Spatial Representation of the NAFO Convention Area

1.0 Introduction

The Northwest Atlantic Fisheries Organization (NAFO) Secretariat, Fisheries and Oceans Canada (DFO) and the Canadian Hydrographic Service (CHS) have collaborated to update the spatial representation of the NAFO Subareas, Divisions, and Subdivisions as defined in Annex 1 to the *Convention on Cooperation in the Northwest Atlantic Fisheries* (https://www.nafo.int/Portals/0/PDFs/key-publications/NAFOConvention.pdf). This dataset was completed in September, 2021.

A previous version of the data was generated by NAFO in a shapefile format. However, the file had an unknown origin and contained no description of how it was created. Some locations in the NAFO Convention are not defined by coordinates but by a landmark or place name. No information was provided to explain how those points were determined. There were also several areas that included corner points not defined in the NAFO Convention. Additionally, the shapefile was clipped to a coastline that was accurate for Canada, but very coarse in the United States of America and Greenland. Some portions of the coastline in Nunavut and Prince Edward Island were missing entirely.

This version of the dataset was created to correct some of the deficiencies in the previous version, as well as to document the decisions made for the points that are not explicitly defined in the NAFO Convention. In 1986 (GC Doc. 86-02REV2 and GC Doc. 86-04REV), the NAFO Scientific Council agreed on a further subdivision of NAFO Subdivision 5Ze into Sub-Subdivisions 5Zc and 5Zu. These were not included in the original shapefile, but are included in the revised version. Lastly, international boundaries have been updated based on accepted coordinates between the USA and Canada, and Canada and Greenland.

This version of the NAFO Divisions is not intended to be used for legal purposes and is being provided for mapping / illustrative purposes only.

2.0 Methods

The coordinates listed in Annex 1 of the NAFO Convention (2020) were used to create point, line and polygon files. All coordinates were converted to decimal degrees, retaining six decimal places. Microsoft Excel and ArcGIS 10.7.1 software were used to create the datasets. Coordinates are provided in csv format, and spatial data is represented in ArcGIS file geodatabase and shapefile formats. The "Geodetic Densify" tool was used to create all rhumb and geodetic lines.

The NAFO Convention does not indicate which datum should be used for spatial representation. The datum used at the time of development of the NAFO Convention would have been North American Datum 1927 (NAD27). However, all datasets were derived using NAD83. Transforming the coordinates from NAD27 to NAD83 would have resulted in coordinates that are no longer rounded to the nearest minute, as well as parallels and meridians that no longer run straight in the north-south or east-west directions. Thus the boundaries would be much more difficult to describe to fishers. The exception is along international boundaries that are not managed by NAFO. The accepted boundaries and any related datum transformations were used.

2.1 Data format

Points

A list of coordinates (.csv file) and corresponding point files (shapefile and ArcGIS feature class) were created from NAFO Convention coordinates where specified, and additional points along the coast and inland where necessary to completely enclose each area. The point file forms the basis of the line and polygon files. The attributes of each point are listed in Table 1.

Table 1. Attribute names and descriptions for all coordinates generated. Attribute names for the shapefile version are in brackets where they differ from the csv and feature classes due to length limitations.

Attribute Name	Description
Label	A label that can be used to identify each area. This is the name of the area based on its lowest level within the hierarchy of areas described in the NAFO Convention (2020).
pt_sequence (pt_seq)	The order in which to join points to create an enclosed boundary.
pt_type - English pt_type_fr - French	The type of point (see Table 2 for details).
source - English source_fr - French	The source of the coordinates. (i.e. NAFO Convention (2020); International Boundary Commission (2018))
NAFO_SubArea (SubArea)	The name of the Subarea as defined by the NAFO Convention (2020).
NAFO_Division (Division)	The name of the Division as defined by the NAFO Convention (2020).
NAFO_SubDivision (SubDiv)	The name of the Subdivision as defined by the NAFO Convention (2020), if applicable.
NAFO_SubSubDivision (SubSubDiv)	The name of the Sub-Subdivision as defined by GC Doc. 86-02REV2 (1986) and GC Doc. 86-04REV (1986). These include Sub-Subdivisions 5Zc and 5Zu.
lat_dd	Latitude in decimal degrees (6 decimal places)
long_dd	Longitude in decimal degrees (6 decimal places)
lat_ddm	Latitude in degrees, decimal minutes (3 decimal places)
long_ddm	Longitude in degrees, decimal minutes (3 decimal places)
line_id	The name of the lines generated from the points, used to generate the line file that is not enclosed inland (described below), and stops at the coastline. This is typically the same as the Label, unless more than one line is required to outline an area, in which case the Label has "-1", "-2" appended to it.

Table 2. Descriptions of the point types listed in the pt_type attribute in the point file

pt_type	Description
Canada-US border	Points along the international boundary within Passamaquoddy Bay as derived from data obtained from the International Boundary Commission (2018).
Coast	A point generated on land near the coastline. The location is either defined by a set of coordinates, or a description within the NAFO Convention (2020).

Corner	A point defining a corner of an area.
Enclose, land	The first point used to define any area is repeated at the end in order to fully enclose each area in the subsequent line and polygon files. The repeated point is on land near the coastline.
Enclose, water	The first point used to define any area is repeated at the end in order to fully enclose each area in the subsequent line and polygon files. The repeated point is on the water.
Geodetic	Points created approximately every 2 km along diagonal lines that are described as geodetic or straight lines in the NAFO Convention (2020).
Inland	A point derived inland; the resulting lines and polygons extend inland so that users can clip boundaries with other coastlines.
Rhumb	Points created approximately every 2 km along diagonal lines that are described as rhumb lines in the NAFO Convention (2020).
Topology	A point that does not define the shape of a given area, but exists as a corner in an adjacent area. This is created so that all edges between subsequent lines and polygons share the same vertices, maintaining topology in GIS systems.

Lines

The points were connected in order to create two line files. The first line file includes boundaries for fully enclosed areas that extend inland. These were generated by joining all the points in sequential order using the Label and pt_sequence attributes. The second line file has lines that stop at the coastline and can be used for cartographic purposes. These were created from all points except those that extend inland, using the line_id and pt_sequence attributes. For the line files, the horizontal lines were densified with additional vertices in order for them to retain their shape if visualized by GIS software in a projected coordinate system. This was done using the Project tool in ArcGIS, with the option "Preserve Shape" selected. These additional vertices are not listed in the point file or the list of coordinates.

Polygons

Two sets of polygon files are provided. The first one includes inland areas and are not clipped to any coastline. Users of this file may clip the polygons to a preferred coastline. The second file provides the polygons clipped to a coastline provided by the National Oceanic and Atmospheric Administration (https://www.ngdc.noaa.gov/mgg/shorelines/; file GSHHS_f_L1). Most islands were excluded from this file to simplify the final polygons. This coastline is coarser than ones provided by Natural Resources Canada, however, due to the vast extent of the dataset that includes four countries, this coastline was deemed suitable. Similar to the line files, the horizontal boundaries of the polygons were densified with additional vertices in order for them to retain their shape if visualized by GIS software in a projected coordinate system. These additional vertices are not listed in the point file or the list of coordinates.

2.2 Boundary Issues

Boundary between Subareas 0 and 1

A portion of the boundary between Subareas 0 and 1 follows the international boundary between Canada and Greenland. The coordinates listed in the NAFO Convention for this boundary are based on

NAD27. However, for this version of the dataset, boundary coordinates numbered 2 to 110 from section 1(a) of the NAFO Convention were replaced with those from "*Exchange of Notes Constituting an Agreement to Amend the Agreement Between the Government of Canada and the Government of the Kingdom of Denmark Relating to the Delimitation of the Continental Shelf Between Greenland and Canada Done at Ottawa on 17 December 1973*" (https://www.treaty-accord.gc.ca/text-texte.aspx?id=104991).

The remaining points were retained as listed in the NAFO Convention, using NAD83. The northernmost and southernmost portions of the boundary between Subareas 0 and 1 do not follow the international boundary between Canada and Greenland. In addition, the boundary between Subareas 2 and 1 also follow the descriptions and coordinates in the NAFO Convention, rather than the international boundary. The April 2004 amendment to the original agreement linked above includes coordinates that extend to 74° 24' 01.3N, therefore any coordinates further north revert to the original 1973 agreement that is still in force.

Placenames

The NAFO Convention lists several place names without listing coordinates. For this version of the dataset, locations for these place names were based on the coordinates of the nearest lighthouse obtained from Canadian Coast Guard Notice to Mariners (NOTMAR) List of Lights, Buoys and Fog Signals (https://www.notmar.gc.ca/list-livre-en.php). These include Cape Bauld (3K, 4R), Cape St. Mary (3Ps, 3L), Cape Ray (3Pn, 4R), Fourchu (4Vn, 4W) and Halifax (near Chebucto Head; 4W, 4X). One additional place name, Pte. des Monts (4S, 4T) is listed without a coordinate. The NAFO Convention describes a line for the boundary of Division 4S as follows "*beginning at Pte. des Monts, thence due east to a point at 49° 25' N 64° 40' W*". Therefore a point was using a latitude of 49° 25' N near the coastline, which lies north of the location of Pte. des Monts.

Boundary between Subdivisions 3Pn and 3Ps

The southeast boundary between Subdivisions 3Pn and 3Ps is described by 2 coordinates. The NAFO Convention does not describe the type of line (rhumb or geodesic). A rhumb line was created between these points to be consistent with the majority of the diagonal lines described in the NAFO Convention. The northern coordinate is approximately 10 km from the coastline. Therefore the rhumb line was extended in a northeasterly direction to a point on land near the coastline. The second point along the southern boundary does not reach the southwestern boundary of Subdivisions 3Pn and 3Ps. Therefore the southern boundary was also extended in a southwesterly direction to intersect with the rhumb line that defines their southwestern boundaries.

Boundary between Subdivision 3Pn and Division 4R

The diagonal line between Subdivision 3Pn and Division 4R is described in the NAFO Convention as a "straight" line. This was interpreted as a geodetic line for this version of the dataset. The previous version of the dataset included a rhumb line in this area. This is the only line in the NAFO Convention to be described as "straight".

Terminus of Quebec and Labrador boundary, Divisions 4R and 4S

The boundary between Divisions 4R and 4S includes a rhumb line between the "*terminus of the Labrador-Quebec boundary*" and a point at 49° 25' N 60° 00' W. The location of the terminus is not provided. This location was created by the intersection of the line between Quebec and Labrador and a 1:250,000 waterbody dataset of Quebec. Both datasets were provided by Natural Resources Canada, CanVec series (https://ftp.maps.canada.ca/pub/nrcan_rncan/vector/canvec/fgdb/Admin/; https://ftp.maps.canada.ca/pub/nrcan_rncan/vector/canvec/fgdb/Hydro/).

International boundary between the United States and Canada: Divisions 4X and 5Y

The division between Subareas 4 and 5 is described by a line that begins as follows: "*beginning at the terminus of the international boundary between the United States of America and Canada in Grand Manan Channel, at a point at 44° 46' 35.346'' N 66° 54' 11.253'' W; thence due south to the parallel of 43° 50' N".* However, there is no description of this line to the north of the terminus towards Passamaquoddy Bay. In order to continue this line to the coast, the boundary between Canada and the United States was used as outlined by the International Boundary Commission (IBC) (http://www.internationalboundarycommission.org/en/maps-coordinates/coordinates.php; shapefile version 1.3 updated in 2018). By adopting the updated international boundary, the location of the terminus as described in the NAFO Convention (and thus the vertical line extending due south) was shifted eastward to match the IBC coordinate for the terminus. Furthermore, the diagonal geodetic lines defining the western portion of Division 4X follows the IBC coordinates rather than those in the NAFO Convention.

Boundary between Divisions 4W and 4T; Canso Causeway

In the NAFO Convention, there are no coordinates listed indicating the location of the boundary between Divisions 4W and 4T through the Strait of Canso. For this dataset, points were selected along the Canso Causeway (Highway 104) to complete this boundary.

Boundary between Divisions 3 and 4

The division between Divisions 3 and 4 includes a long diagonal rhumb line described as *"…to the east and north of a rhumb line commencing at 39° 00' N 50° 00' W and extending in a northwesterly direction to pass through a point at 43° 30' N 55° 00' W in the direction of a point at 47° 50' N 60° 00' W"…"*

When a rhumb line is generated between the endpoints defined above, it does not pass through point 43° 30' N 55° 00' W. Therefore, two separate rhumb lines were created, one from each endpoint to the midpoint listed.

Addition of Sub-subdivisions 5Ze and 5Zc

Although not described in the NAFO Convention, Sub-subdivisions 5Ze and 5Zc have been added to the dataset. These were described by GC Doc. 86-02REV2 and GC Doc. 86-04REV in 1986 to differentiate Canadian and US portions of Subdivision 5Ze. The IBC diagonal line was used to split Subdivision 5Ze. The terminus of the diagonal geodetic line did not reach the boundary between 5Ze and 4X at longitude -65° 40', and was therefore extended to meet that boundary.

3.0 Contact Information

For further enquiries or comments please contact:
Kasia Rozalska, Fisheries and Oceans Canada:
DFO.MAR.OceansGIS-SIGOceans.MAR.MPO@dfo-mpo.gc.ca
Canadian Hydrographic Service: chsinfo@dfo-po.gc.ca (English); shcinfo@dfo-mpo.gc.ca (French)
NAFO Secretariat: info@nafo.int