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November 24, 2023

Jeffrey Janes
Policy Analyst, Regional and Strategic Assessment
Impact Assessment Agency

Submitted by email: OffshoreWindNS-EolienneExtracotiereNE@iaac-aeic.gc.ca

Subject: Request for Advice - Committee for the Regional Assessment of Offshore Wind Development in Nova Scotia

Dear Colleague,

The Impact Assessment Agency of Canada (the Agency) requested that Natural Resources Canada (NRCan) to provide advice related to the following:

- Existing regional Environmental Characteristics for both physical environment components;
- Relevant regional-scale mapping data as it relates to the existing environmental information;
- Advice and input regarding spatial and temporal trends for existing physical and biological component in relation to potential interactions with offshore wind development components and activities (e.g., installation and operation of wind turbines, subsea cables, and service vessels);
- Advice regarding general gaps in knowledge or understanding of areas within the Study Area, or future works being undertaken to help address these gaps; and
- Other information or advice that NRCan identifies as being relevant to the Committee's mandate as part of the overall goal and objectives of the Regional Assessment.

NRCan is submitting this response pursuant to section 23 of the *Impact Assessment Act*. Details of NRCan's response can be found below in the Advice Record for Regional Assessment of Offshore Wind Development in Nova Scotia.

NRCan looks forward to revisiting once more data or information becomes available. If you have any questions, comments, or concerns, please contact Natalie.Robinson@nrcan-rncan.gc.ca.

Sincerely,

Natalie Robinson
Impact Assessment Division
Office of the Chief Scientist

CC: Christina Clarke; Peter Unger

Advice Record for Regional Assessment of Offshore Wind Development in Nova Scotia

Department/Agency	Natural Resources Canada
Lead Contact	Natalie Robinson
Email	Natalie.Robinson@NRCan-RNCan.gc.ca

1. Provision of Information on existing conditions

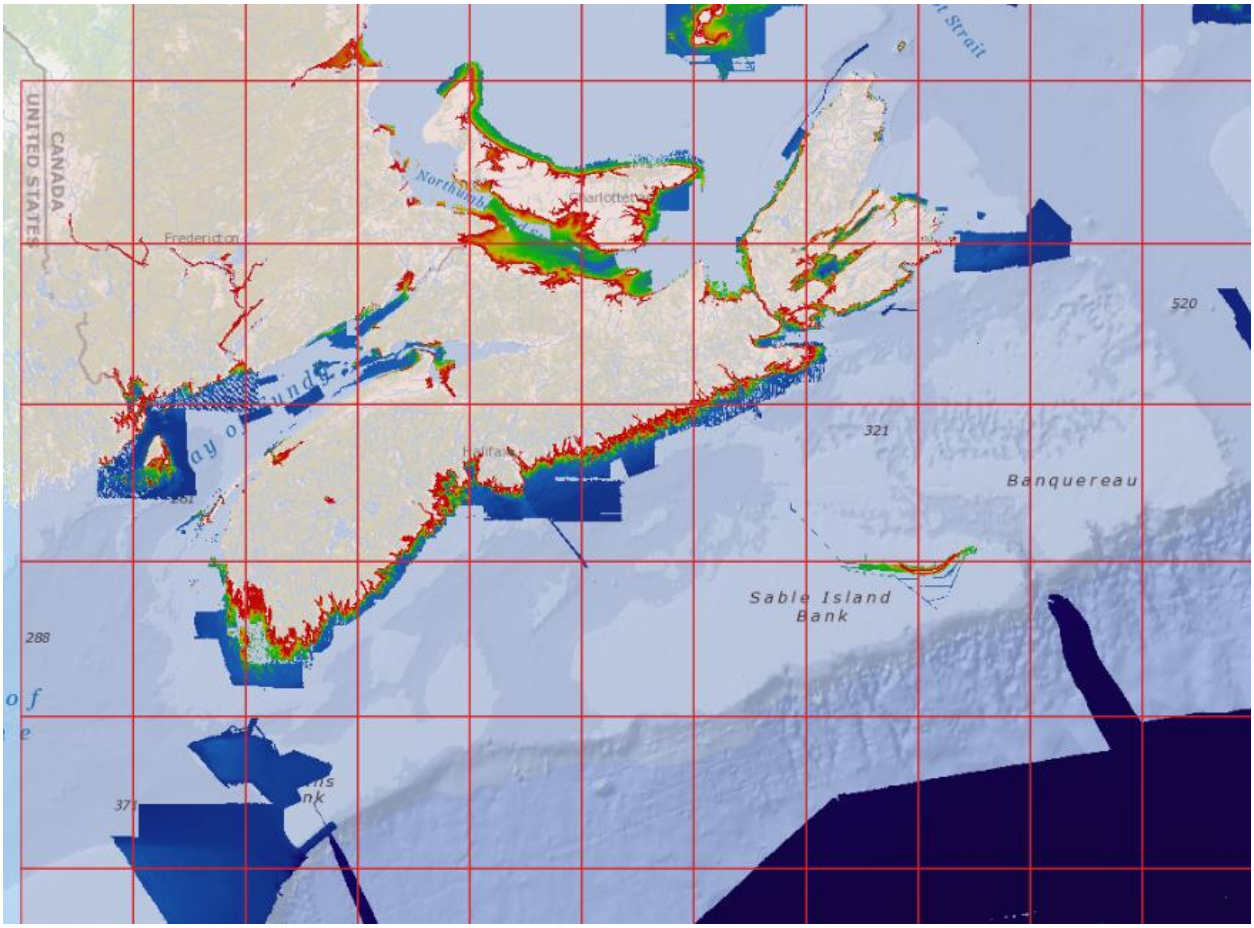
Physical / Oceanographic Conditions

• A general overview / summary of oceanographic conditions within the Study Area including: o Bedrock and surficial geology within the region, as it relates to offshore wind potential.

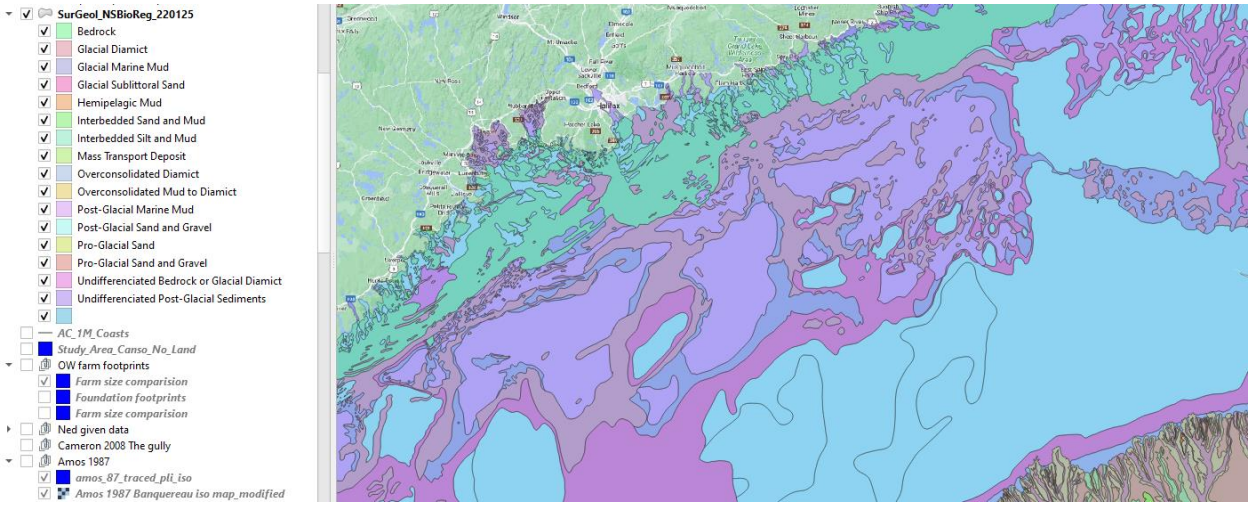
This information has generally been summarized in Eamer et al., 2020 - https://doi.org/10.4095/326514 where the bedrock, surficial geology, and seabed morphology have been described for each physiographic region of the RA area. In addition, key sources of more targeted information, data and maps are provided for each region. The GSC encourages the committee to download that material and let us know if they have any questions.

Relevant regional-scale mapping data as it relates to the existing environmental information
are as follows:

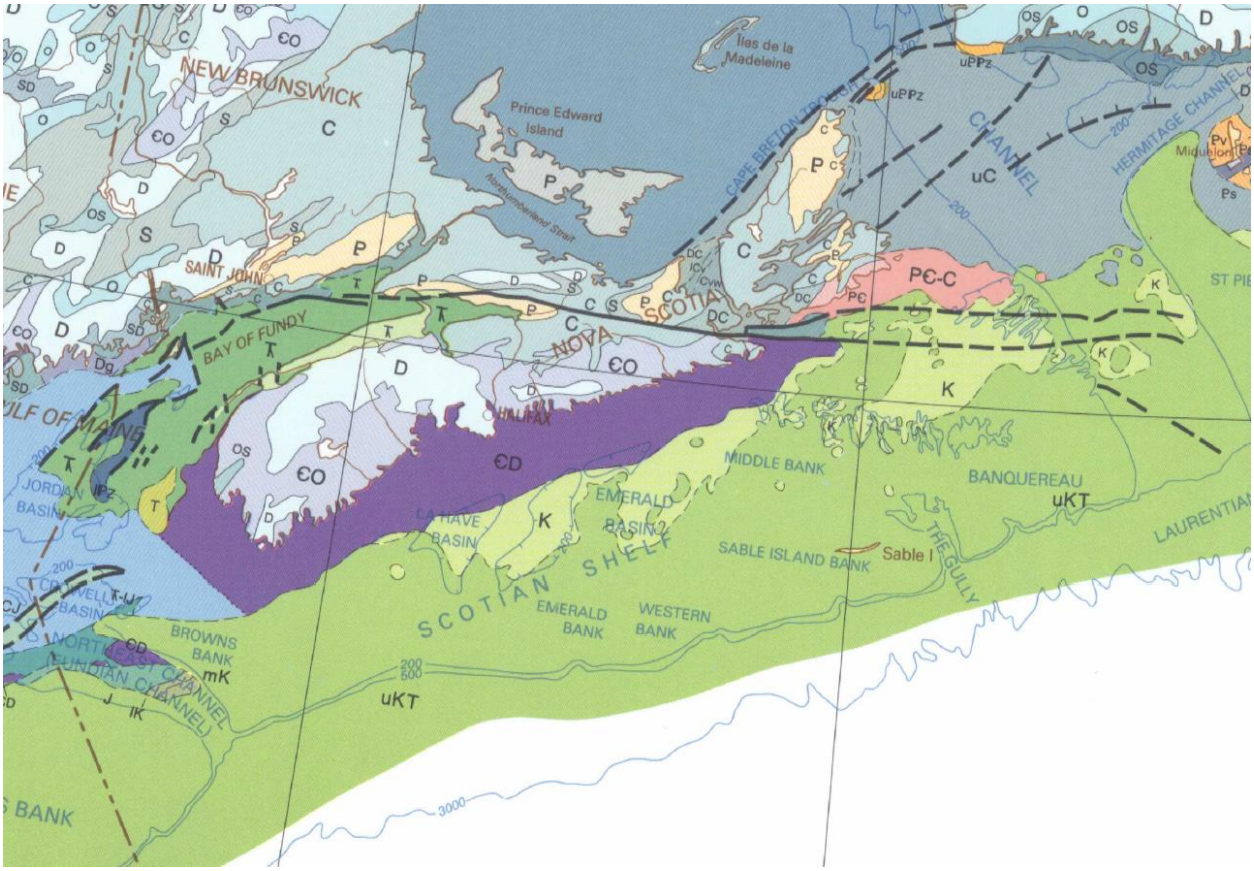
- Bathymetry: gebco provides the best regional bathymetric product, updated yearly: https://www.gebco.net/data_and_products/gridded_bathymetry_data/ and high resolution (e.g., wind-farm scale) mapping data is available through a Canadian Hydrographic Service portal: https://data.chs-shc.ca/dashboard/map, although coverage is not across the RA area. An example of this coverage is shown below, where the high resolution map data is represented by the bold colours from red to blue.



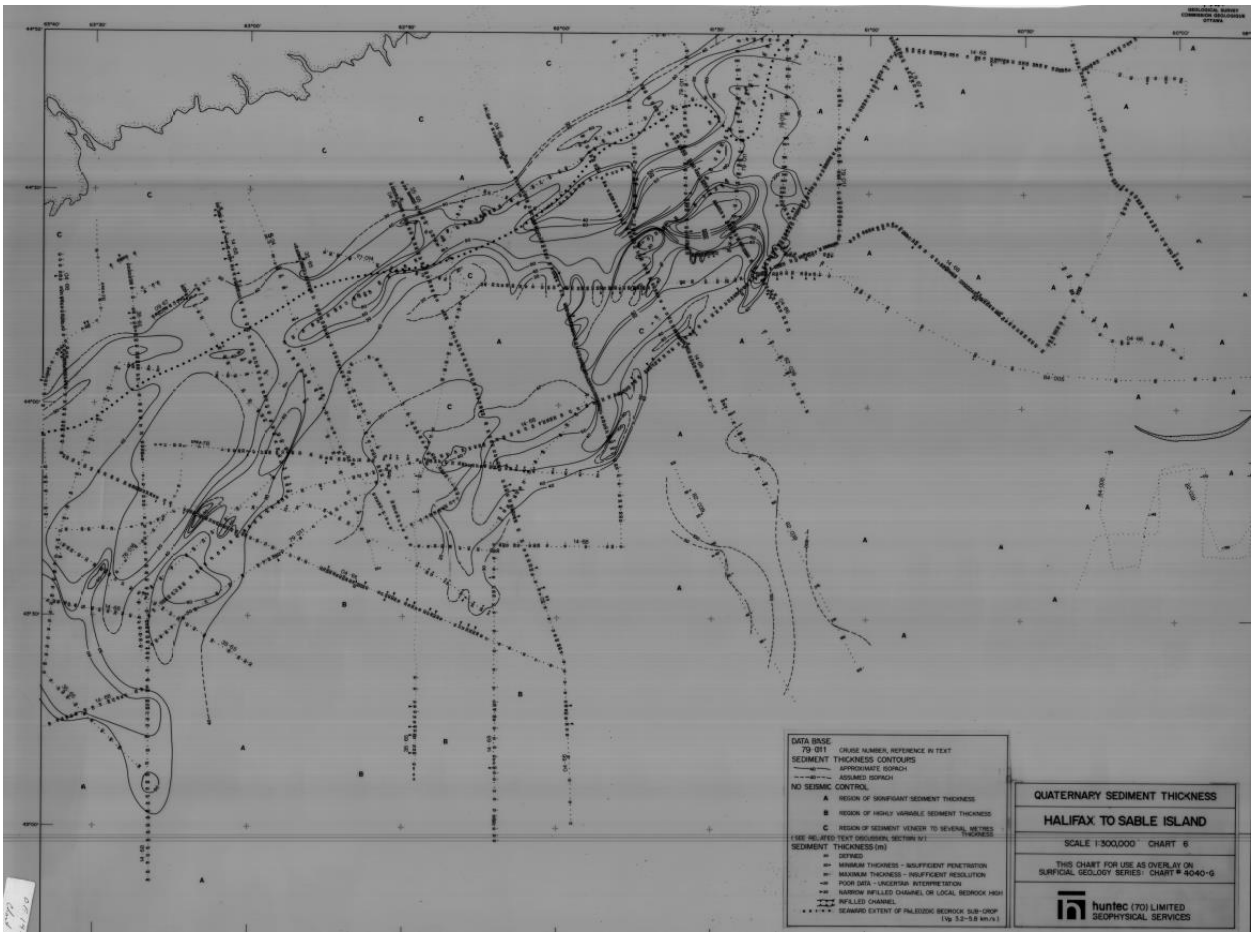
- Surficial geology: for Nova Scotia there is a recently developed surficial geological compilation map produced by Genevieve Philibert (genevieve.philibert@nrcan-rncan.gc.ca) who should be able to provide the data pre-publication. A report on the mapping procedures and data sources can be found here: https://doi.org/10.4095/330474 . In addition, a report on specific geoscience information on DFO areas of interest in the RA study region can be found here: https://doi.org/10.4095/329978 . An example of the scale of data provided by Philibert (2022) is provided below:

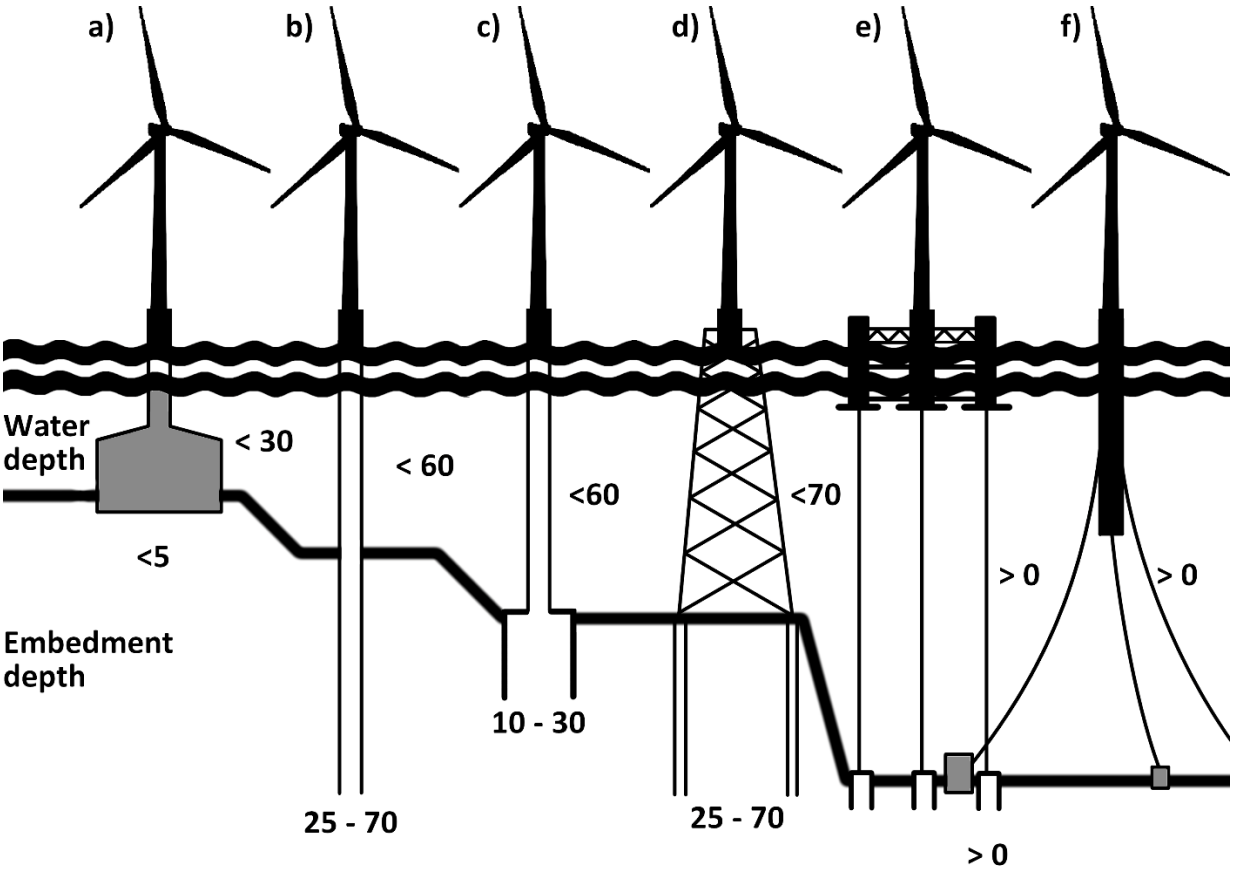

SurGeol_NSBioReg_220125
Bedrock
Glacial Diamict
Glacial Marine Mud
Glacial Sublittoral Sand
Hemipelagic Mud
Interbedded Sand and Mud
Interbedded Silt and Mud
Mass Transport Deposit
Overconsolidated Diamict
Overconsolidated Mud to Diamict
Post-Glacial Marine Mud
Post-Glacial Sand and Gravel
Pro-Glacial Sand
Pro-Glacial Sand and Gravel
Undifferenciated Bedrock or Glacial Diamict
Undifferenciated Post-Glacial Sediments
AC_1M_Coasts
Study_Area_Canso_No_Land
OW farm footprints
Farm size comparision
Foundation footprints
Farm size comparision
Ned given data
Cameron 2008 The gully
Amos 1987
amos_87_traced_pli_iso
Amos 1987 Banquereau iso map_modified

- Bedrock geology: The most up-to-date regional bedrock geology map product that the GSC is aware of is Fader et al. 1989 - https://doi.org/10.4095/127347 - noting that this includes major faults as well, relevant for the discussion of earthquakes.



- Depth of Sediment –
  There are limited data for mapped depth-of-sediment, with a mapset and supporting data provided in https://doi.org/10.4095/130265 . These data are essential for any fixed-bottom foundations which must be placed in suitable sediments under the seabed. An example map is shown below. For context see Eamer et al. 2021 - https://doi.org/10.1016/j.csr.2020.104297 (a figure from that study is shown on the next page).

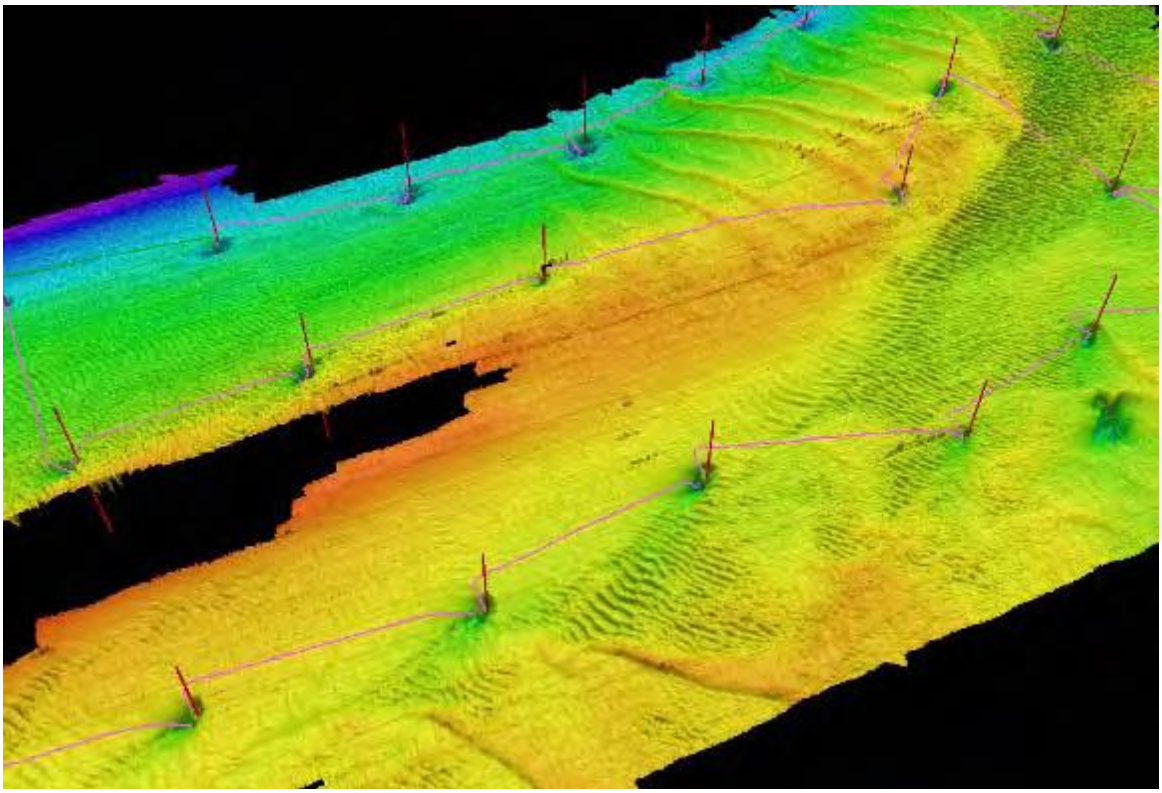




Use of these products can be generally summarized as such – fixed bottom foundations are, as of 2023, in water depths shallower than 70 meters. Surficial geology that is generally supportive of driven piles includes sands and silts, caissons include finer sands and silts ("muds"), and gravity base (~35m water depth limited) can be placed on sands, gravels, tills, and bedrock (may require some surface preparation). Bedrock geology is not particularly important other than the uncertainty around driven piles into Tertiary bedrock, which can be only semi-consolidated (wouldn't result in refusal) in some regions. Piles require > 25m depth of unconsolidated sediment generally, and caissons > 10m.

Any information or studies on dynamic movements within surficial sediments, stability of those sediments, and seasonal variations in their properties

The introduction of infrastructure in the offshore has the potential for changing the forces that act on the seabed, introducing scour or inducing deposition. An example of a detailed account of this in the North Sea is provided in https://tethys.pnnl.gov/sites/default/files/publications/Whitehouse-et-al-2008.pdf , with an example figure provided below:



A recent modelling exercise was completed for the RA study area for seabed disturbance and potential for sediment mobility, which can directly inform the likelihood of these effects occurring on areas of the shelf where infrastructure may be emplaced. This can be found here: https://doi.org/10.4095/331499 and an example model output below:

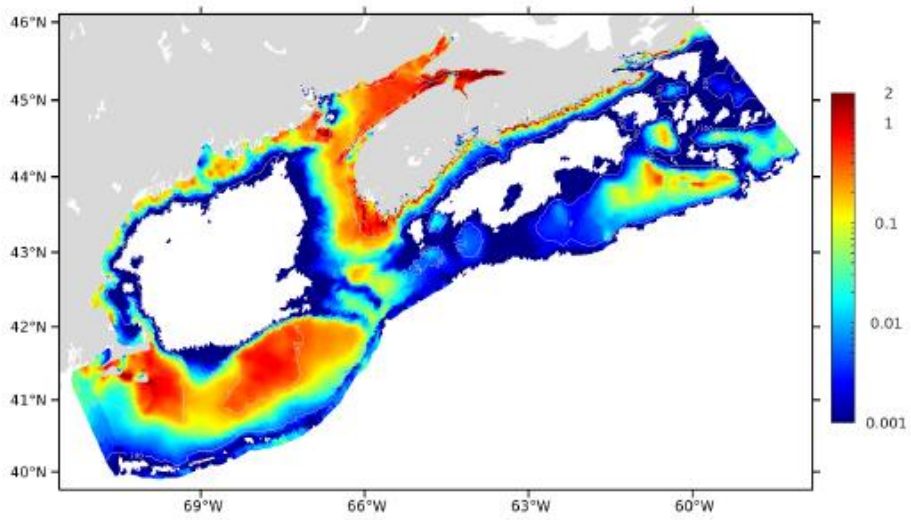


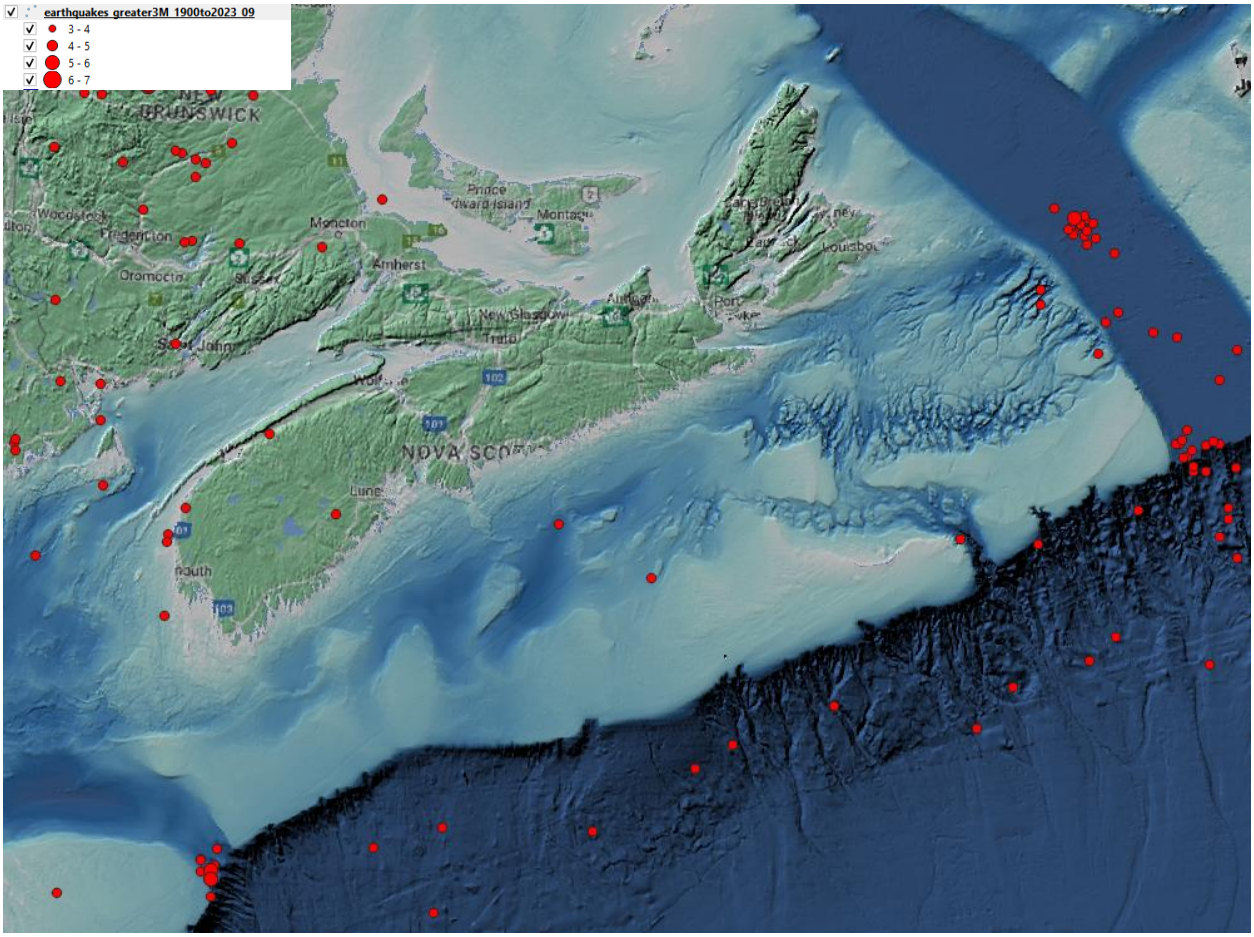
Figure 18 Spatial distribution of Sediment Mobility Index (SMI) on the Scotian Shelf. See text for definition of SMI.

Historical seismic events / activities (last 50 years) within the Study Area, and general trends on potential seismic events / geohazards that may occur within the Study Area:

A database that contains earthquake events to 1985 is available:

https://earthquakescanada.nrcan.gc.ca/stndon/NEDB-BNDS/bulletin-en.php

and the record does show a dearth of seismic events in the regional assessment area (the following map shows earthquakes from 1985 – present that are greater than 3 in magnitude, sorted by size) –



Note that Canada's largest, and deadliest, historically recorded tsunami occurred due to an offshore earthquake and subsequent landslides (e.g., see https://doi.org/10.1016/j.margeo.2004.11.007, https://doi.org/10.1046/j.1365-3091.1999.00204.x), so although the frequency may be low, there could be a risk.

Note that some preliminary mapping of landslides on the Scotian Shelf itself suggests that they are more common, but likely relict (older), features in the RA study area. More information can be found in an upcoming publication from C. Greaves, GSC-A.

If applicable, what the effects of climate change could potentially have on these components and over what expected timeframe:

Not really applicable in the marine environment but all current offshore wind energy projects involve a connection to land through a high-voltage cable (and, future installations may involve hydrogen pipelines or other land connections). As such, relative sea-level rise and increased storminess may have an effect over the lifetime of an offshore wind installation. James et al. (2021) have the most up-to-date projections of sea-level rise for various regions of Canada - https://doi.org/10.4095/327878

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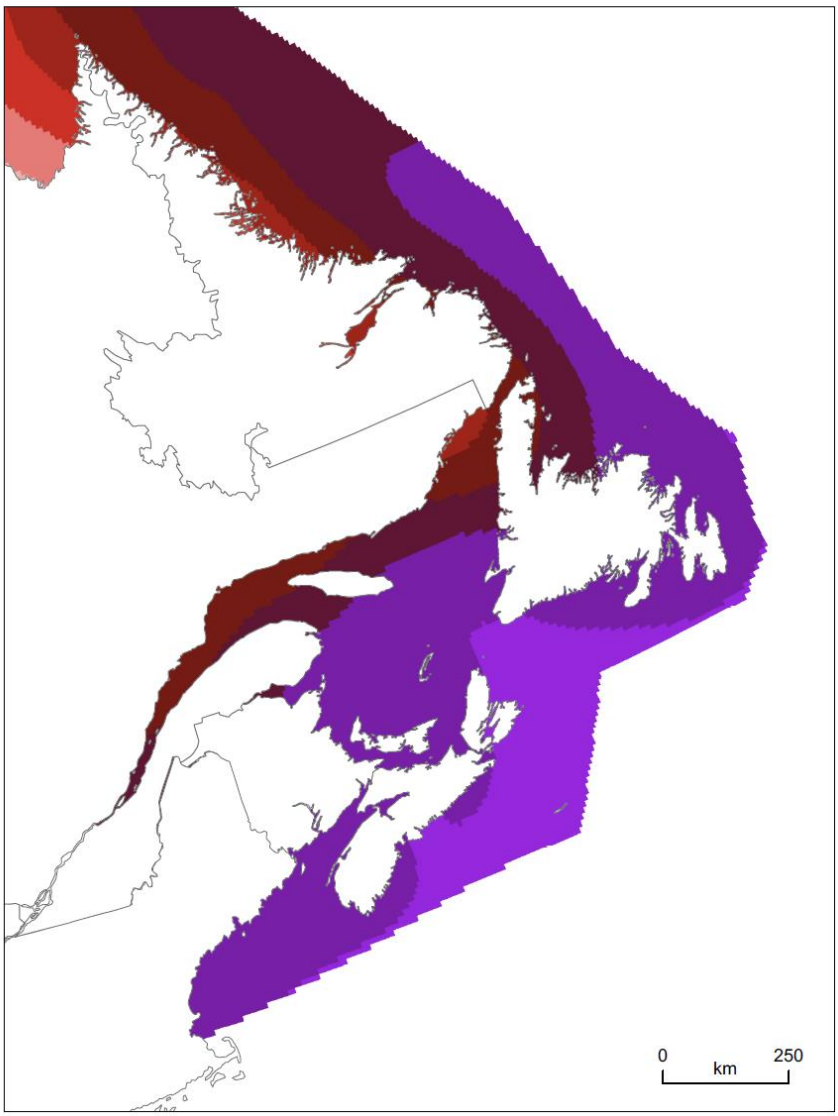
Projected Relative Sea-Level Change for Enhanced Scenario at 2100

Additional Meltwater Sourced from Antarctica



Projections are provided relative to a baseline of 1986 to 2005.

James, T.S., Robin, C., Henton, J.A., and Craymer, M., 2021. Relative sea-level projections for Canada based on the IPCC Fifth Assessment Report and the NAD83v70VG national crustal velocity model; Geological Survey of Canada, Open File 8764, https://doi.org/10.4095/327878

Canada

2. Additional Information

Note that in addition to the following information, a list of data and studies was previously provided in March 2023 (see appendix).

Preliminary Considerations Analysis of Offshore Wind in Atlantic Canada, Natural Resources Canada 2023

The report - https://doi.org/10.4095/331855 - supports the identification of candidate regions within Atlantic Canada that could become designated offshore wind energy areas in the future. These areas would define the boundaries within which developers could bid on the rights to develop offshore wind projects. These candidate regions may be included in government-led regional assessments and may also become the focus of further characterization of various geophysical, socio-economic, and environmental considerations. The study area for this analysis includes the Gulf of St. Lawrence, the western and southern coasts of the island of Newfoundland, and the coastal waters south of Nova Scotia. Twelve input data layers representing various geophysical, ecological, and ocean use considerations were incorporated as part of a multi-criteria analysis (MCA) approach to evaluate the effects of multiple inputs within a consistent framework. Six scenarios were developed to allow for visualization of a range of outcomes according to the level of influence accorded to the input layers and the elements within them.

The science questions underpinning the potential for offshore wind turbines on Atlantic Canada's continental shelves

Additional environmental components have been identified in a recent publication, Eamer et al. 2023 - https://doi.org/10.4095/331697 - where some of the key unresolved scientific questions (and references to key information and data) have been developed after several years of working in this field:

- the distribution of buried valleys under the banks – relevant in the NS RA study area, having been identified under Middle, Canso, and Sable Bank, as well as Banquereau,
- the magnitude and distribution of sediment mobility in shallow waters – affecting the stability and sustainability of infrastructure in the offshore (detailed above)
- offshore mass failures (landslides) – most documented mass failures on the shelf are considered to be relict, a product of the last glaciation, but a more detailed inventory should be taken.
- a detailed inventory and distribution of shallowly buried salt features (salt diapirs) and whether they are actively migrating, and if is there an associated geohazard risk.
- In areas where sea level was lower following ice retreat thousands of years ago, there may be buried coastal and terrestrial sediments that may pose a geotechnical risk to offshore and landfalling infrastructure. Areas where this deserves more detailed attention is in Chedabucto Bay and Sable Island Bank, and more generally along the Atlantic Coast of Nova Scotia.

Open Science and Data Platform

Natural Resources Canada is collaborating with numerous Federal, Provincial and Territorial contributors to provide access to data, scientific publications and information about development and regulatory activities through the Open Science and Data Platform (OSDP): https://osdp-psdo.canada.ca/dp/ The goal of the platform is to provide single-window access to a broad suite of content to support impact, regional and cumulative effects assessments and evidence-based decision making. Amongst over 150,000 content records, the OSDP includes a curated content collection entitled Resources to Understand Potential Effects from Future Offshore Wind Development in Atlantic Canada, which was developed in collaboration with the Impact Assessment Agency of Canada. The content in this collection has been selected to support the understanding of cumulative effects in the area surrounding region. This collection features data and scientific publications within the study areas. Through open access to science and data, the OSDP is a tool available to participants in the Offshore Wind Regional Assessments, and through data integration, can support, modelling, risk analysis and decision making.

3. Data gaps

Basically, all the above highlights the gaps in data that exist to properly assess the impact of future offshore wind infrastructure in the reginal assessment study area. Data and information are lacking particularly, high-resolution mapping, subsurface, and sample data from shallow areas of the shelf, particularly relevant for offshore wind.

Appendix

Theme	Data Title	Publicly available?	Source	Link
Geology	Bedrock Geology	Yes	NRCan	https://doi.org/10.4095/210609
Geology	Surficial Geology	Yes	NRCan	https://doi.org/10.4095/330474
Geology	Marine canyons, slopes, etc.	No	Nrcan / DFO	
Geology	Geohazards	Unknown	NRCan / DFO	
Climatology	Wind speed and direction	Unknown	NRCan / DFO / ECCC	http://www.windatlas.ca/series/index-en.php
Climatology	Fog and visibility	Unknown	NRCan / DFO / ECCC	
Climatology	Precipitation	Unknown	NRCan / DFO / ECCC	
Oceanography	Waves	Unknown	NRCan / DFO / ECCC	
Oceanography	Currents	Unknown	NRCan / DFO / ECCC	
Oceanography	Extreme Weather Events	Unknown	NRCan / DFO / ECCC	
Oceanography	Storm Surges	Unknown	NRCan / DFO / ECCC	
Oceanography	Underwater soundscape	Unknown	NRCan / DFO	
Geology	Database of geotechnical information	Yes	NRCan	https://ed.marine-geo.canada.ca/index_e.php
Geology	Database of radiocarbon dates	Yes	NRCan	https://ed.marine-geo.canada.ca/index_e.php
Geology	Database of expedition reports	Yes	NRCan	https://ed.marine-geo.canada.ca/index_e.php
Geology	Database of high-resolution seismic reflection surveys conducted offshore Atlantic Canada.	Yes	NRCan	https://ed.marine-geo.canada.ca/index_e.php
Geology	Database of underwater photography	Yes	NRCan	https://ed.marine-geo.canada.ca/index_e.php

Geology	High resolution scans of GSC high resolution seismic reflection profiles	Yes	NRCan	https://ftp.maps.canada.ca/pub/nrcan_rncan/raster/marine_geoscience/NRCAN%20Windows%2010%20Software/KMLS/NRCanMarineDataHoldings.kmz
Geology	Geotechnical parameters important for offshore wind energy in Atlantic Canada	Yes	NRCan	https://doi.org/10.4095/329688
Geology	The inner shelf geology of Atlantic Canada compared with the North Sea and Atlantic United States: insights for Canadian offshore wind energy	Yes	NRCan	https://doi.org/10.1016/j.csr.2020.104297
Geology	Seabed conditions on the inner shelves of Atlantic Canada; Geological Survey of Canada	Yes	NRCan	https://doi.org/10.4095/326514
Geology	Scotian Shelf geoscience information within Network Candidate Sites of Fisheries and Oceans Canada	Yes	NRCan	https://doi.org/10.4095/329978
Geology/habitat	Geoscience and Habitat Mapping for Marine Renewable Energy	Yes	NRCan	https://doi.org/10.1016/j.csr.2014.03.014
Geomorphology	The Seafloor of Southeastern Canada	Yes	NRCan	https://doi.org/10.1007/978-3-030-35137-3_20
Geomorphology	Continental Shelves of Atlantic Canada	Yes	NRCan	https://doi.org/10.1144/M41.2
Sediment transport	Sediment mobility data layers for Atlantic Canada: near-bed current, wave parameters, seabed shear stress, sediment mobilization, seabed disturbance	No - soon to be available on FGP	NRCan	https://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/geospatial-communities-and-canadian-geosecretariat/federal-geospatial-platform/11031
Sediment transport	Seabed disturbance and sediment mobility due to tidal current and waves on the continental shelves of Canada	Yes	NRCan	https://doi.org/10.1139/cjes-2020-013
Sediment transport	Modelling Seabed disturbance and sediment mobility on the Canadian Atlantic Shelf	Yes	NRCan	https://doi.org/10.4095/328363

Sediment transport	The influence of turbidity currents and contour currents on the distribution of deep-water sediment waves offshore eastern Canada	Yes	NRCan	https://doi.org/10.1111/sed.12557
Geohazards	A Synthesis of the Distribution of Submarine Mass Movements on the Eastern Canadian Margin	Yes	NRCan	https://doi.org/10.1007/978-94-010-0093-2_32
Geohazards	Recurrence of turbidity currents on glaciated continental margins: a conceptual model from eastern Canada	Yes	NRCan	https://doi.org/10.2110/jsr.2020.66
Geohazards	Are submarine landslides an underestimated hazard on the western North Atlantic passive margin?	Yes	NRCan	https://doi.org/10.2110/jsr.2020.66