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Newfoundland and Labrador Region
Canadian Science Advisory Secretariat
Science Response 2019/035

REVIEW OF THE ENVIRONMENTAL IMPACT STATEMENT FOR THE HUSKY EXPLORATION DRILLING PROJECT

Context

The Proponent, Husky Oil Operations Limited (Husky), proposes to conduct exploration drilling activities on the Grand Banks within the area of its offshore exploration licences (ELs). The ELs are located approximately 350 km east of St. John's, Newfoundland and Labrador (NL). The Project is a multi-well exploration drilling program and would include up to ten wells to be drilled between 2019 and 2027.

The Project requires review and approval pursuant to the requirements of the *Canadian Environmental Assessment Act* (CEAA 2012) as it has been determined that the drilling of a well constitutes a designated project under Section 10 of the Regulations Designating Physical Activities. In addition, the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) requires a project-specific environmental assessment (EA) be completed for offshore oil and gas activities, pursuant to *the Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* and the *Canada-Newfoundland Atlantic Accord Implementation Act* (the Accord Acts). It is intended that the EA review process for the Project will satisfy the requirements of CEAA 2012 and the C-NLOPB's Accord Acts EA processes. Environmental Impact Statements (EIS) have been prepared in accordance with requirements of CEAA 2012, the project-specific Guidelines for the Preparation of an Environmental Impact Statement (EIS Guidelines [CEA Agency 2016]) issued by the Canadian Environmental Assessment Agency (the Agency), and other generic EA guidance documents issued by the Agency as referenced throughout.

On October 18, 2018, the Fisheries Protection Program of the Ecosystems Management Branch in the NL Region of Fisheries and Oceans Canada (DFO) requested that Science undertake a review of specific sections of the EIS for the proposed exploration drilling. DFO Science undertook a Science Response Process for this review. The information from this scientific review will be provided to Ecosystems Management to help form part of the Department's response to the overall adequacy of the EIS documents.

The objective of this review was to evaluate:

- The sufficiency of baseline data and appropriateness of methodologies to predict effects;
- The mitigation measures proposed by the Proponent;
- The level of certainty in the conclusions reached by the Proponent on the effects;
- The manner in which significance of the environmental effects, as they pertain to DFO's mandate, have been determined (i.e., the scientific merit of the information presented and the validity of the Proponent's methodologies and conclusions);
- The follow-up program proposed by the Proponent; and
- Whether additional information is required from the Proponent to complete the technical review.

The information required for this review can be found in a number of sections throughout the EIS reports, and associated appendices. The EIS reports are available on the Agency's website.

This Science Response Report results from the Science Response Process of November 8, 2018 on the Review of the Environmental Impact Statements for the Husky Exploration Drilling Project.

Analysis and Response

The comments provided by DFO Science, NL Region as requested by the Fisheries Protection Program are related to the following sections of the EIS reports:

- **Chapter 4.0 – Existing Marine Physical and Biological Environment**
    - 4.1.3 – Physical Oceanography (pages 4.22-4.34)
    - 4.1.4 – Sea Ice and Icebergs (pages 4.35-4.40)
    - 4.2.1 – Plankton (pages 4.44-4.48)
    - 4.2.3 – Corals and Sponges (pages 4.65-4.71)
    - 4.2.4 – Marine Fish (pages 4.72-4.77)
    - 4.2.5 – Marine Mammals (pages 4.80-4.88)
    - 4.2.6 – Sea Turtles (pages 4.90-4.92)
- **Chapter 6.0 – Environmental Effects Assessment**
    - 6.1 – Fish and Fish Habitat (pages 6.1-6.24)
    - 6.3 – Marine Mammals and Sea Turtles (pages 6.38-6.63)
- **Chapter 7.0 – Accidental Events**
    - 7.3.1 – Fish and Fish Habitat (pages 7.54-7.61)
    - 7.3.3 – Marine Mammals and Sea Turtles (pages 7.66-7.73)
- **Chapter 9.0 – Cumulative Effects**
    - 9.2.3 – Assessment of Cumulative Effects on Fish and Fish Habitat (pages 9.29-9.33)
    - 9.2.5 – Assessment of Cumulative Effects on Marine Mammals and Sea Turtles (pages 9.35-9.37)

To ensure a comprehensive review of the EIS, DFO Science also provided comments on additional sections. The additional comments can be found throughout this Science Response Report.

General comments

The quality of scientific content presented in the EIS varies across sections. While the EIS contains a large volume of information and valuable data, it is not complete in its current form. The EIS does not incorporate many important and relevant data sources (e.g., methodologies for assessing waste dispersion, oil spills, and cumulative effects and baseline data for sensitive benthic areas and species, and recent literature on the impacts from the Deepwater Horizon oil spill), and overlooks many important and basic considerations on ecosystem structure and function. It also does not adequately explore the potential impacts on ecosystem functioning.

Many references are cited and interpreted incorrectly or inappropriately, or are not included in the list of references. In addition, much of the literature cited to substantiate study conclusions is outdated and grey literature is frequently cited in place of primary, peer-reviewed literature. For example, the document states that there has been a moratorium on Witch Flounder since 1994 due to low stock levels. Recent data shows that there has been a commercial quota available for Witch Flounder in the Northwest Atlantic Fisheries Organization (NAFO) Divisions 3N and 3O since 2015. Appendix D should be updated to include data from recent DFO stock assessments.

Many references in the EIS are not accessible to the public (e.g., diesel path and Ocean Ltd. 2017). Due to inaccessibility of reference materials, portions of the EIS could not be assessed adequately by DFO.

The proposed exploration drilling will occur in relatively shallow waters and could emit a variety of underwater sounds and have risks associated with supply and service vessel operations. Depending on the mobile offshore drilling unit (MODU) chosen, semi-submersible or drillship have distinct dynamic positioning system (DPS) thrusters and are thus much noisier than a jack-up rig. Some of this noise will be of long-duration, and its low frequency would cause it to propagate many tens of kilometres from the rig sites.

The EIS also does not fully recognize the extensive research regarding the Deepwater Horizon oil spill; that research could improve the analysis of impacts and recovery time if there were to be a subsurface blowout for the Project. For example, the statement "*In consideration of the present knowledge of Jeanne d'Arc Basin and Flemish Pass, the modeling exercises, and on past monitoring experience with large spills (e.g., Deepwater Horizon, Exxon Valdez, Arrow and others), the predicted residual environmental effects from any of the accidental event scenarios on marine mammals and sea turtles are not likely to be significant (i.e., not predicted to cause a decline in abundance or change in distribution of marine mammal or sea turtle populations within the Study Area, jeopardizes the achievement of self-sustaining population objectives or recovery goals for listed* Species at Risk Act *(SARA) species, or results in permanent and irreversible loss of critical habitat)*" may not be true. A number of studies arising from post-event monitoring of Deepwater Horizon have shown changes in small cetacean physiological effects (e.g., disease, reduced pregnancy rates) in the years following this large spill.

The drill mud and cuttings dispersion models used to assess potential effects of drilling wastes on the benthic environment do not adequately reflect the known behaviour of the fine particulates associated with these materials. The drilling waste dispersion model is a simple advection-deposition model based on grain size and assuming that the fines (which make up 87% of the waste for water-based drilling mud [WBM]) flocculate to particles of 1 um and are treated as such. It does not include any resuspension, shear or other benthic boundary layer dynamics and it assumes that the flocculated particles have the same density as all the other particles. Near bottom currents associated with waves and storms have the potential to resuspend fine sediments and transport them to depositional areas elsewhere. These may be at considerable distance as has been seen in the Norwegian Trench where there is evidence of significant barium deposition from drilling muds disposed of in the North Sea at distances of 200-300 km (Lepland et al. 2000, NGU 1997). Flocculated particles have structure and porosity that affect their density and drag and thus their settling behavior. In addition, break up and re-flocculation dynamics will affect the size and transport of the particles. These dynamics need to be incorporated into modeling of the waste dispersion process as they will assist in identifying the eventual effects of these fines. This is particularly important since the eventual fate of the fines associated with drilling wastes are likely to be in depositional areas where sensitive species such as corals and sponges are known to occur.

Recent advances in the understanding of the potential effects of offshore oil and gas activities on fish and fish habitat, and in particular sensitive benthic areas and species, is not discussed. Sensitive benthic areas and species are not specifically identified as a valued component (VC) in the EIS; potential habitat effects on sensitive benthic areas are considered to be covered under the fish habitat VC. As a result, potential effects of the project on sensitive benthic species such as corals and sponges are not explicitly evaluated. Given the increasing evidence for potential widespread and long-term effects of project activities on these sensitive species, and given the recognition of the need for extra protection, this exclusion is an oversight in the EIS. In addition, existing mitigation measures for exploratory drilling programs currently in place for the NL offshore such as pre-drilling surveys and avoiding drilling near aggregations of sensitive species are not analyzed in the EIS.

Recent literature on the effects of SBMs and cuttings show that significant toxicological effects would rarely be expected to occur beyond the 250-500 meters range, except possibly in very shallow waters, or waters with weak currents (e.g., EPA 2000, Neff et al. 2000, Mathieu 2002, Buchanan et al. 2003, Association of Oil and Gas Producers [OGP] 2003, CSA 2004, Hurley and Ellis 2004, Jacques Whitford Stantec Ltd. 2009). Similar observations have also been made in the 2004 White Rose EEM. Literature has also reported on the low chronic toxicity potential of a sedimentary SPM for flatfish (e.g., Payne et al. 1995).

Information from the environmental effects monitoring (EEM) program for the nearby White Rose production facility is used to characterize benthic habitat and associated communities, and to identify the potential zone of influence of the proposed exploration drilling program. The EIS can thus identify site specific potential effects of Project activities. Unfortunately, there are several important aspects of the local benthic environment that are not included:

1. The sediment type that underlies some of the EL area is different than that near the White Rose platform. Figure 4-3 shows that EL 1151 in particular is over the Sackville Moraine where surficial sediments are primarily gravels and not the sand found around White Rose. This means that the benthic fauna will be different and the sedimentary regime is likely to be quite different. This will be particularly significant for the deposition and eventual fate of the fine materials (>80%) associated with drilling muds and cuttings. The Proponent should characterize the benthic fauna and habitats of this area and evaluate the potential fate and effects of drilling wastes within the area of the Sackville Moraine.
2. The White Rose EEM program has identified the presence of corals and sponges in the benthic samples. However, this information is not included in the current EIS and the Proponent did not assess the importance of sensitive benthic species in the Project Area or the likelihood that there are significant densities of these species.

While the synthetic mud, inshore diesel and offshore crude oil numerical simulations are based on past simulations for projects located within the proximity of the proposed exploratory drilling, the previous simulations could not be evaluated during this review. The conclusions made throughout the document regarding numerical simulation modeling cannot be accepted due to the lack of documentation and supporting references.

Information within the EIS pertaining to vulnerable marine ecosystems (VMEs) and ecologically biologically significant areas (EBSAs) is incomplete and misleading. While some DFO and NAFO literature is cited, the maps in the EIS do not show the current VME or EBSA areas located inside or outside of the EEZ; nor the associated NAFO fisheries closures. The EIS should be updated to include current information pertaining to VMEs and EBSAs within or near the Study Area.

The EIS is also lacking an assessment of the potential for introduction of aquatic invasive species (AIS). This risk, which is related to the movement of equipment that has been moored in other environments, is not mentioned in the document. AIS should be assessed for the use of a mobile drilling unit. It is recommended that the EIS be updated to include an assessment of the possible introduction of AIS.

The EIS does not analyze the potential effects of project lighting on predator-prey interactions between fish and aggregations of fish. The following literature could be included: Keenan et al. 2007, Fujii 2016, Barker 2016, and Barker and Cowan 2018.

The mitigation measures, although "consistent with the seismic sound in the marine environment (Statement of Canadian Practice; SOCP)" could be improved. For example, better-trained marine mammal observers (MMOs) could be included (e.g., with previous MMO experience and proven species identification abilities), and ceasing some operations (e.g., blasting shaped charges or vertical seismic profiling [VSP]) in poor weather conditions or darkness. Furthermore, initiating shutdown procedures for non-SARA-listed small cetaceans is less precautionary than it could be.

Additional baseline information is recommend (e.g., pre-drill benthic surveys should be completed to identify the presence of species and life stages that are sensitive to Project operations (e.g., sensitive benthic species, larval fish, marine mammals, sea turtles, etc.).

Chapter 2.0 – Project Description

Section 2.6.1 The drilling waste dispersion models run for this EIS only include eight wells. Clarification is required on why 10 wells were not modeled. The models were initiated for a disposal site in the center of the Project Area. Additional information is required on how the dispersion footprints would change if the well sites were near the boundaries of the Project Area. Also, it is recommended that the EIS clarify whether there are sensitive benthic habitats in those areas, particularly toward the northeast and east, and how that might be affected by waste deposition.

Synthetic-based mud (SBM) cuttings from White Rose were modeled to have a large component (up to 70%) of very coarse material (>9.5 mm). In the SBM dispersion model runs in the EIS, such large particles were not included and the SBMs were considered to have >50% fines. The EIS should clarify why there is such a difference between the parameterization for the two studies, and how it affects the predictions.

Chapter 4.0 – Existing Marine Physical and Biological Environment

Some of the baseline information provided in the EIS is outdated and not directly applicable to all parts of the ELs. It is recommended that the EIS be updated with the latest literature to ensure an accurate characterization of the marine physical and biological environment (e.g., DFO Canadian Science Advisory Secretariat [CSAS] advisory documents post-2014).

4.1.3 – Physical Oceanography

Page 4.23. *"This current follows the shelf break with relatively low variability compared to the mean flow."* The EIS should explain which temporal scales are being discussed. It should be noted that the Labrador Current has important variability on seasonal and inter-annual scales.

Page 4.27. Table 4-6. Clarification is required on the difference between "mean speed" and "mean velocity."

Page 4.32. Reference material should be updated. For example, "*During the last 50 years there have been three warming periods in the Labrador Sea: 1960 to 1971, 1977 to 1983, and 1994 to present.*" Does "present" refer to 2018? It should be noted that the Labrador Sea is currently cooling (e.g., Yashayaev and Loder 2017).

Page 4.33. Figure 4-14. The caption of the figure should be changed. The maps are only for fall 2005 and are not representative of the long-term average as the caption suggests.

4.1.4 – Sea Ice and Icebergs

Ice Services Canada with Environment and Climate Change Canada should be consulted on information pertaining to sea ice and icebergs.

4.2.1 – Plankton

Page 4.46. The zooplankton data is outdated and focuses on Dalley and Anderson (1998) and Dalley et al. 2001. Section 4.2.1.3 should be updated to include recent literature.

Page 4.47. It is inaccurate to state that the movement of ichthyoplankton is passive. While the horizontal movements of ichthyoplankton are primarily driven by currents, ichthyoplankton do have some ability to move horizontally within a parcel of water in order to pursue prey (whereas directed movement towards a distant location is somewhat futile as the movement of the parcel of water is often more rapid than the movements of the ichthyoplankton within that parcel of water) and many species undergo diel migrations which gives them some control over where they go as current directions and speeds can vary by depth.

Page 4.48. Table 4.17. The relative abundance data is not current, as it is based on literature from 1997-98. There have been a number of significant shifts in population abundances since the late-1990s. It should be noted that 1997-98 was six to eight years after the collapse of many Newfoundland fish stocks during the early-1990s. Over the subsequent 20 years, many stocks have begun to recover (e.g., cod) while others remain at relatively low abundances (e.g., capelin). Additionally, there have been some larger scale shifts in ecosystem composition with the community beginning to shift away from one that is dominated by crab and shrimp towards a community dominated by groundfish. A second concern pertaining to this table is the use of abundance. The table should outline both abundance and biomass, as abundance estimates are biased towards small, highly abundant species whereas larger, less abundant species may have similar amounts of overall biomass, simply due to their substantially larger sizes/weights.

4.2.3 – Corals and Sponges

It is recommend that section 4.2.3 on corals and sponges be a sub-heading of section 4.2.2. Benthic species presence-absence data are presented in this section (Table 4.19). However, these are trawl-derived and represent aggregated data over long distances. While in many cases trawl-derived benthos data are all that is available, it should be recognized that this sampling method underestimates both benthic abundance/biomass and species richness. In an earlier study on sandy bottoms of the Grand Banks, only approximately 0.5% of standing benthic biomass is captured by the trawl. More accurate estimates of benthic biomass on the Grand Banks can be found from grab samples collected during the course of a three year trawl impact experiment (Prena et al. 1999, Kenchington et al. 2001) and a three year grab sampling program under the NL's expanded research on ecosystem-relevant but under-surveyed splicers

(NEREUS) program (Gilkinson 2013). The reference to spatial variability of benthos at small scales should be changed to a range of spatial scales (see Schneider et al. 1987).

It is also recommended that Table 4.19 be re-organized and updated as there are errors. The table should include taxon, not spp., as many taxa are identified to high levels only.

The baseline data presented on coral distributions from research vessel (RV) surveys should be updated, as the EIS' distribution maps of sea pens and black corals were based on 2014, 2015 DFO RV trawl surveys.

It is not clear how various spatial area terms throughout the EIS were applied. For example, “Special Areas” can be ambiguous as it can include VCs and ecologically and biologically significant areas (EBSAs), and it is not clear how Special Areas relate to corals and their distribution patterns. Also, the term “Fish and Fish Habitat” is a separate term (a VC) which includes corals, although corals can be present in areas not noted as fish habitat. The term “Benthic Habitat” is also used separately although this incorporates fish habitat.

There are few details in the EIS regarding the methods to be used to monitor drilling activities, although possible usage of a remotely operated vehicle (ROV) is stated.

Asconema sponges are not captured in the EIS. Please see Murillo et al. 2016 for depth distribution information.

Page 4.66. Figure 4-22. NAFO closures should also be included on the map.

Page 4.67. It should be noted that some soft corals and *Acanella arbuscula*, a gorgonian coral, are also found on soft mud substrates.

Page 4.70. Figure 4-25. This figure should be replaced; as it is quite difficult to view as it is distorted. It should also include small gorgonians (i.e., *Acanella arbuscula*) and include recent NAFO data.

4.2.4 – Marine Fish

Page 4.72. Table 4.22. The table lists the most abundant fish species (by weight) in the Study Area. Note that in fisheries stock assessment terminology, “abundance” is generally employed when discussing numbers of fish with respect to numbers per tow, etc. The use of abundance in this context is not clear. Appropriate terminology should be “Table 4.22 lists the 25 fish and shellfish species with highest captured weight (kg) from DFO multi-species surveys.”

The table refers to DFO 2017 as the reference for the data. The only reference that could be found within the documentation was “*DFO (Fisheries and Oceans Canada) 2017a. Research Vessel Data provided by Fisheries and Oceans Canada.”* If this is the reference document for Table 4.2.2 then the table should be changed to indicate DFO 2017a as the data source.

Page 4.74. Table 4.23. Although a number of data sources are noted, DFO 2017a is not included.

It should be noted that the European Union (EU) also conducts RV surveys annually in the summer which encompass NAFO Division 3M and the portions of Divisions 3L, 3N and 3O which are outside Canada's 200 mile limit. These data should be included in the EIS and are readily available online from the NAFO website.

It should be clarified whether Sculpin is currently a species of commercial, recreational or Aboriginal (CRA) value.

The meaning of column 3 (potential for occurrence in the Study Area) is unclear from the text and methodology note within the table *“This qualitative characterization is based on expert* *opinion and an analysis of understood habitat preferences across life-history stages, available species distribution mapping, and catch data for each species within the Study Area."* It should be clarified whether the table is referring to the potential for the species to occur within the overall Study Area or whether the table is referring to the much smaller Project Area. If the table is referring to the potential for the species to occur within the overall Study Area then most of the species should be designated as "high," as the timing of their presence is universally deemed to be "year round" and the "Study Area" is sufficiently large enough that representatives of these species can be readily found. If the table is referring specifically to the much smaller "Project Area" as designated in the EIS, then the maps, table title, and column headings should be adjusted. If the table is indeed referring to the larger "Study Area" then different terminology should be used. At a minimum, a more detailed explanation of what "Potential for Occurrence in the Study Area" should be provided to avoid misinterpretation.

Page 4.76. Table 4.25. The spawning period for Snow Crab should be changed from summer-fall to March-June.

The timing of presence for Northern Shrimp should be changed from May to September to year-round.

Page 4.77. Table 4.26. Blue Shark is listed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), but as of 2016 it is considered Not at Risk by COSEWIC. The error is also made on page 4.115 (Table 4.35) - section 4.2.8.

4.2.5 – Marine Mammals

In the table, figures and text in section 4.2.5.4, the authors list Killer and Humpback Whales; neither are SARA-listed.

Page 4.82. Table 4.27. White-Beaked Dolphins are now the most abundant cetacean in the NL region. As such, the table should change the Potential Occurrence for White-Beaked Dolphins from "Moderate to High" to "High."

4.2.6 – Sea Turtles

Page 4.91. Figure 4-31. The distribution pattern depicted in the figure is biased to offshore, as Sea Turtle sightings are a misleading result of offshore reporting by deep-sea fishing vessels (such as tuna fishers). Leatherback Turtles have been seen on the Grand Banks near the Project Area and also close to the shoreline.

4.2.9 – Special Areas

Outside of Canada's Exclusive Economic Zone (EEZ), two Ecologically and Biologically Significant Areas (EBSAs) were identified at a Convention on Biological Diversity (CBD, 2014) workshop in 2014. These areas, the Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank and the Slopes of the Flemish Cap and Grand Bank, overlap fully with the study area (see Figure 1), yet are not mentioned in the EIS.

Also, a re-evaluation of the Placentia Bay-Grand Banks Study Area (PBGBSA; NAFO Divisions 3NLOPs) to identify EBSAs took place through a CSAS Regional Peer Review Process in January 2017. Publications from this process will be available on the CSAS website in the near future. Information regarding EBSAs relevant to the scope of the Proponent's EIS are provided within this Science Response Report.

Following the re-evaluation, 14 EBSAs were identified and delineated in the PBGBSA (see Figure 1 and Tables 1 and 2): seven in coastal areas (Bonavista Bay, Smith Sound, Baccalieu Island, Eastern Avalon, St. Mary's Bay, Placentia Bay and South Coast) and seven in offshore areas (Northeast Slope, Virgin Rocks, Haddock Channel Sponges, Lilly Canyon-Carson Canyon, Southeast Shoal, Southwest Slope and Laurentian Channel). These EBSAs represent a total area of 130,783 km^2, which is approximately 36.7% of the entire PBGBSA (i.e., inside the EEZ).

The Project Area overlaps with one EBSA (Eastern Avalon), while the EIS Study Area overlaps with all or most of five EBSAs: Orphan Spur, Northeast Slope, Virgin Rocks, Lilly Canyon-Carson Canyon, and Southeast Shoal. A small portion of the Southwest Slope EBSA is also found in the EIS Study Area, and the Baccalieu Island EBSA is adjacent to the western boundary of the EIS Study Area. Physical features and sizes of relevant EBSAs are provided in Tables 1 and 2.

The Orphan Spur EBSA was identified during a CSAS process in 2012. There are no details regarding this EBSA in the EIS documents. As such, information is provided below and can also be found in DFO 2013 Wells et al. (2017).

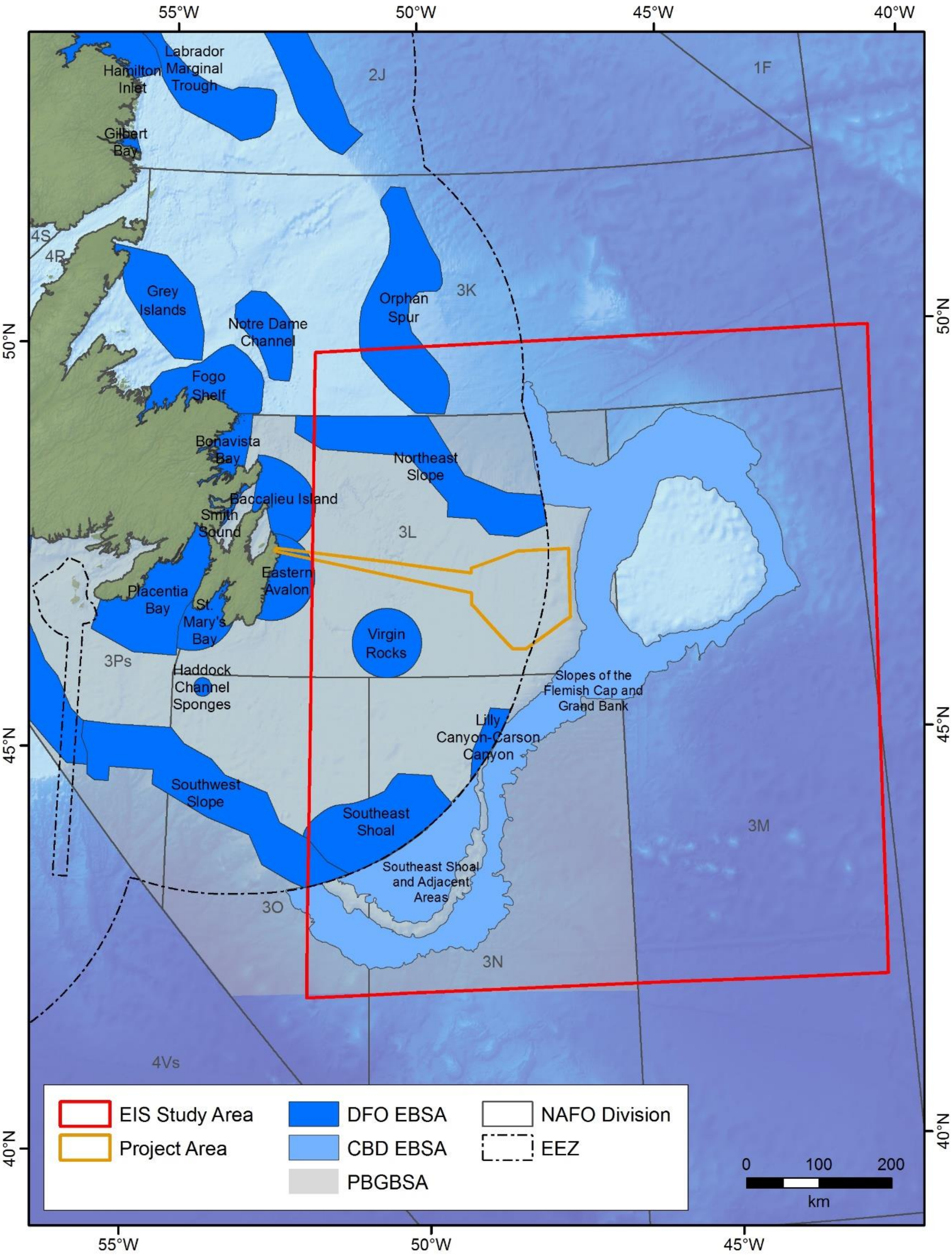

Figure 1. Map showing final EBSAs identified by DFO at a CSAS meeting held in 2017, as well as EBSAs identified at a CBD workshop in 2014.

Table 1. List of Coastal EBSAs indicating key features used to identify and delineate the EBSAs as defined by the Uniqueness, Aggregation and Fitness Consequences criteria, as well as presence of at-risk species.

EBSA (NAFO Div)	Uniqueness	Aggregation	Fitness Consequences*	At-risk species
Baccalieu Island (3L)	-	• Killer Whale • Mysticetes functional group • Capelin • Shrimp • Plankpiscivores (fish) • Spotted Wolffish • Pursuit-diving piscivores (seabird functional group) • Surface-seizing plankpiscivores (seabird functional group)	• Capelin spawning • Significant colonies/foraging - Atlantic Puffin - Razorbill - Black-legged Kittiwake	• Spotted Wolffish • Killer Whale
Eastern Avalon (3L)	• Atlantic Puffin colonies • Common Murre colonies • Thick Billed Murre colonies • Northern Fulmar colonies	• Eelgrass habitat • Capelin • American Plaice • Killer Whale • Mysticetes functional group • Plunge-diving Piscivores (seabird functional group) • Pursuit-diving piscivores (seabird functional group) • Surface, shallow-diving piscivores (seabird functional group)	• Capelin spawning • Significant colonies/foraging - Atlantic Puffin - Common Murre - Razorbill - Thick-billed Murre - Black-legged Kittiwake - Northern Fulmar	• American Plaice • Killer Whale

*As per Wells et al. 2017, fitness consequences would apply to all areas where at-risk species (IAs) important areas were found.

**60 km buffer could be considered a key feature for Northern Gannet, though mean maximum foraging range can be much greater.

Table 2. List of Offshore EBSAs indicating key features used to identify and delineate the EBSAs as defined by the Uniqueness, Aggregation and Fitness Consequences criteria, as well as presence of at-risk species.

EBSA (NAFO Div)	Uniqueness	Aggregation	Fitness Consequences*	At-risk species
Northeast Slope (3L)	• Shrimp • Greenland Halibut • Northern Wolffish • Spotted Wolffish • Roughhead Grenadier • Black corals	• Capelin • Shrimp • Greenland Halibut • Witch Flounder • American Plaice • Atlantic Cod • Atlantic Wolffish • Northern Wolffish • Spotted Wolffish • Thorny Skate • Smooth Skate • Roughhead Grenadier • Piscivores (fish) • Planktivores (fish) • Plankpiscivores (fish) • Small benthivores (fish) • Medium benthivores (fish) • Large benthivores (fish) • Large gorgonian corals • Sea pens • Black corals • Soft corals • Sponges • Common Murre (seabird; pursuit-diving piscivore; non-breeding) • Thick-billed Murre (seabird; pursuit-diving piscivore; non-breeding) • Hooded Seal	-	• American Plaice • Atlantic Cod • Atlantic Wolffish • Northern Wolffish • Spotted Wolffish • Thorny Skate • Smooth Skate • Roughhead Grenadier
Virgin Rocks (3LO)	• Unique geomorphological feature	• Sand Lance • Capelin • American Plaice • Sooty Shearwater • Thick-billed Murre • Killer Whale	-	• American Plaice • Killer Whale
Lilly Canyon-Carson Canyon (3N)	• Roughhead Grenadier	• Snow Crab • Greenland Halibut • American Plaice • Redfish • Roughhead Grenadier • Thorny Skate • Small benthivores (fish) • Common Murre • Sooty Shearwater • Shallow pursuit generalists (seabirds) • Surface, shallow-diving piscivores (seabirds) • Blue Whale • Harp Seals (winter feeding) • Soft corals • Sponges	-	• American Plaice • Redfish • Roughhead Grenadier • Thorny Skate • Blue Whale

EBSA (NAFO Div)	Uniqueness	Aggregation	Fitness Consequences*	At-risk species
Southeast Shoal (3NO)	• Offshore Capelin spawning • Yellowtail Flounder (juveniles, spawning, feeding) • American Plaice spawning	• Sand Lance • Yellowtail Flounder • Witch Flounder • American Plaice • Atlantic Cod • Atlantic Wolffish • Northern Wolffish • Thorny Skate • White Hake • Medium benthivores (fish) • Large benthivores (fish) • Shallow pursuit generalists (seabirds)	• Capelin spawning • Yellowtail Flounder (juveniles, spawning, feeding) • American Plaice spawning	• American Plaice • Atlantic Cod • Atlantic Wolffish • Northern Wolffish • Thorny Skate • White Hake
Southwest Slope (3OPs)	• Small gorgonian corals • Roundnose Grenadier • Haddock feeding and spawning • Redfish spawning	• Witch Flounder • Atlantic Halibut • American Plaice • Atlantic Cod • Northern Wolffish • Redfish • Roundnose Grenadier • Smooth Skate • Thorny Skate • White Hake • Winter Skate • Small benthivores (fish) • Large benthivores (fish) • Planktivores (fish) • Plankpiscivores (fish) • Piscivores (fish) • Surface, shallow-diving piscivores (seabirds) • Blue Whale • Black corals • Small gorgonian corals • Large gorgonian corals • Stony cup corals • Sea pens	• American Plaice spawning • Redfish spawning • Haddock feeding and spawning	• American Plaice • Atlantic Cod • Redfish • Northern Wolffish • White Hake • Smooth Skate • Roundnose Grenadier • Thorny Skate • Winter Skate • Blue Whale
Orphan Spur (3K)	• Atlantic Cod • Witch Flounder • Corals diversity	• Soft Corals • Sea Pens • Black Corals • Stony Cup Corals • Small Gorgonians • Roundnose Grenadier • Skates • Northern Wolffish • Spotted Wolffish • Atlantic Wolffish • Witch Flounder • American Plaice • Atlantic Cod • Redfish • Small Benthivores • Medium Benthivores • Large Benthivores • Piscivores	• Roundnose Grenadier • Skates • Northern Wolffish • Spotted Wolffish • Atlantic Wolffish	• Roundnose Grenadier • Skates • Northern Wolffish • Spotted Wolffish • Atlantic Wolffish

*As per Wells et al. 2017, fitness consequences would apply to all areas where at-risk species IAs were found.

Coastal EBSAs

EBSAs identified in coastal areas are described or delineated in Table 1 and Figure 1. The primary data layers that were used to delineate these areas included eelgrass habitat, salmon, Capelin spawning areas, seabird colonies and waterfowl areas. Data for the entire coast of Newfoundland are unavailable for many ecosystem features, particularly fish species. This is particularly true when considering the variability and scale of local ecological dynamics occurring in nearshore environments.

The distribution and abundance of breeding and foraging seabirds usually reflects the availability of prey in the marine ecosystems on which the birds depend (Birkhead and Furness 1985, Hunt 1991). Globally significant and persistent seabird colonies found on the east coast of Newfoundland are sustained by persistently highly productive waters nearby. The breeding season foraging ranges of piscivorous colonial seabirds were used as a proxy to indicate areas where a high abundance of forage species for these birds is likely to occur. In the absence of long-term tracking studies at individual colonies, use of mean maximum foraging range provides the most appropriate prediction of spatial use during breeding (Soanes et al. 2016; Bogdanova et al. 2014; Thaxter et al. 2012; Cairns 1987). These foraging buffers were used to delineate the seaward extension of some coastal EBSAs, and in most cases this resulted in IAs identified in offshore data layers being captured by the EBSA boundaries. Therefore, all offshore data layers were also reviewed within the boundaries of each coastal EBSA and key ecosystem features were identified based on the criteria described above. Important Bird Areas were reviewed and descriptions were incorporated into identified EBSAs. Though they were not used in the analyses, IBAs were used as a confirmatory step in the EBSA identification process. Community-based coastal inventory (CCRI) data were also reviewed to determine what species were present in each EBSA, but these data were not used in the identification of EBSAs.

Baccalieu Island (3L)

The Baccalieu Island EBSA (Figure 1) is centered on the island itself and extends north to Bonavista and south to Pouch Cove. This EBSA was identified because of important seabird colonies that are found on the Island. The foraging range of Atlantic Puffin, Black-legged Kittiwake and Common Murre (60 km) was used to delineate the seaward boundary. There are also several other key features in surrounding waters including IAs for Capelin, shrimp, plank-piscivorous fish, Spotted Wolffish and marine mammals.

Baccalieu Island is recognized as an important bird area (IBA) as it hosts the world's largest known nesting colony of Leach's Storm-Petrel. Approximately 3.4 million breeding pairs have been estimated, which represents approximately 40% of the global population and about 70% of the western Atlantic population of this species (IBA Canada 2018a).

The island also supports continentally and globally significant populations of Atlantic Puffin (30,000 pairs - approximately 7% of the eastern North America population); Black-legged Kittiwake (~13,000 - approximately 5 to 7% of the western Atlantic breeding population); and Northern Gannet (1,712 pairs - approximately 2.4% of the North American population). The island has the greatest abundance and species diversity of seabirds in eastern North America. Other seabirds nesting on the island include Common Murre, Thick-billed Murre, Razorbill, Black Guillemot, Northern Fulmar, Herring Gull and Great Black-backed Gull (IBA Canada 2018a). Baccalieu Island is the largest protected seabird island in Newfoundland and Labrador – the Baccalieu Island Ecological Reserve.

The enduring presence of such significant populations of mostly piscivorous seabirds is a strong indicator that surrounding waters are persistently highly productive and provide ample food for these colonies to thrive. This is confirmed by the presence of Capelin spawning areas at each of the three headlands captured within the boundaries of this EBSA. Also, Capelin and shrimp IAs are found within the foraging range of these seabirds. Plank-piscivore and Spotted Wolffish IAs are also found in this EBSA. All fish and shrimp IAs are located near the seaward boundary of the EBSA. DFO RV trawl survey data are not collected in shallow nearshore waters (i.e., closest set to Baccalieu Island is ~20 km away) so information on all fish and shrimp species are not available in these areas. However, acoustic surveys have been conducted closer to shore in this area and have confirmed the presence of Capelin aggregations (Mowbray 2014).

Killer Whales and Mysticetes IAs are found here based on sightings data. These cetacean species are also likely taking advantage of the highly productive waters in the area.

Eastern Avalon (3L)

The Eastern Avalon EBSA (Figure 1) is located on the eastern side of the Avalon Peninsula and extends from the southern boundary of Chance Cove Provincial Park north to Pouch Cove. The seaward boundary was delineated based on the foraging range (60 km) of piscivorous seabirds that occupy colonies within Witless Bay. This EBSA was identified based on a combination of coastal data, including Capelin spawning beaches, waterfowl areas and seabird colonies, with additional key features identified based on offshore data.

Eelgrass habitat is not particularly common in this EBSA but one area is found in Deadmans Bay and Blackhead Bay, just north of Cape Spear. Capelin spawning is more prevalent along the coast in this EBSA. The most northerly Capelin spawning beach is in Flatrock and the most southerly one is in Cappahayden. Twenty-seven other spawning sites have been identified between these two sites.

American Plaice IAs were found toward the outer boundary of this EBSA (and extending out on Grand Bank) during the Engel time series. IAs for this species have primarily been distributed on the Southeast Shoal and in Halibut Channel during the Campelen years. As with all EBSAs on the east coast of Newfoundland, Killer Whales and mysticetes are commonly sighted in the Eastern Avalon EBSA.

At least 10 species of seabirds have important colonies in this area, including the only significant Northern Fulmar colony in the PBGSA, near Bauline East. Furthermore, this area contains the Witless Bay Islands IBA, which supports the largest colony of Atlantic Puffins in eastern North America (IBA Canada 2018b). Significant colonies for six species are found on islands within Witless Bay. In addition to the only Northern Fulmar colony in the top decile being found here, two of three Atlantic Puffin colonies, three of five Razorbill colonies, five of fourteen Black-legged Kittiwake colonies, one of two Common Murre colonies, and both Thick-billed Murre colonies in the top decile for each respective species are located within this EBSA.

A high count of dabbling ducks observed within one coastal block polygon within the EBSA is believed primarily to be the result of anthropogenic rather than natural food resources in the vicinity of the city of St. John’s. Consequently, this information was not considered in the evaluation of this EBSA.

In addition, pelagic seabird transect survey data confirm IAs for several seabird functional groups in this EBSA: plunge-diving piscivores, pursuit-diving piscivores and surface shallow-diving piscivores. These birds rely on forage fish prey in the waters surrounding these islands and adjacent areas on the Grand Bank. Acoustic surveys have shown that Capelin are found in this area, with some years having higher densities than others (Mowbray 2014). This was confirmed by the presence of Capelin IAs in this area, however only the Engel fall IA took up a large portion of the EBSA.

Offshore EBSAs

Seven candidate EBSAs were identified in the offshore portion of the PBGSA, mostly based on the composite layer with spring RV data only (Table 2, Figure 1). Data layers used to identify offshore areas included those for corals and sponges, at-risk species, core fish species, fish functional groups, seabird functional groups and marine mammals.

In the offshore, using a combination of data and expert knowledge, much of the shelf edge and slope along the Grand Banks was highlighted as ecologically important based on measures of high productivity and diversity relative to the shelf itself. The most significant areas of aggregation were often associated with areas of unique bathymetry, such as banks, channels, slopes, shoals, troughs, canyons and fjords. Some areas along the shelf edge and slope fall outside the PBGSA, but nonetheless were delineated as EBSAs (see below).

Northeast Slope (3L)

The Northeast Slope EBSA (Figure 1) is found on the northeast edge of Grand Bank and extends from the Trinity Basin east and south along the shelf edge and slope to the Sackville Spur. This EBSA was delineated based on the composite layer (spring RV survey data only). The northwest boundary was extended westward based on the composite layer including both spring and fall RV survey data, as well as IAs for sponges, Atlantic Cod, shrimp, Greenland Halibut, and Spotted Wolffish. The northeast portion of this EBSA, which includes the Labrador Slope and part of the Trinity Trough, is adjacent to the southern boundary of the Orphan Spur EBSA (DFO 2013). The key data layers that contributed to this area include those for Capelin, shrimp, Greenland Halibut, Witch Flounder, American Plaice, Atlantic Cod, all three species of wolffish, Thorny Skate, Smooth Skate, Roughhead Grenadier, all six fish functional groups, sea pens, black corals, soft corals, sponges, Common and Thick-billed Murre and Hooded Seals. Several other species or functional groups are also found here.

Most species or functional groups were identified here based on the aggregation criterion. However, six species were identified based on the uniqueness criterion: two core fish species (Greenland Halibut, shrimp), three at-risk species (Northern and Spotted Wolffish and Roughhead Grenadier) and a coral functional group (black corals). This was the only IA for Greenland Halibut on the Engel fall data layer. While Greenland Halibut were found outside this EBSA boundary on other data layers (i.e., Campelen fall, Campelen spring, Engel spring), the majority of all high concentration areas for Greenland Halibut were found in this area. Similarly for shrimp, the IA on the Campelen fall data layer was found in this area, but extends southwest and southeast beyond the EBSA boundary. One of two shrimp IAs on the Campelen spring data layer had a similar distribution. The other, much smaller, IA for shrimp is found along the South Coast of Newfoundland. Most of the IAs for all the threatened Northern Wolffish data layers (except Campelen spring) are found within this EBSA and extend from the Trinity Basin area along the shelf edge and onto the Labrador Slope. Spotted Wolffish (also threatened) show a similar distribution and this area was confirmed as being important for this species by Kulka et al. (2004). Roughhead Grenadier (special concern under COSEWIC) IAs are found on the Slope in this EBSA with distributions extending to the Sackville Spur. The only Roughhead Grenadier IAs found in the PBGSA on the Engel fall data layer were found in this EBSA. Finally, black corals, which are a rare, non-aggregating species, were found in this EBSA. Only two black coral IAs were found in the PBGSA: in this EBSA along the Labrador Slope and in the SW Slope EBSA; both were small in size.

Five other at-risk species were found here as key biological features, meaning the fitness consequences criterion applies to them, along with the three at-risk species discussed above. American Plaice IAs were generally distributed across the Grand Bank during Engel years, with one large IA being found on the shelf edge in the NE Slope EBSA. In the Campelen years IAs identified for this species shifted southward towards the Southeast Shoal, with the exception of one small IA which was found in the NE Slope EBSA. Large IAs for Atlantic Cod were found in this EBSA in three of four data layers. Cod IAs on the Campelen spring layer were found in 3NOP only. Atlantic Wolffish IAs are found in two main areas in the PBGSA – the NE Slope EBSA and the SE Shoal EBSA. A few other IAs are found outside of these EBSAs but not consistently across data layers like those found in the NE Slope and SE Shoal areas. Smooth Skate and Thorny Skate IAs were found in the NE Slope EBSA during the Engel years but IAs for these species were only found in more southern areas (SW Slope, Laurentian Channel for both species; SE Shoal for Thorny Skate) during the Campelen years.

Other core fish species found here include Capelin and Witch Flounder. Capelin IAs were mainly found throughout the northern portion of NAFO Division 3L, including the NE Slope EBSA, on all data layers except Engel spring, which showed a more southerly distribution. It was noted by Carscadden et al. (2013) that Capelin distributions have changed over the last few decades. However, the methods used to find IAs may not be sufficient to see the finer-scale spatial and temporal changes for this species that appear to be influenced by factors such as temperature and population abundance. Witch Flounder IAs were mainly found throughout the NE Slope EBSA, the SW Slope EBSA and the Laurentian Channel EBSA and this pattern was consistently found on all data layers for this species.

The majority of fish functional group IAs were found in EBSAs that were identified on shelf edges and slopes, including the NE Slope EBSA. Small benthivore IAs were found in this EBSA on all four data layers. Planktivore IAs were found here only on Campelen data layers. Medium benthivores and piscivores were found here on only fall data layers. Large benthivores were found here only on the Engel fall data layer. Plankpiscivores were found here on all data layers except Campelen spring. Piscivore IAs were found here only on fall layers. A review of all Piscivore IAs revealed that the Laurentian Channel and SW Slope are more important areas for this functional group.

Other than black corals, two other coral groups, plus sponges, are found in this EBSA. Large gorgonian IAs were found in patches along the Labrador Slope in this EBSA and the same areas were identified as significant benthic areas (SBAs; Kenchington et al. 2016). Soft coral IAs were found all along the Labrador Slope to the EEZ boundary. Sponge IAs were found near the Trinity Moraine/Trinity Basin end of this EBSA, however this IA was not confirmed by the presence of a sponge SBA.

During non-breeding, Common Murre are found in the eastern half of this EBSA, as well as areas north and south, with concentrations occurring there during early and late winter. Thick-billed Murre are found throughout the middle of this EBSA and as far south as the Virgin Rocks EBSA during early winter. Finally, Hooded Seals are found in this EBSA in the Labrador Slope area as well as areas north and south. They feed primarily on squid, Arctic Cod, Atlantic Cod, Greenland Halibut and redfish in the deep waters along the shelf edge during the winter (December to late February) prior to pupping and in late April-May after pupping has finished (Hammill and Stenson 2000, Stenson, pers. comm.).

Virgin Rocks (3LO)

The Virgin Rocks EBSA (Figure 1) is found at the center of the Grand Bank and includes a unique geomorphological feature that covers several square kilometers. Shallow shoals of jagged underwater ridges and rocks are nearly exposed in some areas – as shallow as 3.6 m from the surface of the water (Rao et al. 2009).

This EBSA was originally delineated based on the composite layer (spring RV survey data only), meaning a high diversity of species aggregate here. A review of individual data layers revealed that most IAs were located south of the Virgin Rocks. However, it was decided to modify the boundary to encompass areas north, south, east and west of the Virgin Rocks feature. The radius of the circle (~50 km) was chosen based on the distance from the center of the Virgin Rocks to the outer edge of the grid cell in the top 60% of the spring composite layer.

A subsequent review of all data layers revealed that the key features in this area are core fish species, at-risk species and pelagic seabirds. Core fish species include Sand Lance and Capelin, which constitute important prey for predatory seabirds, fish and cetaceans, were also found in high concentrations in this area (Table 2). It is worth noting however, that Capelin IAs were only found here on the Engel spring data layer. In Campelen years (1995-2016), Capelin IAs were generally found further north. Given that Capelin distributions have changed over the last few decades (Carscadden et al. 2013), the methods used to find IAs may not be sufficient to see the finer-scale spatial and temporal changes for this species that appear to be influenced by factors such as temperature and population abundance.

American Plaice IAs on Engel fall data layer cover a large portion of the Grand Bank and includes the Virgin Rocks. An IA for Sooty Shearwater covers most of this EBSA and extends east and south to the EEZ. A Thick-billed Murre IA also covers this EBSA and extends north to the PBGSA boundary. While none of the pelagic seabird IAs were considered key features of this EBSA, it is worth nothing that IAs for five seabird functional groups were found here. Finally, an IA for Killer Whales was found at the center of this EBSA.

This area was identified as a Special Marine Area by CPAWS (Rao et al. 2009) and is described in that report as an area with high plankton productivity and diverse and productive kelp beds. This area also has important spawning habitat for Atlantic Cod, American Plaice and Yellowtail Flounder, and is a congregation area for Capelin and seabirds.

Lilly Canyon-Carson Canyon (3N)

The Lilly Canyon-Carson Canyon EBSA (Figure 2) is found just inside the EEZ on the western edge of Grand Bank. This EBSA was delineated based on the composite layer (spring RV survey data only) and includes the Lilly Canyon and Carson Canyon, which were previously identified as an EBSA (Templeman 2007). The new EBSA boundary includes the shelf and slope areas surrounding the canyons. The key species with IAs in this EBSA include Snow Crab, Greenland Halibut, American Plaice, redfish, Roughhead Grenadier, Thorny Skate, Common Murre, Sooty Shearwater, soft corals, sponges, Blue Whales and Harp Seals. The key functional groups include small and large benthivores (fish), shallow pursuit generalist seabirds and surface shallow-diving piscivores. Most features were identified based on either the aggregation or fitness consequences criteria; however, Roughhead Grenadier was identified here based on uniqueness. The IAs for this species on the Campelen fall data were mainly found in this EBSA, although one small area was found at the east end of the NE Slope EBSA, extending beyond the EEZ.

As this EBSA is relatively small compared to other offshore EBSAs, most key features were found throughout the entire EBSA. IAs were found here on two or more data layers for most fish species. Small benthivore IAs were found here on all four data layers. IAs for some species (i.e., Harp Seals, Sooty Shearwater, Common Murre) were found in this EBSA and over large parts of the eastern Grand Bank, including the shelf edge and slope. Soft corals are found mostly in the southern end of this EBSA on the shelf edge. Sponge IAs were found in deeper waters near the EEZ boundary, while a small sponge SBA was identified between the 200 m and 500 m bathymetric contour in Carson Canyon near the north end of the EBSA. This area is also known to have a high proportion of Iceland Scallops (Ollerhead et al. 2004, DFO 2016).

Southeast Shoal (3NO)

The Southeast Shoal EBSA (Figure 2) is found just inside the EEZ on the southeast portion of Grand Bank. It includes the portion of the Southeast Shoal inside the EEZ as well as part of the Outer Shelf Zone of the Grand Bank. This area was originally a smaller area delineated based on the 60% composite layer (spring RV survey data only) but the area was extended to incorporate IAs for Atlantic Wolffish and American Plaice, two at-risk species.

Most species and functional groups were identified here based on the aggregation criterion but there are some unique features of the SE Shoal and the area has fitness consequences for several species.

In terms of fitness consequences, this area has previously been noted as an important feeding, spawning and juvenile area for Yellowtail Flounder (Frank et al. 1992, Walsh 1992, Walsh et al. 2001, Kulka et al. 2003, Fuller and Myers 2004, DFO 2016), an important nursery area for American Plaice (Walsh et al. 2001, Walsh et al. 2004) and a spawning area for Capelin (Carscadden et al. 1989, Fuller and Myers 2004). Furthermore, the SE Shoal is the only EBSA that contains IAs for Yellowtail Flounder, making it unique. Walsh et al. (2001) stated that the SE Shoal is the single nursery area of the entire stock of Yellowtail Flounder. In their report, they proposed both small and large closed areas based on their distribution. American Plaice IAs were found here and south of the EEZ during Campelen years but were mostly distributed further north over the Grand Bank in earlier years. American Plaice spawning also occurs in this EBSA but a small portion of this spawning area extends into the Southwest Slope EBSA (see below).

Capelin IAs were found in a small portion of this EBSA (and further south outside the EEZ) in the spring data layers. The SE Shoal has been identified as the only known Capelin offshore spawning site on Grand Bank (Templeman 2007, Fuller and Myers 2004). However, at least one earlier study has indicated that Capelin appear to spawn at various places on offshore bank areas provided that suitable bottom conditions are available at proper depths (Pitt 1958).

Several at-risk species, other than those discussed above, have IAs in this EBSA. These include Atlantic Wolffish, Northern Wolffish, Thorny Skate and White Hake. As mentioned above, Atlantic Wolffish IAs are found in two main areas in the PBGSA – here and in the NE Slope EBSA. The only IA for White Hake based on Engel fall data was found here, although this may not be representative as the Engel trawl was less efficient than the Campelen trawl at catching small fish (Kulka et al. 2005).

Core fish species that have key IAs here include Sand Lance and Witch Flounder. Sand Lance IAs are distributed across 3NOP during Engel and Campelen years, with some IAs falling within the SE Shoal EBSA. Witch Flounder are mainly found in the Laurentian Channel, SW Slope and NE Slope EBSAs, with some IAs falling within the SE Shoal EBSA boundary.

Medium and large benthivore fish functional group IAs are found on the northeast side of this EBSA but are not unique to this area.

Though not unique to this area, this EBSA encompasses a large portion of the largest contiguous cluster visible on the IA layer for shallow pursuit generalist seabirds, likely indicative of occurrence of forage fish resources in this area.

While the Mysticetes functional group IA was not a key feature of this area, Whitehead and Glass (1985) described the significance of this area to humpback whales and other cetacean species. They noted that, during the summer months, humpbacks concentrated on the central part of the shoal over concentrations of prey, which were likely spawning Capelin.

Walsh et al. (2001) also indicated that the SE Shoal contains the highest benthic biomass on the Grand Bank.

Southwest Slope (3OPs)

The Southwest Slope EBSA (Figure 1) extends along the southwest slope of Grand Bank from the southern end of the Laurentian Channel to the boundary of the EEZ. It ranges in depth from 200 m to just over 2,000 m. This EBSA was delineated based on the 60% composite layer (spring RV survey data only), meaning it contains important areas for a number of species and taxonomic groups. The boundary was extended to the south to capture IAs for corals and species at risk. This EBSA had a high number of key features, similar to the NE Slope EBSA. While the NE Slope EBSA had more unique and aggregating features, the SW Slope had more features based on fitness consequences. In the SW Slope EBSA, at-risk fish species, corals and fish functional groups were the main groups driving the patterns appearing in the composite layer. Witch Flounder IAs are found here along with IAs for 11 at-risk species: American Plaice, Atlantic Cod, Northern Wolffish, redfish, Roundnose Grenadier, Smooth Skate, Thorny Skate, White Hake, Winter Skate and Blue Whale. IAs for five fish functional groups are found here, including small and large benthivores, planktivores, plankpiscivores and piscivores. Coral IAs include those for black corals, small and large gorgonian corals, stony cup corals and sea pens. Finally, surface shallow-diving piscivorous seabird IAs are found here.

Many of the IAs for individual species are found throughout the entire length of the SW Slope EBSA (Witch Flounder, redfish, Thorny Skate, White Hake, Blue Whale). The same can be said for several of the fish functional groups (small and large benthivores, plankpiscivores, piscivores). However, the IAs for some species were mainly concentrated in the northwest end of the EBSA (Atlantic Cod, Winter Skate) while others like Northern Wolffish were concentrated in the southeast end of the EBSA. American Plaice IAs were found at both ends. Other IAs were found all along the SW Slope but not beyond the edge of Halibut Channel (Smooth Skate, planktivores fish functional group). Surface, shallow-diving piscivore seabird IAs were found from the center of the EBSA and extending toward the southeast, with the largest IA directly south of Whale Deep.

Most of the coral IAs were generally found beyond the 200 m depth contour. A small black coral IA was found near the southeast end. Large gorgonian coral IAs were mostly found in the northwest end of the EBSA but one large IA was found in same area as the IAs for black coral and surface shallow-diving piscivorous seabirds. Stony cup corals were found all along the slope as far as Halibut Channel. Another small IA is found at the north end extending into French territorial zone/Laurentian Channel. Sea pen IAs are found in patches all throughout the length of the EBSA.

In 2007, a research team completed a deep-sea cruise at three stations that all fall within the boundaries of the SW Slope EBSA: Haddock Channel, Halibut Channel and Debarres Canyon. The objective of this cruise was to collect in situ observations of deep-sea corals in the area. Over 160,000 coral colonies were enumerated and 28 species were found over seven remotely operated platform for ocean science dives (ROPOS; Baker et al. 2012). This study confirmed the presence of many of the coral species and groups that were found here during DFO RV surveys.

In terms of uniqueness, all known small gorgonian IAs in the PBGSA were located in this EBSA. However, a small SBA for small gorgonian corals also occurs in 3L (see Kenchington et al.

2016, Figure 54), and is not included within the boundary of any EBSA. The majority of IAs for Roundnose Grenadier were found throughout the entire EBSA. Finally, a haddock feeding and spawning area, as well as a redfish spawning area (Ollerhead et al. 2004) that was digitized during the 2016 EBSA refinement process (DFO 2016) was included as an overlay in this area and is captured almost entirely by the candidate EBSA boundary.

The American Plaice spawning area digitized from the 2016 EBSA refinement process (DFO 2016) is mainly concentrated in the SE Slope EBSA, however a small portion of it extends into the SW Slope EBSA. The Atlantic Halibut areas acquired during the 2016 EBSA refinement process also fall within the boundaries of this EBSA. A review of RV survey point data for this species revealed that they are found in many other areas throughout the PBGSA. These areas include the SE Shoal, the Laurentian Channel, and areas outside the EEZ boundary.

Orphan Spur

The Orphan Spur EBSA encompasses a large area that extends along the Labrador Slope and outer shelf in NAFO Division 3K, and includes the Orphan Spur and part of the Trinity Trough Mouth Fan. The northern portion of the EBSA extends from 400 m to 2,000 m depth, although south of the Orphan Spur the maximum depth is approximately 1,000 m. Similar to the Labrador Slope EBSA, this area is high in diversity as a number of species are found here in high concentrations. The dominant data layers used to identify this EBSA were those for corals, fish, marine mammals and seabirds, including rare or endangered fish species. Black Corals, Sea Pens, Small Gorgonians, Soft Corals and Stony Cup Corals are all found in parts of this EBSA in high concentrations. During the Campelen period, high densities of Witch Flounder, American Plaice, Atlantic Cod and redfish were distributed throughout the EBSA. Several rare or endangered fish species (Spotted, Northern and Atlantic Wolffish, Skates and Roundnose Grenadier) were found throughout this EBSA in large concentrations during the Campelen period, with the wolffish species heavily influencing the demarcation of the southwestern boundary. With the exception of planktivores and plankpiscivores, many of the fish functional groups were abundant throughout this EBSA during both Campelen and Engel periods. Female Hooded Seals are found in this area from August to September, while Harp Seals feed here during the winter. Also, several seabird species (murres, storm petrels, Black-legged Kittiwake, Great Black-backed Gull, skuas and jaegers, Northern Fulmar, Greater Shearwater, Sooty Shearwater, Dovekie) have been known to frequent this area. Bycatch data have shown that this area seems to be important to several species of sharks. Coral bycatch has been recorded to 1,300 m depth in this area, and the Orphan Basin area to the east of this EBSA is known to be important for a diverse array of marine birds and other taxa. Although similar habitat types would be expected in the Orphan Basin based on the geomorphology of the area, data are generally limited beyond 1,000 m. Therefore further exploration into the ecological significance of this area is highly recommended if management action is contemplated.

EBSAs outside the EEZ

The 60% composite layers (both for spring and spring/fall) were used to delineate areas outside the EEZ (Figure 2). While describing these areas in detail is beyond the scope of this report, the overlap or adjacency of these areas with EBSAs that were identified by the Convention on Biological Diversity (CBD; 2014) is noteworthy. Further to that, it is interesting to note that the areas in the 60% composite layer on the Southeast Shoal mostly fall outside (between) the boundaries of the two areas identified by the CBD. Further investigation into the features of these areas is required to determine the reason for this observation.

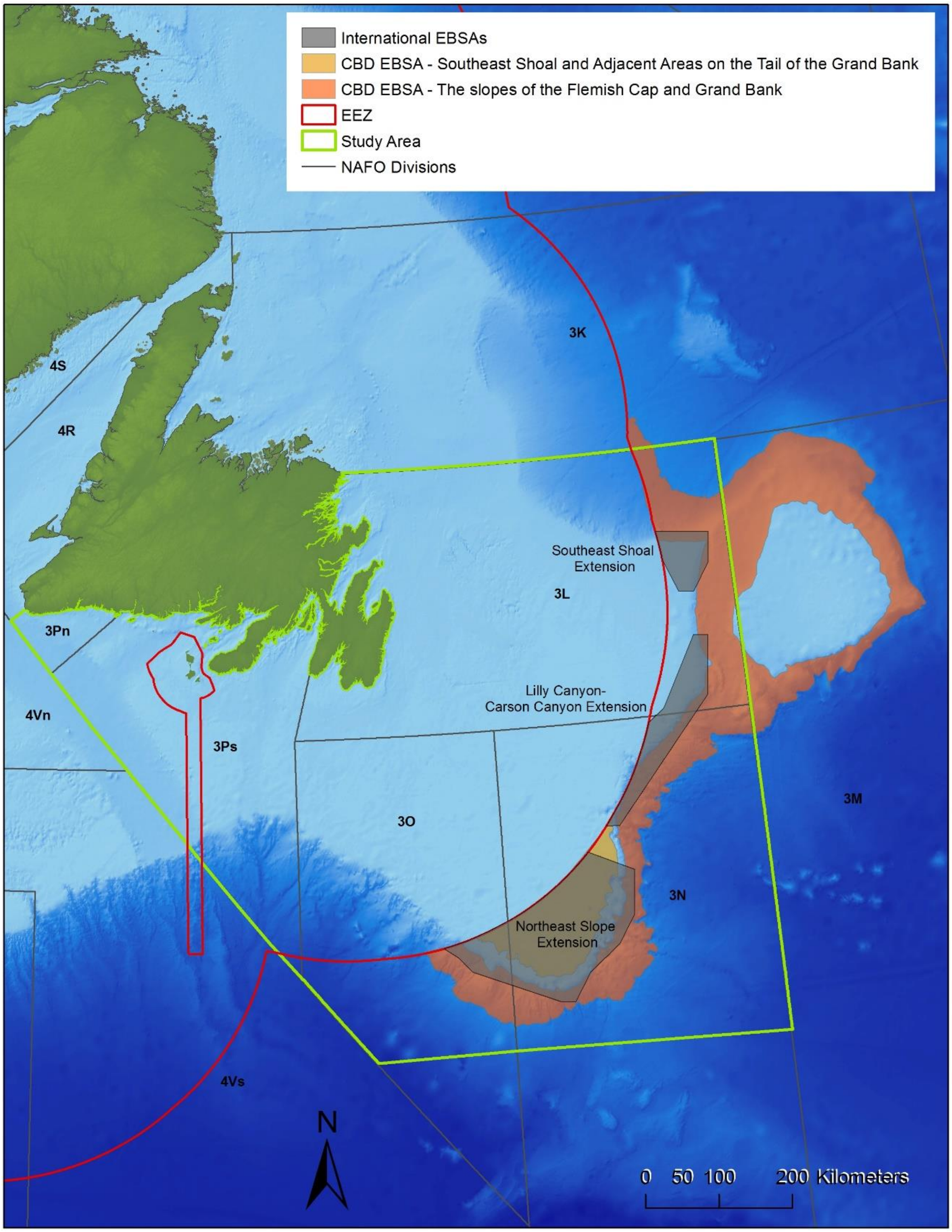

Figure 2. EBSAs identified in international waters based on composite layers.

4.3.1 – Commercial Fisheries

Tables 4.40 and 4.41 do not accurately represent Northern Shrimp quotas in the Study Area. Allocated quotas are not divided by NAFO Divisions 2J or 3K, nor are there quotas for small geographical areas within each Shrimp Fishing Area (SFA). Quotas for the large-vessel shrimp fleet, and for vessels licensed through provinces other than NL, are missing.

The text in section 4.3.1.6.1 (Northern Shrimp) heavily emphasized the stock in SFA 6, when only a small portion of the Study Area overlaps that SFA and none of the Project Area does. In addition, it appears that 3M makes up a significant portion of the Study Area but there is little reference to the area within the document. This stock (as well as the stocks for 3L, 3N and 3O) are assessed via NAFO and documents are available on the NAFO website.

Chapter 6.0 – Environmental Effects Assessment

6.1 – Fish and Fish Habitat

Page 6.2. Several sub-lethal effects were not discussed such as reduced growth rates, decreased fecundity, altered reproductive success, increased vulnerability to predation, changes in the quality of eggs/sperm, decreased larval survival rates, etc. These effects can have profound impacts on fish populations.

Page 6.8. The EIS states "*Underwater sound associated with offshore supply vessel (OSV) traffic is not expected to be at levels that would cause health effects, injury, or mortality to marine fish species; therefore, operation of the OSVs (including transit and transfer activities) is not predicted to result in a change in risk of mortality for fish and fish habitat. Fish are also anticipated to temporarily avoid the immediate areas of OSV traffic, thereby reducing the risk of fish mortality or physical injury due to vessel strikes or contact with propeller blades*." However, on page 6.1 it is noted "*The definition of "fish" under the Fisheries Act is inclusive of marine mammals and sea turtles as marine animals; however, marine mammals and sea turtles are considered as a separate VC in section 6.3.*" It should be clarified that noise/encounters with vessels for marine mammals and sea turtles may be an issue.

In addition to not including several sub-lethal effects, the risk of bioaccumulation is not discussed.

Page 6.9. The EIS states that helicopters may result in changes in habitat quality and use. However, the EIS also states in section 6.1.9 "*operation of OSV's is not predicted to result in risk for fish and fish habitat*." Table 6.3 also indicates that operation of helicopters could change habitat quality and use. It is recommended that discrepancies be made consistent possibly by separating the effects of helicopters from those of OSVs.

"*The loss of fish habitat will be mitigated through compliance with the* Fisheries Act *including potential requirements for offsetting if required*." Clarification is requested on whether the offsetting occurred with respect to other offshore oil and gas developments. Additional information on context would also assist. A copy of the Proponent's Environmental Protection and Compliance Monitoring Plan (EPCMP) is recommended in the EIS.

Page. 6.10. The sound rules are based around fish two grams and heavier. Clarification is requested regarding whether seasonal shutdowns will be used when there are high numbers of eggs/larvae in the area. They have less ability to avoid the gear than larger fish and with regional current flows, plus extended use of surveys, it would be possible for large numbers of eggs/larvae to be harmed over a period of several days with fish being transported through the activity areas.

Page 6.11. The EIS references Sætre and Ona 1996 to demonstrate that the use of acoustics would have minimal effects on fish larvae for many types of zooplankton in a field study using a single seismic survey air gun. The EIS should clarify why the assumed conditions in the simulation can be considered applicable to the present situation. Literature is also required to support the conclusions that the lethal radius of each air gun is only two meters (see McCauley et al. 2017).

Page 6.12. The EIS states that there were no effects of sediment deposition beyond 1,000 m from the drill site, but the context of the passage within 1,000 m is ambiguous.

Clarification is requested on burial patches. For example, the EIS states that some patches 100-200 m from the well site will be buried 1-10 mm thick, and that some locations will be buried 25 to 50 mm thick. It should be noted that 1-10 mm patch burials can be fatal for some infauna with low motility.

Page 6.13. Clarification is recommended on the concentrations of polycyclic aromatic hydrocarbon (PAHs) around existing sites at depths with the highest densities of larvae and the layers with highest densities of zooplankton. At what concentrations of PAHs did they start seeing effects on nauplii metabolism?

Page 6.14. It is unclear as to how total petroleum hydrocarbon (TPH) is related to PAH, or what proportion of TPH is PAH. Given the concentrations of TPH, it is plausible that fish within 5 km and possibly up to 8 km away from the source are potentially experiencing harm from PAH given the sensitivities of herring larvae to PAH. It is recommend that a broader review of species and life-stages sensitivities to PAH be provided in order to give a clear view of the potential for harm from PAH.

Page 6.16. It should be noted that fish/squid will be attracted to the sea surface at night which will increase their risk of predation by both fish and seabird predators.

Page 6.17. This section does not include the potential lethal and sublethal effects of surveys on fish (particularly eggs, larvae and juvenile (e.g., fish under 2 g mentioned elsewhere) and zooplankton. In prior sections, the cited literature substantiating minor impacts used seismic equipment which appears to be less powerful than the equipment currently in use. A recent paper by McCauley et al. (2017) found that marine seismic survey air gun operations could have significant negative effects on zooplankton up to 1.2 km (and potentially beyond) from the source with large numbers of dead adult and larval zooplankton and high mortality rates for larval krill. It is plausible that intensive, multiday surveys over small regions could cause local mortality for zooplankton in the Study Area and in downstream waters. This could have strong negative effects on fish and life-stages of fish that have limited abilities to move to new habitats in search of food.

Additionally, benthic macroinvertebrates could be affected by the drilling associated survey as many have pelagic larvae which may suffer mortality or physical malformations following seismic surveys (McCauley et al. 2017). This could potentially be examined by looking at settlement rates of benthic macroinvertebrates at areas that underwent seismic surveys versus areas without seismic surveys.

Page 6.19. This EIS considers only smothering as a significant and short term effect with a threshold at 10 mm. It does not take into account the more recent literature on effects on sensitive benthic species and the potential for interference with feeding, etc. or the recent studies of Trannum et al. (2010) where benthic communities were affected by 3 mm of WBM. In addition to effects on sediment oxygen, the authors suggested that the observed effects may be also related to the sharpness of WBM particles when compared to natural sediments, and recommend a reconsideration of attributing WBM effects to purely physical (smothering) processes.

Page 6.22. Sufficient information has not been provided to determine that the magnitude of the effects from the proposed Project will be low or that the extent of the effects will be localized. More information is needed on water column PAH concentrations for a range of depths and distances from the source. In addition, information is needed on the tolerance of fish larvae, eggs, and zooplankton to PAH both in terms of mortality and for sub-lethal effects (e.g., deformities, changes in fecundity, etc.).

Similarly, more information is needed on the effects of seismic survey on fish eggs and larvae and on zooplankton. Much of the cited literature is outdated and cites air guns with lower power than existing methods, and frequently uses only a single air gun rather than an array of air guns.

Changes in habitat quality are considered to be reversible at the completion of the project. An estimated timeframe for reversal to occur and the basis for that estimated timeframe should be provided.

Page 6.23. The geographic extent of the “Drilling Associated Surveys” listed as the Study Area should be clarified. Will the effects be this widespread i.e., not localized to the drill area?

Page 6.24. It is recommended that monitoring include measurements of water column PAH at multiple depths and distances from the source.

With respect to acoustic surveys, it would be useful to track settlement rates for microbenthic organisms following seismic surveys to monitor effects on recruitment.

Page 6.24. No follow-up monitoring has been proposed other than compliance monitoring and the EEM program. Considerations about EEM for exploratory drilling are contained in an earlier ESRF Report by Buchanan et al. (2003).

6.2 – Commercial Fisheries

It is now commonly accepted, that from a more practical consideration, spills, “large and small” have potential to foul fishing gear as well as taint fisheries resources. This could lead to fishery closures for some time with attendant economic consequences. However, considering small boat spills, risks from the fishing and transportation industries would be expected to pose greater risks than occasional small boat traffic associated with exploratory drilling.

Throughout the assessment, the ecosystem is indicated as “non-pristine.” However, this determination is not presented or justified in the EIS. It is an important aspect of the analysis and should be included.

Note that on page 6.81 bird effects are considered in an “undisturbed” context while Table 6.21 says disturbed.

6.3 – Marine Mammals and Sea Turtles

The noise exposure criteria section 6.3.10.1.3.2 (plus subsequent sections discussing effects and residual effects) should also cite the most recent review of marine mammal behavioural responses (e.g., see Gomez et al. 2016).

The qualifications for MMOs should be described/stated in the mitigation section (6.3.10.2, 6.3.12, and elsewhere). Canada does not yet have formal training standards for MMOs; it is essential that in potential circumstances of injury (e.g., well VSP or unpredictable support vessel movements) that the MMOs have sufficient skill to detect and identify nearby mammals or sea turtles. This is particularly important if the mitigation measure, such as source array shutdown, is to be implemented only for Schedule 1 SARA-listed species.

While it is useful to state that MMOs would be monitoring for marine mammals during activities such as wellhead abandonment blasting or VSP surveys, these types of activity should only occur when the MMO would have a high probability of detecting a marine mammal or sea turtle. The operator should commit to not conducting these types of operations in high sea states, fog, or low light conditions.

Page 6.53. While sound propagation has been shown to vary widely depending on location, source characteristics, and season, it is likely that operational sounds could be detected by marine mammals far outside the 120 dB propagation modeling distances which are cited in the EIS. Even during ramp-up, airgun sounds have been detected more than 50 nautical miles from their source (although the source was usually in deeper waters than most of the Project Area). DFO deployed an acoustic recorder in 1,100 m of water on the western side of the northern Flemish Pass in 2018; at this location vessel noise (at low amplitude) from the Hibernia/Hebron complex was detected (Delarue et al. 2018). This parallels the results of the JASCO acoustic programme in this area.

Page 6.56. The conclusion that *"… there are no known feeding areas or sensitive areas; thus, concentrations of marine mammals, and especially sea turtles, are unlikely*" is incorrect. Large groups of marine mammals are seen in the offshore and this combined with low survey effort, does not negate the possibility that there could be predictable or persistent areas of aggregation within the region in the Study Area where operational sounds or spills may occur.

Page 6.57. There has been reports of ship strikes to large whales by support vessels on the Grand Banks. Given sea states, fog, and night operations this vessel impact could be more than "short term" for an animal which is struck by a transiting supply vessel. At a minimum, vessel operators should immediately report a possible vessel strike to DFO, and take imagery of the animal if seen. This apply applies to other sections of the EIS discussing supply and servicing vessel operations.

Page 6.63. If there is a vessel strike (or any other serious marine mammal or turtle issue), the Proponent should contact DFO's contractor at Tangly Whales (888-895-3003), or DFO (jack.lawson@dfo-mpo.gc.ca; Jackie Kean Jackie.Kean@dfo-mpo.gc.ca)

6.5 – Special Areas

Literature is required to validate conclusions on rapid return times for sensitive benthic habitat.

Chapter 7.0 – Accidental Events

The literature for the Accidental Events Chapter is outdated and should be updated to include more recent oil spills. For example, the most recent data for Table 7.3 is 2010.

The recovery of deep-water corals following the Macondo blowout is not complete (see Girard and Fisher 2018) and many of the observed effects are also attributed to the use of dispersants. These aspects of a blowout need to be considered in the EIS. The Proponent states that only the upper water column will be affected by a blowout as the proposed Project will have shallow water wells. Several factors are not considered in this analysis such as:

- the effect of dispersants on sensitive benthic organisms.
- the effect of the cold ocean temperatures on the behavior of oil is only considered in how it is weathered not in how its buoyancy might be affected.

- The blowout scenario used considers that the gas oil ratio is 138 and 275. The gas volumes are much greater than the oil volumes released and in the model serve to entrain the oil to the surface. However, gas dissolves rapidly in the water column as it transits and the effect of these dissolved hydrocarbons on pelagic organisms is not considered in the assessment.

Overall, the results of the accidental events section are based on previous Chapters which are incomplete. Further information is required prior to the validation of Chapter 7's conclusions.

7.1 – Spill Prevention and Response

Further information is required in the EIS on the exact measures to be taken in response to a marine oil spill. Methodological information is also required for the completion of a situation assessment.

Further information is required on net environmental benefits to understand the following statement in the EIS "*Some response methods have the potential to cause adverse environmental effects but may be justifiable because of overriding benefits and/or the avoidance of further, more serious, effects.*"

7.2 – Accidental Event Probabilities and Models

The shallow gas versus deep-well blowout section only presents statistics on shallow blowout. Further information is required.

Page 7.27. New mud spill trajectory modeling was not completed in the EIS. Instead, simulations for the White Rose Project (Husky 2012) were used. Model equations reported in this report (i.e., pages 14-15 in Husky 2012) are illegible and results cannot be assessed.

Page 7.44. SL Ross and LGL 2013 (draft) is cited but this report is not available. Primary literature should be used.

Page 7.63. The text for the worst case scenario is unclear. It states that "*subsea and surface blowout rates of 40,476 bopd were modelled for 120 days or until the oil evaporated and dispersed from the surface*." This would seem to imply that the model run ran "*for 120 days or until the oil evaporated and dispersed from the surface*", but it does not state how long the simulated blowout lasted. The Deepwater Horizon oil spill flow rate was estimated to be 62,000 barrels per day and lasted for approximately 87 days. Clarification is required on why 40,476 bopd was used as the basis for the worst case scenario. What is the basis for completing 120 day simulations? Additionally, details should be included pertaining to transit time to the site considering sea ice season, storms and extreme ice situations. Information on repose times are also recommended.

The worst case scenarios used in the EIS may be inadequate. For example, Louisiana is currently dealing with a number of leaking wellheads as a result of Hurricane Ivan toppling a platform in 2004 resulting in 16 oil wells potentially leaking at the site. It is recommended that multiple worst case scenarios be developed (e.g., Deepwater Horizon type release with large volumes of oil for several months and Hurricane Ivan type releases – several wells leaking slowly for many years).

Page 7.81. The model shows minimal dispersion of oil in the water column so no benthic affects are assumed. The EIS should explain if dispersants are used.

Recent literature is required to support the Proponent's following statement on spill trends "*the overall trend of spills and blowouts is decreasing world-wide.*"

The EIS does not present a new model in the synthetic-based whole mud spill trajectory modeling section of the EIS. Instead, the EIS refers to modeling completed for the White Rose

Project. The proposed sites are 17 to 48 km (calculated as the centroid of the claim, not the well location). It should be noted that ocean conditions (e.g., currents) may change considerably in the region. The EIS did not identify possible differences between the proposed Project and the White Rose site.

The Ocean Ltd. 2017 reference is not accessible to the public. As such, the trajectory modeling information conclusions cannot be verified. It is essential that the EIS be updated. In addition, *The Proponent has determined that "a nearshore spill of 5,000 m*^{3} *of marine diesel will move in a predominantly easterly direction year-round from a spill location 10 nm from St. John's."* It is unlikely that the release of 5 million L of diesel would follow a straight line given the known circulation for the Study Area.

The Proponent states that "*At the exploration stage it is not possible to define all possible factors needed to calculate blowout rates, blowout duration, and expected release volume.*" Similar to other EIS' recently submitted for offshore NL, the EIS should contain a "worst case" scenario within the offshore spill model scenarios section.

The statement "*This tendency [of northeasterly to southern dispersion] has also been predicted in the oil spill trajectory models conducted for three exploration drilling assessments (ExxonMobil 2017, Statoil 2017, Nexen 2018) recently submitted for offshore NL*" is misleading. The EIS should be updated with information outlining the differences between the Study Area and the referenced Projects regarding simulations.

The statement "*The centre for EL 1152 is just 45 km northwest from the modelled spill source. The centroid for EL 1155 is only approximately 48 km northwest and the centroid for EL 1151 is only approximately 43 km northeast from the modelled spill source*" is inaccurate. Oceanographic conditions may change within 43-48 km, as demonstrated in Figure 4-12.

Further information is required to clarify the statement "*Shifting the spill source by a distance of only 45 km would not demonstrably affect the spill trajectories and would have no effect on the weathering behavior*."

Table 7.17 should be clarified as there was no new numerical modeling completed in the oil property parameters used in the spill modeling section.

Additional information on the modeling used in the EIS is required to verify the statement "*Given the proximity and similar water depths and oceanography between the White Rose field and adjacent ELs, the model inputs would not change for a new model*."

The reference cited in the following statement cannot be accessed online, "*The primary accidental event model used for the assessment of effects from a blowout was originally presented in the White Rose Extension Project (WREP) EA (Husky Energy 2012a*)."As such, the simulations in the EIS cannot be verified or accepted.

The WREP EA modeling report (SL Ross 2011) is stated to be available in Appendix H. However, SL Ross 2011 is not included in the references. Furthermore, SL Ross Environmental Research Ltd 2011 has been criticized by peer-reviewed literature (e.g., Bourgault et al. 2014). As such, the modeling presented in the EIS cannot be verified or accepted.

The statement "*Given the geographic scale and duration of a blowout scenario, the water currents used in the model are seasonal mean current fields...*" is incorrect. As suggested by Bourgault et al. (2014), seasonal currents for the purpose of modeling dispersion which requires high resolution data (e.g., hourly) should not be used.

7.3.1 – Fish and Fish Habitat

Clarification is required on whether there is potential for an oil dispersant to be deployed in the case of an accidental event. If there is the potential for use of a dispersant, the effects of the dispersant with respect to toxicity should be discussed in the EIS. Additionally, the effects of interactions between the dispersant, oil, water temperatures, and organism life stage on toxicity should also be discussed. Toxicity is likely to vary by species, life stage, and temperature.

Page 7.54. The discussion of oil spill effects on phytoplankton and zooplankton is weak given literature following the Deepwater Horizon oil spill. Some literature suggests that the effects of the oil spill on phytoplankton and the microbial food web can vary in response to the specific composition of crude oil from a site (e.g., different wells have different mixes of carbon compounds which can increase or reduce the toxicity of the crude). If possible, it is recommended to profile the crude coming from nearby wells and determine where it fits in the spectrum of oils that have been tested. Additionally, mixing depth of the water column and water temperature are concerns as they can interact to affect the length of time needed for microbial action to degrade crude in the water column. Metabolic activity on the Newfoundland Shelf may be substantially slower than in the Northern Gulf of Mexico due to water temperature differences (e.g., near freezing vs. 20 to 30°C).

The Proponent states that the "*Full recovery of zooplankton communities is expected to occur soon after a spill due to their short generation time, high fecundity and ability to avoid oil patches (Seuront 2010)*." This statement is unreasonable given that the study is based on microcosm experiments using small containers (~2 L) containing small oil patches of 1 to 7 cm in diameter. This is a substantially different scenario from a 200 m water column with thousands of barrels of oil leaking per day. There is also literature on how transferable microcosm experiments are to large spatial and temporal scales. Additionally, many zooplankton species live for a year or more. This would likely result in their recovery to take multiple years.

The Proponent also states that "*In previous oil spills such as the Prestige spill, zooplankton abundance and community structure returned to former levels within days to several weeks of the spill (Johansson et al. 1980; Varela et al. 2006)*."Although local levels of zooplankton could likely return to close to normal levels in a relatively short time due to diffusion, the overall zooplankton population may take more time to recover given generation times of a year or more.

The EIS does not analyze the amount of PAH that would be in the water column during a spill. It is recommended to update the EIS with data in order to compare information regarding PAH effects on herring larvae which experienced sub lethal effects at concentrations of 0.129 to 6.012 µg/L total PAHs. The EIS focuses on animals becoming fouled and does not examine the physiology of fish and plankton being exposed to an oil spill in depth.

The EIS also does not analyze expected mortalities or food web effects/interactions. Ainsworth et al. 2018 used a spatially explicit biogeochemical end-to-end ecosystem model (Atlantis) to simulate the impacts of the Deepwater Horizon oil spill and found the biomass of large reef fish decreased by 25% to 50% in areas most affected by the spill while the biomass of large demersal fish decreased by 40% to 70%. Their results suggested that due to age structure effects on populations, there could be delayed impacts on fishery yields. The expected recovery time for high-turnover populations was predicted to occur within 10 years, but slower-growing populations were expected to take 30+ years to recover. It appears that much of the mortality was due to starvation as fish struggled to recover from toxicological impacts. An important factor was high rates of benthic deposition of oil killing prey on the bottom for fish that feed on demersal prey. They were able to feed on the pelagic food web, but that had energetic costs.

While fish may be able to avoid large masses of oil, they will still be exposed to PAH in the water column. In addition, prey on the bottom will be killed by oil settling on the bottom. Due to a lack of demersal food, many demersal/benthic predators are going to have to feed in the water column increasing mortality on pelagic fish. Future recruitment of pelagic fish would be reduced due to increased predation pressure, potentially failed recruitment as a result of the spill, and increased predation mortality as demersal fish try to survive in areas with depleted prey.

Page 7.58. Most of the analysis is focused on benthic organisms which are ~200 m below a likely spill location and therefore unlikely to be affected. There is little discussion in the EIS as to how a diesel spill would affect pelagic organisms, which in many cases would be highly affected as they would be closest to any plume and surrounding waters. On the contrary, in the offshore area, the large spatial extent of the region combined with the relatively small volume of diesel potentially being spilled means this is likely to have minimal population level effects for most species of fish and zooplankton.

Page 7.59. Clarification is required on potential blowouts occurring in an area with sea ice.

Page 7.61. The Proponent states that "*An accidental event is predicted to be reversible and is not expected to cause an adverse effect on fish and fish habitat resulting in a decrease in abundance or alteration in distribution of the population over more than one generation or so that natural recruitment would not reestablish the populations(s) to baseline conditions within one generation.*" Although a species may live for 10+ years, reproductive recruitment or strong year classes may be sporadic in nature (e.g., 2002 relatively strong year class of Northern cod). It should also be noted that a number offshore species such as cod, redfish, etc. are currently at historic low levels with respect to spawning stock biomass (SSB). If a spill scenario occurred during a significant recruitment year, there may be more overall impacts on fish populations than indicated in the EIS.

Based on Ainsworth et al. 2018 and numerous recent publications on the effects of the Deepwater Horizon oil spill, the statement "*the predicted residual environmental effects from any of the accidental event scenarios on fish and fish habitat is not significant such that a significant decline in abundance or change in fish population*" is unreasonable. One estimate of the economic value of the ecological damages from the Deepwater Horizon oil spill was $8.8 billion (USD; Bishop et al. 2017). The EIS should be updated to include literature on the Deepwater Horizon oil spill and other spills in order to provide a thorough overview of the likely effects if a similar event were to occur during the proposed Project.

7.3.3 – Marine Mammals and Sea Turtles

Another adverse impact of oil spills on marine mammals, particularly large-magnitude events during the summer and fall, would be the fouling of mysticete baleen by oil. Such an encounter would render the baleen less efficient for filtering the whales' food and would prolong ingestion of petroleum products from the oiled baleen (Geraci 1990). The EIS should be updated to include this information.

Chapter 9.0 – Cumulative Effects

The cumulative effects (CE) Chapter of the EIS identifies potential for interactions and then concludes that they are not significant with a high level of confidence. The analysis used to reach these conclusions is not presented. This deficiency is reflected in the section specific comments below.

As the potential effects of the Project have been determined to be extremely limited in both duration and spatial scale, the assessment of CEs is conducted only within this limited footprint.

There is no consideration of the broader picture of increasing exploration and production activities in the area. These have the potential to cumulatively affect fish and fish habitats throughout the area. The potential for far field effects such as resuspension and redeposition of drilling waste fines or of the chronic and accidental inputs of hydrocarbons and other chemicals into the receiving waters of the area is increasing with this increased activity. CEs need to be analyzed systematically as opposed to each new Project being review independently.

9.2.3 – Assessment of Cumulative Effects on Fish and Fish Habitat

This section considers underwater noise, routine discharges, and deposition of drill muds and cuttings. However, much of the section considers the direct impact of these disturbances but gives little consideration to the CEs. Cumulative Effects are generally dealt with in a cursory manner with the following being a paraphrasing of the logic "the disturbance is localized and reversible and therefore, there is no effect." This CEs analysis is not presented in the EIS beyond the qualitative statement quoted in section 9.2.4.

Furthermore, the disturbances are generally considered in relation to the CE of that disturbance and not in relation to other disturbances. For example, CEs considered in relation to noise was the number of ships in the area. Although the Proponent states additional ship traffic as a result of this project is minimal, there are no assessments of the influence of noise thresholds in the area.

The Proponent states that the observed zones of effect from the 2004 White Rose EEM are the most appropriate for the current Project as the amount of drilling is limited and the amounts of wastes are similar. It is then argued that the observed zones of effect are not that much different from those observed in the 2014 survey. This is used as a rationale to consider that the effects of the proposed project will be relatively minor and short-term. Alternatively, most of the fines associated with the drilling wastes which make up the majority of the deposition (>80%) are rapidly transported out of the EEM monitoring area and deposited elsewhere. It could be concluded that the potential for CEs from all of the drilling operations occurring in the area may be much more significant than previously considered.

The evaluation of the potential for CEs is also deficient in the area of accidental events. The summary spill statistics from CNLOPB indicate that there have been almost 500,000 L spilled between 1997 and 2017 (CNLOBP 2018). This is mostly (~60%) synthetic based muds (SBM). The CEs assessment of accidental events does not consider the effects of an accidental spill associated with this Project on top of the existing spill environment.

Page 9.30. The potential effects of seismic surveys on early-life stage fish is understated and mostly overlooks potential effects on zooplankton.

Page 9.33. The Proponent concludes that "*…the residual cumulative environmental effects on fish and fish habitat are predicted to be not significant. This conclusion has been determined with a high level of confidence."* However, it is not clear what this confidence is based on or what it means as no analyses have been performed. A similar statement is made on page 9.35.

9.2.4 – Assessment of Cumulative Environmental effects on Commercial Fisheries

The Proponent states "*Given the high level of confidence, the nature of the Project (i.e., exploration drilling), and the existing knowledge of potential cumulative environmental effects related to this type of activity gained through existing EEM and existing literature, no additional monitoring and follow-up requirements are proposed for fish and fish habitat*." Monitoring for PAH levels in the water column at various depths and distances from drilling sites is recommended, and further work to examine the susceptibility of fish eggs, larvae and zooplankton to PAH should be completed.

9.2.5 – Assessment of Cumulative Effects on Marine Mammals and Sea Turtles

The Proponent concluded that there will be no significant or residual effects for marine mammals or sea turtles as the proposed operation is only a small addition to an already-busy offshore area. However, the EIS did not consider that small additional impacts could add up to significant changes in the biological characteristics of these fauna, and threaten the recovery plans for SARA-listed species. Researchers have seen displacements of marine mammals for the duration of seismic exploration in Canada, the United States, the United Kingdom and in other areas when there has been project-related monitoring. The magnitude and duration of these displacements in an area such as the NL offshore when there are multiple seismic operations that overlap temporally and spatially is an example of a risk to marine mammals that come yearly to NL waters to feed. While the area of influence related to oil drilling and extraction operations is smaller than it is for mobile seismic airgun arrays, the operations are of long duration and of broadband sound sources.

It is recommended that the Proponent and other companies proposing exploratory drilling on the Grand Banks commit resources to sound monitoring to gain a better understanding the magnitude and characteristics of the sound outputs, and also which animals are there and how their behaviour and distribution might change. Monitoring such as replicate aerial or shipboard surveys could be a cost-effective option, and would yield biological and physical information.

Conclusions

The sufficiency of baseline data and appropriateness of methodologies to predict effects

- The quality of scientific content presented in the EIS varies across sections. While the EIS contains a large volume of information and valuable data, it is not complete in its current form. The EIS does not incorporate many important and relevant data sources (e.g., methodologies for assessing waste dispersion, oil spills, and cumulative effects and baseline data for sensitive benthic areas and species, and recent literature on the impacts from the Deepwater Horizon oil spill), and overlooks many important and basic considerations on ecosystem structure and function. It also does not adequately explore the potential impacts on ecosystem functioning.
- Models used in the EIS are outdated, and the scenarios and basic assumptions are inappropriate for the proposed Project.
- Many references are cited and interpreted incorrectly or inappropriately, or are not included in the list of references. In addition, much of the literature cited to substantiate study conclusions is outdated and grey literature is frequently cited in place of primary, peer-reviewed literature.
- Many references in the EIS are not accessible to the public. Due to inaccessibility of reference materials, portions of the EIS could not be assessed adequately by DFO.

The mitigation measures proposed by the Proponent

- The mitigation measures, although “consistent with the seismic sound in the marine environment (SOCP)” could be improved. For example, better-trained marine mammal observers (MMOs) could be utilized, and ceasing some operations (e.g. blasting with shaped charges or vertical seismic profiling [VSP]) in poor weather conditions or darkness.

- Many of the mitigation measures are not adequately explained in the EIS or are cited to be in the Environmental Protection Plan (EPP), which was not provided to DFO.
- Existing mitigation measures for exploratory drilling programs currently in place for the NL offshore (e.g., pre-drilling surveys and avoiding drilling near aggregations of sensitive species) are not analyzed in the EIS.

The level of certainty in the conclusions reached by the Proponent on the effects

- There are conclusions made in the EIS regarding numerical simulation modeling which cannot be accepted due to the lack of documentation, supporting references and inappropriate assumptions and methodologies.
- Detection levels for monitoring of PAH are inadequate as the minimum detection level is higher than the published effect level for the referenced species (i.e., herring).

The manner in which significance of the environmental effects, as they pertain to DFO's mandate, have been determined (i.e., the scientific merit of the information presented and the validity of the Proponent's methodologies and conclusions)

- Sensitive benthic areas and species are not specifically identified as a valued component (VC) in the EIS; potential habitat effects on sensitive benthic areas are considered to be covered under the fish habitat VC. As a result, potential effects of the project on sensitive benthic species such as corals and sponges are not explicitly evaluated.
- Information within the EIS pertaining to vulnerable marine ecosystems (VMEs) and ecologically biologically significant areas (EBSAs) is incomplete and misleading. While some DFO and NAFO literature is cited, the maps in the EIS do not show the current VME or EBSA areas located inside or outside of the EEZ; nor the associated NAFO fisheries closures. The EIS should be updated to include current information pertaining to VMEs and EBSAs within or near the Study Area.
- Several sub-lethal effects were not included in the EIS (e.g., reduced growth rates, decreased fecundity, altered reproductive success, increased vulnerability to predation, changes in the quality of eggs/sperm, decreased survival rates, etc.). These effects can have profound impacts on marine organisms.

The follow-up program proposed by the Proponent

- No follow-up monitoring has been proposed other than compliance monitoring. Reference is made to an EEM program. However, it is unclear whether this refers to the White Rose EEM or a new EEM to be developed.
- Given the uncertainty with respect to the Proponent's conclusions of no significant effects, follow-up monitoring should be required.

Whether additional information is required from the Proponent to complete the technical review

- Further information on spill prevention and response, and accidental event probabilities and models, is required prior to the validation of Chapter 7's conclusions.
- It is recommended that the EPP be made available publicly for review.

- In its current form, and until the problems identified in this report are addressed, the EIS is not considered a reliable source of information for decision-making processes.

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