Fisheries and Oceans Canada | Pêches et Océans Canada
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Canadian Science Advisory Secretariat
Newfoundland and Labrador Region **Science Response 2020/033**

REVIEW OF THE IMPACT ASSESSMENT AGENCY'S DRAFT REGIONAL ASSESSMENT OF OFFSHORE OIL AND GAS EXPLORATORY DRILLING EAST OF NEWFOUNDLAND AND LABRADOR

Context

The Impact Assessment Agency (IAA), in collaboration with Natural Resources Canada and the Newfoundland and Labrador (NL) Department of Natural Resources, and guided by a Committee appointed by the Minister of Environment and Climate Change Canada (ECCC), is developing a Regional Assessment (RA) pertaining to offshore oil and gas exploratory drilling east of Newfoundland and Labrador. The final Agreement to Conduct a Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador (hereafter referred to as "the Agreement") was signed on April 15, 2019 between Her Majesty the Queen in Right of Canada as represented by the federal Ministers of the Environment and Natural Resources and Her Majesty the Queen in Right of Newfoundland and Labrador, as represented by the provincial Ministers of Natural Resources and Intergovernmental and Indigenous Affairs. On the same date, a joint committee was established between the Governments of Canada and Newfoundland and Labrador. The roles of the Committee, as well as the Task Team and the Technical Advisory Group are described in the Agreement.

The RA is intended as a Regional Study pursuant to the *Canadian Environmental Assessment Act* (CEAA 2012) and will assess the potential effects of existing or future physical activities carried out in the Study Area (see Figure 1) which contains multiple current and proposed oil and gas exploration and production activities. The focus of the RA is to bring together existing and available data on the environmental setting of the Study Area, in order to provide a general, regional-scale description of key environmental components at a level of detail that is considered useful and appropriate for the purposes of the RA. According to the RA Agreement, the RA "*will meet or exceed the rigour and performance of the current environmental assessment* [hereafter referred to as impact assessment] *and regulatory review process used for the approval of exploratory drilling*."

Once the Committee submits the RA, the Minister of ECCC will decide how the results will be used to help inform future project decisions for exploratory drilling in the Study Area. The Minister may also make regulations that would exempt future offshore exploratory well projects from federal impact assessment requirements "*if they are proposed in the area where the RA was carried out and it meets the conditions for exemption established by the Minister in those regulations*." Proposed offshore exploration well projects that do not meet the conditions of the Regulation would be subject to a project-specific impact assessment. In addition, all exploratory drill projects, regardless of whether or not they meet the Regulation, would still be subject to other regulatory processes (e.g., a regulatory review under the *Fisheries Act*, *Oceans Act*, and *Species at Risk Act* conducted by Fisheries and Oceans Canada [DFO] through the Fish and Fish Habitat Protection Program [FFHPP]).

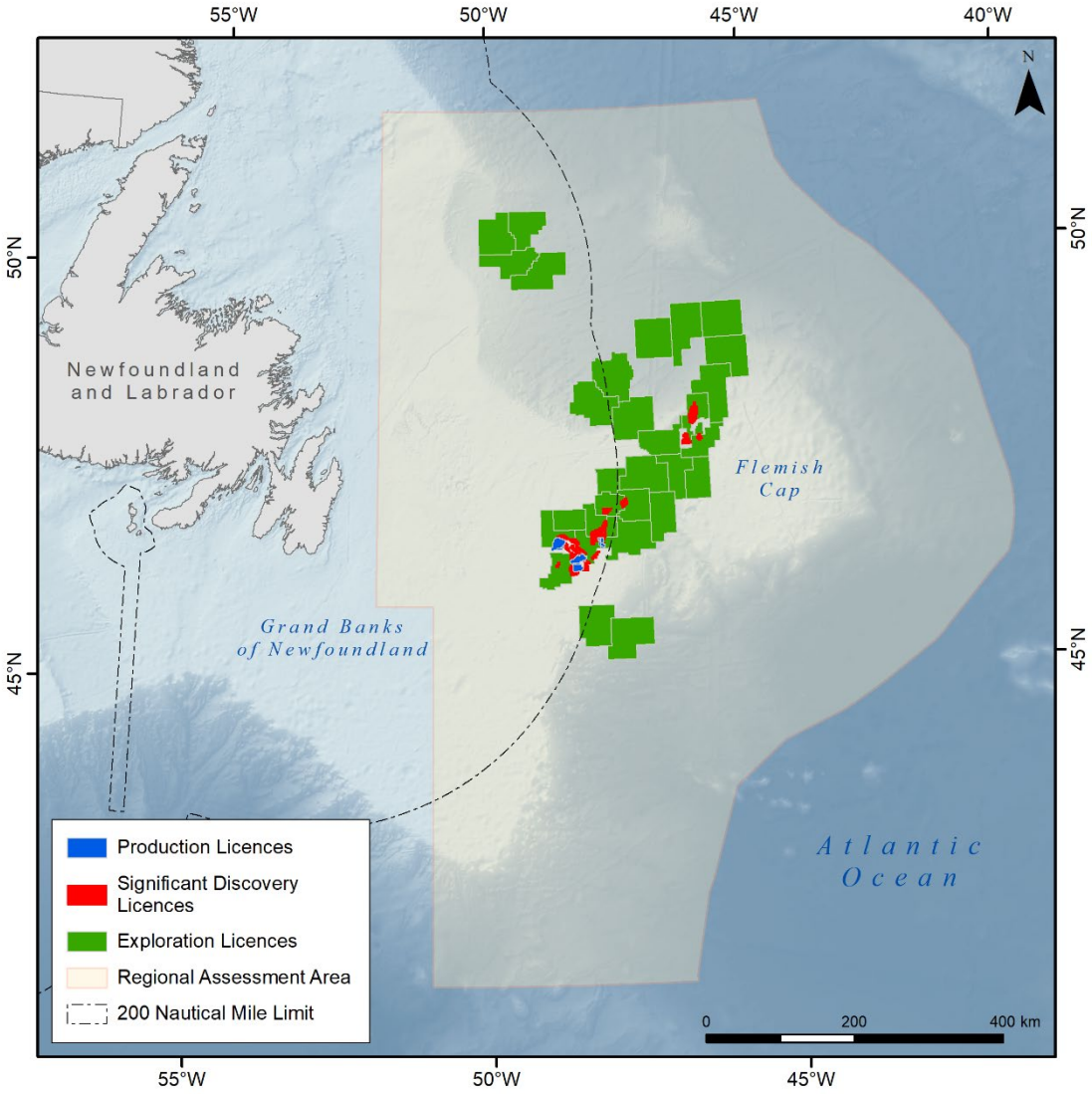

Figure 1: Regional Assessment Study Area. Adapted from Appendix B of the final RA Agreement.

On November 4, 2019, DFO's Ecosystems Management received from the IAA a request to review draft modules of the RA. This review will be utilized by the IAA to further develop the RA. DFO Science was subsequently asked by Ecosystems Management to review draft versions of technical modules relating to the existing biological environment with the following objectives:

1. For each draft module, verify the accuracy and completeness of the information that has been presented with a focus on the regional scale nature of the RA.
2. Identify any highly sensitive areas and species (within the RA Study Area), that the RA Committee may consider applying special mitigations.

DFO Science also reviewed the Special Areas Module (5e).

A draft Table of Contents provided to DFO indicated that a Main Report will be written, which will reference supporting Technical Documents. The Main Report is expected to contain the

Approach, Methods and Activities, the Environmental Setting, Potential Effects and their Management, Cumulative Effects, Integrating Indigenous Knowledge, Sustainability, Climate Change and other Considerations, and RA Recommendations and Conclusions. The supporting technical documents are expected to consist of several modules, with each module containing Sections which provide an overview of various components of the ecosystem, as well as the offshore exploratory drilling process and potential effects. The content of the modules (text and all mapping) are to be housed within a GIS system.

Science Branch undertook a Science Response Process (SRP) for the Review of the IAA's draft RA of Offshore Oil and Gas Exploratory Drilling east of Newfoundland and Labrador for those draft modules that were provided. This Science Response Report results from the Science Response Process which took place on November 29, 2019 on the Review of the Impact Assessment Agency's draft Regional Assessment of Offshore Oil and Gas Exploratory Drilling east of Newfoundland and Labrador. This scientific review was provided to Ecosystems Management to help form part of DFO's response to the IAA on DFO's review of the draft RA modules.

Since that time, the draft modules reviewed by DFO Science have been revised and published. Additional information on the Regional Assessment process can be found on the IAA website.

Analysis and Response

The comments provided by DFO Science, NL Region are related to the following draft modules[1] of the RA Supporting Technical Documents:

- Module 5a - Plankton and invertebrates and supporting draft figures
- Module 5b - Finfish and supporting draft figures
- Module 5c - Marine mammals and sea turtles and supporting draft figures
- Module 5e - Special Areas and supporting draft figures.

General comments that pertain to the text, figures, and references in all the draft modules reviewed are provided first, following which general comments on each of the draft modules are provided. Specific comments on the text and figures for each of the draft modules are contained in the Appendices at the end of this report. **Text quoted directly from the modules is italicized and in quotation marks and any new suggested text is underlined.** Information that should be taken into consideration as the RA is updated in the future is included in Appendix E. All references, whether cited in the body of this report, or in the appendices, are provided in the Sources of Information section, with the exception of references cited in text quoted directly from the draft modules.

General Comments on Text

DFO Science was asked to verify the accuracy and completeness of the draft RA modules that were submitted for review, with a focus on the regional scale of the RA Study Area. The review determined that there were multiple mischaracterizations and/or omissions of available research from the referenced literature. Reported baseline information was incomplete and outdated for most sections of the draft modules reviewed. **This adversely impacts the reliability and credibility of the draft modules reviewed to a significant extent, and, as a consequence,**

[1] Some of the Module titles and/or numbers may change prior to the document being released for public consultation.

could affect the appropriateness of the conclusions and/or recommendations in the RA. In its current form, and until the problems identified in this report are addressed, these RA modules are not considered reliable sources of information for decision-making processes from a scientific perspective.

DFO Science was asked to identify highly sensitive areas and species within the RA Study Area for which the RA Committee may recommend the application of special mitigations. Several federal and international bodies/authorities have developed criteria to aid in the identification of "sensitive", "important", or "special" areas (e.g. Ecologically and Biologically Significant Areas [EBSAs], Significant Benthic Areas [SiBAs], Vulnerable Marine Ecosystems [VMEs], etc.) and have conducted scientific peer review processes to delineate and describe these areas (e.g., DFO 2004, DFO 2013b, DFO 2019c, Kenchington et al. 2016, Northwest Atlantic Fisheries Organization [NAFO] 2013, 2018, CBD 2014). **As these areas have been acknowledged as Special Areas in the draft modules provided (including in sections titled "Identified Important/Key Areas and Times" in Modules 5a, 5b, and 5c), it is implicit that such areas are highly sensitive to human impacts and additional special mitigations should be applied for any future exploratory drilling activity within these areas.** This is particularly true for areas that have defined benthic conservation objectives, for which it has been recommended that oil and gas exploration activities should be managed with higher risk aversion when compared to areas without these habitats (DFO 2019b).

A discussion of stocks that are under moratorium and/or in the critical zone under the DFO or NAFO precautionary approaches is not included in the RA (e.g., 2J3KL Atlantic Cod, 2J3KL Witch Flounder, 3LNO American Plaice). **Special mitigations should be considered and applied to these stocks based on their spatial and temporal distributions.**

DFO Science was asked to identify ***additional*** highly sensitive areas and species within the RA Study Area for which the RA Committee may consider applying special mitigations. In the absence of the complete document, and given the errors and gaps in the draft modules provided, DFO Science is not able to provide explicit advice in this regard, beyond that provided above. While the four draft modules reviewed aim to identify "important" or "key" areas or species in the Study Area, the criteria used within the RA to determine importance are not always explicitly identified, differ from section to section, and may or may not be useful in the context of the RA. For example, in Module 5a, areas of high primary production are considered important while in Module 5b, importance is determined based on the most abundant species of fish. While these may be relevant, they do not represent the full suite of criteria that should be considered in the RA. **It is recommended that the RA include a systematic and transparent process for developing and applying relevant criteria to aid in the identification of "important" areas or species. This will allow for consistency between and within the modules.** As an example, please see Clark et al. (2014) for application of the EBSA criteria to a test case for offshore seamounts.

In the past, the quality of the environmental impact statements (EISs) submitted by proponents of offshore oil and gas exploratory drilling projects in the Newfoundland and Labrador region has been highly variable and all have contained significant errors and gaps in the environmental information provided and in the assessment methodologies (DFO 2013b, 2014, 2018c, 2018d). In addition there is often minimal or no transfer of lessons learned or incorporation of recommended improvements to subsequent assessments. The RA is intended to make an important contribution to improving the rigour and scientific defensibility of the impact assessment of exploratory drilling projects in the region. **It is therefore essential that:**

1. **the biological and environmental information provided in the RA is based on the scientific community's current understanding of the biogeochemistry and ecology of the region, and should be based on a thorough and up-to-date literature review, and**
2. **methods, along with their limitations and assumptions, and data gaps are clearly identified.**

This latter point is important given that the Study Area is very large and includes many different habitats with large differences in sensitivity to disturbance. It is also important to note that much of our knowledge of the region is constrained to the portions of it that are surveyed by Research Vessel (RV) surveys (DFO and European Union) and Atlantic Zonal Monitoring Program (AZMP). In particular, the pelagic zone and deep waters (i.e., >1500 m) of the Study Area are not well represented in existing sampling and monitoring programs. To ensure data are up-to-date and methods and data gaps clearly identified, it is recommended that a more systematic process is used to construct and maintain an "evergreen" platform for continuous improvement of the assessment process as knowledge gaps are filled and new methodologies and mitigation techniques are developed.

DFO Science was not provided the complete RA to review, as only four sections were provided from Module 5: Existing Biological Environment. **In order to conduct an effective review, DFO Science would have benefitted from the provision of the entire RA in order to have the background and contextual information necessary to help reviewers understand how the information contained within the RA is to be used.** Not having access to key information precludes a comprehensive and thorough scientific evaluation. Expertise exists within DFO Science to review parts of the RA that were not made available (e.g., sections on Cumulative Effects, Existing Physical Environment, overviews of potential effects on various ecosystem components). Also, DFO Science has numerous oceanographic datasets which were not utilized in the preparation of the RA.

The ecosystem in the Study Area is in a state of flux and has shown different ecological states over time. Focusing only on the recent state of the ecosystem is inappropriate, as it provides only a partial perspective of the potential impacts of future projects. **The various ecosystem components should be examined using temporal scales that are relevant to biological or ecological processes (e.g., life history considerations, population fluctuations).** Furthermore, the shortened time period for some ecological components was insufficient to identify and/or differentiate between natural perturbations within the ecosystem and residual environmental effects due to future projects. This is particularly important within the context of impact assessments on the cumulative impacts of projects that may be proposed within the next several decades.

The question of scale needs to be considered carefully in the RA. The scale of the information provided needs to be both ecologically relevant (as determined by the habitat complexity and biogeochemical processes in the Study Area) and relevant to the potential extent and duration of the environmental effects of individual offshore oil and gas exploration projects. The scale of information provided is also relevant to the analysis of cumulative effects of multiple projects with each other and with other human activities and pressures in the Study Area.

Completing an ecosystem-based assessment of the draft RA modules was not requested as part of this review. **It is recommended that the RA employ an ecosystem-based approach**, taking into account ecological processes and functions, including pattern and connectivity of habitat patches, natural disturbance regime, structural complexity, hydrologic/oceanographic patterns, nutrient cycling, purification services (assimilative capacity), biotic interactions, and

genetic diversity. Habitat types should be identified through distributions of biota, surficial geology and substrate bedforms, as well as ocean currents and other oceanographic features and processes (e.g., transport of food, larvae, temperature influences, etc.). This is because ecosystems are integrated rather than a sum of their parts.

The assumptions used for mapping and presenting information in tables are not made explicit throughout the text and data gaps are not consistently identified. This leads to inappropriate generalizations of observations from surveys that are spatially and temporally restricted. **The Study Area cannot be considered as a single ecological unit and the criteria used to define the ecological units described in each module should be explicit.**

Concerns were raised that the quality of the draft modules and the sections within them was not balanced. As an example, **the section on Atlantic Salmon (Section 1.7.1. of Module 5b) is a model for how the RA should be written.**

The interpretation and review of the draft modules was hampered by numerous grammar, punctuation, spelling inconsistencies and errors. Also, there are a number of structural inconsistencies throughout the documents in how information is displayed. For example, the presentation of Data Sources appears as a paragraph in some sections and a bulleted list in others. The headings within sections are also not consistent. Distinct terms are often used interchangeably and erroneous conclusions are drawn from the improper use of these terms (e.g., abundance vs. biomass; habitat suitability vs. predictive mapping).

There is a general lack of use of scientific names and taxonomy throughout. It is important to explicitly define species and groups using proper scientific names so that it is clear what species or taxonomic groups are being considered. If common names are used, accepted standards should be applied.

While the Terms of Reference for the Technical Advisory Group for the RA calls for making available "*all known physical, biological, social and economic characteristics of the area in a digitized, interactive and plain-language accessible format to the extent possible*", this should not be interpreted to mean that the technical documents prepared for the RA should be in plain language. Scientific rigour requires that scientific language be used to ensure that an adequate assessment can be made and that the conclusions can be clearly communicated. Plain language overviews can be developed from the scientific review but the converse is not possible.

It is important to highlight that **a thorough and detailed review of the RA was difficult to undertake due to the short review period (30 days). The specific comments in this Science Response should be taken as indicators of the types of problems that exist in the RA and serve as guidance on how the RA should be revised.**

General Comments on Figures

Average relative density layers for finfish, shrimp, and crab were provided by DFO Science on February 14, 2019. An updated set of layers were provided on March 11, 2019 with instructions to delete all of the original layers and use only the updated layers. The updated set of layers included data for eight functional groups and 38 dominant and/or at-risk species. Dominant species were identified by calculating the average weight of each species per tow (kg/tow) for each functional group and selecting those species that fell in the top 90%. Upon examining the Figures in the draft modules, it was noted that there were several functional groups and species

that were not included, while there were figures for some species that should not have been included. See Table 1 below outlining these discrepancies, including notes at the bottom:

Table 1: List of average relative density layers for functional groups and species provided to the IAA for use in the RA.

Functional Group/ Species Common Name	Dominant Species	At-risk Species	Included in RA
Forage Fish	n/a	n/a	No
Large Benthivores	n/a	n/a	Yes
Medium Benthivores	n/a	n/a	Yes
Piscivores	n/a	n/a	Yes
Planktivores	n/a	n/a	Yes
Plank-piscivores	n/a	n/a	Yes
Shrimp	n/a	n/a	No[1]
Small Benthivores	n/a	n/a	Yes
Atlantic Wolffish	Yes	Yes	Yes
Arctic Cod	Yes	No	Yes
Blue Hake	Yes	No	Yes
Common Alligatorfish	Yes	No	No
Common Grenadier	Yes	No	Yes
Common Lumpfish	Yes	Yes	No
Capelin	Yes	No	Yes[2]
Atlantic Cod	Yes	Yes	Yes
Snow Crab	Yes	No	No[3]
Daubed Shanny	Yes	No	No
Fourline Snakeblenny	Yes	No	No
Fourbeard Rockling	Yes	No	No
Goitre Blacksmelt	Yes	No	No
Greenland Shark	Yes	No	No
Hookear Sculpin	Yes	No	No
Haddock	Yes	No	No
Longhorn Sculpin	Yes	No	No
Lumpfish	Yes	No	No
Mailed Sculpin	Yes	No	Yes
Northern Alligatorfish	Yes	No	No
Northern Wolffish	No	Yes	Yes
American Plaice	Yes	Yes	Yes
Redfish	Yes	Yes	Yes
Roughhead Grenadier	Yes	No	Yes
Roundnose Grenadier	No	Yes	Yes
Silver Hake	Yes	No	No
Smooth Skate	No	Yes	No
Spotted Wolffish	No	Yes	Yes
Sand Lance	Yes	No	Yes
Seasnails	Yes	No	No
Spatulate Sculpin	Yes	No	No
Thorny Skate	Yes	Yes	No

Functional Group/ Species Common Name	Dominant Species	At-risk Species	Included in RA
Threebeard Rockling	Yes	No	No
Turbot (Greenland Halibut)	Yes	No	Yes
White Hake	Yes	Yes	No
Winter Skate	No	Yes	No
Witch Flounder	Yes	Yes	Yes
Yellowtail Flounder	Yes	No	Yes
Longnose Eel	No	No	Yes[2]

1. Average relative density layer not included in draft module figures. Only point data of Northern Shrimp from RV survey and commercial fishing activity of Northern Shrimp were included. If the intention was to display only Northern Shrimp (and not all commercial shrimp species), *_shr_dom geotiff should have been used as described in the instructions from DFO Science.
2. Yes, but should not be included as per direction from DFO Science.
3. Average relative density layer not included in draft module. Point data from RV survey and commercial fishing activity were included.

The average relative density data layers were originally provided as geotiff rasters. However, the layers in the documents were classified into five classes, and no information is provided as to the classification method. By classifying the layers, the general patterns and trends are the same, but use of a non-continuous scale may result in a loss of detail in the data displayed which could lead to a misrepresentation of important areas.

The dynamic nature of fish and invertebrate populations, and the fluctuations in biomass/abundance, should be taken into consideration on a temporal and spatial scale in the RA. At the very least, the limitations of the maps provided should be addressed in the text and the ability of dynamic representation be identified as an important need. For example, large variations in some populations can occur quite frequently (e.g., Redfish) and this would not be captured in the average relative density layers. The agency should incorporate a periodic review of the RA, including the data layers housed within the GIS platform. This should take into account regime shifts, climate change, and new information as it becomes available.

It is not clear how the text is going to be linked to the GIS application. For some species or ecological components, the text does not match the data displayed in the figures. There was no information in the draft modules to explain how the text and figures are to be conveyed and updated. Therefore, it is difficult to determine whether the information is sufficient, appropriate, or accurate for the GIS application under development. Further, there appears to be a lack of information on the source of data/maps in the figure captions and the figures are not referenced in the text. This information should be, at a minimum, incorporated into the text that will be displayed in the GIS application.

Exploration Licenses, Production Licenses, Significant Discovery Licenses, Calls for Bids, Sectors, and Producing Platforms should be included on all maps produced for the RA.

General Comments on References

The Strategic Environmental Assessment (SEA) is referenced as a source for additional information in each of the draft modules reviewed. The SEA was not deemed reliable for decision-making purposes by a DFO Science review (DFO 2014), and it is uncertain if the deficiencies have been addressed.

In draft Modules 5b and 5c, it is noted that *"Additional and more detailed life history and habitat information for these species can be found in the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014), which can be consulted for further details on these items*". Referring to the SEA in this manner may suggest that the RA is an update of the SEA from 2014. Although the study areas of the RA and SEA are similar, they are not identical. For this reason, the RA should not be treated as an update of the SEA.

Several references used throughout the RA are outdated, and many references are omitted or incorrectly interpreted. Examples include, but are not limited to, the following:

- The RA uses several Environmental Assessments and Environment Impact Statements as sources which should not be used as supporting material due to reasons outlined in the CSAS scientific peer review process. It should be noted that many of these EIS's have been peer-reviewed under Canadian Science Advisory Secretariat (CSAS) processes which concluded that they were poor sources for decision-making purposes (e.g., Draft Eastern Newfoundland SEA Report - DFO 2014).
- There are instances throughout the RA whereby key sources of literature are not referenced correctly (e.g., instead of referencing a specific journal article, another EIS which has previously cited the journal article is referenced instead).
- Multiple outdated stock assessment reports are cited for commercial species, although there is current information regarding stock size and distribution publicly available (see publications by the CSAS and Scientific Council Reports by NAFO).
- There is a notable absence of NAFO-generated scientific literature on VMEs and benthic communities.
- Personal communication (pers. comms.) citations were used in the draft modules although published literature is available for analysis (e.g., plankton sections). It is recommended that appropriate references be utilized.
- There are instances where citations are noted in the text but are missing in the reference list.

Module 5a – MARINE FISH AND FISH HABITAT – PLANKTON AND INVERTEBRATES

General Comments

The module on Plankton and Invertebrates contains significant errors and omissions and, as such, is not considered a sound basis for decision-making as currently drafted. From DFO Science's perspective, the limited level of detail in the module is not sufficient for impact assessment. While issues have been identified with the other three draft modules reviewed by DFO Science, most of them can be addressed through revisions. However, **it is recommended that the draft module on Plankton and Invertebrates be rewritten.**

It is evident that this module was prepared without consideration of the biophysical and chemical context of the Study Area. There is no consideration of using habitat suitability models to extend the mapping of vulnerable habitats to areas that are poorly surveyed. The survey data used is limited to shallow depths and the information presented neglects to present even the very limited information available for the deeper waters of the Newfoundland and Orphan basins or the Orphan Knoll and other seamounts in the Study Area. There is information on

bathymetry, surficial sediments and geomorphology available for these areas that could feed into existing habitat suitability models (see for example Auster et al. 2005; Conti et al 2019; Robert et al 2016) and serve as a proxy for direct observation of the associated biota.

The sections on plankton, benthos and invertebrates rely heavily on the DFO RV survey. A thorough discussion of the sampling methods and potential biases should be included in all Data Sources sections. Specifically, there should be clarity on areas of poor representation based on the methods used. For example, the document fails to point out the geographic limitations (mostly in shallow waters (<1500m) resulting in no coverage in large portions of the Study Area) and assumptions (survey protocols and spatial representativeness) of the various surveys. The report implies that what is representative of the shelf ecosystems is applicable to the entire Study Area. This is incorrect. Several biogeographical classification systems have been applied to the Study Area and they indicate that there are a number of ecological provinces within the Study Area (Devred et al 2007) that differ significantly in biophysical properties and behaviors. These ecological provinces are dynamic and vary seasonally and interannually (Devred et al 2009). Distinct ecosystem production units have also been identified for the shelf regions of the Study Area based on physics, chemistry and biodiversity of the shelf regions (Pepin et al 2014). These studies clearly demonstrate that the Study Area cannot be considered as a single ecological unit. In order for the module to be used as supporting documentation for a RA of exploratory drilling, the information provided should be on an ecologically and operationally relevant scale.

Datasets originating from the DFO RV survey have varying levels of quality control depending on what they are utilized for. Only basic quality control is performed on data for species with little commercial value (i.e., most invertebrate species). Therefore, these data need proper analysis and careful presentation. As such, maps and tables of summarized data for some taxa should not be included in the RA without consulting with DFO Science. For more details, please see the information provided in the Specific Comments in Appendices A and B.

Data from DFO RV surveys have been used to inform geographic range for multiple pelagic and benthic invertebrates. This survey targets species closely associated with the bottom, and it is not appropriate for pelagic species or for benthic species found within or attached to the bottom. For these reasons, these species are easily missed in the survey creating an under-representation of presence in an area. It is not appropriate to display presence-absence for these species based on these surveys. Information is available in the literature for these species and groups, although it is recognized that for some species, it is limited.

Fisheries landings data have been used for multiple pelagic species and benthic invertebrates to inform geographic range. The limitations of using fisheries landings data must be explicitly described in the RA, because such data: (i) are limited to where fishing is allowed/conducted; (ii) only represent information recorded on landed species of commercial value; (iii) do not include bycatch species or SARA-listed species that are discarded at sea. Consequently, all incidentally-caught species and their geographic ranges remain "invisible"/unknown to this RA; thereby constituting a large data gap in the RA, and rendering relevant species' geographic ranges inaccurate and misleading. It should be noted that Canadian At-Sea Observers constitute the sole source of fisheries data on total catch (i.e., commercial landings and discards at sea by species).

The RA should contain a list of data gaps by species as a result of the Government of Canada's "rule of five" which ensures confidentiality by de-personalizing information when data sources are limited. These data gaps can be partially addressed by describing areas where fisheries

occur without making commercial fishing data available. It should be recognized that there are some fisheries (e.g., Arctic Surfclam) for which the "rule of five" applies and data relating to these fisheries should not be included in the RA or the GIS application associated with the RA.

The criteria used to determine important areas or species need to be made explicit. In this module importance is equated with high primary productivity. While this may be one relevant criterion it cannot be considered a proxy for all aspects of the marine environment and is of limited utility in identifying areas, seasons, or species that are particularly sensitive to disturbance.

The available literature is insufficient to understand invertebrate communities (benthic and planktonic) in some parts of the Study Area (e.g., abyssal habitats).

There is a general focus on commercial species. These species tend to have the most information as it relates to distribution and life history. There needs to be more focus on ecologically important groups, using the best available data and information in the literature.

In instances where phytoplankton biomass magnitude and persistence is used as a criterion for delineation of spatially important areas or ecologically and biologically significant areas, the dynamic nature of the pelagic ecosystem needs to be taken into consideration (McIver et al. 2018).

There is generally a superficial treatment of the topics, and while the descriptions on corals and sponges appear much better than in previous assessments, the treatment of invertebrates in general is of poor quality and is incomplete. The draft document has major data gaps that would have been greatly reduced if a rigorous literature review of the existing scientific information for the Study Area had been carried out.

Introduction

The determination of the differences between plankton and invertebrates needs clarification. It is important to note that these groups are not mutually exclusive and the report lacks explicit definitions and descriptions in the introduction.

Plankton

Overall, the plankton component provides a brief introduction regarding the description of the main taxa of plankton and limiting factors within the RA Study Area. Important aspects regarding the life cycle and phenology, the impact of environmental conditions along with some limited information regarding the distribution, abundance, and biomass patterns based on available literature are presented and references provided. Some of the general descriptions of plankton and their relative importance could be enhanced based on the specific recommendations listed below identifying the particular descriptive component. There is some confusion in the text regarding the use of primary productivity which is a rate measurement and biomass which is the quantity per unit area (e.g., standing stock). For instance, biomass cannot be used as a proxy of primary productivity and high phytoplankton biomass does not directly imply high primary productivity. In fact, the highest rates of primary production based on direct observations occur during peak irradiance levels during summer (June-July months) and not during the spring period when the biomass of phytoplankton reach their highest levels in the water column. Solar energy that reaches the RA area is highly variable seasonally with extreme low levels during late autumn and winter, transitioning to long daily periods of insolation during late spring and summer. This makes the availability of sunlight one of the major driving factors for plant-based photosynthesis in the northwest Atlantic. A literature reference regarding the rates of primary productivity is provided in the specific comments in Appendix A.

The transport of zooplankton from deep ocean areas within the RA is considered a critical component of the productivity of adjacent Shelf waters. A study by Pepin (2013), addresses the importance of connectivity between these deep slope water and the adjacent continental shelf areas that is relevant for a variety of plankton taxa in the RA. Some of the keystone taxa such as calanoid copepods undergo diapause in deep water (>400 m) from late summer through winter before returning to the upper water column in early spring. A proportion of this deep population then acts to seed the adjacent shelf waters through general ocean transport processes. Large-scale currents such as the Labrador Current can also act to transport plankton southwards from the Labrador Shelf into the RA. An example illustrating the importance of connectivity is cited below in the detailed comments.

This section is based on the premise that satellite images of chlorophyll a are a proxy for primary productivity and thus for planktonic productivity overall. This overly simplistic approach ignores important components of the pelagic ecosystem such as the role of the microbial loop (Azam et al. 1983) both as prey (Figueiredo et al. 2009) and competitors (Paranjape 1990) for crustacean zooplankton and ichthyoplankton (Laurel et al. 2001). Also overlooked are the role of appendicularians and other mucus net feeders as consumers of primary production (López-Urrutia et al 2003) and their importance in the transfer of carbon and fine particulates to deep waters. This latter is an important consideration for assessing the fate of fine particulates associated with drilling wastes that do not settle out near the exploratory drilling operation (DFO in prep)[2].

In addition to the work cited in this module, young of the year fish (ichthyoplankton) were collected inshore and along oceanographic sections using conventional high-speed sampling gear (Bongo nets) just north of the RA during the Offshore Labrador Biological Sampling (OLABS) program in 1979 (Buchanan and Browne 1981, Buchanan and Foy 1980). Although the OLABS program did not occur within the boundaries of the RA, this study may provide some insights into the ichthyoplankton community structure southwards from large scale currents mentioned previously. Over 25 species of ichthyoplankton representing 12 families were identified during the OLABS study. Mean densities and biomass of ichthyoplankton varied spatially across the Labrador Coast and Shelf region. The study suggests the importance of inshore coastal regions as nursery grounds for a variety of fish species of both commercial and non-commercial importance.

Zooplankton

This section is very superficial in its treatment and description of zooplankton. Additional research is required to represent the breadth and depth of information available on zooplankton within the Study Area. Additional specific comments are provided in Appendix A.

Identified Important Areas and Times for Plankton

The statement that important phytoplankton areas correlates with important zooplankton areas, while a sensible expectation during phytoplankton blooms, does not recognize that any area where zooplankton may concentrate during winter (e.g., when in diapause) would also be important, although uncorrelated with phytoplankton concentration. Furthermore, winter concentration areas of copepods in diapause would be deep, and potentially more susceptible to infrastructure placed on the bottom. Given the potential importance of the implications associated with this statement, including the implicit absence of winter concentration areas that

[2] DFO. In prep. Review of the Environmental Impact Statement for the BP Canada Energy Group Newfoundland Orphan Basin Exploration Drilling Program. Can. Sci. Advis. Sec. Sci. Resp. Rep.

could be derived from it, the reference to studies supporting it is needed. Otherwise, the statement needs to be clarified and include the potential of deep winter concentration areas uncorrelated with phytoplankton.

Pelagic Invertebrates

The layout of this section is hard to follow. The Pelagic Invertebrates section starts with data sources followed by principle species (jellyfish, scallops, clams). Then it covers the importance of each species, followed by the life history of each species. It would be easier for the reader to follow if the document addressed one species at a time, in its entirety, before advancing to the next.

Similar to previous EIS documents, the RA does not contain shrimp data from the Flemish cap, although Spain-EU has been doing annual multi-species summer surveys of that region (as well as 3LNO outside Canadian Exclusive Economic Zone, EEZ) for many years. It is difficult to determine from the maps provided if the Study Area overlaps with shrimp areas in 3M, but it is worth noting that the shrimp fishery in 3M will resume starting in January 2020. Additionally, no reference is made to the NAFO documents that support shrimp in Divisions 3LNO or 3M. Figures are generated from their surveys for other fishes, but not for invertebrates.

Principal Species

While there is limited information for many invertebrates, this section superficially covers many groups for which relevant information exists. For example, squids are simply referred to as "squids", only referencing short and longfin squids as species. These are traditional commercial species, but *Gonatus* sp. is also a common squid in NL waters, especially on the shelf edge, and is the main squid prey item for Greenland halibut (Dwyer et al. 2010). There are multiple species of squid observed in Newfoundland waters. The commercially harvested species *Illex illecebrosus*, is the most abundant but the functional diversity of this group makes other species important as well.

Shrimp are a more complex group than simply northern shrimp. They do make up the bulk of the biomass but there are more species. It is important to highlight the diversity in species and functional roles. Species can be benthic, pelagic, or benthopelagic. The diversity in functional roles means that these shrimp have differing sensitivities to marine activities.

It is important to consider jellyfish (i.e., Class Scyphozoa in phylum Cnidaria) separately from ctenophores or comb-jellies (i.e., Phylum Ctenophore). These two groups superficially are similar in ecological function, but they can have different sensitivities to environmental conditions. It is not appropriate to group them.

Benthic Invertebrates

The Benthic Invertebrate section was poorly written and incomplete. It would benefit from an Introduction in which the reader would be informed what will be discussed in this section, like the data that are used, commercial and non-commercial species discussed, with a mention of corals and sponges, and key invertebrates.

Importance

There is little discussion about the ecological importance of benthic invertebrates. Therefore, this section should be entitled "Commercial importance", if that is the intention of this section. However, it should be recognized that benthic invertebrates are important on many other levels beyond their commercial value. The ecological function of the benthos should be acknowledged, as well as the importance of benthic pelagic coupling. Biogenic habitat forming species, such as

sponges, are an important part of deep-sea ecosystems. They are found on continental shelves and slopes, but also on seamounts, mounds, island slopes, and on the abyssal plain (Pham et al 2019). These latter habitats are not considered in the draft document. They are an important component of the benthic biota that perform significant ecological functions including biogenic habitat, benthic pelagic coupling and filtration. As another example, polychaetes and brittle/basket starts are important components of the diets of flatfishes like witch flounder, American plaice and yellowtail flounder. Potential impacts on these taxa could have significant cascading effects at the ecosystem level.

Identified Important Areas and Times for Benthic Invertebrates

This analysis is very limited by the types of data available and only considers shelf and slope habitats with some reference to data for the Flemish Cap. Other habitat types and features such as deep basins, seamounts and the Orphan Knoll are not addressed. Even if the data for these areas is limited, they are important habitats in the Study Areas and need to be considered. For example, seamounts are recognized as having a high degree of endemism and are thus considered important areas for biodiversity conservation (Kulka et al 2007). Habitat suitability modelling could be used to identify potentially sensitive habitats where direct observation is lacking. Geomorphology and sediment types have been mapped for the Study Area (for example see Blue Habitats) and these along with depth, rugosity, slope and orientation are readily available and often used as input parameters for these models (Auster et al 2005; Robert et al 2016).

Corals

Identified Important Areas and Times

The use of the acronym SBA to refer to Significant Benthic Areas can be confused with Sensitive Benthic Areas in the context of DFO's Sensitive Benthic Areas policy. To avoid confusion, the acronym SiBA should be used for Significant Benthic Areas, and SeBA for Sensitive Benthic Areas. These two types of areas indicate different things in DFO's Sensitive Benthic Areas policy.

There is a fundamental mischaracterization of what the United Nations General Assembly (UNGA) 61/105 called for. This resolution calls for the protection of VMEs, but did not call for the protection of "14" VMEs. VMEs constitute habitats that are particularly vulnerable to fishing impacts (and impacts in general), and coral and sponge habitats (which include the distinct communities associated with them, including, for example, their infauna) are some clear examples of VMEs, but are not the only ones. NAFO identified a long list of VME indicator species that apply to the Study Area, and many of them are not corals and sponges (e.g., erect bryozoans, stalked tunicates). There is no list of 14 VMEs; VMEs are identified by their ecological features and susceptibility to impacts. Food and Agriculture Organization (FAO) Guidelines for the management of deep sea fisheries provide the criteria to be used to identify VMEs and to assess if they are experiencing Significant Adverse Impacts (SAI).

Sponges

Identified Important Areas and Times

It should be noted that if habitat modelling suggests that sponges are in a particular location, that does not guarantee that high densities of sponges occur there. It is possible that sponges are completely absent in that location due to repeated dragging. Similarly, if habitat modelling

suggests the absence of sponges, this does not mean an area is not suitable habitat if other stressors have removed the sponges from this area in the past.

NAFO does not conduct surveys. The surveys that are used in NAFO analyses typically are Canadian, Spanish, and EU surveys (specifically on the Flemish Cap).

While grey literature from DFO is used, there is a notable absence of NAFO scientific grey literature in this section. Some of the NAFO studies have been published primary literature, and several of them are cited here, but there is much more information on corals, sponges, and VMEs in NAFO Scientific Council Reports, especially from the NAFO Scientific Council Working Group on Ecosystem Science and Assessment, WGESA (formerly known as NAFO Working Group on Ecosystem Approaches to Fisheries Management, WGEAFM, and not to be confused with the joint Commission-Scientific Council Working Group on the Ecosystem Approach Framework to Fisheries Management, WGEAFFM). The RA should utilize these resources and the information that NAFO has generated on these topics for more than a decade.

Module 5b – MARINE FISH AND FISH HABITAT – FINFISH

General Comments

This module requires substantial revisions based on general and specific comments provided below.

Module 5b takes a species focus, and while some ecological processes and elements are described, this module does not provide an integrated ecological perspective. Consideration must be given to ecologically and biogeochemically relevant components of the Study Area. The Study Area is part of a broader ecosystem, and the methodology of defining sub-regions within the Study Area is not properly explained. While the sub-regions make general sense, the boundaries are arbitrary, and, consequently, the sub-regions are mostly treated as isolated units without any attempt at describing the ecotones and interfaces that integrate them. For example, the basis of the boundary between the Orphan Basin and the Northeastern Grand Banks sub-regions is unclear. The boundary cuts through a continuous portion of the NE Newfoundland Shelf, resulting in stock definitions and areas of high relative density for multiple species (e.g., Cod [Fig. 18], Witch Flounder, Capelin [Fig. 8], American Plaice [Fig. 10]) straddling both sides of the boundary. Boundaries can be better defined using updated references (e.g., Pepin et al. 2010 to Pepin et al. 2014). It is recommended that the sub-regions be redefined to increase consistency of depth ranges between similar areas (i.e., Northeastern vs. Southeastern Grand Banks), which will align better with stock boundaries and species distributions. For example, extend the Northeastern Grand Banks sub-region to greater depths which will better justify the definition of the Orphan Basin.

Habitats and geomorphological features are described in the overview, although under-sampled areas, such as the Newfoundland Seamounts and the Orphan Knoll, are subsequently not addressed. Seamounts in particular are recognized as important habitat because of a high degree of endemism and the presence of biogenic habitats that are sensitive to disturbance (Auster et al 2005: Kulka et al. 2007). The literature needs to be reviewed for each sub-region, including the fauna and flora associated with special habitat features (e.g., the Virgin Rocks, canyons, knolls, seamounts).

Limitations of the RV survey data are not well discussed in Module 5b, particularly for small pelagic fishes (e.g., Capelin, Sand Lance, Arctic Cod, Myctophidae) for which the bottom trawl is not an appropriate sampling method. Data from the RV surveys for pelagic species should be

used only as an indicator of presence. DFO Science will follow up with the Agency and provide data from the Capelin spring acoustic surveys (1982-92, 1996, 1999-2005, 2007-2015, 2017-2018).

Module 5b generally fails to take account of the growing literature on the importance of the mesopelagic zone in terms of biomass and ecological processes in the world's oceans in general (Irigoien et al. 2014; Jones and Checkley Jr. 2019) and in the Study Area in particular (Pepin 2013). In the NL region, knowledge of the mesopelagic zone and deep ocean areas is minimal – especially compared to the Newfoundland shelf. This is an important knowledge gap to highlight given that industrial activities are extending into progressively deeper waters.

The heavy reliance on abundance data, and the lack of consideration of DFO RV survey design, results in a likely biased perspective on what species are important and why. While species listed in Module 5b are numerically important in the areas covered by the RV surveys, they may not be the most sensitive to disturbance or represent key species for ecosystem function. The calculation of "most abundant" has been done based on a summation of total numbers caught in survey sets. This approach does not consider the stratified nature of the survey and may not be an accurate representation of the most abundant taxa. The maps in Module 5b provide information on relative density based on biomass. This is not equivalent to abundance. There should be consistency in metrics used to limit the possibility of misinterpretation of the contents of Module 5b. A focus on the most abundant species overlooks those that may be rare and/or have limited distribution. These low abundance and small range species may be more susceptible to impacts. Consideration is not given to life history traits, whereby species that are slow-growing, have low fecundity, and are long-lived may be less able to recover should they be impacted. The focus in this document on the most abundant species in the surveys tends to skew toward fast-growing, short-lived species that are typically more abundant (e.g., Capelin, Sand Lance, Arctic Cod, species within Myctophidae or mailed sculpin groupings). Numerical dominance does not necessarily reflect dominance in the system given biomass differences and varying functional roles. Some of the "Species" discussed are groupings of species, with family Myctophidae encompassing 248 species across 33 genera. Abundance of an entire family should not be considered on the same scale as that of a species.

There are concerns over the accuracy and consistency in terms used. For example:

1. the use of "species" when describing patterns in a group of species (mailed sculpins) or entire family (Myctophidae);
2. "Aggregation" when describing areas of higher relative density;
3. lack of understanding on the difference between biomass and abundance, and the application of one term when describing trends or patterns observed in the other;
4. regime shifts vs. trophic interactions (Section 1.3 paragraph 2). In general, regime shift is mischaracterized in Module 5b and the term has been used incorrectly. Additional details are provided in specific comments on Section 1.3.

There are obvious differences in the level of detail provided for different species (e.g., Atlantic salmon vs. all others), and this unevenness is not based on availability of information. If Atlantic salmon provides the standard for the level of detail required for describing species, then all other species are severely under-addressed. Finfish species information is largely derived from Coad & Reist (2018). A broader literature review and inclusion of more information on population trends, life history, movements, ecological roles, and trophic relations is recommended.

1.2 Key Information and Data Sources

It is important to highlight the limitations of the data sources used in Module 5b. The DFO RV surveys do not sample at depths greater than 1,500 metres (m) and most DFO surveys do not survey beyond 750 m (although there is some coverage up to 1,500 m). The EU trawl surveys do not go beyond 1,500 m. Only target projects have gone beyond 1,500 m in the NL region (e.g., Nereida Project), but sampling is limited in both time and space. Therefore, given the near absence of deep ocean data and the significant proportion of habitat that is not covered in this RA, there is no support for the statement that there is a sound understanding for all areas.

The focus on Campelen data only is problematic. The Engel trawl provides data before the regime shift in the region (late 1980s and early 1990s) and this is an important time period to consider in Module 5b. More details on methodology on species rankings is required.

1.3 Overview of Key Ecological Regime Shifts and Assemblages

Changes in community composition will occur under a variety of circumstances. However, trophic cascades and regime shifts are two different concepts and should not be conflated. Further, "cascading effects" do not necessarily cause regime shifts. A regime shift, by definition, is a large, *persistent* change in structure and function. It is recommended that this section focus less on currents and oceanography patterns to define geographic zones and more on defining fish assemblages and characterizing regimes and/or possible shifts.

It is recommended that pre-1995 data be included in the RA (i.e., Engel trawl data). Fish distributions prior to the regime shift in the late 1980s/early 1990s were different than what are seen today. There needs to be a discussion on changes in fish distribution since the regime shift, as well as a discussion on the changes in productivity state and structure of the ecosystems being assessed and their implications for ecosystem functionality.

The sub-regions of the Study Area cannot be treated in isolation, especially the transition between the Grand Bank, through the Flemish Pass, and onto the Flemish Cap. These community transitions could be lost if the area is analyzed as discrete sub-regions only. There is no explanation of the methodology used to define the boundaries between these sub-regions.

Corals and sponges are referred to as microhabitats in the Flemish Pass; this wrongly portrays these habitats as small and/or discrete. They actually constitute large habitat complexes along the entire Flemish Pass, especially sponges.

The Orphan Knoll is mentioned as a VME, but the many VMEs identified in the Flemish Cap, Flemish Pass, and Grand Banks Areas are not included in the RA. This omission should be rectified.

Several citations are outdated or missing in this Section and 2019 scientific publications need to be reviewed and included.

1.4 Subregions and Their Associated Finfish Assemblages

Consistency is needed in the depth ranges used to define "shelf", "slope", and "banks" areas in Canadian waters and for the Flemish Cap.

Finfish assemblages within sub-regions are described based on trends in functional groups, without any consideration of the dominant species that make up the functional groups.

DFO RV survey data are collected with bottom trawls which have a limited ability to pick up pelagic species signals. Inferences should not be made on the assemblage composition or

aggregation areas of taxa within the planktivores functional group (e.g., higher abundances of lanternfish in certain areas) without providing a reference to support this information.

1.6 Other Select Fish Species

This Section only addresses the fish species from the sub-regions covered by the DFO RV survey and applies it to the whole Study Area without considering the differences identified among sub-regions that are covered by the survey. This section should be written on a sub-region by sub-region basis considering the "important" species identified for each.

1.7 Species of Identified Interest by Indigenous Groups

The amount of information devoted to salmon is significant in comparison with any other species. If this is the level of detail considered relevant for Atlantic salmon, then it could be concluded that the level of detail provided for the other species is insufficient. For most of the other species there is sufficient knowledge to generate reviews of similar depth and content as the one on Atlantic salmon.

1.7.1 Atlantic Salmon

This section of Module 5b was well done. The information presented on Atlantic Salmon was factual, thorough, relevant and up-to-date regarding published literature. Research on Atlantic Salmon in the marine environment has been a priority for DFO and many stakeholders in recent years and there are ongoing projects that will fill current knowledge gaps.

Table 9

Table 9 needs to be updated with a thorough review of spawning times of key species with uncertainty and variability in spawning times included in the Table. This is extremely important because this Table could be used to inform seasonal planning of activities.

1.10 Identified Important Areas for Marine Finfish in the Study Area

This section mentions the northeast area of the Grand Bank as an important concentration area for silver hake. Silver hake is a warm water species which is far more abundant in NAFO Division 3Ps and Division 3O along the shelf break. A broader perspective and understanding of ecosystems is required.

Module 5c – MARINE MAMMALS AND SEA TURTLES

General Comments

Given that this module is intended to provide an overview of marine mammal and turtle species that may be present in Study Area, this review simply addresses the accuracy of the distribution and biological data provided.

Overall, this module is an inadequate description of the species present and the key biological features that are important, as it contains errors and omissions. The module incorrectly equates "marine mammals" with cetaceans, rather than cetaceans, pinnipeds, and Polar Bears (that do occur occasionally in the area). Many references are used improperly, do not support the statements being made, or are superseded by more recent publications.

The module does not describe the potentially large area of exposure to man-made acoustic disturbance for endangered cetaceans such as Blue Whales and Right Whales. For these two species (and other mysticetes and many fish species in the northwest Atlantic) their

communication and hearing space is significantly reduced through exposure to underwater noise from seismic exploration and shipping (e.g., Cholewiak et al. 2018, Putland et al. 2017).

Overall, areas of high importance for Blue Whales, Right Whales and Fin Whales have been identified and any planned activities in these areas should be subject to increased monitoring effort and mitigation measures.

1.1 Marine Mammals and Sea Turtles

The module provides a detailed description of the caveats associated with marine mammal and sea turtle sightings database provided by Dr. Lawson of DFO. Despite all of these considerations for interpretation of species occurrence in the Study Area, the sightings database is the sole source of information used to generate the species distribution maps. This small subset of data should be used supplementary to the available literature rather than as the primary source of data. Where possible, other sources of distributional information should be incorporated in the maps and tables. There are a considerable number of primary and CSAS papers that describe marine mammals in the area, including the results of surveys of the area, which do not appear to have been referred to. These publications should be included, as they address many of the caveats associated with the opportunistic sightings. Using the sightings database to describe distribution offshore and in winter periods is problematic, as much less effort is expended in these areas and periods. Poor weather also significantly reduces the chances of detecting smaller species such as dolphins, Minke Whales, and sea turtles. Individuals of almost all the cetacean species (including SARA-listed) remain in the waters of the Study Area during winter. Thus areas such as Flemish Pass or the southern Orphan Basin cannot be assumed to be free of cetaceans during these periods. This is also an important consideration for ice-breeding seals that reproduce on moving ice that extends into the Study Area.

As literature on marine mammals is very extensive, it is recommended that these be referenced to develop better descriptions of marine mammal distributions and seasonality in the Study Area.

1.1.1 Mysticetes

In this section, it is noted that "most species are migratory in nature and are present for specific times (generally from late May to early September), feeding on specific prey species such as plankton and krill or small schooling fish such as Capelin." The diets of the different species vary greatly. Therefore, impact on particular prey (e.g., zooplankton vs forage fish) will have different impacts on the various species. This should be identified and more information should be provided on the specific marine mammal diets in the RA.

1.1.2. Odontocetes

Generalizations such as some species being "coastal" and others being "oceanic" are incorrect, and should be subject to a dedicated survey event near proposed development areas. Sperm Whales, Right Whales, and Blue Whales have been observed very close to shore in shallow waters, and Harbour Porpoises have been observed far offshore in waters thousands of meters deep.

1.1.3. Pinnipeds

Information provided on Harp Seals and Hooded Seals fails to identify the area as important for whelping, nursing of pups, and breeding. Over 90% of the entire population of Hooded Seals and between 70 and 98% of the Harp Seals give birth on the ice that often extends into the

Study Area. For this reason, an EBSA has been identified in the area. This EBSA was not noted in the module.

1.1.6. Overview of Key Areas and Times for Marine Mammals and Sea Turtles in the Study Area

Statements about cetaceans and (particularly) pinnipeds in this module are often oversimplified. In some years the Study Area includes important ice habitat used for pupping of Harp Seals and Hooded Seals, as well as moulting of Harp Seals. The areas near the north part of the Grand Banks and shelf edge, particularly around the Flemish Pass and Flemish Cap, are important feeding areas for multiple cetacean species, and Harp Seals and Hooded Seals, respectively. The latter information is described clearly in the papers cited but not included in this module.

Module 5e – SPECIAL AREAS

General Comments

This module provides a review of the mandates for identification, designation, and protection of special areas in the Study Area and includes a list of those that have been identified and/or designated under each mandate. It also includes the criteria used for the identification of these areas. It does not include any consideration of how these criteria relate to vulnerability to human disturbance.

The process for identification and protection of special areas is ongoing and additional special areas may be identified in the future. **Special mitigations should be applied in areas that are deemed special (e.g., VMEs, SiBAs, EBSAs) but are not currently protected by other management measures.** These unprotected special areas are often confused in the RA with spatial management tools used to protect some of or portions of these areas (e.g., marine refuges, VME closures); **mitigation measures should therefore be considered at the scale of the actual areas, not at the scale of the protected portions.**

There seems to be a general misunderstanding of what VMEs and SiBAs are, and the difference between these concepts, which define habitats, and hence, how their biological/ecological functions are exerted at the scale of the full habitat extent, and the management measures used to protect them (e.g., fisheries closures, marine refuges, marine protected areas [MPAs]).

There is a lack of consistency throughout this module with regard to how the various special areas are listed and described. For example, some figures have special areas on the maps but these areas are not described in the text or tables (e.g., Hatton Basin, Lobster Closure Areas, and the Salmon Migration Closure on the marine refuges map). Also, most sections only discuss the special areas that are found in Newfoundland and Labrador waters (e.g., Section 1.1.12) while some sections discuss the special areas found nationwide (e.g., see Section 1.1.1.8). Finally, most of the maps are at different spatial scales with no apparent reason for these differences. For example, some maps are at the bioregion scale (e.g., NL Bioregion, Large Ocean Management Area [LOMA], National Parks and Historic Sites), some maps are cut off near Hamilton Inlet (e.g., Provincial Ecological Reserves, Provincial Parks, Provincial Historic Sites) or just north of Nain, Labrador (e.g., Marine Refuges, National Marine Conservation Areas), and others are zoomed to the extent of RA Study Area with special areas to the north excluded from the map (e.g., EBSAs, SiBAs). A consistent scale is recommended for the special areas maps, and consistency is recommended with respect to the list and description of special areas within a regional context.

Missing from the document is a discussion on how data are collected (e.g., for corals and sponges) and how they are used (SiBAs vs. VMEs, Canadian Closures vs NAFO Closures), and most importantly the caveats associated with each data type (e.g., trawl data gathered only from trawlable substrates). Furthermore, data gaps are critical to special area determination. These determinations cannot be made if the data are not available to assess habitats against the criteria for identifying SiBAs or VMEs. It is recommended that this section include a discussion of data gaps in addition to the assumptions that have been used for identifying and mapping the special habitats that have been identified.

Ecological functioning of SiBAs and other special areas is dependent on the physical oceanography of the region (e.g., transport of food, larvae, temperature influences, etc.), however there is no consideration of these important linkages in this module. These oceanographic processes are important in the functioning of special areas that may require the application of special mitigations (Radice et al. 2016, Kenchington et. 2019, Lundberg and Moberg 2003, Le Corre et al. 2018, Stephenson et al. 2009, Horne et al. 2016.).

The identification of special areas in Canadian waters and the NAFO Regulatory Area (i.e., SiBAs vs. VMEs) was based on different criteria and this should be described better in this module. Furthermore, it would be useful if the various criteria used to identify special areas, or some combination of them, were also applied in Modules 5a, 5b, and 5c.

The module on fish and fish habitats generally does not adequately describe benthic habitats and SiBAs/VMEs, often referring to this module, and this module is mostly focused on management tools and frameworks with very limited, and often inaccurate or confused, descriptions of what these habitats are, and the functions they provide.

The EEZ is based on jurisdictional mandates and the ecological functioning of special areas should be taken into consideration based on their ecological importance and connectivity, and not only whether they are found inside or outside that line.

Following the development of new Convention on Biological Diversity (CBD) guidance on Other Effective Conservation Measures (OECMs), the Department has been carrying out a review of Canada's guidance and criteria for OECMs as well as reassessing the current marine refuges. The information in this section, while generally accurate at the current time, will need to be revised once the new guidance becomes available.

There is a very poor understanding of how NAFO operates, its constituent bodies, and how it works in terms of identifying, delineating, and protecting (or not) VMEs (see comment on Section 1.1.3.2).

Overall, the text for this section deals with each topic separately (i.e., National vs. International), which is fine, however there needs to be some discussion that ties everything together (with text and maps). The reader needs to see and understand where old, new, and planned well sites are located in relation to VME/SBAs, Marine Refuges/NAFO Fishing Closures, EEZ, bathymetry, etc.

1.1.1.2 Ecologically and Biologically Significant Areas

There is a mischaracterization of EBSAs. EBSAs are not just linked to productivity; an area can be identified as an EBSA because it contains unique features, but these features may not contribute significantly to productivity.

The most recent processes (DFO 2019c, Wells et al. 2019) have revised and updated the originally identified EBSAs in the Placentia Bay-Grand Banks area (Templeman 2007),

superseding them. For a description of current status, reference to the most recent identification and delineation process is required. The same applies to LOMA-related language. LOMAs were pilot projects and they no longer exist. If the goal is to refer to current status, references to the LOMA are unnecessary.

1.1.1.3 Significant Benthic Areas

There is a mischaracterization of the SiBA concept. SiBAs are not just "noted for the presence of corals and sponges", they constitute regional habitats which are generated by the structure provided by the corals and sponges, but also include the associated community (i.e., benthos, infauna, fishes, etc.). Furthermore, SiBA habitats are defined by high concentrations of corals and sponges, not just mere presence. There are many other locations where this taxa may be found, but SiBAs are the locations where their aggregation and concentration is such that it provides the structure for the formation of a distinct habitat.

Further to this, the difference between Significant Benthic Areas and Sensitive Benthic Areas should be described in this section. The acronym SiBA should be used for Significant Benthic Areas. SBA can be confusing because Sensitive Benthic Areas (SeBA) are different from SiBAs under DFO's Policy for Managing the Impacts of Fishing on Sensitive Benthic Areas, and both areas have been referred to as "SBA" in different documents. This distinction was made at the Marine Fish and Fish Habitat Technical Advisory Group meeting, and this was reflected in the meeting notes.

1.1.1.5 Marine Refuges

While marine refuges may have been created to achieve Aichi targets, the protection of corals and sponges is mandated under DFO's Sensitive Benthic Areas policy (see link provided above), which was developed to address the coastal states commitments required by UNGA 61/105. Marine refuges that protect corals and sponges fulfill both, but Canada's requirements to protect corals and sponges are independent of Aichi targets.

This section requires additional text to make linkages between Canadian Marine Refuge Areas and NAFO VME closures.

1.1.3.1 Vulnerable Marine Ecosystems

There is a mischaracterization of VMEs. The FAO Guidelines define VMEs not EBSAs. The concept of EBSA (both under the CBD and DFO) is more encompassing than that of VMEs. VMEs are EBSAs, but not all EBSAs are VMEs.

1.1.3.2 NAFO Fisheries Closure Areas

There is a mischaracterization of NAFO fisheries closures, given the misunderstanding indicated above about how a VME is delineated. NAFO closures to protect VMEs (or locations likely to contain VMEs, like seamounts) do indeed protect areas of high concentration, because the entire VME area is an area of high concentration. The actual size and location of the closures is currently defined through an iterative process where Commission-Scientific Council WGEAFFM discusses all available scientific information on VMEs, as well as spatial distribution of fishing effort (e.g., see Figures 2-4), trying to achieve a compromise between VME protection and restricting access to fishing grounds. These discussions generate recommendations for the Commission, where contracting parties will discuss these recommendations, modify them, negotiate options, and finally adopt (or not) a particular closure(s). In 2016, Scientific Council performed an Assessment of Significant Adverse Impacts (SAIs) on VMEs and found, for

example, that the sea pen VMEs in the NAFO Regulatory Area were at high risk of SAI largely due to the poor coverage of the established closures for that VME. As this indicates, NAFO closures are a compromise between conservation and fishing, and there are areas of significant concentrations of VMEs outside NAFO closures.

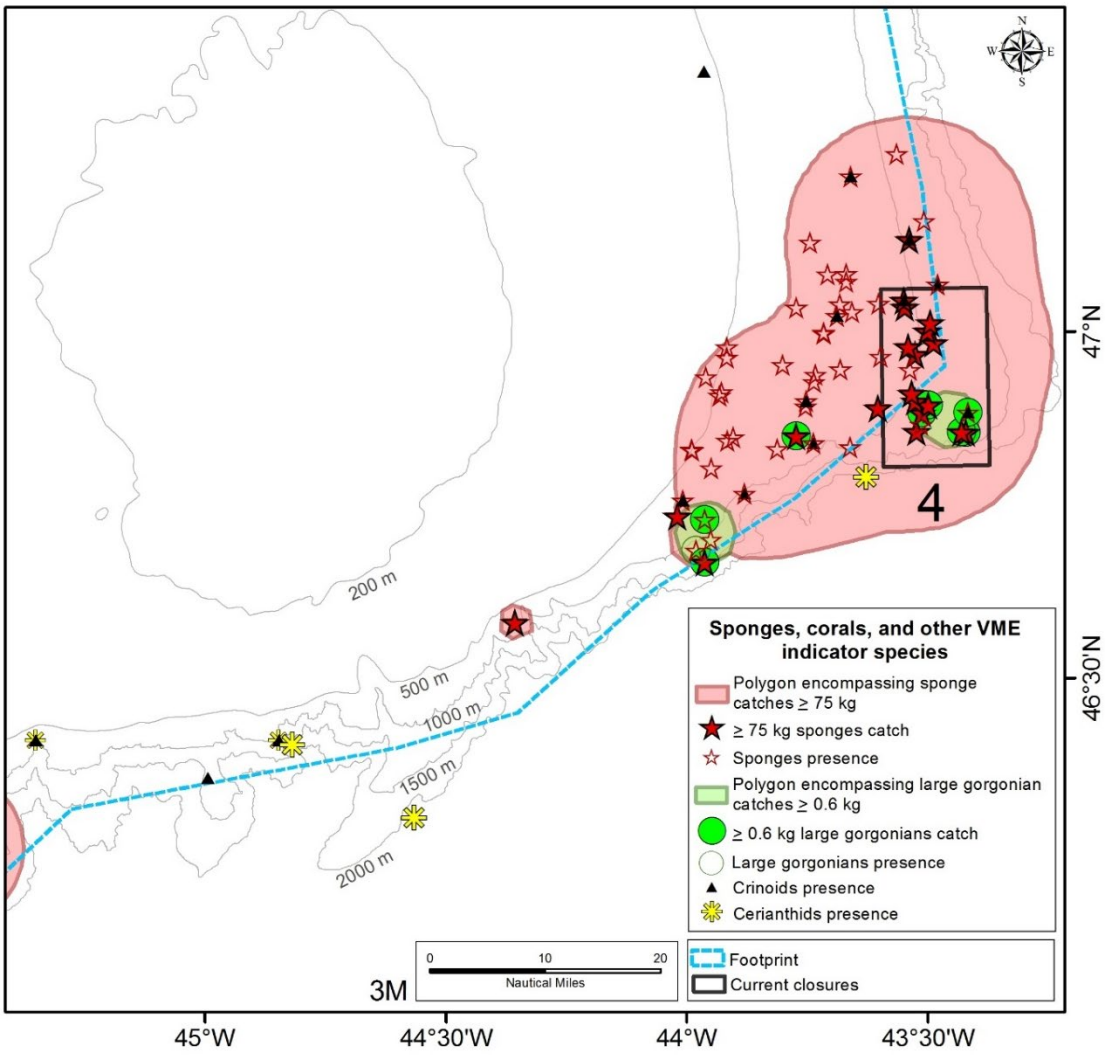

Figure 2: NAFO WGESA (NAFO 2013) illustrating point data (stars represent bycatch by threshold), sponge and coral modeled data (pink and green polygons), closures (black box), and fished areas (blue line at 2,000 m). This body of work illustrated that VMEs are located in areas where fishing is low or non-existent.

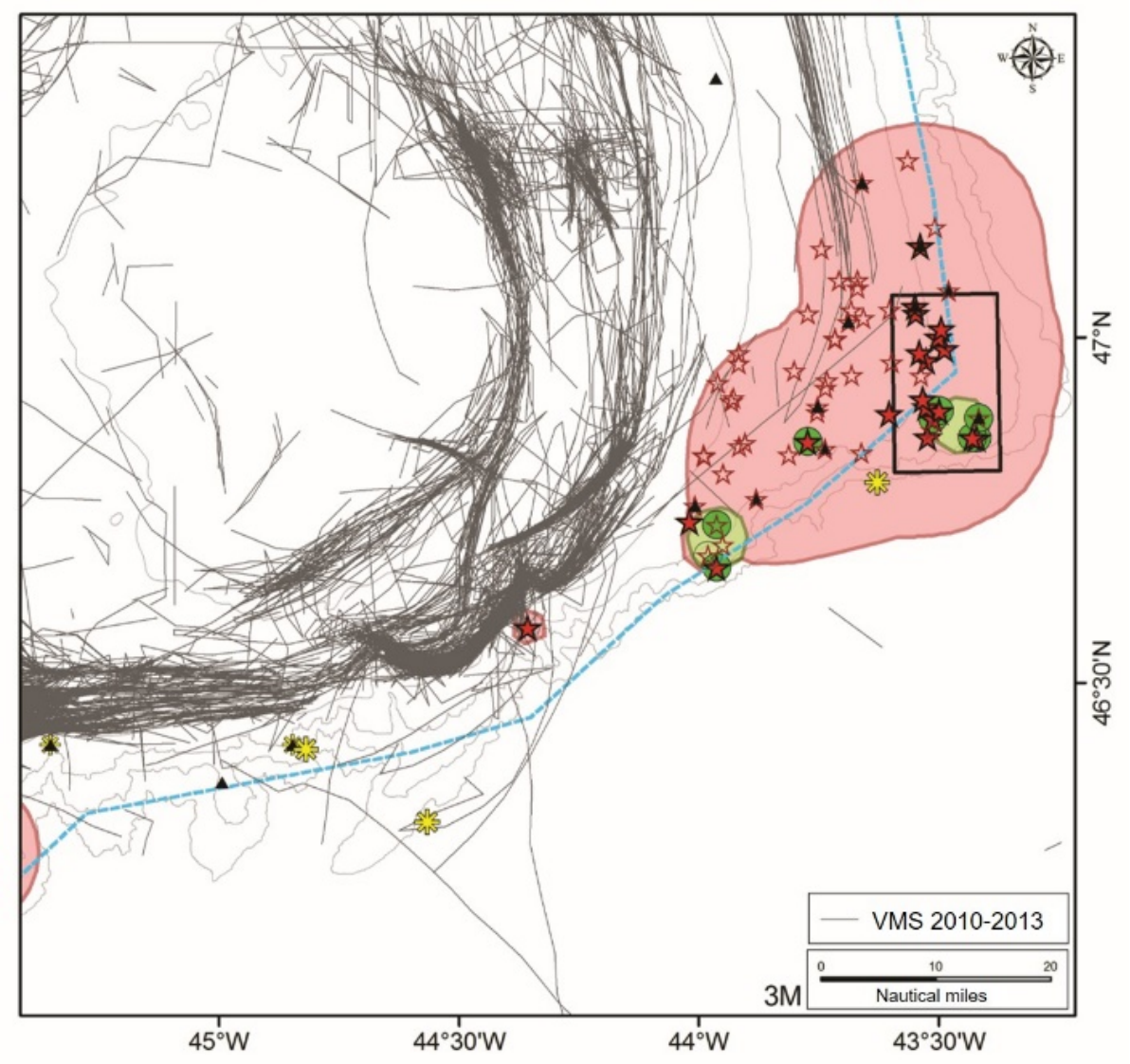

Figure 3: NAFO WGESA (NAFO 2013) illustrating point data (stars represent bycatch by threshold), sponge and coral modeled data (pink and green polygons), closures (black box), fished areas (blue line at 2,000 m), and fishing footprint (Vessel Monitoring Systems data of vessel tracks as gray lines). This body of work illustrated that VMEs are located in areas where fishing is low or non-existent.

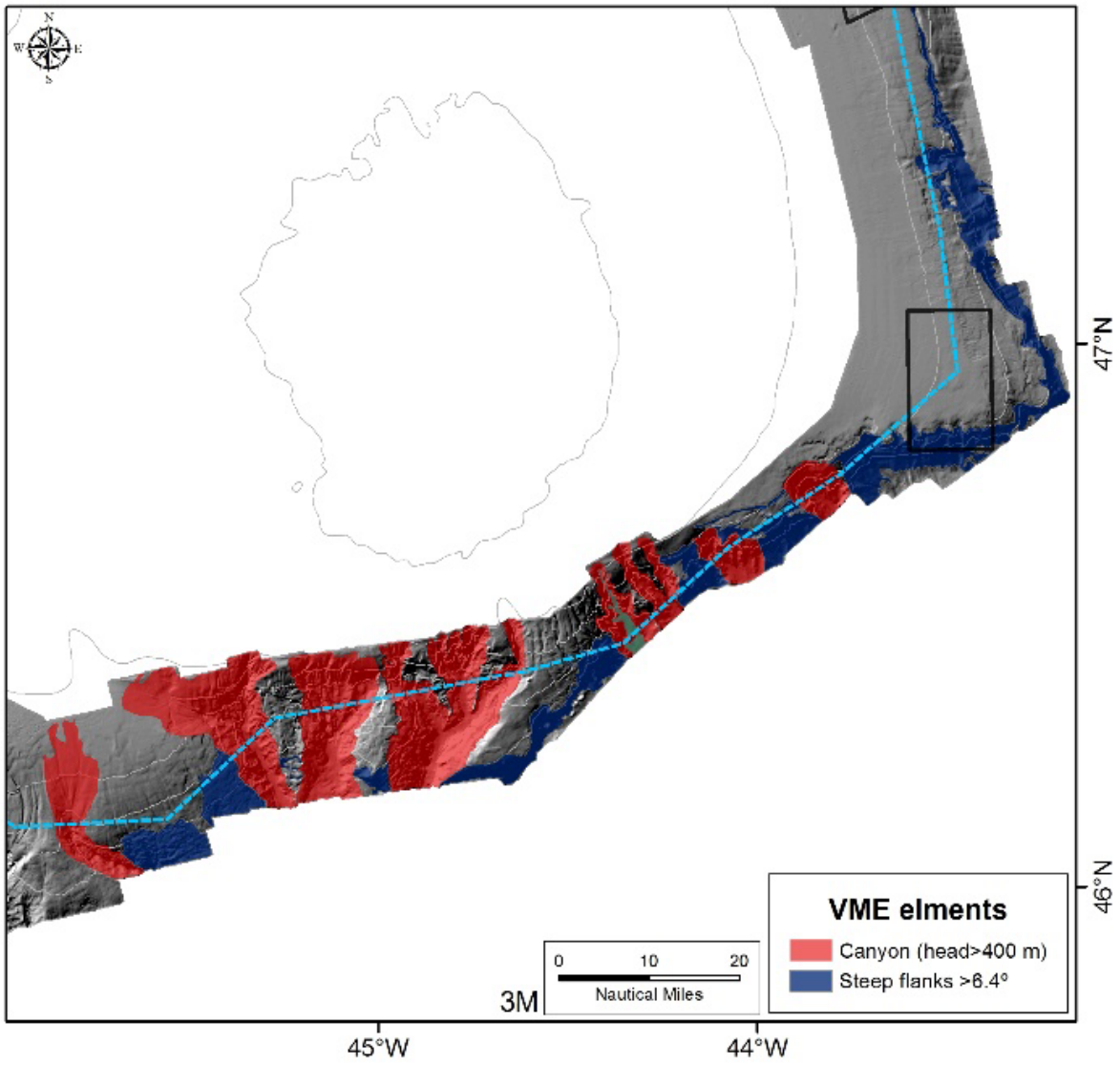

Figure 4: NAFO WGESA (NAFO 2013) illustrating geological data based on joint CAD-NAFO benthic/multibeam survey conducted in 2009-2010. This body of work illustrated that VMEs are located in areas where fishing is low or non-existent.

Conclusions

- **It is important to highlight that a thorough and detailed review of the draft RA modules provided was difficult to undertake due to the short review period (30 days).** The specific comments in this Science Response Report should be taken as indicators of the types of shortcomings in the draft modules and serve as guidance on how they should be addressed.
- **A complete and rigorous review of the draft modules provided is not possible without also being provided the context, the GIS application, and other technical modules, including those on the physical and chemical environment.** The ecology of the Study Area, its biodiversity, habitat distribution, productivity, interconnectedness, variability,

vulnerability and other ecological characteristics of relevance to this assessment are determined by the biophysical – chemical characteristics of the environment. By only reviewing the biological information, DFO Science's review has been done in the absence of the full environmental and ecological context of the Study Area.

- Data layers provided by DFO were modified, misrepresented, or missing in the draft modules without providing justification or methods, calling into question the reliability of the analysis. A rigorous literature review was not completed in the draft modules and DFO Science encountered several instances in which available information was omitted, misinterpreted, and/or mischaracterized. Also, data gaps were not identified in a consistent manner which led to inappropriate generalizations of observations from surveys that are spatially and temporally restricted. **As such, the draft modules reviewed, in their current form, do not accurately describe the existing biological environment. From a DFO Science perspective, until the problems identified in this report are addressed, these draft modules of the RA are not considered a reliable source of information for developing conclusions and/or recommendations for decision-making processes.**
- As areas previously identified by federal and international bodies/authorities have been acknowledged as Special Areas in the draft modules provided (including in sections titled Identified Important/Key Areas and Times in Modules 5a, 5b, and 5c), it is implicit that such areas are highly sensitive to human impacts and **it is recommended that additional special mitigations should be applied for any future exploratory activity within these areas.**
- **It is recommended that special mitigations also be considered and applied to stocks that are under moratorium and/or in the critical zone under the DFO or NAFO precautionary approaches.**
- **It is recommended that the RA include a systematic and transparent process for developing and applying relevant criteria to aid in the identification of "important" areas or species.** This will allow for consistency between and within the modules and improve their utility in the assessment process.
- The RA is intended to make an important contribution to improving the rigour and scientific defensibility of the impact assessment of exploratory drilling projects in the region. **It is therefore essential that:**
    1. **the biological and environmental information provided in the RA is based on the scientific community's current understanding of the biogeochemistry and ecology of the region, and should be based on a thorough and up-to-date literature review, and**
    2. **methods, along with their limitations and assumptions, and data gaps are clearly identified.**
- To ensure data are up-to-date and methods and data gaps clearly identified, it is recommended that a more systematic process is used to construct and maintain an "evergreen" platform for continuous improvement of the assessment process as knowledge gaps are filled and new methodologies and mitigation techniques are developed.

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Appendix A – Specific Comments on Module 5a – PLANKTON AND INVERTEBRATES

Specific Comments on Text

Introduction

Page 1, paragraph 1

"Plankters (individual organisms that constitute plankton) are pelagic, occurring in the upper portion of the water column where ocean circulation affects their distribution (Melle et al. 2014)."

This is true for phytoplankton only. Zooplankton occupy the entire water column and perform diel vertical migration over tens to thousands of meters.

Plankton

Page 1, paragraphs 1 and 2

Only the upper water column is considered here. Plankton are also found in deeper waters. Some such as copepods over winter at depth, others are an important component of the deep scattering layer in the mesopelagic (Fennell and Rose, 2015).

Page 1, paragraph 3

Copepods undergo vertical diapause so are probably not Holoplankton.

Data Sources

"…regionally relevant data related to plankton distribution…"

It should be noted that AZMP biogeochemical time series (1999-2018) is very relevant in the present case. Further, the Continuous Plankton Recorder (CPR) which is cited later, contains information on the spatial and temporal distribution on over 400 phytoplankton and zooplankton taxa. Together with the AZMP time series, represent the most current data available on spatial and temporal distributions of plankton in the North Atlantic. Data can be obtained from Sir Allister Hardy Foundation for Ocean Sciences (SAHFOS; CPR Survey)

Detailed seasonal zooplankton and chlorophyll data from DFO AZMP are available for the period 1999-2018 at regional and zonal scale from DFO. Contrary to satellite data, which only gives information on surface chlorophyll concentration, AZMP chlorophyll data covers the first 100 m of the water column. The AZMP time series is a long-term comprehensive dataset that covers the Flemish Cap and Flemish Pass areas and, as such, should not be disregarded.

Phytoplankton

It should be made explicitly clear that phytoplankton are being considered as a general proxy for zooplankton distributions due to data deficiencies.

Page 2, paragraph 2

"Phytoplankton are microalgae that process organic matter from carbon dioxide and dissolved nutrients..."

Phytoplankton use sunlight, CO_2 and nutrient to produce organic compounds.

"Other factors that influence phytoplankton include sea surface temperature and vertical water column stabilization."

> Plankton living in an area below the surface are affected by temperatures within their depth range, not just the surface. No citation is listed in the reference section for the satellite imagery. It is suggested that the following be cited for additional information: NOAA (2019) and Bedford Institute of Oceanography (2019).

Principal Species

Please specify the depths that the CPR sampling occurs at. It should be stated whether or not seasonal trends at those depths are representative of the full water column.

Zooplankton

Given the importance of zooplankton, other important taxa should be mentioned beyond just copepods.

Importance

"…smaller warm-water copepods and non-copepods are increasing in abundance."

> This statement may apply to the Scotian Shelf but not the Flemish Cap-Flemish Pass area. There is a large increase in the abundance of Oithona copepods which are not indicators of warm water conditions. Water temperature in the Flemish Cap area (and northern Grand Bank and Labrador Shelf) has been cooling since 2015. The system is in a cold phase, rather than in a warming phase like in the Gulf, Scotian Shelf or southern Grand Banks.

Principal Species

This section does not include *Oithona* species even though they are by far the most abundant copepod species, although their contribution to zooplankton biomass is limited due to their small size (Pepin et al. 2011).

"As indicated above, C. finmarchicus is still the most abundant species in the zooplankton community occurring off Newfoundland and Labrador."

> This is inaccurate. *Oithona* spp. copepods are by far the most numerous copepod (*Oithona similis* and *Oithona atlantica*). However, due to its large size, *C. finmarchicus* is the main contributor to total zooplankton biomass almost everywhere in the North Atlantic. It is noted that throughout the section, there is confusion between abundance and biomass.

"…other important zooplankton taxa include bivalves, cladocerans, barnacles, and gastropods (Dalley et al. 2001; Nexen 2018)."

> There are also larvaceans (tunicates), chaetognaths (arrow worms), euphausiids and amphipods that make up a significant component of the diet of keystone pelagic species such as Capelin (see Orlova et al. 2010, Obradovich et al. 2014, O'Driscoll et al. 2001).

Ichthyoplankton and Invertebrate Eggs and Larvae

"Most marine fish species have a planktonic life history stage (i.e., ichthyoplankton) that move passively in the water column and are often entrained in water currents and gyres (Bradbury et al. 2008), upwelling zones (Ings et al. 2008 in AMEC 2014), and thermoclines (Frank et al. 1992

in Amec 2014), which may determine recruitment and population stability due to dispersal and settlement behavior (Cowen 1985)."

The first part of this sentence does not necessarily link with the second half. Abiotic and biotic factors have roles to play in the survival of fish larvae. To be clear, larval survival (which is impacted by abiotic and biotic factors like starvation, predation, dispersal, temperature) is related to recruitment.

"The ability for ichthyoplankton to move within the water column is variable."

This sentence should be deleted, as it is made redundant by following sentence.

"Larvae have some limited capability of directed movement, while egg stages are ~~more~~ dependent on currents and ocean conditions (Snelgrove et al. 2008)."

Fish larvae have been shown to undergo diel vertical migratory behavior from an early stage in development which allows them to control their position in the water column. Pelagic eggs are completely passive and are dependent on currents.

"Spawning times for various marine species often coincide with phytoplankton and zooplankton *blooms, thereby providing adequate prey availability for larvae in the water column (C-NLOPB 2014)."*

This reference suggests an inadequate understanding of the literature. A better reference is required, specifically from the early life history field such as Cushing (1972, 1990). Further, the majority of fish larvae feed on zooplankton, not phytoplankton.

Importance

"Recruitment strength of a fish or *invertebrate stock is largely driven by the larval stage (Dalley et al. 2002), since it is the shortest life stage and most vulnerable to changing environmental conditions and predation. The transport of ichthyoplankton and benthic invertebrate eggs and larvae influences the abundance and distribution of fishes and benthic invertebrates (Carter-Lynn 2009)."*

Please explain how a short life stage makes an animal more vulnerable. Also, there is a clear link between how transport influences distribution but the link to abundance is less obvious. It is not that this life stage is short, it i's that the early life stage is particularly vulnerable to predation, starvation and disease before the larva metamorphoses into a juvenile. It has been documented that 95-99% of mortality occurs in the larval stage. This needs to be better articulated and cited with seminal papers in early life history research like Anderson (1988) and/or Houde (2008).

"A change in the community structure of plankton can be used as an indicator for regime shifts that would otherwise take longer to detect in mature stocks (Villagarcía et al. 1999)."

Recent studies on the connectivity in marine ecosystems are quite relevant as well (Le Corre et al. 2018). Upstream areas such as the Labrador Shelf may contribute significantly to inputs of a variety of zooplankton and ichthyoplankton that may be important to the RA Study Area. Further, it is not clear what "mature stocks" has to do with this sentence.

Principal Species

*"DFO Research Vessel (RV) surveys conducted along the northeast Newfoundland Shelf during 1994–*1999 *indicated that ichthyoplankton assemblages were dominated by capelin (73.5% of*

total abundance), sand lance (11.3%), lanternfish (5.9%) and Arctic cod (3.4%) (Dalley and Anderson 1998; Dalley et al. 1999 in Amec 2014)."

The DFO RV survey referenced in this context was a specific pelagic juvenile fish survey using an International Young Gadoids Pelagic Trawl (IYGPT; mid-water pelagic trawl) mainly focused on young of the year Atlantic cod. Juvenile Capelin were sampled very well in this survey. There are distribution maps of juvenile Capelin produced from this survey that should be included in Module 5b (not in the ichthyoplankton section; Anderson et al. 2002). The data presented in this paragraph are from the IYGPT trawl (i.e., sampling the nekton). These fish are YOY and not considered ichthyoplankton. This has to be made clear as these are different life stages and their ecology and biology are different.

Bongo tows for ichthyoplankton were also conducted during the pelagic juvenile fish survey but only Capelin and herring larvae were identified. Larval distributions for these two species can be discussed in this section.

AMEC (2014) should not be cited in this sentence or the final sentence of the paragraph.

Identified Important Areas and Times for Plankton

Plankton timing, where describing spatiotemporal distribution of the blooms should probably mention the bloom is predominately light-limited.

Page 5, paragraph 1

This paragraph implies that only areas of high primary productivity are important areas for zooplankton. This excludes consideration of overwintering areas and the non-bloom periods when predation on microzooplankton may be particularly important (Ohman and Runge 1994).

Page 5, paragraph 2

"Many benthic invertebrates and fishes in Newfoundland waters use the productive areas of the shelf edge and slope of the southwestern region of the Grand Banks as spawning grounds during spring."

This statement requires a reference because there is uncertainty about which benthic invertebrates use the slope edges and Southwest Grand Bank as spawning grounds.

Page 5, paragraph 3

This paragraph highlights the interannual variability in biological processes as influenced by the local and regional oceanography. It also states that future conditions are subject to change which could imply that individual assessments at specific project scales will be required for future exploratory drilling proposals.

"It is important to note that while locations along the Grand Banks, Flemish Cap, and Flemish Pass are typically considered important offshore areas for plankton, specific timing and location of concentrated areas is subject to variability in a given year. Multiple oceanographic variables can influence the dynamics of plankton which can in turn have further implications to the marine ecosystem."

This section needs references for the first and second sentence.

Page 5, Table 1

There are citations in Table 1 that are not included in the Reference List (e.g., Ollerhead et al. 2004).

Please clarify if this section refers roughly to spawning/mating times for each species or larval release periods. It seems more likely to be the latter, at least for some species. If mating, Snow Crab should be January-June (Mullowney et al. 2018).

Data Gaps

There should be information provided on the spatial coverage of surveys in terms of depths sampled and spatial extents. If communities in deep ocean areas of the Study Area appear similar to shelf areas, this should be stated as an assumption.

Page 6, bullet 1

"Since measurements of primary productivity of specific phytoplankton species are very limited (Harrison et al. 2013), chlorophyll a data is frequently used as a proxy."

Satellite imagery only captures surface observations. It is recommended to look for further details and information regarding primary productivity in the North Atlantic (including the RA Study Area) that are contained in Bouman et al. (2018).

Page 6, bullet 5

"There are limited data on invertebrate meroplankton in the northern areas of the Newfoundland Shelf, and for phytoplankton concentration (i.e., ocean color data prior to 1998 (Fuentes-Yaco et al. 2007; MODIS 2019)."

The CPR has several indices of phytoplankton abundance including the color index, dominant diatom and dinoflagellate taxa, extending back to the early 1960's for the Newfoundland Shelf and should be utilized.

Page 6, bullet 6

"Little data is available for regional zooplankton distribution and abundance within the Regional Assessment Study Area."

The Atlantic Zonal Monitoring Program (AZMP) 20-year time series (1999-2018) provide a comprehensive dataset on seasonal zooplankton abundance, biomass and distribution for the Study Area. While it is true that AZMP in the Newfoundland and Labrador Region have not been routinely reporting on CPR data, the CPR surveys have continued largely uninterrupted since 1991. The AZMP time series as mentioned above still represents the most extensive series given depth-integrated sampling versus the CPR sampling device which is largely a near surface collector. Further, the "pers. comm." reference is inappropriate for use in this context. The AZMP program routinely reports its findings in a peer-reviewed format and is posted on the CSAS website.

Page 6, bullet 7

"The spatial patchiness of egg and larval distribution makes it difficult to obtain representative plankton samples. In addition, samples may be biased due to gear effects (Pepin and Shears 1997; Pepin et al. 2005)."

Again, AZMP sampling campaigns have used the same methodology since 1999. However, this is also true of the CPR Survey. The size of the mesh and the near-surface

sampling results in considerable uncertainty in the determination of abundance of zooplankton taxa given their ability to undergo extensive vertical migration as noted earlier. Larger macrozooplankton taxa also have the ability for net avoidance in general due to the oncoming pressure wave as the collector device or net approaches.

Pelagic Invertebrates

There needs to be more emphasis on the important ecological role of this group.

This group has been summarized as being squid, shrimp, and jellyfish. It is more diverse that this, and needs to be highlighted.

Page 6, paragraph 8

"…for higher taxa …"

Higher "trophic levels" would be more suitable.

Data Sources

Page 6, paragraph 9

A demersal trawl is not the best method for studying pelagic species. This limitation should be acknowledged.

"…such as the Eastern Newfoundland and Labrador Strategic Environmental Assessment."

See General Comments on References regarding the use of the SEA in this manner.

Importance

Page 7, paragraph 4

"However, since the mid-1990s, the net production of northern shrimp has been decreasing and has remained low, although biomass is predicted to increase on the eastern Newfoundland Shelf within the Regional Assessment Study Area (DFO 2018b)."

There is no reference to potential increases in biomass in DFO 2018b so this statement is incorrect. A similar comment applies to Div. 3LNO, which is overlooked and should be included accordingly.

Life History

This section discusses shrimp, but as mentioned above there is taxonomic diversity within the shrimp and it should not be assumed that specific life history traits for Northern shrimp, *Pandalus borealis,* holds for all species. It is important to note which general life history traits are shared by all shrimp and those specific to species or genera.

Similarly, squid can include many other species including those in the genera *Rossia* and *Gonatus* which differ from Northern short-fined squid *Illex illecebrosus*.

Life history of Class Scyphozoa is addressed but not the phylum Ctenophora. They have different life histories and this should be addressed.

Page 7, paragraph 7

"Compared to other shrimp stocks in the Atlantic Ocean, shrimp in Newfoundland and Labrador waters are generally larger due to higher food availability and typically have slower growth rates and longer life spans (Koeller et al. 2007)"

This statement is incorrect and should be either removed or revised with a new or more appropriate reference such as Koeller et al. (2007). The statement no longer applies to NL stocks as shrimp from this region are quite small.

"Male shrimp change into females after mating at 1–2 years of age and sometimes live *for another eight years."*

Identified Important Areas and Times

When referring to areas occupied by squid, the description of areas occupied from the literature are used for short-finned squid *Illex illecebrosus*, and reference is made to the DFO RV surveys for "squid" but the figure produced has a legend for "cephalopods". The map is produced using data that does not represent all cephalopods. It does not include observation of multiple species including *Illex illecebrosus* and also excludes octopus. This data needs to be used with extreme caution as only basic quality control has been performed, as previously mentioned in the General Comments section for the Plankton and Invertebrates Module.

The document is missing the link to a ctenophore figure.

First link: *Distribution of Northern Shrimp* Fishery *in the Regional Assessment Study Area...*

Third link: It should be noted that cephalopods are being used as a proxy for Short-fin squid due to data classification ambiguity.

Data Gaps

A key data gap that is not explained in this section is that these are species that have not been well researched, so little is known about them.

Benthic Invertebrates

The taxonomic and functional diversity of this group should be addressed in the introduction for this section.

The DFO database has not been typically curated for species other than shrimps (for which there are many more species than the ones described here) and crabs. Corals and sponges are some of the other taxa that have been curated since the mid-2000s (but this work is typically not reflected in the standard data repository). DFO Science should be consulted with regards to the availability of reliable data for invertebrate taxa.

Page 9, paragraph 8

"Benthic species are characteristically patchy in distribution, abundance, and diversity, and these parameters are influenced by environmental or biological factors (Ramey and Snelgrove 2003)."

This reference is incorrectly cited, and additional ones are needed. This is one reference from one area of the Grand Banks. References need to be relevant to the statement being made. With such a broad statement covering a multitude of topics, it is necessary to use references for all the parts of the statement.

Sea pens and bamboo corals can form large-scale continuous habitats.

"While infaunal invertebrates live within the surficial sediment, epifaunal invertebrates, including encrusting or attached sessile species live on the substrate."

This statement is not entirely accurate. Stony cup corals, the only group of stony corals found in the region, can be free-living, sitting on the sea floor unattached (e.g., *Flabellum alabastrum*).

Data Sources

DFO has more data available than the 2013-2017 data range used in this section of the RA. A rationale should be provided as to why only a subset of existing data was used.

Principal Species

The terms "benthic species, benthic communities, benthic invertebrates" should not be used to generalize about the benthos. Please specify macrofauna, megafauna, meiofauna, infauna, epifauna etc. when citing studies.

This section focuses on commercial species. Emphasis of the other non-commercial species could simply be made by introducing all species first and highlighting the commercial species later.

Page 10, paragraph 1

"The benthic community in offshore Newfoundland and Labrador is high in species diversity, consisting of as many as 246 invertebrate species on the Grand Banks (Kenchington et al. 2001)."

This is one study in one area on the Grand Banks and does not represent the entire RA Study Area and should be reflected as such.

"Since all these species are commercially important, increased focus is typically placed on these animals. Similarly, the following sections will also place a higher emphasis on these species."

This is not an ecosystem approach. Other non-commercial species (like corals) are important for the survival and fitness of these commercially valued species (i.e., sea scallops spat use bamboo corals as habitat).

Stating that snow crab and scallops are the main invertebrate species in the RA Study Area requires rationale and a reference.

Page 10, paragraph 2

"Other benthic invertebrate species in offshore Newfoundland and Labrador that are either taken as bycatch in commercial trawls or caught during scientific surveys include echinoderms (e.g., basket stars, brittle stars, sea urchins, sand dollars), molluscs (e.g., whelks, crustaceans (e.g., hermit crabs, toad crabs), and polychaeate worms (Prena et al. 1999; Kenchington et al. 2001)."

Corals and sponges are invertebrates as well and a sentence is needed explaining they will be covered in detail separately. In addition*, "Prena et al. 1999; Kenchington et al. 2001"* studies are not representative of the whole area.

Importance

There is no mention of benthic invertebrates that are Vulnerable Marine Ecosystem (VME) species that are not sponges or corals. Specifically there is no information on the tunicate, *Boltenia ovifera* or Phylum Bryozoa.

Page 10, paragraph 3

Mullowney et al. (2019) states that the Snow Crab fishery begins early April, not May as indicated in this paragraph.

Page 10, paragraph 4

"Icelandic scallops are heavily predated upon by polar sea stars and common sunstars (DFO 2009, 2018d)."

> On the same page under 'Life History of Key Benthic Invertebrates' 2nd paragraph, last line, the following is stated: *Scallop predators include flatfish species and some large crustaceans (Black et al., 1993).* The text should be consistent and refer to all known predator types and list all references in both sections.

The key predatory species of Iceland Scallop are *Leptasterias polaris* and *Crossaster pappossus*. The species names should be used in the text as well.

> *Life History of Key Benthic Invertebrates*

This section should be titled: Life History of Key Commercially Important Benthic Invertebrates, given that the focus is on commercial species. Despite being a diverse group, a discussion of non-commercial species is missing. As mentioned this is a diverse group, but a general discussion of the life history of the other taxonomic groups is needed.

Page 10, paragraph 6

It is recommended that a more appropriate reference be provided for snow crab feeding habits than Nexen 2018.

The youngest crab molt several times per year. In later stages of adolescence they enter into a roughly annual molting cycle during winter/spring. Females are mated in a soft-shelled condition only during their first (primiparous) mating event, after that they're terminally molted and mated in hard-shelled condition. Both males and females cease molting upon undergoing the molt into morphometric maturity, which means adult body features. For females, that molt is same as sexual maturity molt, but for males they are sexually mature as adolescents before terminal molt (Mullowney et al. 2019).

Populations do not migrate towards areas of cold temperatures. It is more appropriate to state that populations occur in areas of cold temperatures as it is probably more likely an inability to survive post-settlement in warm areas.

"Snow crab feed on a variety of other organisms, including polychaetes, brittle stars, crustaceans, shrimp, and fish (Nexen 2018)."

> All of these species are also known to associate with corals.

Page 11, paragraph 1

"The larvae may remain planktonic for up to 10 weeks before settling to the seafloor."

> Larvae have been documented on octocorals, including bamboo and Acanthogorgia.

Page 11, paragraph 3

"Due to their strict temperature range requirement, snow crabs migrate from hard substrates in cold, shallow waters to deeper softer substrates where water is warmer for mating and/or moulting (DFO 2018c)."

This statement requires more detail such as the timeframe (i.e., a year or over their lifetime).

Identified Important Areas and Times for Benthic Invertebrates

This section should be renamed "Commercially Important Areas for Benthic Invertebrates" and a section on ecological importance should be added. Similar to the life history section, "Benthic Invertebrates" is inaccurate for this paragraph. If the intention is to specify the taxa, then say "…for Commercially Important Benthic Invertebrates: Identified Important Areas and Times for Snow crab, Icelandic scallop, and Stimpson's surf clam". Also, the use of the adjective "important" is concerning and it should be specified that it is commercially important, or alternatively the term should be omitted

The strict temperature range for crab is mentioned, but exact temperatures are not given. If these temperatures are known, including them is important.

Ecological characteristics of habitats such as connectivity, sensitivity to disturbance, resilience, etc. should also be documented in this section.

Page 12, paragraph 1

"While DFO RV survey and commercial catch data provide some regional overview of the distribution of important benthic invertebrates, there is little data available to provide a regional scale overview of other benthic invertebrate species throughout the Regional Assessment Study Area."

Please provide an example of what the 'other' benthic invertebrates described in this sentence are.

"Environmental Effects Monitoring Reports for producing oil fields on the Grand Banks identified polychaete worms as the dominant benthic taxa*."*

Please be specific, when mentioning benthic taxa, to distinguish between infauna and epifauna.

Page 12, paragraph 2

"Bottom surveys along the Flemish Cap (Nesis 1970; Altuna et al.; Murillo et al. 2016) identified species of sponges, crustaceans, sea stars, urchin, hydrozoans and sea anemones as the primary taxa."

Clarification is needed on the number and types of surveys (e.g., benthic trawl, rock dredge with the NERIDA, box cores, drop camera, etc.). The results from grab surveys are not comparable to epibenthos surveys (e.g., camera). If nematodes and corals are identified as the main organisms, this is probably based on very different gear types.

Corals were identified here in Murillo et al. (2011) and should be included.

Data Gaps

"It is unknown how climate change may affect the Stimpson's surf clam due to ocean warming and acidification."

Climate change is discussed as a potential threat, however the effects of other potential threats, such as the potential impact of oil and gas-related activities are not mentioned. If those effects are to be discussed here, consistency in the document is required. Further, climate change could affect more species than just the Stimpson's surf clam, so this

should be expanded to all benthic invertebrates, especially those with calcium carbonate structures.

The underrepresentation of data on distribution and importance of benthic invertebrate is a key data gap, and the explanation of this needs to be strengthened. Elevating this to the top point would emphasis this as a major data gap.

Fourth bullet in list

"There is a lack of regional scale data...."

Please elaborate on the type of data referred to in this bullet (biodiversity, distribution, impacts, life history, etc.). Canada and Spain have been surveying these areas for decades and invertebrates are covered extremely well in both surveys.

Corals and Sponges

Page 12, paragraph 4

"Corals and sponges are a subset of benthic invertebrate species that are considered ecologically important…"

All benthic invertebrate species are ecologically important. Please rephrase this.

"…mostly due to their habitat forming capacity and sensitivity to external stressors."

Corals and sponges are not important because of their sensitivity. Their sensitivity makes them vulnerable, which is problematic because they are important and provide key functional roles in the ecosystem among other reasons.

Data Sources

Please provide the rationale for only using the 2013-2017 data range.

The non-curated DFO RV trawl survey data are not a reliable source of information for corals and sponges.

Page 12, paragraph 5

"…displays probabilities for species presence…"

The models did not identify the probabilities of species' presence. Instead, they provided a prediction of how suitable a habitat was based on known observations of species' distribution. This should be clarified in this section.

"…display areas that have higher potential for the presence of these species throughout the Newfoundland and Labrador region…"

The statement should be written as "…identify areas of potentially suitable habitat throughout the NL region."

Corals

In this document, soft corals, gorgonians, and sea pens are grouped as "soft corals". This terminology is incorrect. Please keep them separate: stony corals, soft corals, sea pens, gorgonians, black corals.

Please specify cold-water corals instead of just corals.

Page 13, paragraph 2

"Corals are members of the phylum Cnidaria, and include stony corals (Order: Scleractinia), soft corals (Order: Alcyonacea), and black corals (Order: Antipatharia)."

> This statement is incorrect. Alcyonacea include soft corals and gorgonians. Scleractinia include reef-forming (like Lophelia) and solitary cup corals. Pennatulacea include sea pens. Antipatharia included black corals. Stylasteridae include lace coral. This needs to be reflected in the entire document.

Page 13, paragraph 3

"Deep-sea cold-water stony corals, similar to those found in shallower waters, form large aggregations (reefs or mounts) and are supported by a common skeleton which provides structural habitat on the seabed. Stony corals require calcium carbonate (CaCO3) to form their skeletons, which can be directly precipitated from seawater (Roberts et al. 2009; Kenchington 2014)."

> Reef-forming corals and mounts are not found in this region
>
> The Kenchington 2014 reference is inappropriate. It is suggested to use Sherwood et al. 2006, 2009; Sherwood and Edinger 2009 as more appropriate references for this statement.

Page 14, paragraph 4

The term "Red corals" usually refers to corals in the family Corallidae, which are not that common in NL waters and should therefore be removed from this discussion.

Sea pens are not in the order Alcyonacea. Hence, based on the classification of soft corals in the first sentence of this paragraph, they are not soft corals. Sea pens, order Pennatulacea (shown in tables).

"Most soft corals have a certain degree of flexibility due to their non-rigid skeleton, allowing them to bend in water currents"

> This is incorrect. Soft corals and sea pens can be 'relatively' flexible compared to bamboo corals which have 'limited' flexibility.

"Sea pens have specialized polyps that develop into rigid stalks and form a "root"…"

> Gorgonians species (Acanella and Radicipes) have a specialized root anchored into soft muds too.
>
> For this statement, please cite Williams (2011) instead of Kenchington (2014).

Page 13, paragraph 5

Black corals can be branched and unbranched. They are also grouped with stony corals in the subclass Hexacorallia and should therefore be kept together in the text.

Life History and Ecological Importance

This section does not include anything about longevity, growth rates, and substrate preference. This is important in terms of vulnerability. The branching shapes and large sizes also makes corals vulnerable to physical disturbance. There is missing information on the size ranges of corals, which may be important if size determines/triggers mitigations. It is recommended that a paragraph about what is known about these parameters in NL species be included. Also, more

information is needed on associations; there are dozens of primary literature sources highlighting associations between cold-water corals and other organisms, including the NL region (e.g., Baillon et al. 2012).

Page 13, paragraph 6

"Corals are slow growing and long-lived organisms, which makes them vulnerable to physical disturbances such as bottom-contact fishing and oil and gas drilling activities."

Coral morphology (shape and size) also play a role in their vulnerability.

Page 13, paragraph 7

"Corals found in the Antarctic at depths of 150–600 m may mature slowly, and slow-growing subarctic species that occur offshore Newfoundland and Labrador may share this biological trait (Orejas et al. 2002 in Roberts et al. 2009)."

This is speculation based on one source. A discussion on slow growth rates and longevity should incorporate the following references to provide a better basis for this conjecture: Baillon et al. 2014a, Mercier et al. 2011, Waller et al. 2014, Watling et al. 2011, Ribes et al. 2007.

"Corals can also reproduce via asexual propagation which is integral to the formation of deep-water reefs and mounts (Roberts et al. 2009; Wagner et al. 2012)."

There are no reef building taxa like Lophelia known to occur in the Study Area. Further, if the term "mount" was meant to be "mound", it has not been shown that "mounds" form in the NL bioregion.

It is suggested that the following references be used in describing reproduction : Baillon et al. 2014b; 2015; Eckelbarger et al. 1998; Rice et al. 1992; Tyler et al. 1995; Brito et al. 1995; Cordes et al. 2001; Mercier and Hamel 2011; Orejas et al. 2002, 2007; Sun et al. 2009a, b, 2010, 2011.

Page 13, paragraph 8

"Being sessile invertebrates, corals must be distributed proximally to other conspecifics to ensure successful reproduction (Nexen 2018)."

Nexen 2018 is not a good reference for this statement as it is not the original source and there are other primary publications that would be more appropriate.

"A decrease in fecundity with depth has been noted for deep-sea solitary stony corals (Waller et al. 2002; Flint et al. 2007 in Mercier et al. 2011), meaning that deep-water coral habitats may take longer to develop than those in shallower depths."

This statement is unclear and should be rephrased.

Page 14, paragraph 4

Please see comment above about lack of reef building corals. The first sentence should read "All corals are ecologically important…"

Page 14, paragraph 5

"Soft corals, such as sea pens…"

> This terminology is incorrect as previously indicated. Gorgonians and sea pens are not soft corals. The terminology for cold-water corals in NW Atlantic is available in several publications and makes a distinction between these groups.
>
> Bamboo corals like Acanella can also create meadows.

"While removal of soft corals does not seem to significantly affect fish assemblages (Kenchington et al. 2014)..."

> Kenchington et al. 2014 is not included in the reference list. Regardless of this, caution should be applied to using one reference or the assumptions should be clearly articulated. This is one paper from one area with one specific substrate. Providing details on where, when, and in which context are important. Several other publications would suggest the opposite. This paper is referred to frequently throughout this module; it is recommended that other, more suitable, primary literature be reviewed and incorporated.

Page 14, paragraph 6

Please include a reference for the first sentence. Also, the data source that was used to determine the number of species should be stated as Canadian RV survey data have documented >70 species.

"Unlike stony corals, black corals do not form reef structures (Wagner et al. 2012)."

> This statement is not entirely correct because soft corals, gorgonians, sea pens, and hydrocorals also do not form reef structures. Furthermore, not all stony corals form reefs.

Spatial Distribution

There is no mention of deep ocean habitats in this section, and how these areas have not been well ground truthed. The description of the distribution of soft corals is insufficient.

Page 14, paragraph 7

Richness is defined but not diversity. Please provide a definition for diversity, as it can mean many things.

Page 15, paragraph 1

"Lanternfish" refers to a number of Myctophid species, so a plural verb must be used when mentioned: "These species were particularly..."

Page 15, paragraph 2

"Species distribution modelling has predicted that large gorgonians may also have a patchy distribution throughout the Grand Banks, and the Northeast Newfoundland Slope holds suitable habitat for sea pens (Fig 29 to 31) (Guijjaro et al. 2016)."

> There are limitations to the data used in this reference as they are trawl data only and this should be articulated.

Page 15, paragraph 3

"Predictive modelling of coral distributions was conducted by Gullage et al. (2017) using DFO RV observations and oceanographic data. Their intention was to map currently known and

potential habitat for corals and sponges *and to provide a regional scale overview of potential spatial distributions of corals in offshore Newfoundland and Labrador"*

Gullage et al. 2017 did not model sponges. Furthermore, the intention of the study was to predict potentially *suitable* habitat.

"Absence-presence datasets…"

Data that went into the Species Distribution Models (SDMs) were presence only. No absence data were used to generate these models and the text should reflect this accordingly.

Page 15, paragraph 4

"Random forest modelling (RF) conducted by DFO (Guijarro et al. 2016) supports the output results of the predictive modelling conducted by Gullage et al. (2017)."

It cannot support Gullage et al. (2017) because it was published prior to the 2016 study. Please rephrase.

The results from Gullage et al. (2017) generally support the results from Guijarro et al. (2016) on the continental shelf, shelf edge, and upper slope. However, the two approaches (Random Forest vs Maxent) actually showed very different extrapolations of habitat suitability (identified as probability presence by Guijarro et al. 2016) in deeper waters. The drawback of the Random Forest approach for extrapolating species distribution was noted by the authors of the 2016 publication.

Page 15, Table 2

The title of this table should be "Known spatial distribution of deep-water corals…".

The table separates soft corals from the others which is the ideal presentation of the groupings. Please update the rest of the section to follow this set of groupings accordingly.

Acanthogorgia is classified as a large gorgonian not a small one, as indicated in the table.

Page 16, Table 3

There needs to be a clear distinction between solitary stony cup corals versus stony reef-forming corals like Lophelia. This is important because previous mitigations were established around the occurrence of Lophelia and so far, no Lophelia have been documented in this regions.

Soft corals are mentioned here but there is no text on this group under the corals section therefore it is important to ensure that soft corals are represented correctly in this table.

The values provided for minimum and maximum depths for Sea Pens and Gorgonians in Table 3 are incorrect. The values for average minimum and maximum trawl depth are provided below for 2013-2017 data. These ranges may change if additional years of data are taken into consideration.

-	Within RA	
	Avg. Depth Min. (m)	Avg. Depth Max. (m)
Sea Pens	97	1438
Large Gorgonians	44	1469

-	Within RA	
	Avg. Depth Min. (m)	Avg. Depth Max. (m)
Small Gorgonians	161	1407

Identified Important Areas and Times

There is no information provided about times for corals. This should be identified as a data gap and potentially consider renaming the section.

"The Northeast Newfoundland Slope is an important area for small and large gorgonian corals, sea pens and sponges, whereas the Flemish Pass, Flemish Cap and the western slope of the Grand Banks are important areas for corals and sponges. These areas have been recognized domestically and internationally, some of which overlap with other protected areas."

The depth limits of the RV surveys should be noted to better understand whether the maximum depth is a function of the species distribution or the method.

Page 17, paragraph 2

"…e.g., corals and sponges, and sea pens…"

Please revise this statement as sea pens are corals.

"Black corals, gorgonians, and stony corals are considered to be most at risk to disturbances because their carbonate skeleton they can be permanently dislodged from substrates (Gilkinson and Edinger eds., 2009)."

This sentence is not entirely correct because not all stony corals are attached to substrate. The authors are editors of a report, meaning the correct source is not being cited.

"…predicted the spatial distribution of cold-water corals…"

This paper did not predict the spatial distribution of cold-water coral species. It predicted the spatial distribution of suitable habitat for the outlined cold-water coral species.

"For sea pens and soft corals…"

This description is accurate for sea pens, but the text actually indicates that there was very little overlap observed for the species level models of soft corals (Figure S26 in supplement). As a result, the area of conservation priority for soft corals could not be well defined at the functional group level, due to the broad distribution of the individual species throughout the region. Instead, the main suggestion of the publication was to focus conservation efforts for soft corals at the species level.

Taken from Gullage et al. 2017:

"… the suitable habitats highlighted by functional group models (Figs. 2−4) did not consistently reflect the habitats occupied by each of the species they included. Instead, the functional group models were found to overgeneralize the distribution of suitable habitat, reducing the applicability of functional group models. Similar findings were also reported by Yesson et al. (2012), whose global SDMs of octocorals, generated at the sub-order level, did not accurately illustrate the distribution of suitable habitat for individual taxa. The combination of species level SDMs (Fig. 16, Figs. S25 & S26 in

Supplement 3) supports this point, illustrating, particularly for soft corals, that individual species within a functional group may in fact occupy very different niches in the environment (Fig. S26). From a conservation perspective, these findings highlight the importance of developing models for individual cold-water coral species, rather than for broader taxonomic categories."

Data Gaps

"Information on the distribution of deep-sea corals within the Regional Assessment Study Area is limited."

This sentence should be rewritten to emphasize specific areas where data gap is more pronounced. Please use the maps that you have provided in the document to better describe these gaps in distribution.

"There is little available information regarding the life history strategies of demosponges in the western Atlantic Ocean (Mariani et al. 2003)."

Please include Spetland et al. 2007 as another reference to be used as it provides important context. An important data gap is on the effects of anthropogenic impacts on these corals, their survival, reproduction, recovery, and functional roles. Considering the context of this document, it is very important to mention what is known and what are the gaps in this regard.

Sponges

Life History and Ecological Importance

Similar to corals, there is missing information on longevity and growth rates of sponges.

This section refers to Mariani et al. 2003, 2006 in its description of shallow-water sponges. A more appropriate reference would be Spetland et al. 2007.

When referring to geodiid sponge, please mention the family. The term geodiid is not a well-known term.

Page 18, paragraph 4

"Deep-sea sponges are ecologically important because they enhance nutrient cycling and energy exchange through their filtration capabilities and biogeochemical processing abilities, thereby linking benthopelagic food webs."

Deep-sea sponges are ecologically important for other reasons as well. Please rephrase this sentence (i.e., the use of the word "because"), or update with additional reasons for their ecological importance.

Spatial Distribution

Page 19, paragraph 1

"Sponges are widely distributed from along the Northeast Newfoundland Shelf to the Tail of the Grand Bank at depths ranging from 100–1,300 m."

Please provide a reference for this fact or how this information was obtained, through survey data, etc.

Data Gaps

Similar to the corals section, a bullet on the potential effects of anthropogenic impacts on sponges, their survival, reproduction, recovery, and functional roles would be appropriate. Other data gaps that should be included:

- Life history aspects (e.g., growth rates, longevity, reproduction, behavior, for several species).
- Population ecology and connectivity between potential populations (including inshore).
- Spatial restrictions of scientific surveys leading to areas that are underrepresented.
- Data Gaps need to have glass sponges added with demosponges.

Specific Comments on Figures

The ocean color figures presented in Figures 1-4 are meant to represent the seasonal surface concentrations of chlorophyll a that are used as a proxy of phytoplankton biomass within the RA area. This requires clarification, as it appears that raw data may have been used to construct these figures without removal of extreme outliers and without applying proper cloud and ice masking. The seasonal surface concentrations of chlorophyll a that were noted within the text are significantly higher compared to standard ocean colour imagery that is available from other corrected sources and direct measurements within the water column based on oceanographic monitoring programs such as the Atlantic Zone Monitoring Program (AZMP). These figures do highlight the relative surface distributions of phytoplankton biomass within the RA area but, must be used with caution since they only represent conditions in the upper 1 m of the water column as pointed out in the detailed comments below. Although ocean colour imagery is generally useful to describe the extent and timing of the spring and fall phytoplankton blooms, it does not provide any information about the dynamics within the water column throughout the other times of the year. Sub-surface chlorophyll a concentrations often form at depth throughout the RA seasonally and are typically related to the availability of macronutrients referred to as the nutricline. These enhanced levels of phytoplankton biomass located at depth (referred to as the chlorophyll maximum layer) are important to a variety of zooplankton taxa that undergo daily vertical migration and a common feature throughout the RA.

The symbology and labels throughout the Figures document associated with Module 5a are often hard to understand, read, or distinguish. The symbology is, in some cases, inconsistent between maps.

The north arrow on all maps appears to be incorrect, as the maps are projected, but the north arrow is pointing towards Map North (default). The arrow should be fixed and set to True North, or removed entirely as it is redundant with the graticule labels.

Some of the figure captions state "X within the Regional Assessment Study Area;" however, the figures still show data outside of the RA boundary. The caption should be clarified (i.e., remove or replace "within the Regional Assessment Study Area").

There is no commercial fishing distribution map for Icelandic Scallops.

Missing or additional information requested for maps:

- Bathymetry needs to be labeled on all maps and map legends to include the 500 m, 1,000 m, 1,500 m and 2,000 m contours labeled on the maps or colored darker in order to give the reader a reference.

- Additional maps are needed for all active and inactive well sites spatial and temporal. This informs the reader of areas already impacted by the oil and gas sector in relation to known biological data over a temporal scale.
- Fishing footprint using VMS data, published by NAFO WGESA (2008-present), needs to be added to an existing map or a new map. It can highlight areas already impacted by fishing in relation to oil and gas footprint.

Figures 1-4:

- These figures show composites of Chlorophyll a for 2018. It should be explained why 2018 was selected and how it compares to the long term trends in this area.
- The coastline should not be used in chlorophyll maps because there is interference from the land. By leaving the coastline in, the artificially high levels of concentration around the coastline mask the actual high concentrations elsewhere. This layer must be clipped to be accurate.
- The chlorophyll a data layer is transparent, despite being the sole focus of this map, therefore please remove the transparency.
- Please ensure the appropriate months are utilized in the legend: e.g., December-February instead of December-January.
- The contour interval is not stated; it should ideally be in the legend.
- The Orphan Knoll, Orphan Basin, Grand Banks, etc., labels are new. Please provide a description as to what they are, and why they are different from the subregions used on the finfish maps.
- The subregions are missing from these maps.

Figure 5: The caption states that this map represents "*Spatial distribution of northern shrimp from DFO commercial data*," however that is incorrect. This is "commercial northern shrimp fishing activity" and does not imply spatial distribution of the species.

Figure 6:

- Presence/absence point data are not particularly useful for indicating the spatial distribution of northern shrimp. The DFO NL RV survey data were analyzed by DFO Science and a layer of northern shrimp average relative density was provided that should have been used for this purpose.
- The shrimp figure is different from the fish figures from Module 5b, in that it has a different format and does not show average relative densities.
- The average relative density layer also covered a longer time-scale (1995-2017) than the data displayed here (2013-2017).
- It should be clarified in the caption that this figure is based DFO NL RV survey data.

Figure 7: This map illustrates spatial distribution of cephalopods, which is a big group that lumps octopus and squid (an important food source) together. These taxa should be displayed separately on the same map.

Figures 7-9: The RV data used to derive this map are not likely appropriate for the analysis of cephalopods, scyphozoans, and ctenophores due to the limited data quality checks performed. These maps should be removed.

Figure 10: The caption says that this is "*Spatial distribution of snow crab from DFO commercial data,*" however that is incorrect. This is "commercial snow crab fishing activity" and does not imply spatial distribution of the species.

Figure 11: Presence/absence point data is not useful for the purpose of spatial distribution of snow crab. The DFO NL RV survey data were analyzed and a layer of snow crab average relative density was provided that should have sufficed for this purpose. The average relative density layer also covered a longer time scale (1995-2017) than the data displayed here (2013-2017). Finally, it should be clarified in the caption that this data came from DFO NL RV surveys.

Figure 12: The RV data used to derive this map is not likely appropriate for the analysis of Icelandic scallops. This map should be removed.

Figure 13: The caption states "*Spatial distribution of Stimson's (Arctic) surfclams from DFO commercial data,*" however that is incorrect. This is "commercial *Stimpson's* (Arctic) Surfclam fishing activity" and does not imply spatial distribution of the species.

Figure 14: The RV data used to derive this map is not likely appropriate for the analysis of Arctic Surfclams. This map should be removed.

Figures 15-16:

- These two figures should be combined to display SiBAs and VMEs on the same map.
- The source of the VME layers should be included in the figure caption and more information should be provided in the text on what NAFO VME boundaries represent. Furthermore, the NAFO VME *closures* should also be displayed on this map.
- Please spell out VME and SiBA in figure captions.
- In both maps the SiBAs/VMEs overlap each other, but the symbols are opaque, rendering it difficult to see the shape of the underlying areas. It is recommended that the symbology be changed and that a solid fill not be used for all of these symbols.
- The names of the VMEs should be double-checked, as they are different from the names in the VME layers obtained by DFO NL. For example, the sea pens layers match; however, the layer for Large & Small Gorgonian Corals appears to be the Large Gorgonian layer, and the Corals and Sponges layer appears to be the Sponges layer.
- VME or SiBA should be added to all legend labels (e.g., Large & Small Gorgonian Corals VME, Large Gorgonian Coral SiBA, Sponge SiBA).
- In the captions, it would be helpful to spell out VME (i.e., "Vulnerable Marine Ecosystems") and SiBA (i.e., "Significant Benthic Areas") instead of just using the acronym. Additionally, these maps show VMEs/SiBAs outside the RA Study Area, so "*within the Regional Assessment Study Area,*" should be removed from the Figure captions, as that is misleading.

Figures 17-19:

- As in the text, it is noted that data are limited to 2013-2017 (Page 17-19), even though much more information exists for this area. Documenting temporal changes are important

especially for long-lived animals like corals. Other relevant published data can be found in the following publications: NAFO WGESA (2008-2018); Wareham and Edinger (2007); and Wareham (2009).

- Distribution maps show presence/absence for corals and sponges. Additional maps need to be added, or combined with existing ones, to show biomass as graduated circles, which will highlight important areas in relation to the RA Study Area.
- Data from DFO-NL and EU trawl surveys should be plotted on the same map. Different symbology should be used to distinguish between the two surveys; but keeping these two datasets on the same map would give a better picture of the coral/sponge distribution in the region.
- The caveats regarding the temporal range of the data need to be highlighted. Absence records for the 2013-2017 period do not mean complete absence. Surveys in other years might (and have) have caught corals in areas where they look absent.
- All of these figures appear to be incorrect when compared to the DFO NL RV survey dataset. There are presence records outside of the EEZ for all of these groups; however the maps in this document indicate that there are no corals present outside the EEZ. In fact, some of the records inside the EEZ are different from the DFO NL RV survey data too.
- Please indicate the threshold used for presence vs. absence (e.g., kg >0?). Additionally, if using presence/absence in point format, the caption could be changed to "Presence/absence of small gorgonian corals from random stratified DFO NL RV survey," or similar, instead of spatial distribution.
- Additionally, these maps show sets outside the RA Study Area, so the caption "*within the Regional Assessment Study Area*" is misleading.

Figures 20-22: It should be noted within the text that the Spanish and EU Surveys are based upon 12 years of data while Canadian data sets encompass only a 5 year period.

Figures 25-31:

- There is no discrimination between "*Predictive Mapping*" (which can be assumed to be Gullage et al. 2017's data, Figs. 25-27) and "*Species Distribution Modelling*" (Figs. 28-31). Even if properly referring to the sources (e.g., Gullage et al. 2017), it must be stated how the layers were produced to provide context. For instance, predictive modelling based on x, y, and z variables.
- Please explain why soft corals were not mapped, as they make an important contribution in terms of biomass and functional role.

Figures 25-27:

- These figures are assumed to represent layers produced by Gullage et al. 2017. The legend in the RA indicates that the raster layers illustrate "*Predicted Probability of Presence for xx Corals*". This is not the case. The original publication identified these layers as illustrating the habitat suitability for different functional groups of corals.
- For accuracy, these figure captions should read "Predicted Habitat Suitability for XXX within the Regional Assessment Study Area", instead of "*Predictive Mapping of Large Gorgonian Corals within the Regional Assessment Study Area*".

- These figures indicate that habitat suitability ranges from 0-1 for each functional group, which is incorrect. The actual modelled range of habitat suitability is contained within the raster layers and also provided by Gullage et al. 2017.
- Figure 27 is meant to illustrate habitat suitability for sea pens. However, it appears as though the raster layer that is depicted in the RA is actually the model for *Pennatula* sp. This particular model is not the same as the one generated for all sea pens by Gullage et al. 2017, as it did not incorporate the same species. Species included in the Gullage et al. 2017 sea pen model were: *Funiculina quadrangularis, Halipteris finmarchica, Pennatula grandis, Pennatula aculeata, Pennatula sp.,* and *Anthoptilum grandiflorum*. Instead, the map presented in the RA only depicts the habitat suitability of sea pen species in the Genus *Pennatula*. This raster needs to be replaced with the correct file: Sea_Pen.asc.
- These figures are taken directly from Gullage et al. 2017 and the source of these layers should be referenced in the figure captions, not just in the main text.

Figures 28-31:

- These figures appear to be additional maps depicting species distribution. It is not clear where these maps originated as they are not referred to in the text, nor are they referenced in the figure captions. They contrast the peer-reviewed findings of Gullage et al. 2017, but appear to be more similar to those in Guijarro et al. 2016 (the exception being Figure 28). If these layers were generated specifically for the RA, it is necessary for reviewers to provide information on what data were used to generate the models, as well as the method used to model species' distributions. Particularly concerning, Figure 28 indicates there is a high probability of presence for small gorgonians along the continental shelf of eastern NL. Data for small gorgonians presented in Figure 17 shows that DFO RV Trawl surveys have observed very few small gorgonian corals in this area.
- If these figures are taken directly from Guijarro et al. (2016), it is important to reference the publication and note in the caption and/or text of the RA that adaptations were made to the raster layers for the purpose of display. Specifically, the original publication used classified rasters, which clearly highlighted any area(s) where zero probability of presence for particular functional groups existed. However, by generating continuous rasters, as was done for the RA, these areas have become almost impossible to separate from those with low probabilities of presence.
- If these figures were taken directly from the Guijarro et al. (2016), it is also important to indicate the nuances of the layers as described in the original paper within the RA. Specifically, it appears that probability of presence for many of the functional groups is high from the edge of the continental shelf extending to the abyssal plain. This was captured in the original paper, but it was highlighted by the authors that the random forest models were poor at extrapolating habitat suitability beyond the ranges of environmental conditions associated with the true observations of a particular species (e.g. deep water). Taken directly from Guijarro et al. (2016), "*Given the fair to poor prediction of biomass by the random forest models, **particularly in deep water**, generalized additive models (GAMs; Hastie and Tibshirani 1986) were developed to compare to the random forest results and to determine whether predictions could be improved for the areas considered as extrapolated by random forest models*."
- Figures 28 and 31 appear identical, even though they are intended to illustrate the probability of presence for two different functional groups (small gorgonian corals and

sponges). It is likely that the wrong layer is displayed in at least one of these maps. It appears that it may be the one for the small gorgonians.

Appendix B – Specific Comments on Module 5b – FINFISH

Specific Comments on Text

1.1 Introduction and Overview

Page 1, paragraph 2

"The intent is to provide a general, regional-scale description of the potential presence and distribution of these species in the region, based on existing and available information and at a level of detail that is considered appropriate for the purposes of the Regional Assessment."

Please provide specifics on how this *level of detail* was determined and defined.

1.2 Key Information and Data Sources

NAFO does not have RV surveys; surveys are conducted by contracting parties.

Russia also conducted RV surveys throughout the area, and there are other non-DFO Canadian surveys conducted by the Celtic Explorer, Addie n Ainsley, Scotia Tradition, Fishing Fionnatic, and Clears Cover Pride, to name a few.

Page 2, paragraph 1

"While it is also acknowledged that some marine habitats (especially the very deep, abyssal regions) and assemblages (particularly the pelagic) are somewhat *underrepresented in the available datasets."*

These areas are very much underrepresented, not somewhat underrepresented. Since deep water drilling is becoming a reality, the lack of understanding of these environments has to be explicitly stated.

Page 2, paragraph 2

"The DFO RV surveys use a random stratified design, with sampling occurring in the spring (NAFO Divisions 3LNOPs) and fall (NAFO Divisions 2J3KLNO). The data presented herein include spring and fall data and *cover two time series – the Engel time series (1981 to 1995) and the Campelen time series (1995 to 2017), which are markedly different due to the gear types that were used, as outlined in McCallum and Walsh (1997)."*

NAFO Divisions 3LNOP (not just Ps).

Page 2, paragraph 3

"The RV *data set was processed and subjected to a spatial analysis by DFO, through which it was queried and cleaned…"*

"…using an eight km grid system using interpolation techniques…"

More detail is needed, including what interpolation techniques were used to generate the layers.

"…upon further processing and analysis…"

The Agency was provided with very detailed methodology for the processing and analysis of the average relative density layers. This methodology should be explicitly included in the RA.

"This is the case because the Campelen trawl gear provides a standardized and more efficient methodology for data collection compared to other gear types and collection protocols."

> The Engel data were also standardized. A better rationale for only including data from the Campelen time series is required.

Page 2, paragraph 4

Data are collected for many more species than the subset of "commercially important" ones listed here.

The Capelin spring acoustic survey should be a part of this data set. The layer depicting the acoustic survey data has been prepared by experts, and will be provided to the Agency.

1.3 Overview of Key Ecological Regime Shifts and Assemblages

Page 3, paragraph 1

"Other drivers include abiotic factors such as changes in temperature ~~regime~~, water chemistry, and dominant currents…"

Page 3, paragraph 2

"The overall Northwest Atlantic region has witnessed various regime shifts over the past number of decades, where there have been large abrupt changes in ecosystem structure and functioning."

> This statement should be re-worded as follows: "The most recent regime shift in the Northwest Atlantic occurred in the late 1980s and early 1990s, where there was a large abrupt change in ecosystem structure and functioning."
>
> Regime shifts and trophic cascades should not be conflated. A regime shift is an abrupt, large and long-lasting change in the ecosystem. Changes in climate is a driver of regime shifts. Please review the literature on regime shifts (e.g., Choi et al. 2004, Pedersen et al. 2017, Drinkwater 1996, Drinkwater 2006).

*"For example, capelin is an important prey source for a variety of species (*need references: Buren et al. 2014, Buren et al. 2019, Mullowney and Rose 2014, Rose and O'Driscoll 2002*) and their dynamics are highly dependent on* zooplankton *that, in turn, are affected by* phytoplankton*, nutrients, sea ice and water temperatures* (need reference like Buren et al. 2014)*."*

> The second half of this sentence needs further explanation. Adult Capelin population dynamics are influenced by phytoplankton bloom and zooplankton dynamics (i.e., *Calanus finmarchicus*), and Buren et al. 2014 ice model paper and Lewis et al. 2019 Capelin forecast model would be suitable references. But, research conducted over the past 40 years has determined that Capelin year class strength is set at an early stage (i.e., the first few weeks of life). See the work by Frank and Leggett 1981, Frank and Leggett 1982, Leggett et al. 1984 Carscadden et al. 2000 and Murphy et al. 2018. These early life history research papers determined that matching larval emergence from beach sediments and onshore wind events was an important requirement for survival. Onshore wind events are associated with high zooplankton prey availability and few larval predators. More details are required on Capelin life history in this RA.

"Anthropogenic effects on these components (such as fishing and climate change)…"

> Please provide more details as what "these components" are is not clear.

"In the early 1980s on the Grand Banks, Atlantic cod was the dominant predator in the groundfish community at the middle depths (Pedersen et al. 2017). That species dramatically declined in numbers from the mid-1980s to the 1990s as a result of decades of overfishing and a regime shift *(Pedersen et al. 2017).* The regime shift, which was associated with a prolonged cold period, produced favorable conditions for invertebrates (Dawe et al. 2012). Furthermore, the *decline in groundfish species resulted in a trophic cascade where biomass of invertebrates (including shrimp ~~and crab~~) increased due to* a decrease in *predation* pressure *(Dawe et al. 2012, Nogueira et al. 2016, Pedersen et al. 2017)."*

Before suggested edits, these statements implied the decline in cod caused a decline in other groundfish.

The regime shift produced conditions conducive for invertebrates including changes in predation, environment. While a decrease in groundfish predation likely influenced shrimp, the same cannot be said for crab (Dawe et al. 2012).

Page 3, paragraph 3

This paragraph does not describe the importance of seasonality. Over the year, the value of a particular habitat to a particular species in a particular life stage varies vastly. For example, sandy beach areas are very important for Capelin in the summer when they are spawning and for Capelin eggs/larvae. In winter, the same habitat is essentially irrelevant.

"These assemblages are often associated with specific habitats and comprised of *species that have similar or overlapping ecological preferences…"*

"Species' life history characteristics, trophic linkages, and predator-prey dynamics also influence assemblage composition."

Please provide a reference for this statement.

Page 3, paragraph 4

"…as follows: 1) the Grand Banks (including Northeastern and Southeastern areas), 2) the Flemish Pass, 3) the Flemish Cap, 4) the Orphan Basin and 5) Abyssal Areas, with continental slopes serving as transition areas between subregions…"

Please provide details on the areal proportions of these regions in the Study Area?

Page 4, paragraph 1

"The Tail of the Grand Banks (southeastern Grand Banks) is a highly productive area resulting from the mixing of these currents that brings *nutrients to the surface (DFO 2018a)."*

"The Northeastern Grand Banks is typically influenced by the Labrador Current and ~~so~~ has colder nutrient-rich water."

"Conversely, various transient large *pelagic species, such as white shark and swordfish, typically remain on the southeastern portion of the Grand Banks as they prefer warmer water temperatures* relative to other species of sharks (COSEWIC 2006). They are warm-blooded thermoregulators that can tolerate 5-27°C and have been acoustically detected in inshore areas off Newfoundland."

"The Grand Banks ecosystem has seen regime shifts associated with overfishing of groundfish species (Pérez-Rodríguez et al. 2012, 2013, Pedersen et al. 2017, Nogueira et al. 2018)."

Regime shifts is not the right word choice here. Periods of overfishing occurred on the Grand Banks but that does not equate to regime shifts. Please check references, two of these references are for Flemish Pass (i.e., Pérez-Rodríguez et al. 2012, 2013).

Page 4, paragraph 2

"This area is influenced by the Labrador current that partly *flows southward…"*

"Corals and sponges ~~and corals~~ are distributed throughout the Flemish Pass…"

Corals and sponges are distributed in other areas as well, please expand or update accordingly.

"This area has highly productive slope habitats caused by upwellings of nutrient rich water, with a predominantly fine substrate in the deeper portions of the canyon."

"Upwelling" is not the reason; please review literature on frontal interactions (e.g., Belkin et al. 2009).

Page 4, paragraph 4

"The Orphan Basin is in a boundary region between the Labrador Current and the North Atlantic Current (Han et al. 2008, Greenan et al. 2010)."

This sentence should be deleted as it appears to be inaccurate (or at least the interpretation is not clear). The Orphan Basin is the region where part of the Labrador Current deviates towards the North Atlantic Current, but the North Atlantic Current does not reach the Orphan Basin (using the term boundary implies that both currents co-exist there). It is more accurate to say that the Flemish Cap area is the boundary.

Page 5, paragraph 2

"Abyssal areas within the Study Area include…"

It should be noted that little is known about these areas.

"These areas are influenced by the warm Gulf Stream/North Atlantic Current."

Abyssal areas are not influenced by the Gulf Stream.

"No light reaches these depths, and so the base *of the food web is typically consuming detritus…"*

Please rephrase this sentence as the wording is awkward.

"Detritus from surface waters may also play important roles in key life processes for abyssal organisms such as signaling reproduction in benthic invertebrates, including corals and sponges."

Please provide a reference.

1.4 Subregions and Their Associated Finfish Assemblages

1.4.1 Grand Banks

1.4.1.1. Northeastern Grand Banks

Page 5, paragraph 4

"Capelin are distributed throughout the Northeast Grand Banks, with their highest abundance at Shelf-Slope depths."

Please clarify shelf slope depth. Please define these zones in a table for easy reference.

"However, it is important to note that during periods *of low abundance* such as those seen since the collapse in the Capelin population in the early 1990s*, capelin aggregations* in the fall, based on the DFO RV survey*, shift southward ~~resulting in shifting distribution patterns~~ (DFO 2018). Planktivores have high* densities *in the Virgin Rocks area* which *is ~~a~~ considered a* high density *area for capelin (Wells et al. 2017, DFO 2019c)."*

These two sentences are using information from different sources without any understanding of the changes that have occurred in the ecosystem over the past several decades. In the second sentence, the references are also cited incorrectly, as the Wells et al. 2017 research document describes EBSAs in the northern portion of the NL bioregion. The 2019 Science Advisory Report (DFO 2019c) and accompanying research document (Wells et al. 2019) indicated that Sand Lance were a key feature of the Virgin Rocks EBSA Capelin distributions have changed over the last few decades (Carscadden et al. 2013), and the methods used to find important areas for Capelin are likely not adequate (i.e., bottom trawl vs. acoustics).

Further to this, there was no statement in either of the documents referenced that planktivorous fish were found in the Virgin Rocks area in high densities. However, some species of seabirds that prey on Capelin and other forage fish do feed in this area (Wells et al. 2019).

Page 5, paragraph 5

"As capelin is a key driver of piscivore distributions and an important prey item for the dominant species, these functional groups typically *have overlapping distributions."*

"Mailed sculpin typically inhabit sandy bottoms that are distributed throughout the Grand Banks."

Please provide a reference for substrate preferences.

"Lanternfishes are non-dominant within the planktivore functional group, and show higher abundances along the middle slopes. Slope areas along the ***Grand Bank*** *are high aggregation areas for this species group…"*

What constitutes middle slope? An earlier reference was made to *Grand* ***Banks.***

Page 6, paragraph 1

"…this EBSA has an exposed rock shoal that creates unique habitat on the largely fine substrate of the Grand Banks…"

The habitat also includes kelp which should be incorporated.

Table 1

Table 1 shows a ranking of species by abundance per tow and depth range. There seems to be no consideration to the stratified random design of the survey in the abundance analysis. This can introduce bias in the produced list; but more importantly, focus attention on the wrong place/species. For example, Arctic Cod making this list on the Grand Bank is rather worrisome.

To address the above issues, please clarify how "Total Abundance" was calculated. Total abundance must be calculated as stratified estimates. Please provide quantiles associated with "Total Abundance".

Spring Capelin acoustic survey data are needed in this table. DFO will provide these data.

Consider expanding the dataset used to calculate "Total Abundance" (i.e., not just 2004-2017).

1.4.1.2. Southeastern Grand Banks

Page 7, paragraph 1

"The medium benthivores occupying *shelf areas are dominated by yellowtail flounder, a shallow, warm water flatfish species that are characteristic of this region."*

"American plaice dominate the large benthivores functional group…"

> Historically American Plaice dominated the northern Grand Banks. Thorny skate is now one of the dominant large benthivores. These descriptions do not take into account the variability in the ecosystem and fluctuations in the proportions of various species.

Table 2

Comments on Table 1 should also be applied to Table 2.

Please explain why there is a different time period for the data in Table 2 (2008-2017) compared to Table 1.

1.4.2 Flemish Pass

The citation(s) is missing to support statements.

Page 10, paragraph 1

"The upper slope is dominated by deepwater redfish, the *dominant plank-piscivore…"*

Page 11, paragraph 1

"Lanternfish are a key planktivore in this area that is numerically dominant at the middle slope and middle-deep slopes. While this species is not a dominant one, it has relatively high abundances along the slopes of the Grand Banks including the Flemish Pass."

> Please be consistent with language and clarify what "numerically dominant" means and why it is stated in the following sentence that lanternfish "not a dominant one".
>
> "Lanternfish" refers to a number of Myctophid species, so a plural verb must be used when mentioned: "These species were particularly..."

Page 11, paragraph 2

"As observed in Spanish and Canadian RV Surveys, Greenland halibut is a dominant piscivore distributed among all depth areas within the Flemish Pass (Román et al. 2019a), where fish distributions may be associated with biogenic structures. (Kenchington et al. 2013)."

> This sentence implies that Greenland Halibut are there because of the biogenic structures. Please re-work this sentence for clarification.

Table 3

Please apply comments from Table 1 to Table 3.

1.4.3 Flemish Cap

Wolffish are also found on the Flemish Cap. They are a conservation objective for the region.

Page 13, paragraph 1

"…from 2004-2013…"

In recent years (2014-2018), changes have occurred in this region; this needs to be updated to reflect this.

Page 13, paragraph 2

"In terms of occurrence across trawls in the shallow shelf, Atlantic cod, American plaice, and witch flounder were the most dominant…"

Please consider using "widespread" or "ubiquitous" instead of dominant.

Table 4

There are no asterisks in the table indicating dominant species within the functional groups. Please use bold face for dominant species like in other tables.

1.4.4 Orphan Basin

In this section, when describing the Orphan knoll, CBD EBSAs are mentioned. The document does not include the other EBSAs in the region. The deeper waters around the Flemish Cap and along the Flemish Pass have also been identified as an EBSA by the CBD.

"Lanternfish are non-dominant planktivores…"

The terms dominant and non-dominant need to be defined in this document.

"Plank-piscivores, dominated by redfish, have high densities on the upper slope, similar to the Grand Banks."

"Large benthivores were mainly comprised of American plaice mainly in the Shelf-slope areas and…"

This is awkward wording, please rephrase.

"The Orphan Spur EBSA also has high concentrations of corals as well as shark species."

Please provide a reference.

"Proposed critical habitat was based on depth and temperature preferences of northern and spotted wolffish and functions…"

This is awkward wording, please rephrase.

Table 5

Please apply comments from Table 1 to Table 5. Also, it is important to note that these data do not cover all of the Orphan Basin area.

1.4.5 Abyssal Areas

Page 19, paragraph 2

"While there may be local differences in deep sea assemblages, armed grenadier and blue hake are likely key species in abyssal areas."

The reliance of bait for many of these studies limits our true understanding of what the fish assemblage is in deep water. This should be acknowledged.

Page 19, paragraph 3

Annual seasonal migrants for feeding (and mating) also include large sharks (e.g., Basking, Blue, Porbeagle, Shortfin Mako, Thresher, White), so CSAS publications should be reviewed and these species should be mentioned here.

Page 19, paragraph 6

"…advice provided by COSEWIC (2017)."

Not at risk and data deficient categories should also be listed here.

1.5 Species at Risk

Justification is needed for why only species listed on Schedule 1 of the SARA are dealt with in any detail in this section.

Page 20, paragraph 2

"The IUCN is a not-for-profit*, membership union composed of numerous organizations,* scientists, and experts *that voluntarily provide…"*

Page 20, paragraph 3

"…4) white shark (Endangered). While the white shark is a rare migratory visitor to Atlantic Canadian waters,…"

White Sharks have recently been found to be annual "migratory visitors to Atlantic Canadian waters", (e.g., tagging results).

How is "rare" defined? There is no index for this species or an estimate of abundance.

Page 20, Table 6

Please include "Not at Risk" "(NAR)" in Table Footnote to allow readers to clearly differentiate between true "blank" cells, which should equate to not yet assessed by COSEWIC/IUCN (e.g., Little Skate) and assessed NAR species (e.g., Blue Shark).

Barndoor Skate was designated as *Not at Risk* by COSEWIC in 2010.

Blue Shark was designated as *Not at Risk* by COSEWIC in 2016.

Roughhead Grenadier was designated as *Not at Risk* by COSEWIC in 2018.

Page 21, paragraph 1

"Species of Indigenous concern…"

It is suggested that the phrasing be changed to "culturally significant species".

1.5.1 Wolffish (Northern, Spotted, Atlantic)

Page 22, paragraph 1

"Spotted and northern wolffish are designated as Threatened by *COSEWIC and* under *SARA…"*

"Populations declined from the 1950s…"

There is a need for a citation here as there is no single survey index that extends that far back, and conversion factors have not been created for the various survey series.

Page 22, paragraph 2

Citations are missing to support stated information.

1.5.2 White Shark

Page 22, paragraph 3

"White sharks are large apex *pelagic predators found throughout the Atlantic Ocean."*

"They do not breed in Canadian waters…"

There is a need for a citation here, as some evidence suggests that there could be mating off Sable Island.

Sharks do not spawn; they mate.

White Sharks do not prefer "warm water" temperatures, please refer to earlier comments on Page 4, paragraph 1.

"…Gulf Stream while on the Grand Banks…"

The Gulf Stream is south of the Grand Banks, please delete or edit.

"They are capable of diving down *to 1,280 m and consume* marine mammals, carrion, seabirds, *squid and many fish species (COSEWIC 2006). They are listed as Endangered by COSEWIC and SARA, with no critical habitat* yet determined *in* Canadian waters *(COSEWIC 2006)."*

Shark "finning" (illegal in Canadian waters) and lucrative sales of other White Shark body parts on the global black market constitute one of the greatest threats to this species.

Citations are missing here.

1.6 Other Select Fish Species

"This included key shelf taxa *(e.g., capelin, sand lance, yellowtail flounder) and slope species…"*

Lanternfish is not a species.

Table 7

As with the other tables, please clarify what abundance means in this context.

1.6.1 Deepwater Redfish

The description of redfish fails to mention that redfish larvae have been found associated with sea pens, suggesting that sea pen fields could act as nursery ground for the species.

1.6.2 Capelin

Page 23, paragraph 3

The Capelin acoustic survey needs to be discussed. This is the primary method of assessing Capelin and best practice for surveying pelagic species. The Capelin acoustic survey provides trends in Capelin biomass and abundance. DFO will provide these data.

"This species is also characterized by high post-spawning mortality ~~in spent adults after each~~ with up to 100% of males and 50-75% of females dying after spawning ~~*spawning event, although some females may be repeat spawners*~~ (Shackell et al. 1994 ~~*Coad and Reist 2018, Lewis et al. 2019).*~~*"*

"Typically from April to September, capelin release eggs on beaches and deeper waters of the Southeast Shoal (15-50 m) that are fertilized externally (Penton et al. 2012, Trenkel et al. 2014, Maxner et al. 2016, Coad and Reist 2018). The larvae emerge from the sediment in response to warm zooplankton rich waters (Coad and Reist 2018)".

> These sentences should be replaced with the following: "Since the collapse of the Newfoundland Capelin stock in 1991, spawning has been delayed by a month compared to the pre-collapse period (DFO 2019a). Capelin currently spawn at beaches and deep-water sites (<40 m) close to beaches in July and August in the northeastern bays of Newfoundland (DFO 2019a). Capelin eggs adhere to the sediment and hatch date is dependent on temperature. Capelin larval emergence and survival are related to onshore wind events which increases the chance of a match between zooplankton prey and larval emergence (Leggett et al. 1984), although later spawning has resulted in fewer matches between larval emergence and onshore wind events post-1991 (Murphy et al. 2018). Capelin also spawn on the Southeast Shoal (15-50 m) (Carscadden et al. 1989)."
>
> No recent work has been done on Capelin on the SE shoal.

Page 24, paragraph 1

"In addition to their ecological importance, capelin are also an important inshore *commercial ~~species~~* fishery *(~~Lewis et al. 2019~~* DFO 2019a*)."*

> The Capelin SAR (DFO 2019a) is the appropriate reference for the commercial importance of Capelin.

Page 24, paragraph 2

"As Canadian RV surveys are based on bottom trawls*, the…"*

"Capelin are a short lived species that undertake large annual *spawning migrations* from offshore feeding areas on the Newfoundland shelf *to coastal waters* in Newfoundland embayments *and to offshore spawning grounds* on the Southeast shoal *in ~~the spring~~* summer *(June-August) (Maxner et al. 2016,* DFO 2019a*)."*

1.6.3 Sand Lance

Ammodytes dubius should be changed to *Ammodytes* sp. as they are not identified to species in the multispecies survey.

It is important to mention that Sand Lance also occurs in pelagic schools; it is this behavior that makes Sand Lance an important forage species.

"Sand lance are a small ~~demersal~~ semi-pelagic *planktivore that are common throughout the southern Grand Banks and are typically found between 1-11ºC (*Winters 1989*, Wells et al. 2017, Coad and Reist 2018)."*

"This species has an unique life history where it alternatively *~~typically~~ burrows into sand or small gravel substrates ~~where the body is immersed in the sediment and their heads are exposed~~* and swims pelagically in schools (Winters 1989)*."*

"Sand lance abundance has been increasing since the 1950s and they ~~have become~~ are *an important prey species for predatory fish, marine mammals and seabirds* especially since *~~after the reduction of many capelin stocks~~* collapse of the Newfoundland Capelin stock *(Winters 1983, Baillie and Jones 2004, Friedlaender et al. 2009, Wells et al. 2017)."*

"The larvae of these species are planktonic, ~~but~~ and *they seek bottom areas after reaching 35 mm in size (Amec 2014)."*

This is typical of a lot of fish species

1.6.4 American Plaice

"There is no directed commercial fishery for American plaice."

It should be clarified that this is not because it is not of commercial interest, but because it is under moratorium. Stocks are depleted and the population is listed as threatened under COSEWIC.

1.6.5 Yellowtail Flounder

Yellowtail are "*likely present in the Study Area year-round.*"

Yellowtail *are* present in the Study Area year-round. Please update this sentence.

1.6.6 Lanternfishes

Lanternfish are important consumers of plankton and are prey for fish, invertebrates, mammals and birds (Pepin 2013). Lanternfish are also present in offshore waters in very high numbers.

"… due to their conspicuous production of bioluminescence using *light-producing organs…"*

"…represent a key link between both surface and deep-water food webs as well as between *zooplankton and larger piscivores."*

"Lanternfish are likely the dominant planktivore in the deeper waters off the Grand Banks where capelin are not found, and in colder ecosystems to the north."

Pepin (2013) should be referenced for lanternfish in offshore pelagic communities.

"While many lanternfish species inhabit the Study Area, it is unknown if lanternfish *undertake seasonal migrations and* may be *present* in the Study Area *year-round."*

Seasonal migrations of these taxa are largely unknown.

1.6.8 Greenland Halibut

"Deeper water surveys typically find Greenland halibut abundant *at depths below Canadian RV trawl limits (Snelgrove and Haedrich 1985, Murua and De Cárdenas 2005, OBIS 2019,* Coté et al. 2018*)."*

1.7 Species of Identified Interest by Indigenous Groups

1.7.2 American Eel

There is no mention of whether this species is likely to occur in the Study Area.

1.7.4 Tunas (Albacore, Bigeye and Atlantic Bluefin)

"Tunas typically remain within the warmer water of the Gulf Stream and are usually observed to the south and east of the Grand Banks over deeper waters."

Tuna also have a nearshore distribution that is not associated with the Gulf Stream.

Tuna are also observed to the west of the Grand Banks.

Critical habitat is only designated for SARA species.

Non-indigenous license holders also have commercial licenses for tuna.

1.8 Key Reproductive Times and Areas

It is important to state that for some species spawning areas are not known (e.g., blue hake).

"Many larval stages occupy surface waters as ichthyoplankton and are associated with phytoplankton blooms and associated increases in zooplankton where there are higher food levels in the water column."

> Last sentence is awkwardly phrased. Re-phrasing is suggested as follows: "The marine larval stage is a particularly vulnerable period where fish larvae experience 95-99% mortality (Houde 2008). Recruitment strength in many fish species is set during the early life history period (reviewed in Houde 2008), and a match between fish larvae and their preferred prey (phytoplankton and zooplankton) is hypothesized to be an important driver of fish larval survival (Cushing 1972, 1990)."

Table 9

Blue shark mate in the Study Area in the summer.

Atlantic Canadian pregnant female Porbeagle sharks are still feeding in prey-rich, cooler Newfoundland waters in September-November. Some then begin a long, southern migration in December-January to the Sargasso Sea to birth live young. Adults will migrate in March-May back to Newfoundland waters to feed and mate. Other pregnant females give birth in Newfoundland waters, but timing is yet unknown. Therefore, please delete all colored blocks and add: "Mating may occur in Study Area, but timing is unknown. Springtime mating occurs".

1.9 Fish Migration Patterns

This section provides very limited information. Few species are considered and specifics are lacking.

Page 42, paragraph 1

"…from seasonal movements, to spawning migrations, to feeding aggregations."

> Seasonal movements are not exclusive to spawning and feeding migrations. Replace "aggregations" with a more appropriate word choice.

Page 42, paragraph 3

Please see earlier comments on White Shark.

Please see earlier comments on pregnant Porbeagles that give birth in Newfoundland waters.

Page 42, paragraph 4

"…with adults living and feeding at sea, and spawning and juvenile rearing occurring *in freshwater."*

1.10 Identified Important Areas Marine Finfish in the Study Area

It is worth noting the vulnerability of deep ocean fish species in this section (See Devine et al. 2006).

There is no mention of White or Silver Hake even though they are identified as present in high numbers on the NE Grand Banks.

Page 43, paragraph 5

"Coldwater corals and sponges support *marine species as biogenic habitat (Baillon et al. 2012 and 2014a, Kenchington et al. 2013)* and therefore *aggregations…"*

1.11 Key Data Gaps

Page 44, paragraph 2

"Areas beyond the continental shelf are not well studied due to the technical difficulties at sampling at these depths. Information on marine fish and invertebrates in these areas are limited to sporadic sampling that is sufficient for determining presence of species…"

> Very little information exists regarding the deep ocean environments in the Study Area. What does exist is largely derived from bait dependent methods. There is a lack of information on what species occur in this part of the Study Area, and it is also challenging to identify key habitats or sensitive time periods. This sentence should be edited to reflect these points.

Specific Comments on Figures

The symbology and labels throughout the Figures document associated with Module 5b are often hard to understand, read, or distinguish. The symbology is, in some cases, inconsistent between maps.

The north arrow on all maps appears to be incorrect, as the maps are projected, but the north arrow is pointing towards Map North (default). The arrow should be fixed and set to True North, or removed entirely as it is redundant with the graticule labels.

Some of the figure captions state "*X within the Regional Assessment Study Area;*" however, the figures still show data outside of the RA boundary. The caption should be clarified (i.e., remove or replace "within the Regional Assessment Study Area").

Figure 1:

- "*Identified subregions*" – more information should be included in the caption as to how the subregions were identified. They do not appear to be aligned with the bathymetry.
- The bathymetry is presented as contour lines and as a colored classification, but these two layers do not match. This mismatch is very obvious in some areas (e.g., upper right hand corner). The classified layer should be re-developed based on the contours.
- The colour scheme of this map is difficult to interpret. For a continuous variable such as depth, a continuous colour ramp should be used, not a discrete colour ramp as seen in the figure. The blue contour lines are also very hard to see on top of this current colour scheme. It is recommended to use ColorBrewer 2.0 to choose a sequential colour scheme where the deepest waters can be a dark blue.
- The depth legend title could be simplified (e.g., bathymetry or depth, not both).
- The subregions are missing from the legend.
- The contour interval is not stated anywhere; it should ideally be in the legend.
- The scale bar of this map is inconsistent from the others (120 km vs. 150 km). This map is also missing the numeric scale (e.g., 1:5,000,000).

Figures 2-13, 15, 17-23, and 31-34:

- "*Planktivore (Dominant and Non-dominant species) Distribution from Canadian RV Data (1995-2017)*" – this is not distribution, this is average relative density. Additionally, the source of the data should be changed from Canadian RV to DFO NL RV survey data.
- The average relative density data layers were originally provided as geotiff rasters. However, the layers in the documents were classified into five classes, and no information is provided as to the classification method. By classifying the layers, the general patterns and trends are the same, but use of a non-continuous scale may result in a loss of detail in the data displayed which could lead a misrepresentation of important areas.
- DFO Science recommended using the labels high and low in the legend, however it was not recommended to use a "medium" term and it should be removed.
- The symbology of some features could be improved. The purple delineations and labels of the subregions are difficult to read. The ELs, PLs, SDLs, CFBs, Sector, and Producing Platforms are impossible to see on some maps (e.g., red Producing Platforms over red average relative density values, thin yellow CFB outlines on white water). These improvements could be made by using different kinds of symbols (e.g., filled, lined, textured), contrasting colors, etc.
- The Hibernia, Hebron, White Rose, and Terra Nova labels are displayed over the finfish data, hiding some of the data and making it difficult to see. They could be moved over the blank space of the ocean instead.
- The depth contours are drawn over the average relative density layer, which not only are difficult to see, but may lead the reader to think the contour is related to the density and may cause some confusion. It is recommended that the contour layer be displayed under the average relative density layer.

Figure 8: The RV survey data are not the best data source for the analysis of Capelin. DFO Science has prepared a layer for Capelin based on the acoustics data, and will provide it accordingly. As a result, this map based on RV survey data should be removed.

Figure 12: When it was originally sent, this data layer was called Mailed Sculpin. However, the data are for *Triglops* sp., so it should be clarified that this layer be called Mailed Sculpins (NS), where NS refers to not speciated. Mailed Sculpins (NS)/*Triglops* sp. includes mailed sculpin, moustache sculpin, arctic mailed sculpin, and northern mailed sculpin.

Figure 14: Moustache sculpin are grouped under mailed sculpins because of identification issues when coding, so it is impossible to create a layer for just moustache sculpin. They are grouped with and included above in Figure 12 and should be represented in no other figures.

Figure 16: The RV survey data are not appropriate for analysis of lanternfish because of their pelagic nature. As such, DFO Science previously indicated that a layer will not be provided for this species group.

Figure 23: Longnose eel was provided in the first data transfer, but was subsequently removed from analysis, as was indicated during the second data transfer. This map should be removed.

Figures 24-30: There is no consistency in presented information for the Flemish Cap relative to other areas: maps are provided on an annual basis, information is given on both biomass and abundance.

Figures 37-39 show diversity, evenness, and richness; however, this is for finfish species only and is based only on the fall RV survey data. There were additional layers provided by DFO that included fish plus shrimp and crab that are more representative of the diversity ecosystem as a whole. As well, maps of the spring data should also be included, as the diversity, evenness, and richness values between the two surveys are not interchangeable.

Figure 37: Please provide the source of this layer. It appears as though the classification is incorrect, as the numeric breaks do not match the breaks calculated by DFO NL. This layer should be classified into 5 classes using quantiles. There is a specific procedure that is necessary for classifying quantiles correctly in ArcMap; this method was outlined in the README document that accompanied the layers provided by DFO Science, and should be used accordingly.

Figure 39: The richness layer that DFO NL sent to the Agency was clipped to the same footprint as all the other finfish maps. However, this figure does not reflect that clip, and has values in the 9-21 class beyond the footprint. This layer should be re-mapped to ensure it is clipped appropriately.

Appendix C – Specific Comments on Module 5c – MARINE MAMMALS AND SEA TURTLES

Specific Comments

1.2 Marine Mammals and Sea Turtles

Page 1, paragraph 3

1.1.2. Mysticetes

Page 2, paragraph 2

This module notes that baleen whales "*are typically solitary animals or clustered in small groups or pods.*" While many baleen whales are found in small groups, large pods are recorded in many areas. This means that a particular activity may impact a large number of individual whales.

Page 2, Table 1

Blue Whales are described as "wildly distributed throughout world's oceans and occurs primarily in coastal, shelf and oceanic waters (COSEWIC 2002)". This statement applies to the entire species, leaving the wrong impression about the NW Atlantic population, which is very small (<250).

Fin Whales are common on the continental shelf within the Study Area. It should not be implied that they are primarily among the shelf edge. This is evident in reports from systematic surveys here, and elsewhere in the world, that show they occur close to shore, on the shelf, and offshore in deeper waters.

The small number of confirmed Sei Whale sightings is likely a product of the difficulty in discriminating distant Sei Whales from Fin Whales; the DFO sightings database has a large number of fin/sei records year-round. These whales have been sighted near active seismic operations and in shipping areas such as Placentia Bay, so they should not be considered "uncommon" within the context of some human activities.

Like many Odontocetes, Mysticetes do not all migrate out of the Study Area during winter months. In particular, water temperatures in the Flemish Pass and Flemish Cap remain close to 15˚C even when the continental shelves north coast of Newfoundland and Labrador are ice-covered. Research in these areas have detected multiple individuals and multiple species even during the winter. Large whales, such as Fin Whales and Humpback Whales, have also been sighted in ice-infested waters around Newfoundland in the winter and spring so these periods should not be considered "whale free".

Page 2-7, Tables 1, 2, 3, and 4.

The seasonal occurrences of Mysticetes, Odontocetes, Pinnipeds, and sea turtles likely to occur in the Study Area are briefly described in Tables 1, 2, 3, and 4, respectively. Given that the maps in the module are sightings only and provide no indication of species' seasonal presence patterns, it would be beneficial to the reviewer to have a figure similar to Bird Presence Gantt chart in Figure 4.111 of the Eastern Newfoundland SEA (Amec 2014). The Gantt chart would provide a visual overview of the seasonal patterns of abundance and life cycles of marine mammal and sea turtle species in the SA.

1.1.2. Odontocetes

Page 4, Table 2

For Harbour Porpoise, it is noted they "may occur year round, but most likely present in northern coastal waters during the summer months". There are a number of publications (including from the Study Area) indicating that Harbour Porpoise are not as coastal as previously assumed. These can be found in the citation index.

Page 3, paragraph 1

In recent years, groups of Sperm Whales have been associated with almost every trawler operating on the Grand Banks; this learned behaviour means that these whales may follow vessels into planned marine development areas, and the whales will be habituated to vessel approach and less likely to avoid ship strike or seismic onset.

This module briefly describes the reliance of Odontocetes on acoustic means of communication and their auditory range. It should be noted the Ziphiidae appear to be particularly sensitive to the effects of anthropogenic noise produced by SONAR and seismic airguns.

1.1.3. Pinnipeds

Page 5, Paragraph 1 and Table 3

Walrus are also occasionally found in the Study Area. There was a NW Atlantic population (extirpated) that was considered separate from the Atlantic Walrus but is now considered part of the same population by COSEWIC. It is listed as Special Concern. This species needs to be included.

All of these pinniped species are seen in the waters of the Study Area throughout the year – not just *"most common in the Study Area in the winter months".*

The phrase *"most pinniped prefer open ocean"* is an oversimplification of the habitat requirements of these species. There are published papers describing the habitat of most of these species that should be incorporated. For examples, the habitats of Harp Seals and Hooded Seals are very different and cannot be treated as if they are the same.

The phrase *"all four seal species that are regularly found in the area are considered secure (Hammill et al 2012)"* is also an oversimplification. The term 'secure' should be defined. Also, the reference cited refers to Harp Seals only. If it is implied that populations are not at risk, references for the other species are needed, and the reference for Harp Seals should be updated to the primary publication (Hammill et al. 2015). Given that there are no estimates of Harbour Seal abundance, it is hard to substantiate this claim.

Ringed Seals and Barded Seals are present off Newfoundland and Labrador year round.

The description of the Harbour Seal distribution is incorrect. They are found along the north coast and Labrador as well as the south coast and west coast of Newfoundland. This has been well described in the literature since 1971.

An example of how papers are cited, but not interpreted correctly, is given with the description of the Hooded Seal distribution. They are not present throughout the continental shelf. With the exception of the pupping period, hooded seals are found almost exclusively along the shelf edge. The references cited (Andersen et al. 2012, Andersen et al. 2013, Andersen et al. 2014) clearly indicate this fact. The reference to Lesage et al. 2007 is irrelevant to the statement being made and should not be used.

1.1.4. Sea Turtles

The more observation effort that is undertaken, the greater the number of leatherback turtles are detected both offshore and in nearshore areas. Areas of high use near and within the Study Area have been identified in a recent paper (Mosnier et al. 2019) and the data should be incorporated. This information should be included in the Species at Risk section, and could be used to designate Critical Habitat for this species in the near future.

1.1.5. Species at Risk

Although it has not yet been officially designated, important habitat for Blue Whale and Fin Whale has been identified (e.g., DFO 2018a) and should be referenced.

Beluga Whales, usually solitary individuals but occasionally large herds, have been sighted in Newfoundland and Labrador waters of the Study Area. Younger solitary Beluga Whales are very curious and approach vessels and underwater activities.

1.1.6. Overview of Key Areas and Times for Marine Mammals and Sea Turtles in the Study Area

Although difficult to sight at sea, Leatherback Sea Turtles have been seen frequently in waters very close to shore in addition to offshore areas. Wherever there are aggregations of jellyfish prey, which have been increasing recently in magnitude and area, Leatherbacks and Sunfish are found.

Lilly Canyon is not an important feeding area for Harp Seals and should not be identified as such. The northeast slope is much more important and should be identified.

The reference to Hooded Seals feeding *"between December and May when pupping occurs"* is incorrect. Hooded Seals do not pup in May; rather, they pup on sea ice in March. They feed in this area between early winter and June, both before and after pupping. As such it is a very important feeding area for building up energy reserves for pupping and moulting.

Page 13, Figure 4

Given there are only three turtle species depicted in the Sea Turtle Sightings map, it is recommended that two more distinguishable colors be used for the leatherback and loggerhead sightings than brown and orange, respectively.

1.1.7. References

It is recommended that the authors review and incorporate information from the following additional references: Hamill et al. 2015, Lawson and Gosselin 2009, Lesage et al. 2017, Lesage et al. 2018, Moors-Murphy et al. 2019, Moors-Murphy et al. in prep[3], Mosnier et al. 2019, Stenson et al. 2011, Stenson et al. in prep [4], Stenson et al. 2018.

[3]Moors-Murphy, H.B., Lawson, J.W., and Wingfield, J. In prep. Occurrence of fin whales (*Balaenoptera physalus*) off Nova Scotia, Newfoundland, and Labrador. DFO Can. Sci. Advis. Sec. Res. Doc.

[4]Stenson, G.B., Gosselin, J.-F., Lawson, J.W., Goulet, P., and Hammill, M.O. In prep. Estimated pup production of Northwest Atlantic harp seals in 2017. DFO Can. Sci. Advis. Sec. Res. Doc.

Appendix D – Specific Comments on Module 5e – SPECIAL AREAS

1.1 Special Areas

1.1.1 Federally Designated Areas

1.1.1.1 Bioregions and Large Ocean Management Areas

Page 3, Map of Newfoundland and Labrador Shelves Bioregion

This map should be combined with the Placentia Bay-Grand Banks LOMA map to show coverage, overlap, and gaps in relation to the RA Study Area.

Page 4, Map of Placentia Bay-Grand Banks Large Ocean Mapping Area

The acronym LOMA stands for "Large Ocean Management Area".

1.1.1.2 Ecologically and Biologically Significant Areas

Page 5, paragraph 1

EBSAs are identified, not designated. Also, EBSAs are not ranked. In the NL bioregion, EBSAs were identified based on the criteria of uniqueness, aggregation, and fitness consequences; the criteria of naturalness and resilience were not used during the identification process (DFO 2013a, DFO 2019c).

Page 5, paragraph 3

"While most areas have some ecological function, the EBSA process to identify an area as "significant" is to conclude that if the area were disturbed, the ecological consequences (in space, in time, or outward through the foodweb) would be greater than an equal disturbance of most other areas. Although, the nature of those consequences could differ greatly among specific cases (DFO 2004)."

> This paragraph was taken from DFO 2004, page 2 but several key words were removed:
>
> "All species, habitat features, areas etc. have some ecological function. However, to identify an area or species as "significant" is to conclude that if the area or species were perturbed severely, the ecological consequences (in space, in time, or outward through the foodweb) would be greater than an equal perturbation of most other areas or species, although the nature of those consequences could differ greatly among specific cases."

Page 5, paragraph 4

This entire paragraph should be re-written as follows:

Since 2012, the EBSA criteria have been applied to the entire Newfoundland and Labrador (NL) Shelves Bioregion in two separate data-driven processes. The first process focused on the area north of the Placentia Bay-Grand Banks (PBGB) Large Ocean Management Area (LOMA) (DFO 2013a). The second process focused on the PBGB area (DFO 2019c), where EBSAs had previously been identified using a more Delphic approach (Templeman 2007). In the northern Study Area, a total of fifteen EBSAs were identified and described; three of these areas are primarily coastal areas; seven are in offshore areas; four EBSAs straddle coastal and offshore areas; and one is a transitory EBSA that follows the southern extent of pack ice. In the PBGB Study Area, fourteen EBSAs were identified in two different categories: seven based on coastal

data and seven based on offshore data. Currently, seven EBSAs fall within or are directly adjacent to, the RA Study Area.

Page 6, Map of Current EBSAs within the Regional Assessment Study Area

EBSA labels need a larger font.

Page 7, Table: EBSAs Within the Regional Assessment Study Area

It would make more sense to list the EBSAs in this table from North to South (i.e., starting with the Orphan Spur EBSA). Also, this table should only include EBSAs that are found within or adjacent to the RA Study Area.

The word "congregate" should not be used in place of aggregate or concentration – that word has not been used in any of the recent EBSA reference documents.

It appears that the text written in the "Rationale for Identification/Designation" column was based upon the descriptions of EBSAs identified in Templeman (2007) and not the more recent documents (DFO 2019c, Wells et al. 2019). The text should be updated to reflect the most recent information available for these areas.

1.1.1.3 Significant Benthic Areas

The characterization of the small gorgonians SiBA on the Grand Bank as "small" is somewhat misleading. Current SiBA extent, especially in an area like the Grand Bank which has experienced a long history of fishing, likely represents remnants of habitats that have been historically impacted by fishing. Current distributions need to be interpreted under this light.

Page 11, paragraph 1

The whole module lacks references for the generalizations made about special areas. For example, this paragraph could cite Pham et al (2019) regarding the ecosystem valuation of deep sea sponges.

Page 11, paragraph 2

"These areas are not legally protected under legislation, and are only identified and noted for the presence of corals and sponges."

> This statement needs to be corrected to explain that SiBAs had an important role and were key components to help delineate Marine Refuge Area Closures.

Page 12, Map of Significant Benthic Areas in Offshore Newfoundland and Labrador

VMEs should be illustrated on the same map as SiBAs. This will help the reader understand the spatial scale of these key areas.

1.1.1.5 Marine Refuges

The DFO (2017b) reference used in this section should be citing the guidance document.

Page 17, paragraph 3

"To date DFO has identified and established eight…marine areas off Newfoundland and Labrador"

> The scope of this section needs to be clarified to describe the marine refuges for Newfoundland and Labrador as a region, as the NL Shelves Bioregion, or just within the RA Study Area (also see comment on the Table on page 19 below). Newfoundland and

Labrador has fourteen closures, but of these, only eleven are within the NL Shelves Bioregion. The lobster closures are counted as seven individual closures of which two are in the Gulf of St. Lawrence Bioregion. The Bay of Islands Salmon closure is also in the Gulf bioregion. All fourteen are shown in the figure on page 18.

Page 18, Map of Current Marine Refuges Within or Near the Regional Assessment Study Area

This figure needs to be updated. The NE Newfoundland Slope Marine Refuge Area has a piece missing from it compared to what is provided on the DFO website.

Page 19, Table: Marine Refuge Areas in Newfoundland and Labrador

It is not clear whether this table is meant to list the marine refuges for Newfoundland and Labrador as a region, as the NL Shelves Bioregion, or just within the RA Study Area. Only five of the fourteen marine refuges for the Newfoundland and Labrador region are listed in the table. All the closures are shown in the figure on page 18, so they should probably be listed in the table.

The title should be clarified in line with the previous comment e.g. "Marine Refuge Areas within the Newfoundland and Labrador Region".

"Division 3NO Coral Closure" should be "Division 3O Coral Closure"

Table Column *"Rationale for Designation"* – Since this is about the rationale, only the conservation objectives listed in the table on the DFO website should be provided. The habitat and species of interest were the main criteria for the designation. Some of the other information is from the context and not strictly part of the rationale. Another column could be added for context to provide some of the additional benefits.

Funk Island – The specific conservation objective is to "conserve Atlantic cod and its habitat". The benefit to smooth skate is in addition to the main Conservative Objective for this area and therefore should be included in the context. Also as part of the context, the closure also overlaps the Notre Dame Channel EBSA as well as part of the Fogo Shelf EBSA.

Hawke Channel – The conservation objective is to "conserve benthic habitat and Atlantic cod".

Division 3O Coral Closure – The conservation objective is to "protect coral and sponges.". The context omitted that the closure overlaps a significant portion of the Southwest Slope EBSA.

Hopedale Saddle – The conservation objective is to "Protect corals and sponges and contribute to the long-term conservation of biodiversity." The context omits that the closure overlaps the Outer Shelf Nain Bank, Labrador Slope, and Hopedale Saddle EBSAs.

Table Column "Area" – some of the areas are incorrect:

- Northeast Newfoundland Slope – 55,353 km^2
- Division 3O Coral Closure – 10,422 km^2 (portion within the EEZ)
- Hopedale Saddle – 15,411 km^2

Table Column "Legal Protection": These are not *Oceans Act* closures; they are closures under the *Fisheries Act*. Replace with "Yes. *Fisheries Act* through a Variation Order and/or Condition of Licence"

The same DFO (2017b) reference is used for the information in the table although the document only provides guidance. The specific information for the marine refuges comes from the table (and links) available at DFO and this document should be referenced.

1.1.1.6 Fishing Closure Areas within Canada's Exclusive Economic Zone

This section of the report may be confusing to readers and should be combined with the Marine Refuges section as "Closures under the Federal *Fisheries Act*". Marine Refuges are closed under the *Fisheries Act* through a Variation Order and/or Condition of Licence. However, it is important to note that not all Fishery Closures are Marine Refuges. There are many Fishery Closures in the NL Shelves and a listing of all notices can be found here.

1.1.1.8 National Wildlife Areas, Marine Wildlife Areas and Migratory Bird Sanctuaries

This section goes into details on areas nationwide. If you do this for one section, then it should be completed for all sections.

Page 27, Map of Migratory Bird Sanctuaries Near the Regional Assessment Study Area

This map needs an inset box showing a magnified version of the relevant areas.

1.1.3 Internationally Designated Areas

1.1.3.1 Vulnerable Marine Ecosystems

The term Regional Fisheries Management Organizations (RFMOs) is more commonly used to refer to bodies like NAFO. Replace Regional Fishery Body (RFB) with RFMO throughout.

There is significant confusion of NAFO working groups (WG). The working group created in 2008 was called the Working Group on Ecosystem Approaches to Fisheries Management (WGEAFM), and it was a Scientific Council (SC) Working Group. This SC WG was later renamed the Working Group on Ecosystem Science and Assessment (WGESA). WGESA (formerly WGEAFM) generates the scientific analysis and studies that SC uses to provide advice on ecosystem issues, including VMEs. The renaming of WGESA was done to avoid confusions with a joint Commission-Scientific Council Working Group that was created in 2013-2014 named Working Group on the Ecosystem Approach Framework to Fisheries Management (WGEAFFM – two "Fs"). This joint Commission-SC WG includes both managers and scientists, and its role is to discuss the scientific advice relevant to the implementation of the ecosystem approach to fisheries in NAFO (the NAFO Roadmap to EAF), and to provide recommendations on this topic to the NAFO Commission. Koen-Alonso et al. (2019) describes the NAFO Roadmap, including a brief summary of the evolution of these working groups over time.

The identification of VMEs is not done based on presence; it is done based on high concentrations of VME indicator species such that they define functional and distinct habitats.

The VME map only shows the main VMEs for sponges, large gorgonians and sea pens, but does not include, for example, the locations of bryozoans, sea squirts, and small gorgonians that are also VME indicator species, but for which the available data have not yet allowed for reliable mapping of those habitats. Those locations are summarized in NAFO Reports.

Stony corals are mentioned repeatedly with no clarification between the reef-forming kind (e.g., Lophelia – which is not found in this region), and the solitary stony cup corals of which there are several species found in this region.

There is reference to knolls and seamounts as special areas identified by NAFO but the seamount closures are not identified in the figure on page 40.

Page 39, paragraph 6

"The priority for this working group was is to identify and delineate VMEs within the NAFO Regulatory Area."

> Just to expand on this group, it was a collaboration to pool expertise and resources from several countries. Surveys conducted by DFO Canada (BIO, NL) and EU Institutions helped fill knowledge gaps on the benthos. Unique surveys were conducted (NEREIDA Project) where the NRA was multibeamed and groundtruthed in 2009-2010 (rocks for geology and benthic species for invertebrates) (Muñoz et al. in prep[5]).

"Corals and sponges also act as areas of refuge, nursing, spawning, and breeding grounds for many marine species (WG-EAFM 2008)."

> This is a broad sweeping statement and the reference is not suitable.

> *1.1.3.2 NAFO Fisheries Closure Areas*

Fishing footprint is mentioned here and it should be added and illustrated in the maps.

Page 42, Map NAFO VME Closure Areas in Offshore Newfoundland and Labrador

It would be useful to show names of all the NAFO VME Closures or number them with a legend.

Page 44, Table: NAFO Fisheries Closure Areas off Eastern Newfoundland

If rationale is pulled from the website and quoted directly, a link or reference should be provided (e.g., Orphan Knoll rational).

3O Coral Area Closure rational states, "The area includes mostly soft bottoms with rocky outcrops", but this area is incised with many large canyons along the entre shelf edge.

Add species examples. For example, under Orphan Knoll Seamount, Rationale for Identification/Designation, last bullet:

> *"Coral, including* solitary *stony coral,* large bamboo corals, unique gorgonian corals, and diverse assemblages *of sponges* including unique glass sponges *have been observed on the flanks of the Orphan Knoll* and adjacent mounds*."*

Under 3O Coral Area Closure, Rationale for Identification/Designation:

> First bullet: "*Located on the continental slope from 800 m* – 2,000 m, *this* was the first CAD-NAFO Coral Closure and *is the only NAFO FCA that straddles national and international waters."*
>
> Second bullet: The SW Grand Banks is incised with many large canyons the entire edge of the shelf.

Under Tail of the Bank, Rationale for Identification/Designation, second bullet:

> Acanella is an important small gorgonian coral species that collectively creates large scale habitats.

[5] Muñoz, P.D., Sacau, M., García-Alegre, A., and E. Román. In prep. 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.

Under Flemish Pass/Eastern Canyon, the FCA was expanded to protect large gorgonian corals in the Flemish Pass. This includes bamboo corals (*Keratoisis flexibilis*) mixed with *Asconema* glass sponges in this area. This 'community' is different than the 'Geodia communities' discussed further down in the rational section. Both are equally important in terms of habitat provision.

Under Northeast Flemish Cap, this area includes species that are unique to the region.

Under Northern Flemish Cap, Sea pens can create large-scale habitats.

This table is very repetitive and could be simplified by including those closures identified using the same criteria in a single line or providing a general key of the criteria used with abbreviations or numbers used in the table.

1.1.3.3 International Ecologically and Biologically Significant Areas

While this is not the case in Canada, some EBSAs have been identified in areas within national jurisdiction through CBD led workshops.

Page 50, Table: UNCBD Ecologically and Biologically Significant Areas within the Regional Assessment Area

"Fragile and long-lived corals and sponges have been observed and a Taylor Cone circulation provides a mechanism for retention of larvae."

This text needs to be included in the first description of Orphan Knoll (see Table NAFO Fisheries Closure Areas off Eastern Newfoundland).

1.1.4 Other Identified Special Areas

1.1.4.1 Important Bird Areas

Page 53, Map of Coastal IBAs in Newfoundland and Labrador

Please consider merging this map with the map for Migratory Bird Sanctuaries Near the Regional Assessment Study Area.

1.1.4.2 World Heritage Sites

Red Bay and L'Anse aux Meadows are missing from this map.

Appendix E – Information for Future Consideration in the RA

There are new coral updates for this region. They will be submitted to Frontiers for publication in January 2020 (Wareham-Hayes et al., in pers. comm.), and will provide an update on coral distributions (including depth ranges), diversity, and ecology in the Northwest Atlantic: Newfoundland, Labrador (Nunatsiavut), Baffin Island (Nunavut) Regions. This information was presented at the International Deep-Sea Coral Symposium in 2019. Even though the publication is not yet available for incorporation into the RA modules, the information will be used in Gullage et al. (in prep.[6]) working paper being prepared for a January 2020 CSAS meeting titled "Provision of scientific advice on the baseline information requirements and standard mitigations for the protection of coral and sponge communities from oil and gas related drilling activities". This is relevant to the tables that have been provided in Module 5a, as they will require updating once this publication is available.

NAFO reviews the adequacy of its VME closures and its assessment of Significant Adverse impacts on VMEs on a five year cycle. The next review of the adequacy of the closures is scheduled for 2020, which implies that the analyses that will support the Scientific Council (SC) advice on this topic were carried out by SC WGESA (Working Group on Ecosystem Science Assessment) at its 12th meeting in November 2019. These analyses included an updated identification and delineation of VMEs in the NAFO Regulatory Area (NRA) based on the incorporation of additional data collected since the last formal review of VMEs five years ago. Substantive improvements on the identification and delineation of VMEs are coming out of this work, especially for those VME indicator taxa that previously had more limited information. The SC WGESA report including the updated VMEs is expected to be available during the winter of 2020, and the related SC science advice will be produced in June 2020. Given the relevance and significance of these upcoming results for the RA, it is highly recommended that mechanisms to incorporate this new information into the RA process to be put in place.

[6]Gullage, L., V. Wareham-Hayes, B. Neves, and N. Wells. In prep. Avoidance and mitigation of coral and sponge species during exploratory drilling activities offshore Newfoundland and Labrador. Can. Sci. Advis. Sec. Res. Doc.

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