruz reef system 2

Nine features contained in the geodatabase that describe seagrass distribution were merged and exported to a new spatial layer.

SG_15. Distribution of seagrasses in eastern Yucatan

Classes corresponding to seagrass habitats were extracted from the field "Clases": class 1 "Halodule wrightii"; Class2 "Mix of Thalassia testudinum and macroalgae", Class3 "Mix of seagrasses", Class4 "Mix of seagrasses and macroalgae", Class5 "Syringodium filiforme", Class6 "Thalassia testudinum". Polygons selection was exported to a new spatial layer.

SG_16. Seagrass distribution, Dzilam, Yucatan

As reported by the source, the file contains two grid codes describing “Sand == 1” and “Seagrass == 2”. All polygons corresponding to grid code 2 were selected and exported to a new spatial layer.

SG_17. Aquatic submerged vegetation, Yucatan

Classes corresponding to seagrass habitats were extracted from the field "Habitat": class 1 "seagrass with sand"; Class2 "seagrass with macroalgae", Class3 "seagrass beds".

SG_18. Chelem seagrass distribution

No preprocessing was needed for this dataset.

SG_19. Aquatic submerged vegetation, Campeche

Classes corresponding to seagrass habitats were extracted from the field "Habitat": Class 1 "Mix of Thalassia testudinum and macroalgae"; Class 2 "Mix of seagrasses", Class 3 "Mis of seagrasses and macroalgae".

SG_20. Laguna de Términos seagrasses distribution

Classes corresponding to seagrass habitats were extracted from the field "CLASE", this field is linked to seagrasses species and percentage of seagrass coverage in the attribute table.

SG_21. Los Petenes, Campeche, seagrasses distribution

Classes corresponding to seagrass habitats were extracted from the field "CLASE", this field is linked to seagrasses species and percentage of seagrass coverage in the attribute table.

SG_22. Bahía Ascención, QRoo, seagrasses distribution

Classes corresponding to seagrass habitats were extracted from the field "CLASE": Class1 "TT", Class2 "HW", Class3 "HW-TT", Class 4 and 5 "Algas and TT".

SG_23. Nichupte Lagoon seagrass distribution

No preprocessing was needed for this dataset.

SG_24. Yalahau-Holbox seagrass distribution

No preprocessing was needed for this dataset.

SG_25. Catoche-Xcalak seagrasses distribution

All polygons classified as sea grasses ("Comunidad de Pastos Marinos") within Name of coverage ("Nom_Cob") field were selected and exported to a new spatial polygons layer.

SG_26. Isla de Todos los Santos seagrass distribution

No preprocessing was needed for this dataset.

SG_27. Global Distribution of Seagrasses

A "selection by attributes process" was performed to isolate all seagrasses points corresponding to Canada, the United States and Mexico territories. All points located in the USA territories over the Pacific Ocean as well as Puerto Rico were deselected. A final seagrass layer was exported from the remaining points selection.

SG_28. Canada Eelgrass Locations

No preprocessing was needed for this dataset.

SG_29. Canada Eelgrass Locations 2

Data from the input dataset were converted to a point spatial layer based on the coordinates reported for each record. Records not reporting species name were omitted and the rest of the records were exported to a new point spatial layer.

SG_30. BC Howe Sound Eelgrass locations

The original data is available in a geodatabase that contains different polygon layers and a point layer with locations of presence of seagrasses. The layer with seagrass distribution and a layer that merges all of them. The layer “Eelgrass_HoweSound_Fieldwork2019_coordinates_WM” was selected and exported to a new points spatial layer.

SG_31. New Brunswick seagrass locations

No preprocessing was needed for this dataset.

SG_32. Prince Edward Island seagrass locations

No preprocessing was needed for this dataset.

SG_33. Nova Scotia seagrass locations

No preprocessing was needed for this dataset.

SG_34. National Greenhouse Gases Inventory

The coastal carbon dataset was converted from an excel spreadsheet to a point shapefile based on Latitude and Longitude values per each record, the reference coordinate system assigned was WGS84. Seagrass records were selected by “select by attributes” tool. A few points possibly incorrectly georeferenced over the ocean and further inland were deleted manually to keep only the records along the coast of the United States.

SG_35. Pacific Northwest seagrass locations

Seagrass sample locations were selected and georeferenced into a point spatial layer.

SG_36. North Pacific coast seagrass locations

The original dataset was georeferenced and converted into spatial points by the Mexican Carbon Program. This dataset provides a set of points that describe locations of seagrasses and saltmarshes in the North Pacific coast of the United States. Seagrass points were selected and exported to a new spatial layer.

SG_37. Washington coast seagrass locations

All points classified as different than “no_grass” or “no_data” class in the “site_pt” layer within the source geoDataset were selected and exported to a new points spatial layer.

SG_38. Pastos marinos en la Península de Yucatán

All class names reported as species abbreviations were described as complete species name in a new field. According to information reported by the author of this dataset, the “Year of origin” attribute was defined on a new attribute field.

2021 North America Seagrasses Distribution Map, Cartographic Integration Process

Polygons Map

4. All preprocessed polygon spatial layers (SG_01 - SG_26) were reprojected from their original Coordinate Reference System (CRS) to the standard North American Atlas CRS (Table 3).

Table 13. North American Atlas, Coordinate reference System

| | |
|---------------------------|-------------------------------------|
| Projection | Lambert Azimuthal Equal Area |
| Linear Unit | Meters (1.0) |
| False Easting | 0.0 |
| False Northing | 0.0 |
| Central Meridian | -100.0 |
| Latitude of Origin | 45.0 |
| Datum | D Sphere ARC INFO |
| Spheroid | Sphere ARC INFO |
| Semimajor Axis | 6370997.0 |
| Semiminor Axis | 6370997.0 |
| Inverse Flattening | 0.0 |

5. Definition of standard attribute fields that describe common information recorded in most of the input datasets (Table 4).

Table 14. Standard attribute fields defined for the North America Seagrasses polygons Map update.

| Field Name | Definition | Data Type | Description |
|-------------------|---------------------|-----------|--|
| COUNTRY | Country | Text | Country of location of each polygon (CAN: Canada, USA: United States of America, MEX: Mexico) |
| STATEABB | State or Province | Text | State or province code defining the location of each polygon (two letters country code + two letters state/province code) |
| NAME | Reported Name | Text | Name of the features described by each polygon, as reported by the source of each dataset |
| INPT_SRCE | Input Source | Text | Description of the original dataset used to acquire each polygon |
| YEAR_PUB | Year of Publication | Long | Year of the publication of the last update of the dataset used as input |
| RESP_PARTY | Responsible Party | Text | Name of the entity responsible on providing each dataset |
| YEAR_ORGN | Year of Origin | Text | Year of origin of data reported by the source of each dataset (this can be year when data was taken or when the data was originally published by the source) |
| SURVEY_MET | Survey Method | Text | Reported method of data acquisition as reported by the source of each dataset |
| SCAL_RPRTD | Scale Reported | Text | Scale of the input data used in each polygon or general dataset as reported by the source |
| RESL_RPRTD | Resolution Reported | Text | Resolution of the input data used in each polygon or general dataset as reported by the source |
| SOURCE_DES | Source Description | Text | General description of the source dataset used to derive each polygon |
| CITATION | Citation | Text | Full citation of the used data source |
| SOURCE_ID | Source ID | Text | Identification code of the datasets reported in the data sources full description document |
| AREA_SQMT | Area in m2 | Float | Area calculated using the map CRS, 1 decimal point, thousands separated by comma |

6. GIS steps to integrate selected and preprocessed Seagrasses datasets.

As some of the datasets show spatial overlaps, some criteria were defined to deal with overlapping polygons from different data sources and keep as much spatial information as possible.

In order to define the criteria to prioritize sources datasets on areas where information overlaps, the Mexican Carbon Program conducted a series of three national workshops with experts from Canada, the United States and Mexico.

Experts were asked to rank the sources datasets features that should be considered when selecting the sources of information that must prevail over areas with overlapping polygons. Six quality features were evaluated by the experts, comprising:

- Most updated datasets
- Fine spatial resolution over coarse spatial resolution
- Datasets reporting accuracy
- National or regional datasets over global datasets
- Independent research studies over institutional datasets
- Most complete metadata

A group of eleven experts participated in a survey to rank the criteria (Table 5).

Table 15. Group of Blue Carbon experts from Canada, the United States and Mexico.

| | Name | Country | Institution | Email |
|-----------|-------------------------------|----------------|---------------------------------|--------------------------|
| 1 | Nate Herold | United States | NOAA | nate.herold@noaa.gov |
| 2 | Margot Hessing-Lewis | Canada | Hakai Institute | margot@hakai.org |
| 3 | Gail Chmura | Canada | McGill University | gail.chmura@mcgill.ca |
| 4 | Dan Mulrooney | Canada | Parks Canada | dan.mulrooney@canada.ca |
| 5 | Anna Hilting | United States | NOAA | anna.hilting@noaa.gov |
| 6 | María Teresa Rodríguez Zúñiga | Mexico | CONABIO | mrodrig@conabio.gob.mx |
| 7 | Joanna Acosta Velázquez | Mexico | Aura: manglares y costas, S. C. | joanna.acosta@gmail.com |
| 8 | Iliana Pérez Espinosa | Mexico | COANBIO | iperez@conabio.gob.mx |
| 9 | Carlos Troche | Mexico | CONABIO | ctroche@conabio.gob.mx |
| 10 | Beatriz Carolina Corral Osuna | Mexico | INECC | beatriz.corral@gmail.com |
| 11 | Zulia Mayari Sánchez Mejía | Mexico | Instituto Tecnológico de Sonora | zulia.sanchez@itson.edu |

Based on the survey results, data features were ranked by the experts from the three countries as shown in the figure below (Figure 1).



Figure 3. Criteria for spatial layers prioritization defined by the Blue Carbon group of experts.

As a result of the experts-defined criteria and the characteristics of the information provided by each source dataset, a set of case-by-case decisions were made on areas with overlapping conflicts.

Individual dataset analysis and spatial prioritization decisions were conducted as follows.

Alaska and the Aleutians seagrass distribution

- This layer was prioritized in the Alaska region, although the WCMC dataset is newer, the year reported in seagrasses polygons over Alaska and the Aleutians is more recent in this dataset. WCMC polygons refer to 1997 while polygons in this dataset refer to 2002-2008.

BC Howe Sound Eelgrass distribution

- This layer was preserved in its original shape, this dataset was prioritized over the WCMC seagrass distribution map, as this dataset shows higher spatial detail and is derived from a local field survey.

British Columbia ShoreZone Observed Habitat Polygons

- This layer was prioritized, although the WCMC dataset is newer, the year reported in seagrasses polygons over British Columbia that intersect this dataset are older in the WCCM dataset. WCMC polygons refer to 2009 while polygon features in British Columbia ShoreZone Observed Habitat Polygons refer to 2011. Furthermore, this dataset has mapped seagrass polygons over areas where WCVN dataset do not show any seagrass distribution.

Washington ShoreZone seagrass distribution

- Polygons in this layer that overlap Washington coast seagrass distribution dataset were removed, as the second one refers to more recent data and its metadata is better documented than Washington ShoreZone seagrass distribution.

Washington coast seagrass distribution

- No changes were made to this layer, it preserves all its original polygon features.

San Francisco Bay seagrass distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Isla de Todos los Santos seagrass distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Catoche-Xcalak seagrasses distribution

- Feature polygons in this layer that overlap Bahía Ascensión, QRoo, seagrasses distribution layer were removed, as the second layer shows more consistency and better documentation for the local area of Bahía Ascensión in the coast of Quintana Roo. Remaining polygon features were exported to a new spatial layer.

Bahía Ascención, Q Roo, seagrasses distribution

- No changes were made to this layer, it preserves all its original polygon features.

Yalahau-Holbox seagrass distribution

- Feature polygons overlapping Catoche-Xcalak seagrasses distribution layer were removed and the remain polygons were exported to a new spatial layer.

Nichupte Lagoon seagrass distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Seagrass distribution, Veracruz reef system

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Seagrass distribution, Veracruz reef system 2

- No changes were made to this layer, it preserves all its original polygon features.

Chelem seagrass distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Seagrass distribution, Dzilam, Yucatan

- Polygons in this layer that overlap the Distribution of seagrasses in eastern Yucatan layer are removed to prioritize spatial consistency in the second layer that covers a larger area than the Seagrass distribution, Dzilam, Yucatan dataset.
- This layer covers the same area as the as Seagrass distribution, Dzilam, Yucatán 2 and the mapping methodology is similar, but Seagrass distribution, Dzilam, Yucatan layer reports higher accuracy (89%) than Seagrass distribution, Dzilam, Yucatán 2 (81%).

Aquatic submerged vegetation, Yucatan

- A small area that overlaps the Distribution of seagrasses in eastern Yucatan layer was erased from this dataset. Both layers come from the same source institution but Distribution of seagrasses in eastern Yucatan layer was prioritized as this represent data from a more recent year (2018 and 2020 respectively).

Distribution of seagrasses in eastern Yucatan

- No changes were made to this layer, it preserves all its original polygon features.

Laguna de Términos seagrasses distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Los Petenes, Campeche, seagrasses distribution

- No changes were made to this layer, it preserves all its original polygon features.

Aquatic submerged vegetation, Campeche

- Feature polygons overlapping the Los Petenes, Campeche, seagrasses distribution layer were removed, remaining polygons were moved to a new spatial layer.
- Los Petenes, Campeche, seagrasses distribution layer was prioritized over Aquatic submerged vegetation, Campeche, as the first one refers to a more recent year and also reports accuracy.

Texas Christmas Bay seagrass distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Density of Eelgrass in the USA Northeast Atlantic

- No changes were made to this layer, it preserves all its original polygon features, and it is prioritized over the WCMC global seagrass distribution map, as data from Density of Eelgrass in the USA Northeast Atlantic is more recent.

St. Lawrence wetlands classification (seagrass)

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

New Brunswick Eelgrass Distribution

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

East Canada Eelgrass Inventory

- No changes were made to this layer, it preserves all its original polygon features, there is no spatial overlap with any other layer.

Global Distribution of Seagrasses

- a) Polygons in this layer that intersect other polygons from Alaska and the Aleutians seagrass distribution were removed and the remaining polygon features were exported to a temporary spatial layer.
- b) Polygons in the previous temporary layer that intersect other polygons from BC Howe Sound Eelgrass distribution were removed and the remaining polygon features were exported to a new temporary spatial layer.
- c) All polygon features in Washington state were removed as they are already mapped by the other two state-level layers for the same region. Remaining polygon features were exported to a new temporary spatial layer.
- d) Areas over Quintana Roo state that overlap the already processed layers in the region were erased. Thus, prioritizing regional or local dataset that offer much higher spatial detail, while

the WCMC polygons are much more generalized in the Yucatan peninsula region. A new temporary layer was generated with the resulting polygons after the spatial erase process.

- e) Polygons mapped along the coast of Veracruz were removed as they do not report any feature name and those polygons area already mapped in much more detail in the Seagrass distribution, Veracruz reef system 2 dataset.
- f) Areas over the entire Yucatan Peninsula that overlap the already processed layers in the region were erased. Thus, prioritizing regional or local dataset that offer much higher spatial detail, while the WCMC polygons are much more generalized in the. A new temporary layer was generated with the resulting polygons after the spatial erase process.
- g) Feature polygons that overlap seagrass polygons in the Density of Eelgrass in the USA Northeast Atlantic layer were removed. Remaining polygon features were exported to a new temporary spatial layer.
- h) Merge of all preprocessed spatial layers

Step 01

All the preprocessed spatial layers were merged into a final North America Seagrass map.

- Alaska_seagrass_distribution_laea_final.shp
- BahiaAscensionQRoo_seagrasses_laea_final.shp
- BC_HoweSound_seagrasses_laea_final.shp
- BC_ShoreZone_seagrasses_laea_final.shp
- Campeche_seagrasses_laea_final.shp
- Catoche_Xcalak_seagrasses_laea_final.shp
- Chelem_seagrasses_laea_final.shp
- DzilamYuc_seagrasses_laea_final.shp
- EastCanada_eelgrass_inventory_laea_final.shp
- EastYucatan_seagrasses_laea_final.shp
- LagTerminos_seagrasses_laea_final.shp
- LosPetenes_seagrasses_laea_final.shp
- Nichupte_seagrasses_laea_final.shp
- NortheastAtlantic_eelgrass_density_laea_final.shp
- SFbay_seagrass_distribution_laea_final.shp
- StLawrence_seagrasses_laea_final.shp
- Tabusintac_NB_eelgrass_distribution_final.shp
- TodosSantos_seagrasses_laea_final.shp
- TX_ChristmasBay_seagrasses_laea_final.shp
- VeracruzReef_seagrasses_laea_final.shp
- VeracruzReef2_seagrasses_laea_input.shp
- Washington_coast_seagrasses_laea_final.shp
- Washington_ShoreZone_seagrass_distribution_laea_final.shp
- WCMC_NorthAmerica_seagrasses_polygon_laea_final.shp
- Yalahau-Holbox_seagrasses_laea_final.shp
- Yucatan_seagrasses_laea_final.shp

Output = NorthAmerica_seagrasses_layers_merge.shp

Step 02

All records in the attribute table fields were standardized, different feature names with different codes or abbreviations to indicate species or seagrass distribution characteristics were homogenized in a standard code names, common names were included in most of the records, accompanying the scientific name descriptions when available.

Step 03

A “Dissolve” process was applied to the output layer from the previous step. All individual polygons that are spatially connected and share the same values across the thirteen common attributed fields (except area) will break down into new polygons. This way, the number of polygons and the size of the final spatial layer file is reduced. No multipart features creation is allowed in this step.

Output = NorthAmerica_seagrasses_polygons_dissolve.shp

Step 04

A new field “AREA_SQMT” is created and the area in squared meters is calculated for this field. The area is calculated based on the map coordinate reference system, 1 decimal point and thousands separated by comas are defined.

As a final clean up step, all polygons reported areas smaller than 1 m² were removed.

Step 05

After a final check of attribute table consistency and data display on different GIS platforms, a spatial data file in ESRI “shp” format is generated to provide the final CEC North America seagrasses distribution map.

2021 North America Seagrasses Distribution Map, Cartographic Integration Process

Points Map

1. All preprocessed polygon spatial layers (SG_27 - SG_38) were reprojected from their original Coordinate Reference System (CRS) to the standard North American Atlas CRS (Table 3).
2. Definition of standard attribute fields that describe common information recorded in most of the input datasets (Table 4).

Table 16. Standard attribute fields defined for the North America Seagrass points Map update.

| Field Name | Definition | Data Type | Description |
|-------------------|---------------------|-----------|--|
| COUNTRY | Country | Text | Country of location of each polygon (CAN: Canada, USA: United States of America, MEX: Mexico) |
| STATEABB | State or Province | Text | State or province code defining the location of each polygon (two letters country code + two letters state/province code) |
| NAME | Reported Name | Text | Name of the features described by each polygon, as reported by the source of each dataset |
| INPT_SRCE | Input Source | Text | Description of the original dataset used to acquire each polygon |
| YEAR_PUB | Year of Publication | Long | Year of the publication of the last update of the dataset used as input |
| RESP_PARTY | Responsible Party | Text | Name of the entity responsible on providing each dataset |
| YEAR_ORGN | Year of Origin | Text | Year of origin of data reported by the source of each dataset (this can be year when data was taken or when the data was originally published by the source) |
| SURVEY_MET | Survey Method | Text | Reported method of data acquisition as reported by the source of each dataset |
| SOURCE_DES | Source Description | Text | General description of the source dataset used to derive each polygon |
| CITATION | Citation | Text | Full citation of the used data source |
| SOURCE_ID | Source ID | Text | Identification code of the datasets reported in the data sources full description document |

3. GIS steps to integrate selected and preprocessed seagrass datasets.

Step 01

All the layers previously prepared and preprocessed were merged in a new spatial layer.

- BC_HoweSound_seagrass_locations_laea_final.shp
- Canada_eelgrass_locations_laea_final.shp
- Canada_eelgrass_locations_2_laea_final.shp
- NewBrunswick_seagrass_locations_laea_final.shp
- NGGI_united_states_seagrass_laea_final.shp
- North_Pacific_coast_seagrass_final.shp
- NovaScotia_seagrass_locations_laea_final.shp
- Pacific_Northwest_seagrass_locations_laea_final.shp
- PEI_seagrass_locations_laea_final.shp

- Washington_coast_seagrass_locations_laea_final.shp
- WCMC_NorthAmerica_seagrasses_point_laea_final.shp
- Mex_conabio_seagrass_laea_final.shp

Output = NorthAmerica_seagrasses_points_dissolve.shp

Step 02

All records in the attribute table fields were standardized, different feature names with different codes or abbreviations to indicate species or seagrass distribution characteristics were homogenized in a standard code names, common names were included in most of the records, accompanying the scientific name descriptions when available.

Step 03

After a final check of attribute table consistency and data display on different GIS platforms, a spatial data file in ESRI “shp” format is generated to provide the final CEC North America seagrasses distribution map.