Serial No. N7698 NAFO SCR Doc. 25/050

SCIENTIFIC COUNCIL MEETING –NOVEMBER 2025

New preliminary data on VME encounters in NAFO Regulatory Area (Divs. 3LMNO) from EU: EU-Spain and Portugal Groundfish Surveys (2025) and Canadian surveys (Fall 2023 - Spring 2025).

Abalo-Morla, S.[1], Sacau, M.[1], Command, R.J.[2], Neves, B.M.[2], Hayes, V.[2], Durán-Muñoz, P.[1]

[1]Instituto Español de Oceanografía (COV-IEO, CSIC). Subida a Radio Faro, 50. 36390 Vigo. Spain
[2]Fisheries and Oceans Canada (DFO), St. John's NL, A1C 5X1, Canada

ABALO-MORLA, S., SACAU, M., COMMAND, R.J., NEVES, B.M., HAYES, V., & DURÁN-MUÑOZ, P. 2025. New preliminary data on VME encounters in NAFO Regulatory Area (Divs. 3LMNO) from EU: EU-Spain and Portugal Groundfish Surveys (2025) and Canadian surveys (Fall 2023 - Spring 2025). *NAFO Scientific Council Research Document*, SCR Doc. 25/050: 1-19.

Abstract

New preliminary data on deep-water corals, sponges, sea squirts, and bryozoans from the 2025 EU, EU-Spain, and Portugal, as well as the 2023-2025 Canadian bottom trawl groundfish surveys, have been made available to improve the mapping of Vulnerable Marine Ecosystems (VMEs) indicator species in the NAFO Regulatory Area (Divs. 3LMNO). The results include distribution maps of new records of presence (both non-significant and significant catches) of VME indicator species by VME species group. Additionally, the species composition of VME taxa for significant catches has been included.

1. Introduction

During the 18th NAFO Working Group on Ecosystem Science and Assessment (WGESA) blended meeting (virtual and in presence) new preliminary data on deep-water coral, sponges, sea squirt, and bryozoan catches were presented from the 2025 EU: EU-Spain and Portugal and 2023-2025 Canadian bottom trawl groundfish surveys. These data were made available to the NAFO WGESA to improve mapping of Vulnerable Marine Ecosystem (VME) indicator species in the NAFO Regulatory Area (Divs. 3LMNO).

During the 6th meeting of the NAFO Scientific Council WGESA, new quantitative spatial analyses were applied for corals and sponges for all the available data within the NAFO Regulatory Area (**NAFO, 2013**). Outcomes from those analyses produced the following thresholds for VME indicator species: 75 kg per tow for sponges, 0.6 kg per tow for large gorgonians, 0.15 kg per tow for small gorgonians, and 1.4 kg per tow for sea pens. Based on these thresholds, deep-water coral, sponge, sea squirt, and bryozoan catches were identified and mapped, and overlaid with the current closed areas and VME polygons. New thresholds and VME polygons were presented at the 12th WGESA meeting using additional data since 2013 (**NAFO, 2019**). These are: 100 kg per tow for sponges, 0.6 kg per tow for large gorgonians, 0.2 kg per tow for small gorgonians, 1.3 kg per tow for sea pens, 0.35 kg for *Boltenia* sea squirts, 0.2 kg for bryozoans and 0.4 kg for black corals. Therefore, VME polygons illustrated on the figures below are the modified ones, accepted by the Scientific Council (SC).

2. Survey Data

During 2025, the RV *Vizconde de Eza* carried out three surveys in Division 3L, Division 3M, and Divisions 3NO. Due to operational constraints, data on corals collected during the Fall 2023 & Spring 2024 Canadian surveys were not available for the 17th WGESA meeting in 2024. These data were available in 2025, therefore coral data were presented for Fall 2023 to Spring 2025. Data on sponges, sea squirts and bryozoans focus on Fall 2024 and Spring 2025. Data used in this study were collected from the following surveys:

2.1. EU-Spain and Portugal Flemish Cap groundfish survey (Div. 3M)

The EU-Spain and Portugal Flemish Cap groundfish survey (**Vázquez Rodríguez et al., 2014**), conducted by the Instituto Español de Oceanografía (COV-IEO, CSIC) together with the Instituto de Investigaciones Marinas (IIM) and Instituto Português do Mar e da Atmosfera (IPMA), sampled the Flemish Cap (NAFO Div. 3M) between 135 - 1464 m depth, with a total of 189 tows (182 valid). Out of all valid tows in Div. 3M, 137 tows recorded at least one VME indicator species group. These correspond to 25 sets with Black corals (2 of which contained significant concentrations), 2 sets with Large gorgonians, 88 sets with Sea pens (1 of which contained significant concentrations), 22 sets with Small gorgonians, and 111 sets with Sponges.

2.2. EU-Spain 3NO groundfish survey (Divs. 3NO)

The EU-Spain 3NO groundfish survey (**Paz et al., 2012**), conducted by the Instituto Español de Oceanografía (COV-IEO, CSIC), sampled the Grand Bank of Newfoundland (NAFO Divs. 3NO) between 46 - 1444 m depth, with a total of 116 tows (113 valid). Out of all valid tows in Div. 3NO, 63 tows recorded at least one VME indicator species group. These correspond to 3 sets with Black corals, 1 sets with Large gorgonians, 38 sets with Sea pens, 17 sets with Small gorgonians, 29 sets with Sponges, 6 sets with Sea squirts (1 of which contained significant concentrations), and 5 sets with Bryozoans.

2.3. EU-Spain 3L groundfish survey (Div. 3L)

The EU 3L groundfish survey (**Paz et al., 2012**), conducted by the Instituto Español de Oceanografía (COV-IEO, CSIC), sampled Div. 3L between 125 - 1467 m depth, with a total of 90 tows (82 valid). Out of all valid tows in Div. 3L, 68 tows recorded at least one VME indicator species group. These correspond to 2 sets with Black corals, 1 sets with Large gorgonians (1 of which contained significant concentrations), 34 sets with Sea pens, 18 sets with Small gorgonians, 63 sets with Sponges (1 of which contained significant concentrations), and 24 sets with Bryozoans.

2.4. Canadian Multispecies Surveys (Divs. 3LNO)

The Canadian Multispecies Surveys, conducted by Fisheries and Oceans Canada (DFO) (**McCallum and Walsh, 1996**), sampled the Grand Bank of Newfoundland (NAFO Divs. 3LNO) between mean depths of 39 - 1404 m, with a total of 338 tows (313 valid) (Fall 2023 - Spring 2025). In Div. 3L, DFO conducted a total of 150 tows (142 valid) between 100 - 1404 m depth, with 131 tows recording at least one VME indicator species group. In Div. 3N, DFO conducted a total of 232 tows (216 valid) between 39 - 721 m depth, with 160 tows recording at least one VME indicator species group. In Div. 3O, DFO conducted a total of 49 tows (48 valid) between 77 - 650 m depth, with 33 tows recording at least one VME indicator species group.

For the Canadian surveys, a significant change took place in 2022. DFO is transitioning from the CCGS *Teleost* and CCGS *Alfred Needler* to new vessels, the CCGS *Capt Jacques Cartier* and CCGS *John Cabot* for its annual spring (Div. 3LNOPs) and fall (Div.2HJKLMNO) multispecies survey. The MV *Calvert* was also used as part of the comparative fishing. The new vessels use the same fishing protocols as previous (Needler and Teleost), but minor modifications have been made to the trawl (**Wheeland L. et al., 2023**). Conversion factors between these vessels are not available for corals, bryozoans, and *Boltenia ovifera*, because the available data were insufficient for their development. For this reason, caution should be taken when interpreting the data presented here based on the new vessels, particularly in comparison to pre-2022 data. For sponges, on the other hand, analysis of the CCGS *Teleost-Capt Jacques Cartier*/*John Cabot* comparison (Fall 2021-2022,

2HJ3KL) and CCGS *Needler- John Cabot* comparison (Fall 2021-2022, Fall 3KL) indicated no significant difference in catchability of sponges, and conversion factors do not need to be applied for this taxa (**DFO, 2024**, **2025**).

1. The Fall 2023 sets that fell within the NRA were conducted using the CCGS *John Cabot* (35% of all sets, with one unsuccessful set), CCGS *Capt Jacques Cartier* (51% of all sets, with one unsuccessful set), and CCGS *Teleost* (14% of all sets, with one unsuccessful set). For the CCGS *John Cabot* valid sets, these correspond to 2 sets with large gorgonians (1 of which contained significant concentrations) and 7 sets with sea pens. For the CCGS *Capt Jacques Cartier* valid sets, these correspond to 9 sets with sea pens and 5 sets with small gorgonians (1 of which contained significant concentrations). For the CCGS *Teleost* valid sets, these correspond to 7 sets with sea pens and 2 sets with small gorgonians.

2. The Spring 2024 sets that fell within the NRA were conducted using the CCGS *John Cabot* (61% of all sets, with four unsuccessful sets), and MV *Calvert* (39% of all sets, with one unsuccessful set). For the CCGS *John Cabot* valid sets, these correspond to 7 sets with sea pens (1 of which contained significant concentrations) and 3 sets with small gorgonians. For the MV *Calvert* valid sets, these correspond to and 7 sets with sea pens (3 of which contained significant concentrations).

3. The Fall 2024 sets that fell within the NRA were conducted using the CCGS *John Cabot* (100% of all sets, with 10 unsuccessful sets). The valid sets correspond to 2 sets with bryozoans, 2 sets with large gorgonians (1 of which contained significant concentrations), 9 sets with sea pens, 1 set with small gorgonians (1 of which contained significant concentrations) and 44 sets with sponges.

4. The Spring 2025 sets that fell within the NRA were conducted using the CCGS *John Cabot* (100% of all sets, with seven unsuccessful sets). The valid sets correspond to 5 sets with bryozoans, 4 sets with large gorgonians (1 of which contained significant concentrations), 6 sets with sea pens, 2 sets with *Boltenia ovifera*, 1 set with small gorgonians and 40 sets with sponges.

In summary, there were a total of 395 bottom trawl tows carried out during 2025 EU: EU-Spain and Portugal groundfish survey in the NRA (Figure 1A). 18 of those tows were not valid due to technical problems during the fishing operation. 109 hauls out of 377 valid tows have shown zero catches (i.e. no presence) of VME indicator species. This represents 28.91% of the total valid hauls. A total of 338 tows were carried out in the NRA during the Fall 2023 - Spring 2025 Canadian surveys (Figure 1B). 25 of these were considered unsuccessful (Figure 1B). Out of all sets, there were 17 valid tows done inside the VME closures (eight during EU: EU-Spain surveys, nine during Canadian surveys). As mentioned under the Survey data section, Canadian data for sponges, sea squirts and bryozoans are only shown for Fall 2024/Spring 2025 surveys, while data for corals are shown for Fall 2023/Spring 2024 and Fall 2024/Spring 2025. For simplicity, the coral data are shown for the whole specified period, but detailed by period (i.e., 2023-2024, 2024-2025) in Table 1.

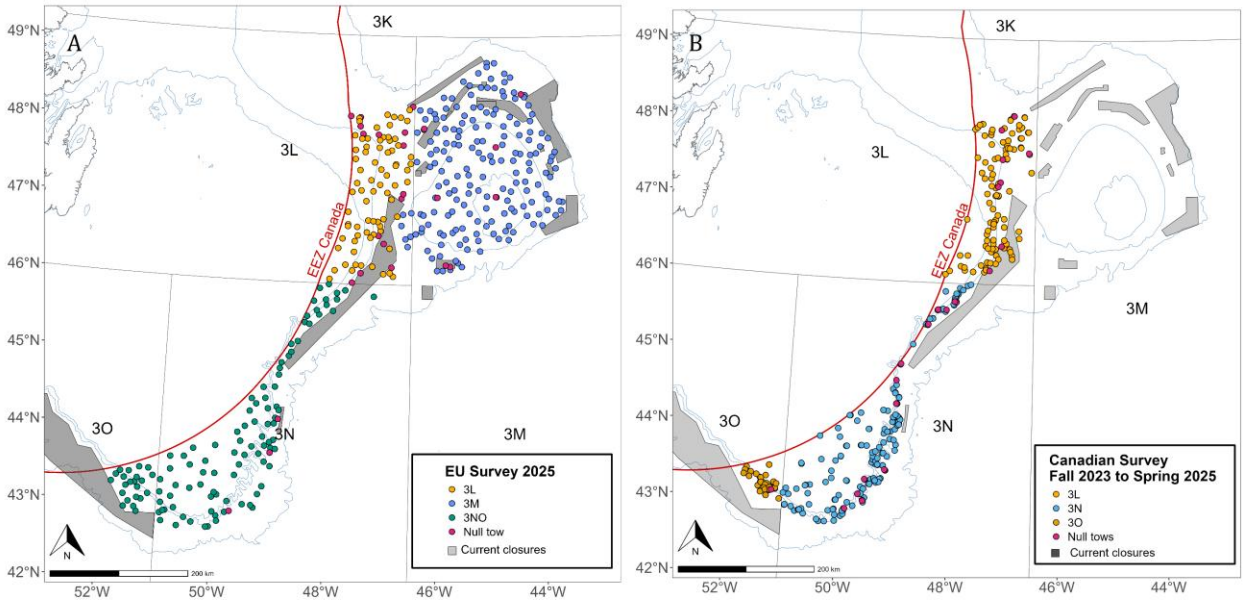

Figure 1. Distribution of sets (start positions) from A) 2025 EU: EU-Spain and Portugal groundfish survey (NAFO Divs. 3LMNO) and B) Fall 2023 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO).

Following previous methodologies used by WGESA, deep water corals were grouped by VME species groups and include: large gorgonians and small gorgonians (Orders Scleralcyonacea & Malacalcyonacea; McFadden et al. (2022)), sea pens (Superfamily Pennatuloidea; McFadden et al. (2022)), and black corals (Order Antipatharia). Sponges and bryozoans are shown at the phylum level (Phylum Porifera and Phylum Bryozoa), and *Boltenia ovifera* sea squirts are shown as "Sea squirts".

3. Results

Distribution maps of presence (non-significant and significant catches) for sponges, large gorgonians, small gorgonians, sea pens, black corals, sea squirts, and bryozoans are presented below (Figures 2-8). The summary of records is presented in Table 1. Location of each record was assigned by start position of each tow for all surveys (**Durán Muñoz et al., 2020**; **McCallum and Walsh, 1996**).

3.1. Sponges

EU: EU-Spain and Portugal 2025 Data: Sponges were recorded in 203 of the 377 valid tows (53.85% of valid tows analyzed), at mean depths between 135 and 1467 m (Figure 2A). There was one significant catch of sponges (≥ 100 kg/tow) in these tows (Figure 2A), which fell outside the VME polygons for sponges. Inside VME closures, sponges were recorded in 8 of the 8 valid tows conducted inside VME closures (100%), and there was one significant catch of sponges in these tows. In the set with significant catch, specimens were identified as *Thenea* sp. and *Geodia* sp. (Table 2).

Canadian (DFO) Fall 2024 - Spring 2025 Data: Sponges were recorded in 84 of the 128 valid tows (65.62% of valid tows analyzed), at mean depths between 44 and 704 m (Figure 2B). There were no significant catches of sponges (≥ 100 kg/tow) in these tows (Figure 2B). Inside VME closures, sponges were recorded in 4 of the 4 valid tows conducted inside VME closures (100%), and there were no significant catches in these tows.

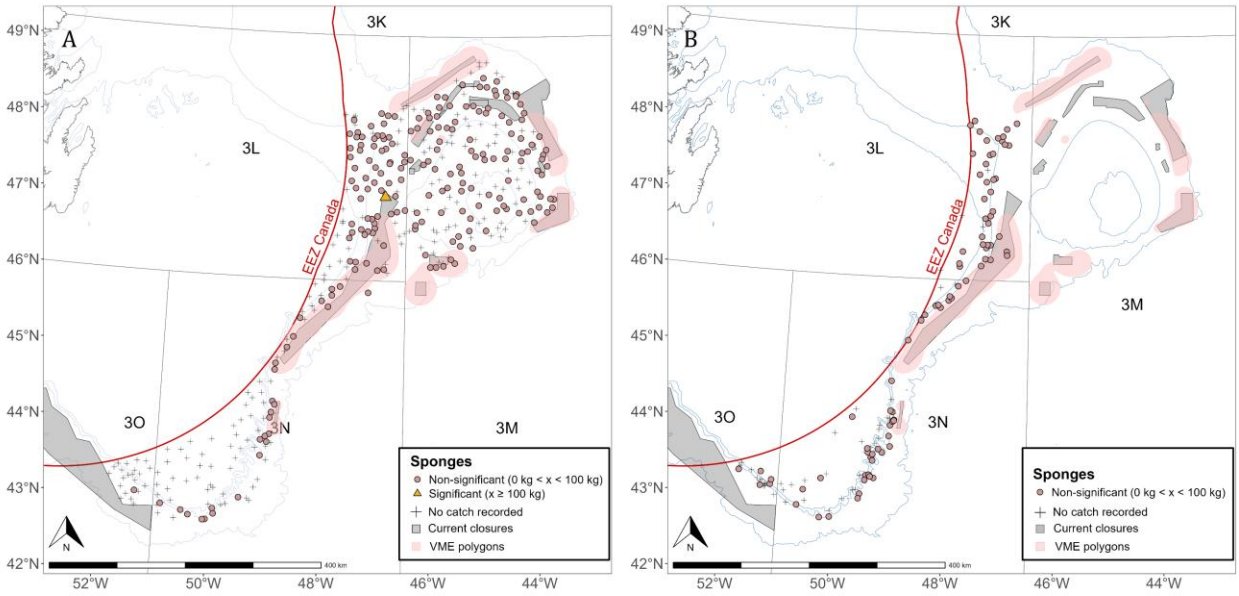

Figure 2. Distribution of catches of sponges in the study area from A) 2025 EU: EU-Spain and Portugal surveys (NAFO Divs. 3LMNO) and B) Fall 2024 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO). Black crosses represent tows with no sponges by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of sponges, respectively.

3.2. Large gorgonians

EU: EU-Spain and Portugal 2025 Data: Large gorgonians were recorded in 4 of the 377 valid tows (1.06% of valid tows analyzed), at mean depths between 572 and 681 m (Figure 3A). There was one significant catch of large gorgonians (≥ 0.6 kg/tow) in these tows (Figure 3A), which fell outside the VME polygons for large gorgonians. No large gorgonians were recorded inside VME closures during the EU 2025 surveys. In the set with significant catch, specimens were identified as *Paragorgia* sp. (Table 2).

Canadian (DFO) Fall 2023 - Spring 2025 Data: Large gorgonians were recorded in 8 of the 313 valid tows (2.56% of valid tows analyzed), at mean depths between 389 and 652 m (Figure 3B). There were three significant catches of large gorgonians (≥ 0.6 kg/tow) in these tows (Figure 3B), one of which fell within the VME polygons for large gorgonians (Table 2). Inside VME closures, large gorgonians were recorded in 2 of the 9 valid tows conducted inside VME closures (22%), and there was one significant catch in these tows. In the sets with significant catch, specimens were identified as *Paragorgia arborea* and *Paramuricea* spp. (Table 2).

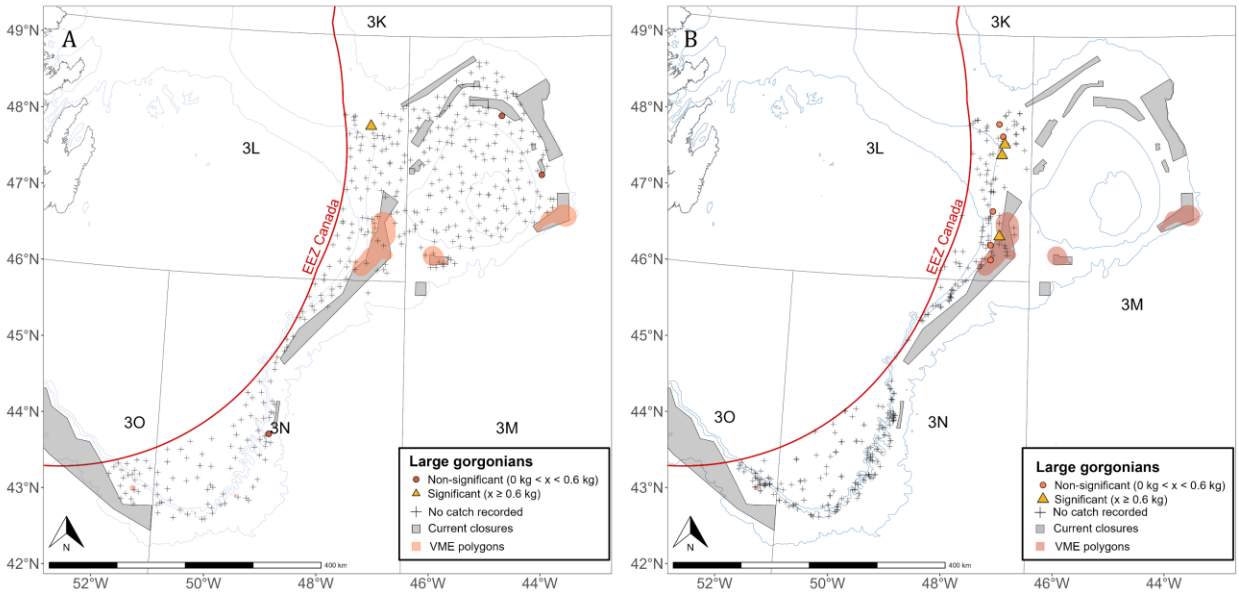

Figure 3. Distribution of catches of large gorgonians in the study area from A) 2025 EU: EU-Spain and Portugal surveys (NAFO Divs. 3LMNO) and B) Fall 2023 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO). Black crosses represent tows with no large gorgonians by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of large gorgonians, respectively.

3.3. Small gorgonians

EU: EU-Spain and Portugal 2025 Data: Small gorgonians were recorded in 57 of the 377 valid tows (15.12% of valid tows analyzed), at mean depths between 231 and 1464 m (Figure 4A). There were no significant catches of small gorgonians (≥ 0.2 kg/tow) in these tows (Figure 4A). Inside VME closures, small gorgonians were recorded in 3 of the 8 valid tows conducted inside VME closures (38%), and there were no significant catches of small gorgonians in these tows.

Canadian (DFO) Fall 2023 - Spring 2025 Data: Small gorgonians were recorded in 12 of the 313 valid tows (3.83% of valid tows analyzed), at mean depths between 53 and 1048 m (Figure 4B). There were two significant catches of small gorgonians (≥ 0.2 kg/tow) in these tows (Figure 4B), one of which fell within the VME polygons for small gorgonians (Table 2). Inside VME closures, small gorgonians were recorded in 3 of the 9 valid tows conducted inside VME closures (33%), and there was one significant catch in these tows. In the sets with significant catch, specimens were identified as *Acanella arbuscula* (Table 2).

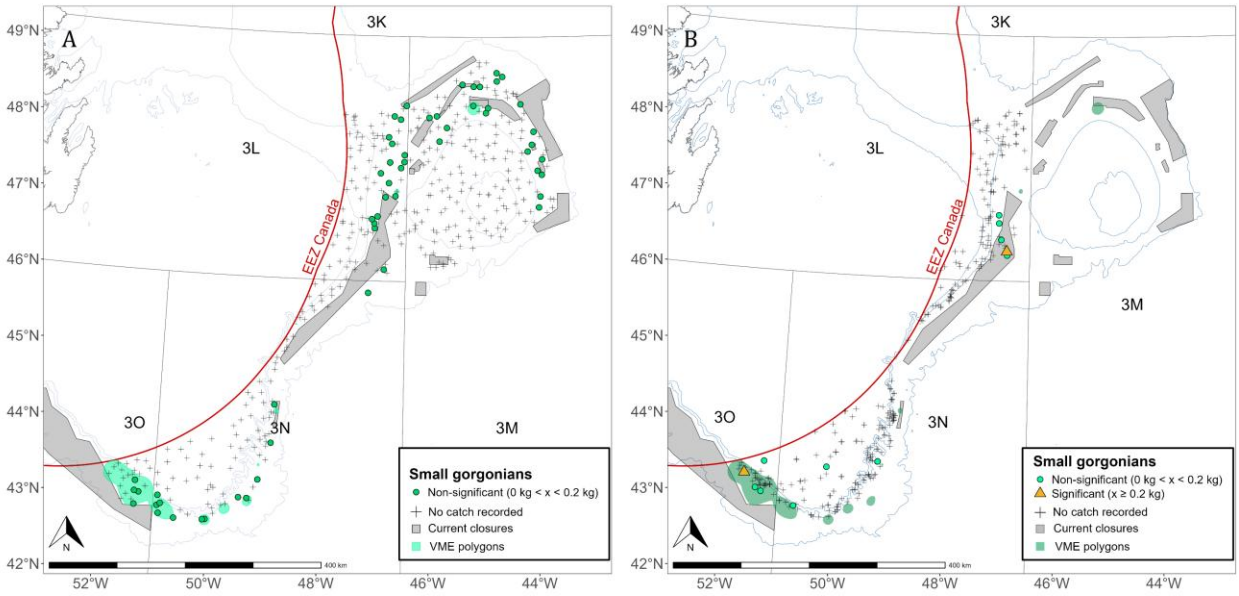

Figure 4. Distribution of catches of small gorgonians in the study area from A) 2025 EU: EU-Spain and Portugal surveys (NAFO Divs. 3LMNO) and B) Fall 2023 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO). Black crosses represent tows with no small gorgonians by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of small gorgonians, respectively.

3.4. Sea pens

EU: EU-Spain and Portugal 2025 Data: Sea pens were recorded in 160 of the 377 valid tows (42.44% of valid tows analyzed), at mean depths between 66 and 1448 m (Figure 5A). There was one significant catch of sea pens (≥ 1.3 kg/tow) in these tows (Figure 5A), which fell within the VME polygons for sea pens (Table 2). Inside VME closures, sea pens were recorded in 3 of the 8 valid tows conducted inside VME closures (38%), and there were no significant catches of sea pens in these tows. In the set with significant catch, specimens were identified as *Anthoptilum* sp. (Table 2).

Canadian (DFO) Fall 2023 - Spring 2025 Data: Sea pens were recorded in 52 of the 313 valid tows (16.61% of valid tows analyzed), at mean depths between 61 and 1184 m (Figure 5B). There were four significant catches of sea pens (≥ 1.3 kg/tow) in these tows (Figure 5B), one of which fell within the VME polygons for sea pens (Table 2). Inside VME closures, sea pens were recorded in 1 of the 9 valid tows conducted inside VME closures (11%), and there were no significant catches in these tows. In the sets with significant catch, specimens were identified as Pennatuloidea spp. (Superfamily) formerly Pennatulacea spp. (Order), *Anthoptilum* spp., and *Anthoptilum grandiflorum* (Table 2).

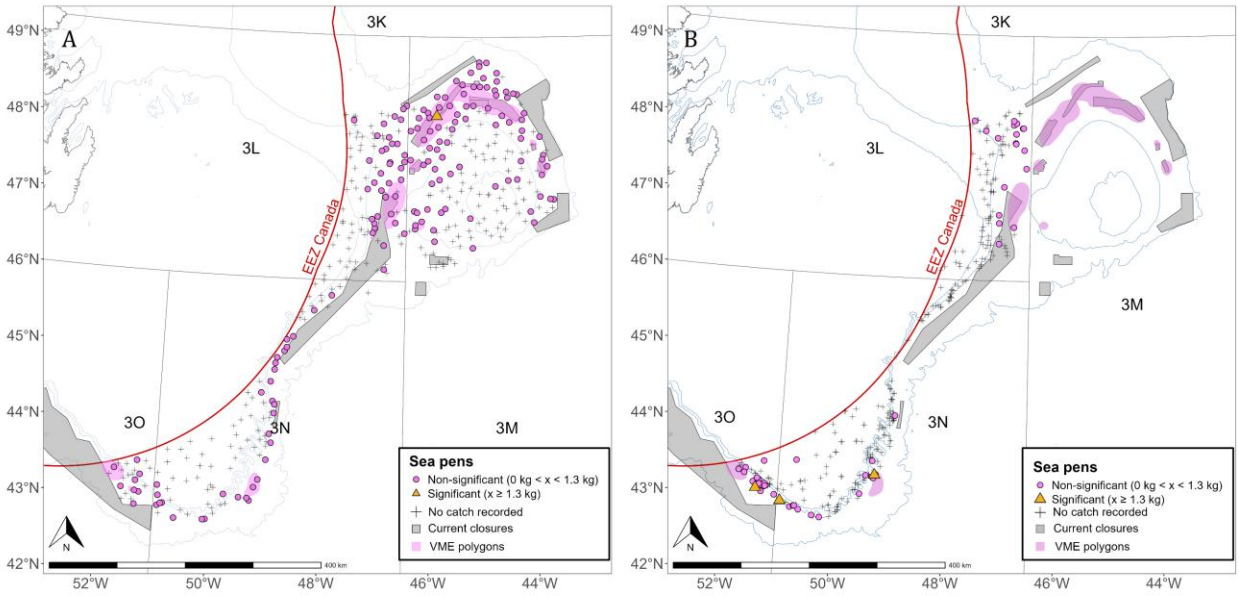

Figure 5. Distribution of catches of sea pens in the study area from A) 2025 EU: EU-Spain and Portugal surveys (NAFO Divs. 3LMNO) and B) Fall 2023 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO). Black crosses represent tows with no sea pens by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of sea pens, respectively.

3.5. Black corals

EU: EU-Spain and Portugal 2025 Data: Black corals were recorded in 31 of the 377 valid tows (8.22% of valid tows analyzed), at mean depths between 231 and 1265 m (Figure 6A). There were two significant catches of black corals (≥ 0.4 kg/tow) in these tows (Figure 6A), both of which fell outside the VME polygons for black corals. Inside VME closures, black corals were recorded in 1 of the 8 valid tows conducted inside VME closures (13%), and there were no significant catches of black corals in these tows. In the sets with significant catch, specimens were identified as *Stauropathes arctica* (Table 2).

Canadian (DFO) Fall 2023 - Spring 2025 Data: Black corals were not recorded in any of the DFO Fall 2023 - Spring 2025 surveys.

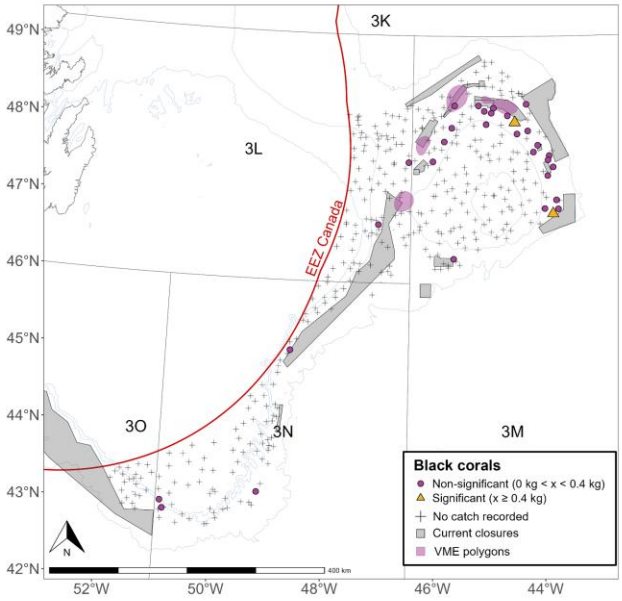

Figure 6. Distribution of catches of black corals in the study area from 2025 EU: EU-Spain and surveys (NAFO Divs. 3LMNO). Black crosses represent tows with no black corals by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of black corals, respectively.

3.6. Sea squirts

EU: EU-Spain and Portugal 2025 Data: Sea squirts were recorded in 6 of the 377 valid tows (1.59% of valid tows analyzed), at mean depths between 57 and 226 m (Figure 7A). There was one significant catch of sea squirts (≥ 0.35 kg/tow) in these tows (Figure 7A), which fell within the VME polygons for sea squirts (Table 2). No sea squirts were recorded inside VME closures during the EU 2025 surveys. In the set with significant catch, specimens were identified as *Boltenia ovifera* (Table 2).

Canadian (DFO) Fall 2024 - Spring 2025 Data: Sea squirts were recorded in 2 of the 128 valid tows (1.56% of valid tows analyzed), at mean depths between 205 and 206 m (Figure 7B), both of which fell inside of VME polygons for sea squirts. There were no significant catches of sea squirts (≥ 0.35 kg/tow) in these tows (Figure 7B). No sea squirts were recorded inside VME closures during the Canadian Fall 2024 - Spring 2025 surveys.

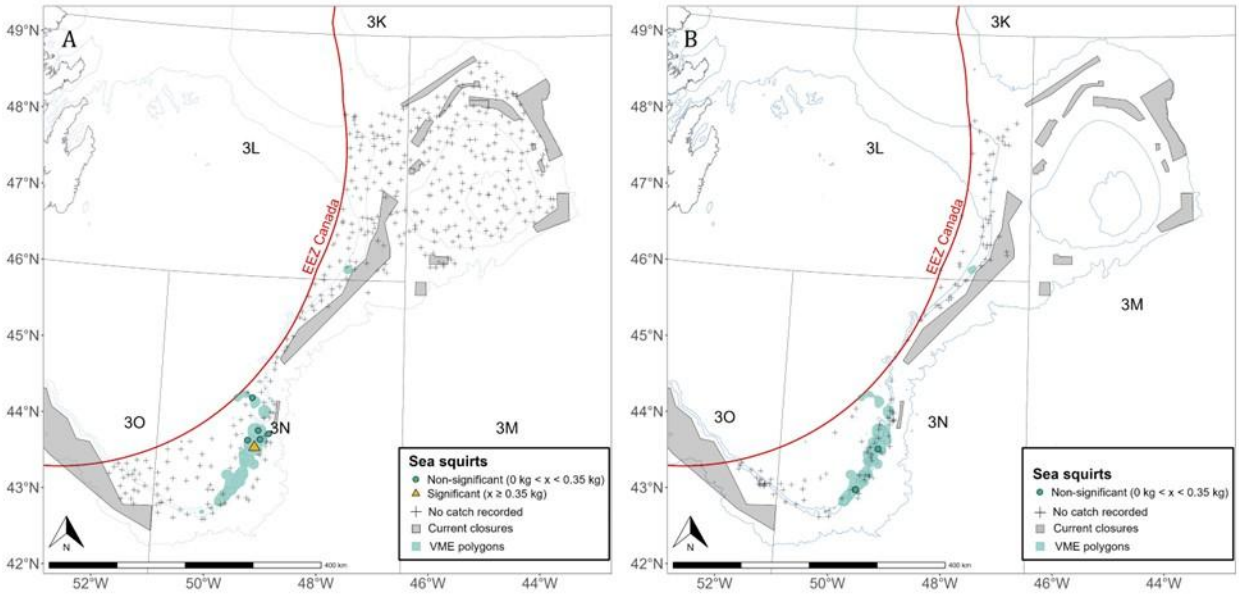

Figure 7. Distribution of catches of sea squirts in the study area from A) 2025 EU: EU-Spain and Portugal surveys (NAFO Divs. 3LMNO) and B) Fall 2024 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO). Black crosses represent tows with no sea squirts by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of sea squirts, respectively.

3.7. Bryozoans

EU: EU-Spain and Portugal 2025 Data: Bryozoans were recorded in 30 of the 377 valid tows (7.96% of valid tows analyzed), at mean depths between 46 and 1199 m (Figure 8A). There were no significant catches of bryozoans (≥ 0.2 kg/tow) in these tows (Figure 8A). Inside VME closures, bryozoans were recorded in 1 of the 8 valid tows conducted inside VME closures (13%), and there were no significant catches of bryozoans in these tows.

Canadian (DFO) Fall 2024 - Spring 2025 Data: Bryozoans were recorded in 7 of the 128 valid tows (5.47% of valid tows analyzed), at mean depths between 189 and 604 m (Figure 8B). There were no significant catches of bryozoans (≥ 0.2 kg/tow) in these tows (Figure 8B). No bryozoans were recorded inside VME closures during the Canadian Fall 2024 - Spring 2025 surveys.

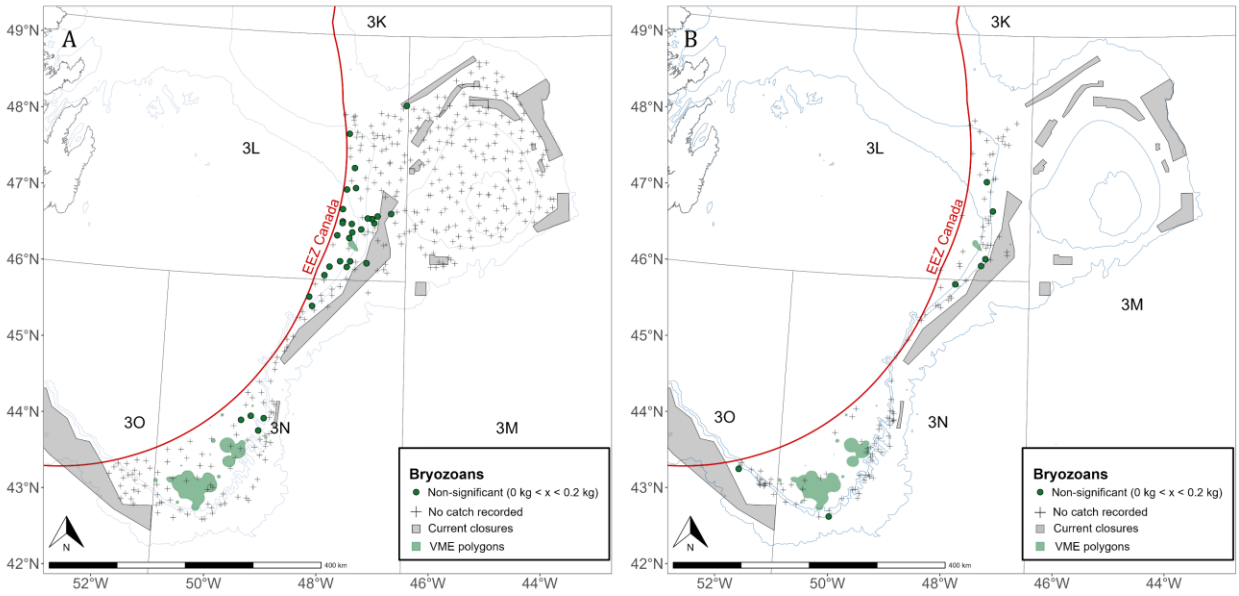

Figure 8. Distribution of catches of bryozoans in the study area from A) 2025 EU: EU-Spain and Portugal surveys (NAFO Divs. 3LMNO) and B) Fall 2024 - Spring 2025 Canadian surveys (NAFO Divs. 3LNO). Black crosses represent tows with no bryozoans by-catch recorded (no presence). Yellow triangles and coloured points represent tows with significant and non-significant catches of bryozoans, respectively.

Table 1. Summary of deep-water coral and sponge records for the NRA from 2025 EU: EU-Spain and Portugal surveys and Fall 2023 - Spring 2025 Canadian surveys. Canadian data are shown as merged periods (2023-2025) and as individual periods (Fall 2023/Spring 2024 and Fall 2024/Spring 2025). Calculations were performed using valid tows.

VME	Presence [Significant and Non-Significant](# of valid tows)	% of valid tows with presence	# of valid tows with Significant Concentrations	% of valid tows with Significant Concentrations	# of valid tows with Significant Concentrations inside VME corresponding polygon	# of valid tows inside VME closures [Significant and Non-significant]
EU: EU-Spain and Portugal						
Sponges	203	53.8%	1	0.27%	0	8
Large gorgonians	4	1.1%	1	0.27%	0	0
Small gorgonians	57	15.1%	0	0.00%	0	3
Sea pens	160	42.4%	1	0.27%	1	3
Black corals	31	8.2%	2	0.54%	0	1
Sea squirts	6	1.6%	1	0.27%	1	0
Bryozoans	30	8.0%	0	0.00%	0	1
Canada (all years)						
Sponges	84	65.6%	0	0.00%	0	4
Large gorgonians	8	2.6%	3	0.01%	1	2
Small gorgonians	12	3.8%	2	0.01%	1	3
Sea pens	52	16.6%	4	0.01%	1	1
Black corals	0	0.0%	0	0.00%	0	0
Sea squirts	2	1.6%	0	0.00%	0	0
Bryozoans	7	5.5%	0	0.00%	0	0
Canada (2023 Fall and 2024 Spring)						
Large gorgonians	2	1.1%	1	0.54%	0	0
Small gorgonians	10	5.4%	1	0.54%	1	1
Sea pens	37	20.0%	4	2.16%	1	1
Black corals	0	0.0%	0	0.00%	0	0

VME	Presence [Significant and Non-Significant](# of valid tows)	% of valid tows with presence	# of valid tows with Significant Concentrations	% of valid tows with Significant Concentrations	# of valid tows with Significant Concentrations inside VME corresponding polygon	# of valid tows inside VME closures [Significant and Non-significant]
Canada (2024 Fall and 2025 Spring)						
Sponges	84	65.6%	0	0.00%	0	4
Large gorgonians	6	4.7%	2	1.56%	1	2
Small gorgonians	2	1.6%	1	0.78%	0	2
Sea pens	15	11.7%	0	0.00%	0	0
Black corals	0	0.0%	0	0.00%	0	0
Sea squirts	2	1.6%	0	0.00%	0	0
Bryozoans	7	5.5%	0	0.00%	0	0

Table 2. Significant catches of VME indicator species in the NRA (Divs. 3LMNO) with their corresponding depth (m) and weight (kg). Note that tow positions are expressed in decimal degrees (with two decimal places).

VME indicator species	Latitude (N)	Longitude (W)	Depth (m)	Weight (kg)	Species
EU: EU-Spain and Portugal					
Sponges >= 100 kg	47.11500	-46.91333	1,175	138.99	*Thenea* sp. (81.27 kg), *Geodia* sp. (46.95 kg), and *Asconema* sp. (9 kg)
Large gorgonians >= 0.6 kg	48.05167	-47.23333	603	11.05	*Paragorgia* sp.
Sea pens >= 1.3 kg	48.19880	-45.93420	1,041	3.44	*Anthoptilum* sp.
Black corals >= 0.4 kg	48.12200	-44.49970	608	0.41	*Stauropathes arctica*
Black corals >= 0.4 kg	46.92220	-43.77180	695	0.486	*Stauropathes arctica*
Sea squirts >= 0.35 kg	43.73567	-49.20783	226	1.86	*Boltenia ovifera*
Canada					
Small gorgonians >= 0.2 kg	43.29483	-51.61983	619	0.21	*Acanella arbuscula*
Large gorgonians >= 0.6 kg	47.66650	-47.08150	576	2.65	*Paragorgia arborea*
Small gorgonians >= 0.2 kg	46.38967	-46.94200	685	0.23	*Acanella arbuscula*
Large gorgonians >= 0.6 kg	46.58900	-47.09300	633	2.16	*Paragorgia arborea*
Sea pens >= 1.3 kg	42.95017	-50.94967	634	1.56	Pennatuloidea spp. (Superfamily) formerly Pennatulacea spp. (Order)
Sea pens >= 1.3 kg	43.10317	-51.40317	627	1.53	*Anthoptilum* spp.
Sea pens >= 1.3 kg	42.95450	-50.94600	642	4.32	Pennatuloidea spp. (Superfamily) formerly Pennatulacea spp. (Order)

VME indicator species	Latitude (N)	Longitude (W)	Depth (m)	Weight (kg)	Species
Sea pens >= 1.3 kg	43.36650	-49.25733	619	1.61	*Anthoptilum grandiflorum*
Large gorgonians >= 0.6 kg	47.80965	-47.03023	563	2.39	*Paramuricea* spp.

Acknowledgements

The data collection of the EU Groundfish Surveys used in this paper has been funded by the EU through the European Maritime, Fisheries and Aquaculture Fund (EMFAF) within the Spanish Work Plan for the collection of data in the fisheries and aquaculture sectors in relation to the Common Fisheries Policy. SAM's contract was supported by BATISCAFO project. This output reflects only the author's view (SAM; MS & PDM) and the European Union cannot be held responsible for any use that may be made of the information contained therein. BMN, RC, and VWH acknowledge and thank DFO-NL personnel and Canadian Coast Guard captains and crew for Canadian data collection. This report was produced using the *NAFOdown* package (**Regular and Rogers, 2023**) in R [version 4.4.2; R Core Team (**2024**)].

References

DFO. (2024). Newfoundland and Labrador Comparative Fishing Analysis – Part 1. In *DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2024/002.* (Erratum: August 2024).

DFO. (2025). Newfoundland and Labrador Comparative Fishing Analysis – Part 2. In *DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2025/037.*

Durán Muñoz, P., Sacau, M., García-Alegre, A., and Román, E. (2020). Cold-water corals and deep-sea sponges by-catch mitigation: Dealing with groundfish survey data in the management of the northwest Atlantic Ocean high seas fisheries. *Marine Policy*, 116(103712). **https://doi.org/10.1016/j.marpol.2019.103712**

McCallum, Barry R., and Walsh, S. J. (1996). Groundfish survey trawls used at the Northwest Atlantic Fisheries Centre, 1971-present. *NAFO SCR Doc.*, *96/50*.

McFadden, C. S., Van Ofwegen, L. P., and Quattrini, A. M. (2022). Revisionary systematics of Octocorallia (Cnidaria: Anthozoa) guided by phylogenomics. *Bulletin of the Society of Systematic Biologists*, 1(3). **https://doi.org/10.18061/bssb.v1i3.8735**

NAFO. (2013). Report of the 6th Meeting of the NAFO Scientific Council Working Group of Ecosystem Science and Assessment (WGESA) [Formerly WGEAFM]. *NAFO SCS Doc.*, *13/24. Serial no. N6277*.

NAFO. (2019). Report of the 12th Meeting of the NAFO Scientific Council Working Group of Ecosystem Science and Assessment (WGESA) [Formerly WGEAFM]. *NAFO SCS Doc.*, *19/25. Serial no. N7027*.

Paz, X., González, C., González Troncoso, D., Guijarro, E., Casas, J. M., and Román, E. (2012). Protocolo de la campaña de investigación pesquera en el Gran Banco de Terranova, Divisiones 3LNO de la NAFO (Programa Nacional de Recopilación, Gestión y uso de los Datos Pesqueros (PNDB)). *Instituto Español de Oceanografía. Centro Oceanográfico de Vigo. Equipo de Pesquerías Lejanas*, 71 p.

R Core Team. (2024). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. **https://www.R-project.org/**

Regular, P., and Rogers, B. (2023). *NAFOdown: An r markdown template for producing NAFO scientific council documents*. **https://github.com/nafc-assess/NAFOdown**

Vázquez Rodríguez, A., Casas-Sánchez, J. M., and Alpoim, R. (2014). Protocols of the EU bottom trawl survey of Flemish Cap. *Northwest Atlantic Fisheries Organization. NAFO Scientific Council Studies*, *46:1-42.* 42 p.

Wheeland L., Trueman S., and R., R. (2023). Coverage of the 2022 Canadian (Newfoundland and Labrador Region) Multi-Species RV Bottom Trawl Survey with notes on Comparative Fishing. *NAFO SCR Doc.*, *23/042*.

Colophon

This version of the document was generated on 2025-11-10 13:26:15.069853 using the R markdown template for SCR documents from **NAFOdown**.

The computational environment that was used to generate this version is as follows:

```
#> ─ Session info ─────────────────────────────────────────────────────────────
#>  setting  value
#>  version  R version 4.4.2 (2024-10-31 ucrt)
#>  os       Windows 11 x64 (build 22631)
#>  system   x86_64, mingw32
#>  ui       RTerm
#>  language (EN)
#>  collate  English_United States.utf8
#>  ctype    English_United States.utf8
#>  tz       America/St_Johns
#>  date     2025-11-10
#>  pandoc   3.2 @ C:/Program Files/RStudio/resources/app/bin/quarto/bin/tools/ (via rmarkdown)
#>  quarto   NA @ C:\\PROGRA~1\\RStudio\\RESOUR~1\\app\\bin\\quarto\\bin\\quarto.exe
#>
#> ─ Packages ─────────────────────────────────────────────────────────────────
#>  package         * version date (UTC) lib source
#>  askpass           1.2.1   2024-10-04 [1] CRAN (R 4.4.2)
#>  bit               4.6.0   2025-03-06 [1] CRAN (R 4.4.3)
#>  bit64             4.6.0-1 2025-01-16 [1] CRAN (R 4.4.2)
#>  bookdown          0.44    2025-08-21 [1] CRAN (R 4.4.3)
#>  cachem            1.1.0   2024-05-16 [1] CRAN (R 4.4.2)
#>  cli               3.6.4   2025-02-13 [1] CRAN (R 4.4.2)
#>  cowplot           1.2.0   2025-07-07 [1] CRAN (R 4.4.3)
#>  crayon            1.5.3   2024-06-20 [1] CRAN (R 4.4.2)
#>  data.table        1.17.8  2025-07-10 [1] CRAN (R 4.4.3)
#>  devtools          2.4.5   2022-10-11 [1] CRAN (R 4.4.3)
#>  digest            0.6.37  2024-08-19 [1] CRAN (R 4.4.2)
#>  dplyr           * 1.1.4   2023-11-17 [1] CRAN (R 4.4.2)
#>  ellipsis          0.3.2   2021-04-29 [1] CRAN (R 4.4.3)
#>  evaluate          1.0.5   2025-08-27 [1] CRAN (R 4.4.3)
#>  farver            2.1.2   2024-05-13 [1] CRAN (R 4.4.2)
#>  fastmap           1.2.0   2024-05-15 [1] CRAN (R 4.4.2)
#>  flextable       * 0.9.10  2025-08-24 [1] CRAN (R 4.4.3)
#>  fontBitstreamVera   0.1.1   2017-02-01 [1] CRAN (R 4.4.0)
#>  fontLiberation      0.1.0   2016-10-15 [1] CRAN (R 4.4.0)
#>  fontquiver          0.2.1   2017-02-01 [1] CRAN (R 4.4.2)
#>  forcats         * 1.0.0   2023-01-29 [1] CRAN (R 4.4.2)
#>  fs                1.6.6   2025-04-12 [1] CRAN (R 4.4.3)
#>  ftExtra         * 0.6.4   2024-05-10 [1] CRAN (R 4.4.3)
#>  gdtools           0.4.3   2025-08-26 [1] CRAN (R 4.4.3)
#>  generics          0.1.4   2025-05-09 [1] CRAN (R 4.4.3)
#>  ggplot2         * 4.0.0   2025-09-11 [1] CRAN (R 4.4.3)
#>  ggridges          0.5.7   2025-08-27 [1] CRAN (R 4.4.3)
#>  ggthemes          5.1.0   2024-02-10 [1] CRAN (R 4.4.3)
#>  glue              1.8.0   2024-09-30 [1] CRAN (R 4.4.2)
#>  gtable            0.3.6   2024-10-25 [1] CRAN (R 4.4.2)
```

```
#> hms             1.1.3   2023-03-21 [1] CRAN (R 4.4.2)
#> htmltools       0.5.8.1 2024-04-04 [1] CRAN (R 4.4.2)
#> htmlwidgets     1.6.4   2023-12-06 [1] CRAN (R 4.4.2)
#> httpuv          1.6.16  2025-04-16 [1] CRAN (R 4.4.3)
#> jsonlite        2.0.0   2025-03-27 [1] CRAN (R 4.4.3)
#> knitr           1.50    2025-03-16 [1] CRAN (R 4.4.3)
#> labeling        0.4.3   2023-08-29 [1] CRAN (R 4.4.0)
#> later           1.4.4   2025-08-27 [1] CRAN (R 4.4.3)
#> lifecycle       1.0.4   2023-11-07 [1] CRAN (R 4.4.2)
#> lubridate     * 1.9.4   2024-12-08 [1] CRAN (R 4.4.2)
#> magick          2.8.7   2025-06-06 [1] CRAN (R 4.4.3)
#> magrittr        2.0.3   2022-03-30 [1] CRAN (R 4.4.2)
#> memoise         2.0.1   2021-11-26 [1] CRAN (R 4.4.2)
#> mime            0.13    2025-03-17 [1] CRAN (R 4.4.3)
#> miniUI          0.1.2   2025-04-17 [1] CRAN (R 4.4.3)
#> NAFOdown      * 0.0.1   2025-03-10 [1] Github (nafc-assess/NAFOdown@b5689f8)
#> officedown      0.4.1   2025-05-20 [1] CRAN (R 4.4.3)
#> officer         0.6.10  2025-05-30 [1] CRAN (R 4.4.3)
#> openssl         2.3.2   2025-02-03 [1] CRAN (R 4.4.2)
#> pillar          1.11.0  2025-07-04 [1] CRAN (R 4.4.3)
#> pkgbuild        1.4.8   2025-05-26 [1] CRAN (R 4.4.3)
#> pkgconfig       2.0.3   2019-09-22 [1] CRAN (R 4.4.2)
#> pkgload         1.4.0   2024-06-28 [1] CRAN (R 4.4.2)
#> profvis         0.4.0   2024-09-20 [1] CRAN (R 4.4.3)
#> promises        1.3.3   2025-05-29 [1] CRAN (R 4.4.3)
#> purrr         * 1.0.4   2025-02-05 [1] CRAN (R 4.4.2)
#> R6              2.6.1   2025-02-15 [1] CRAN (R 4.4.2)
#> ragg            1.3.3   2024-09-11 [1] CRAN (R 4.4.2)
#> RColorBrewer    1.1-3   2022-04-03 [1] CRAN (R 4.4.0)
#> Rcpp            1.1.0   2025-07-02 [1] CRAN (R 4.4.3)
#> readr         * 2.1.5   2024-01-10 [1] CRAN (R 4.4.2)
#> remotes         2.5.0   2024-03-17 [1] CRAN (R 4.4.2)
#> rlang           1.1.5   2025-01-17 [1] CRAN (R 4.4.2)
#> rmarkdown       2.29    2024-11-04 [1] CRAN (R 4.4.3)
#> rstudioapi      0.17.1  2024-10-22 [1] CRAN (R 4.4.2)
#> rvg             0.3.5   2025-03-27 [1] CRAN (R 4.4.3)
#> S7              0.2.0   2024-11-07 [1] CRAN (R 4.4.3)
#> scales          1.4.0   2025-04-24 [1] CRAN (R 4.4.3)
#> sessioninfo     1.2.3   2025-02-05 [1] CRAN (R 4.4.3)
#> shiny           1.11.1  2025-07-03 [1] CRAN (R 4.4.3)
#> showtext        0.9-7   2024-03-02 [1] CRAN (R 4.4.3)
#> showtextdb      3.0     2020-06-04 [1] CRAN (R 4.4.3)
#> stringi         1.8.4   2024-05-06 [1] CRAN (R 4.4.0)
#> stringr       * 1.5.1   2023-11-14 [1] CRAN (R 4.4.2)
#> sysfonts        0.8.9   2024-03-02 [1] CRAN (R 4.4.3)
#> systemfonts     1.2.1   2025-01-20 [1] CRAN (R 4.4.2)
#> textshaping     1.0.0   2025-01-20 [1] CRAN (R 4.4.2)
#> tibble        * 3.2.1   2023-03-20 [1] CRAN (R 4.4.2)
#> tidyr         * 1.3.1   2024-01-24 [1] CRAN (R 4.4.2)
#> tidyselect      1.2.1   2024-03-11 [1] CRAN (R 4.4.2)
#> tidyverse     * 2.0.0   2023-02-22 [1] CRAN (R 4.4.2)
#> timechange      0.3.0   2024-01-18 [1] CRAN (R 4.4.2)
#> tzdb            0.4.0   2023-05-12 [1] CRAN (R 4.4.2)
#> urlchecker      1.0.1   2021-11-30 [1] CRAN (R 4.4.3)
#> usethis         3.2.0   2025-08-28 [1] CRAN (R 4.4.3)
```

```
#>  uuid          1.2-1   2024-07-29 [1] CRAN (R 4.4.1)
#>  vctrs         0.6.5   2023-12-01 [1] CRAN (R 4.4.2)
#>  vroom           1.6.5   2023-12-05 [1] CRAN (R 4.4.2)
#>  withr         3.0.2   2024-10-28 [1] CRAN (R 4.4.2)
#>  xfun          0.53    2025-08-19 [1] CRAN (R 4.4.3)
#>  xml2          1.3.6   2023-12-04 [1] CRAN (R 4.4.2)
#>  xtable        1.8-4   2019-04-21 [1] CRAN (R 4.4.3)
#>  yaml          2.3.10  2024-07-26 [1] CRAN (R 4.4.2)
#>  zip           2.3.2   2025-02-01 [1] CRAN (R 4.4.2)
#>
#>  [1] C:/Users/COMMANDR/AppData/Local/R/win-library/4.4
#>  [2] C:/Program Files/R/R-4.4.2/library
#>  * ── Packages attached to the search path.
#>
#> ──────────────────────────────────────────────────────────────────────────────────────────────────────
──────────
```