



HEBRON PROJECT ENVIRONMENTAL ASSESSMENT AMENDMENT

Pursuant to Hebron Project Comprehensive Study Project (CSR) (September 2011)

FINAL REPORT

Submitted by:

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Amec Fw TF1775224

January 2018



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1.0 INTRODUCTION

The Hebron oil field is located offshore Newfoundland and Labrador, Canada in the Jeanne d'Arc Basin, approximately 350 kilometres southeast of St. John's in water depths of approximately 93 metres (mean sea level) (Figure 1-1). The oil field was first discovered in 1980, and is estimated to contain more than 700 million barrels of recoverable resources. The Hebron Project includes offshore surveys, engineering, procurement, fabrication, construction, installation, commissioning, development drilling, production, operations and maintenance and eventual decommissioning.

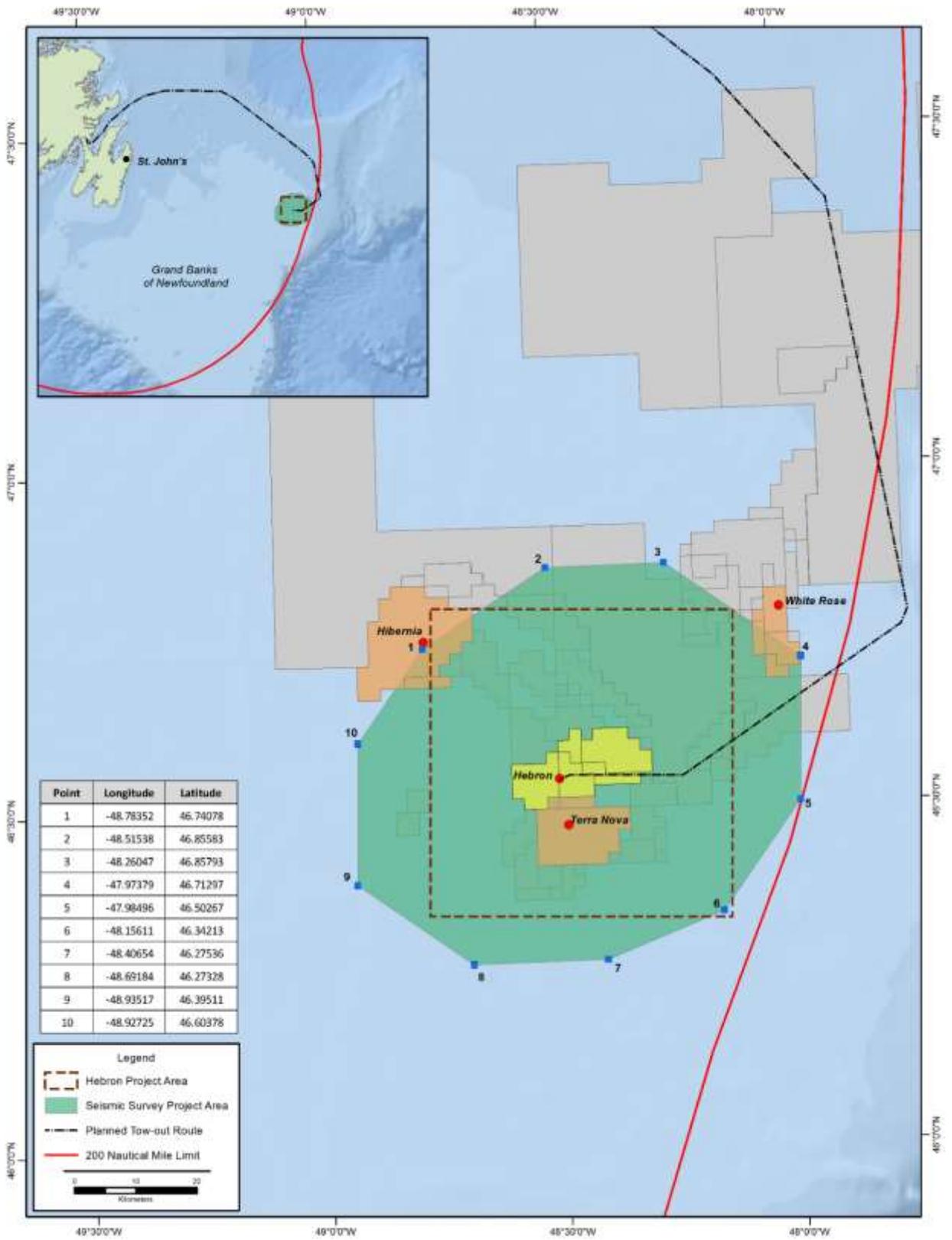
The Hebron field was developed using a stand-alone concrete gravity based structure (GBS), which has been designed and constructed to store approximately 1.2 million barrels of crude oil. The GBS was constructed at Bull Arm, Newfoundland, towed to its final destination on the Grand Banks with first oil being planned for later in 2017. Hebron is a major development project that is delivering significant benefits to Newfoundland and Labrador, including those related to its associated engineering, fabrication and construction activities, the employment and training of a diverse workforce, research and development opportunities, and significant royalty and tax revenues.

1.1 Environmental Assessment Review and Approval

The Hebron Project was subject to a detailed and comprehensive Environmental Assessment (EA) review, pursuant to the requirements of the *Canadian Environmental Assessment Act* (CEAA). That process commenced with ExxonMobil Canada Properties' (EMCP's) submission of a Project Description to the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) in March 2009, which was followed by determinations by relevant government departments and agencies regarding their respective regulatory interests in the Project, associated EA track decisions, and the eventual issuance of an EA Scoping Document by the C-NLOPB. EMCP subsequently prepared and submitted a Draft Comprehensive Study Report (CSR) for the Project in June 2010, which was subject to review and comment by relevant agencies and organizations, followed by subsequent requests for, and the submission and review of, additional information which continued to late 2011. In December 2011 the federal Minister of the Environment issued his EA decision, which stated that "no additional information is necessary" and that "taking into account the mitigation measures described in the Comprehensive Study Report, the Project is not likely to cause significant adverse environmental effects". In June 2013 EMCP submitted an amendment to the Hebron Project CSR, which described proposed changes to a number of planned Project activities. This was also subject to review and the provision of additional information and clarification by EMCP, and was subsequently approved in June 2013.

Since EA approval for the Hebron Project was obtained, and in keeping with standard practice for offshore petroleum projects in this jurisdiction, EMCP has subsequently prepared and submitted annual EA Updates for the Project to the C-NLOPB. These updates provide an overview of planned Project activities for the upcoming year, update any applicable environmental baseline information for key environmental components that has become available since the CSR and previous EA Updates were produced, describe any public and stakeholder consultation activities that have occurred, and evaluate and confirm that the nature and scope of the planned activities are within the scope of those assessed and approved in the EA review, including the appropriateness and adequacy of the associated environmental effects predictions and mitigation measures. In addition, the first EA Amendment, relating to discharge of discrete volumes of SBM – associated drill cuttings associated with shoe-track material, was submitted and approved earlier in 2017.

Figure 1-1 Hebron Project Area



1.2 Purpose and Structure of the EA Amendment

As is often the case with proposed projects and activities at the EA (pre-detailed engineering) stage of their planning and initial design, the Hebron Project has continued to evolve and become further defined since the initial EA documentation was prepared, submitted, reviewed and approved due to various technical factors and considerations.

This EA Amendment describes and assesses a proposed modification to the Project as compared to that which was originally assessed, approved and implemented pursuant to the EA review and approval process summarized above. In particular, it has now been determined that the maximum residual chlorine concentration limit at cooling water discharge is required to be 2 ppm rather than the <0.5 ppm concentration that was listed in the original CSR. Discharges of residual chlorine in cooling water is permitted under the *Offshore Waste Treatment Guidelines* (OWTG) although no performance target is prescribed. A further discussion of the nature of, and rationale for, this proposed Project modification is provided in Chapter 2 of this document.

This EA Amendment provides a description and analysis of any implications of the proposed Project modification described above for the EA's predicted environmental effects, the mitigation measures that have been identified and proposed by EMCP for the Project, and thus for the overall findings and conclusions of the original CSR and associated EA approval.

Following this Introduction (*Chapter 1*), the remainder of this EA Amendment document is organized as follows:

Chapter 2: Project Description: Provides a brief overview of the Project as originally proposed and assessed, and a description of the nature of and rationale for the proposed modification to it.

Chapter 3: Environmental Setting: The identification, presentation and analysis of any new and relevant information on the existing (baseline) environment of the Project Area and its Offshore Study Area (as defined in the original CSR). This description is provided with particular reference to the Valued Environmental Components (VECs) that were considered in the CSR and subsequent EA Updates, focussing on those which are particularly relevant to the Project modification being assessed herein.

Chapter 4: Environmental Effects Assessment: An analysis and discussion of any implications of the proposed Project modification referenced above for the original EA's environmental effects analysis, associated mitigation, residual effects significance determinations, and thus the overall findings and conclusions of the CSR.

Chapter 5: Summary and Conclusion

2.0 PROJECT DESCRIPTION

The following Chapter initially provides a brief overview of the Hebron Project as originally proposed and assessed, for general background and context. This is followed by a description of the nature of and rationale for the proposed modifications to the Project that are the focus of this EA Amendment.

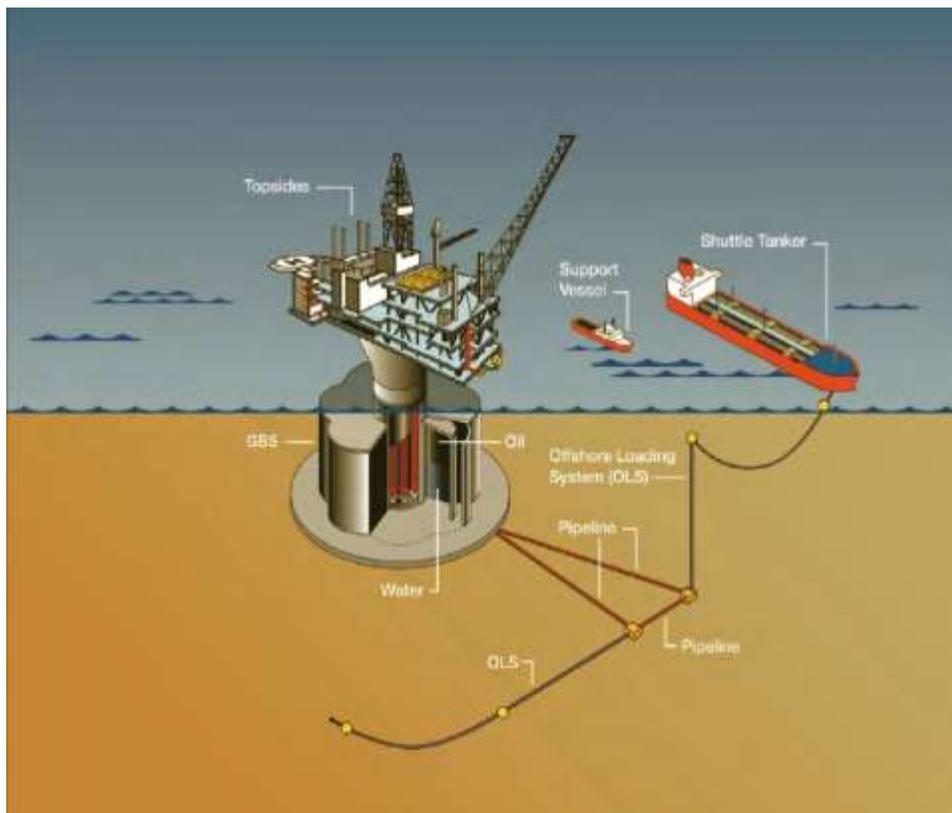
2.1 Original Project Description

The Hebron Project is an oil and gas production project located offshore Newfoundland and Labrador, approximately 350 km southeast of St. John’s. EMCP, as Operator, is leading the development of the Project on behalf of the Hebron Project Proponents: ExxonMobil Canada Ltd.; Chevron Canada Limited; Petro-Canada Hebron Partnership through its managing partner Suncor Energy Inc. (Suncor); Statoil Canada Ltd.; and Nalcor Energy – Oil and Gas Inc.

The Hebron Platform is situated approximately nine kilometers north of the Terra Nova Field, 32 km southeast of the Hibernia development and 46 km southwest of White Rose (see previous Figure 1-1). The Hebron Project is the fourth stand-alone development project on the Grand Banks and, considering the two tieback projects to the Hibernia and White Rose facilities, the sixth offshore petroleum project off Eastern Newfoundland. The Hebron Project will extend the life of the offshore oil and gas industry in Newfoundland and Labrador, and represents an important next step in the development of a sustainable offshore oil and gas industry in the province.

The Hebron field was developed using a stand-alone concrete GBS, similar in concept to the existing Hibernia platform (Figure 2-1). The Hebron Project was towed out to the Grand Banks in June with first oil planned for later in 2017.

Figure 2-1 Generalized Schematic of the Hebron GBS and Associated Components



As described in the original CSR (see Chapter 2), the GBS for the Hebron Project is a reinforced concrete structure designed to withstand impacts from sea ice and icebergs and the meteorological and oceanographic conditions at the Hebron Field. It will accommodate up to 52 well slots with J-tubes inside the central shaft connected to the base of the GBS for potential future expansion. The GBS has been designed to store approximately 190,000 m³ (1.2 million barrels) of crude oil in multiple separate storage compartments. The Offshore Loading System (OLS) consists of two main offshore pipelines running from the GBS to separate riser bases (pipe line end manifolds) with an interconnecting offshore pipeline connecting the two pipe line end manifolds. The notional offloading rate of the system is 8,000 m³ / hour (50,300 barrels per hour). The Topsides hold the drilling support module, drilling equipment set, utilities and production module, flare boom and living quarters, including helideck and lifeboat stations.

The Hebron production facilities have the capacity to handle the predicted life-of-field production stream for 30 plus years. Based on the current initial development phase, the facility has been designed to accommodate an estimated production rate of 23,900 m³ / day of oil.

2.1.1 Offshore Project Area - Planned Activities

As described in Section 1.5.2 (Project Components - Offshore Project Area) of the CSR, the scope of the Project for EA purposes included the following "Project activities within or affecting the marine environment in the offshore area...":

- a) *Tow-out of platform to offshore site;*
- b) *Offshore site and clearance surveys;*
- c) *Installation of the platform at its offshore location (may include site preparation activities such as clearance dredging, seafloor levelling, underbase grouting, offshore solid ballasting, piles and mooring points, and placement of rock scour on the seafloor);*
- d) *Platform commissioning;*
- e) *Operation, production, maintenance, modifications, decommissioning of the platform petroleum production facility;*
- f) *Drilling operations (exploration and development drilling), from the GBS of up to 52 wells, including well testing, well completions and workovers and data logging;*
- g) *Construction, installation, operation, maintenance of an offshore loading system (OLS) (may include dredging activities, pile driving, installation and insulation of riser and OLS (rock dumping, concrete mattress pads);*
- h) *Supporting activities, including diving programs, and operation of support craft associated with the above activities, including but not limited to dredging vessels, shuttle tankers, shuttle tankers connecting / disconnecting to OLS, mobile offshore drilling units (MODUs), platform supply and standby vessels and helicopters; and*
- i) *Associated surveys for all above activities, including: ROV surveys, diving programs, geotechnical programs, geophysical programs (e.g., 2D / 3D / 4D seismic, Vertical Seismic Profiles (VSPs), geohazard/wellsite surveys), geological programs, environmental surveys (including iceberg surveys).*

2.1.2 Planned Seawater Discharge

The Project's planned chlorinated seawater discharge is further described in Sections 2.6.3 (Gravity Base Structure Systems), 2.6.4.2 (Process Systems), and 9.5.2.2 (Effects Assessment on Marine Birds

- Operations and Maintenance) of the CSR. The relevant text is duplicated below as background (emphasis added):

Section 2.6.3 from CSR (Gravity Base Structure Systems)

The GBS will be designed to have temporary and permanent mechanical systems installed as follows:

- ◆ *Seawater systems including storage displacement water, **cooling water** and firewater, will likely include:*
 - *a large-diameter caisson for return of seawater to the marine environment*
 - *separate lift pumps to supply the firewater and seawater systems; firewater pumps will be segregated to ensure that no single point of failure can cause loss of firewater supply*
 - *storage displacement water from the crude oil storage compartments will pass through a buffer cell before horizontal discharge*
- ◆ *Corrosion protection system to protect metal elements against corrosion and biological growth where seawater is present. **The discharge from the hypochlorite system** will be treated in accordance with the Offshore Waste Treatment Guidelines (OWTG) (National Energy Board (NEB) et al. 2010)*

Section 2.6.4.2 of the CSR (Process Systems)

*Seawater lift: seawater will be required for injection into the reservoir to maintain reservoir pressure and to remove heat from the cooling medium. Seawater will be filtered and **sodium hypochlorite** will be added to prevent biological growth in the cooling water pipe*

Section 9.5.2.2 of CSR (Effects Assessment on Marine Birds - Operations and Maintenance)

*....Cooling water will be chlorinated and discharged overboard at an approximate temperature of 30°C, with a **residual chlorine level <0.5 ppm.***

2.2 Proposed Amendment to the Project

This amendment relates to the planned chlorine concentration of the cooling water discharge. Section 2.11 (Cooling Water) of the C-NLOPB's *Offshore Waste Treatment Guidelines* states that:

To prevent biofouling and corrosion of piping and mechanical systems on the installation, it is typical to add biocide to the cooling water prior to circulating it through the installation. Although chlorination is typically used, other biocides may be chosen by the operator for control of corrosion and biological activity as required. All biocides should be screened through the chemical management system developed by the operator in consideration of the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands. The operator shall identify, in its EPP, any biocide that may be discharged in cooling water and the concentrations to be discharged to the sea.

As described and assessed in the CSR, the cooling water system will be injected with sodium hypochlorite to prevent biological growth and corrosion of piping and mechanical systems. It has now been established that the maximum residual chlorine concentration limit cooling water discharge is required to be 2 ppm.

The discharge will be at approximately 15.5 m water depth and is expected to be readily diluted within the receiving marine environment. In addition, the sewage discharge is at the same depth and in close proximity (2.3 m) to the cooling water discharge thereby increasing the probability that any residual chlorine will be rapidly consumed. This EA Amendment therefore proposes a modification to the residual chlorine concentrations at the discharge point from <0.5 ppm to a maximum of 2 ppm.

2.3 Operational Rationale

This proposed increase is required and requested in order to achieve the following objectives:

- 1) *Prevent marine growth and biofouling in firewater and seawater piping (and subsequent impedances to flow rates)*

The Safety Critical Element Performance Standards for Firewater Distribution (SCE-23) and Critical Seawater Supply (SCE-29), require that these systems be maintained free of marine growth in order to meet pressure and flow requirements. In order to meet this requirement, Hebron continuously injects hypochlorite in its firewater and seawater systems. In addition to hypochlorite, the water injection system will also be regularly dosed with another biocide. Once biofouling occurs, neither hypochlorite shock dosing nor the other biocide (e.g. glutaraldehyde) dosing will be capable of removing the build-up. Both chemicals are designed for treatment of free floating (or planktonic) organisms in seawater and are ineffective in removing/eliminating sessile growth/biofilms once formed. As a result, it is extremely important to maintain adequate rates of hypochlorite within the seawater systems to ensure biological growth cannot establish itself on platform piping and equipment or in downhole piping. Following analysis of biological growth found in the water injection system, the Hebron chemicals contractor has recommended a minimum of 1.0 ppm Total Residual Chlorine to maintain effective control based on worldwide experience.

- 2) *Reduce seawater propensity to foaming*

The Minox unit has not yet been commissioned due to significant foaming issues. Hebron has two Minox units which de-oxygenate water before being injected into the reservoir in order to prevent corrosion in the downhole piping. Water injection is needed for reservoir pressure maintenance, and will be required in 2018 once the water injection well is completed. Based on seawater sample test results and analysis of a swab that was taken from the Minox first stage vessel internals, it was concluded that biological activity is a causal factor in the foaming issue. The Minox vendor has asserted that the foaming is caused by consistent under-injection of hypochlorite and recommend increasing the chlorine residuals to at least 1.5 to 2 ppm. Specific organic materials in seawater act as surfactants, generating and stabilizing foam. The increased hypochlorite levels will limit biological activity and therefore reduce propensity to foaming.

2.4 Comparison to other Operators

The other three operators on the Grand Bank also have similar cooling water systems with a residual chlorine concentration in their cooling water. The Terra Nova FPSO and Hibernia GBS both have residual chlorine discharge limits of 2.0 ppm (Suncor Energy 2013; HMDC 2015) and the SeaRose FPSO has a residual chlorine limit of 1.0 ppm (Husky Energy 2013).

All three operating projects have long-term environmental effects monitoring (EEM) programs that includes water column sampling. Hibernia and Terra Nova also monitor phytoplankton pigments, a

potential marker for the effects of residual chlorine on the phytoplankton (See Section 4.2.3). The long-term EEM programs have not detected any changes in the receiving environment related to the cooling water discharges (EMCP 2016).

3.0 ENVIRONMENTAL SETTING

The Hebron Project CSR provided a detailed overview of the existing (baseline) environment within and around the proposed Project Area and associated EA Study Area (nearshore and offshore environments). This description focussed on relevant aspects of the existing physical, biological and socioeconomic environments in these areas, based on information available as of the time of CSR development and submission.

The sections that follow provide a brief, summary update of that description of the existing environmental setting for the offshore Project Area and Study Area, including the various VECs that were considered in the original CSR, namely:

- 1) Air Quality;
- 2) Fish and Fish Habitat;
- 3) Commercial Fisheries;
- 4) Marine Birds;
- 5) Marine Mammals and Sea Turtles;
- 6) Species at Risk; and
- 7) Sensitive or Special Areas.

This description has a particular focus on those environmental components which are considered to be particularly relevant to on-going environmental planning and management related to the Project, and especially, to the proposed modification to the Project that is being addressed through this EA Amendment. The brief overview that follows does not repeat all of the detailed environmental information and analysis provided in the original CSR and previous EA Updates, which should therefore also be referred to as required and relevant.

The descriptions that follow also draw from existing and available information sources, most notably the Eastern Newfoundland Strategic Environmental Assessment (SEA) (Amec 2014), which was prepared and released in August 2014 by the C-NLOPB. In keeping with the direction included in recent project-specific EA Scoping Documents issued by the C-NLOPB, they also do not repeat relevant information from the SEA but rather refer to that document as relevant.

3.1 Air Quality

As described in Section 6.2.2 of the CSR, given its offshore location, air quality within the Hebron Offshore Project and Study Areas is likely to be very good, with only occasional exposure to exhaust products from existing offshore oil production facilities (Hibernia, Terra Nova and White Rose), supply ships and other vessels in the area, as each platform would generally be downwind of another less than 15 percent of the time. This region also receives long-range contaminants from the industrial mid-west and northeastern seaboard of the United States. In describing the existing ambient air quality in the Offshore Study Area in the original CSR, site specific emissions data were presented from the National Pollutant Release Inventory (NPRI) and national greenhouse gas (GHG) reports, which are completed and submitted annually by each of the offshore oil and gas operators located near the proposed Hebron Project. This included 2008 NPRI data for criteria air contaminants for each of the existing offshore oil platforms, GHG data for each of these platforms and the provincial and national totals, and national GHG emissions by sector for the period 2004 to 2007.

Given that the proposed modification to the Project (increase in residual chlorine of seawater discharge) will not result in any increased or otherwise altered interactions with or effects on the atmospheric environment, no additional or updated environmental baseline information is required or provided for the purposes of this EA Amendment.

3.2 Fish and Fish Habitat

Various species of marine fish and invertebrates and their habitats have been identified within or nearby the Hebron Project Area and its Offshore Study Area as defined in the original CSR. These species and habitat form the basis of the marine ecosystem, and support fisheries which have commercial, historical and recreational importance.

The overall presence, distribution and abundance of marine species and any important habitats in the Offshore Project and Study Areas are summarized in the original CSR and associated Updates, which include information on relevant life history characteristics. Updated information on the presence, life histories, and spatial and temporal distributions of marine species in the region is also provided in the Eastern Newfoundland SEA (Amec 2014, Section 4.2.1) Provided below is a summary of the most recent information available in respect to fish and fish habitat within and near the Hebron Project Area.

3.2.1 Benthic Macroinvertebrates

Benthic macroinvertebrates are a diverse group of marine biota that are made up of numerous taxa which live on, or in the top layer of the sea floor. Benthic macroinvertebrates play key roles in nutrient cycling and are a key prey item from many species (Barro Froján et al. 2012; Murillo et al. 2016), including species with commercial, recreational and historic value. As indicated in the CSR, shrimp (*Pandalus borealis* and *Pandalus montagui*), green sea urchins (*Strongylocentrotus droebachiensis*), and sand dollars (*Echinarachnius parma*) were the most abundant benthic invertebrates found in the Project Area. Soft shelled clams (*Mya arenaria*), snow crab (*Chionoecetes opilio*), toad crab (*Hyas araneus*), Icelandic scallop (*Chlamys islandica*), polychaetes, macoma clams (*Macoma balthica*) and seastars were also present. This coincides with available publications that indicate that the assemblage of benthic macroinvertebrates along the shelf habitat of the Grand Banks is typically dominated by echinoderms such as sand dollars, sea stars and sea urchins. Schneider et al. (1987), for example, found brittlestars (*Ophiopholis* sp.), sand dollars and Icelandic scallop accounted for almost 75 percent of the total benthic macroinvertebrate abundance in photographic surveys of habitats at depths similar to the proposed Project Area (70-100 m).

Canadian RV surveys provide comprehensive trawl data for the Grand Banks and indicate that Northern shrimp, striped shrimp, and snow crab are key invertebrate taxa in regards to abundance and distribution (Amec 2014). More recent data from Canadian RV surveys (2008-2012, see the Figures that follow) indicate striped shrimp are found in relatively high abundance in the general region (although recent EEM baseline fish sampling have not found these in great abundance in the Project Area itself), while the highest concentrations of Northern shrimp were found to the northeast. Snow crab are also found within and around the Project Area. Detailed life histories and key spawning times for these and other species are presented in detail in the Eastern Newfoundland SEA (Amec 2014, Section 4.2.1).

Figure 3-1 Striped Pink Shrimp Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)

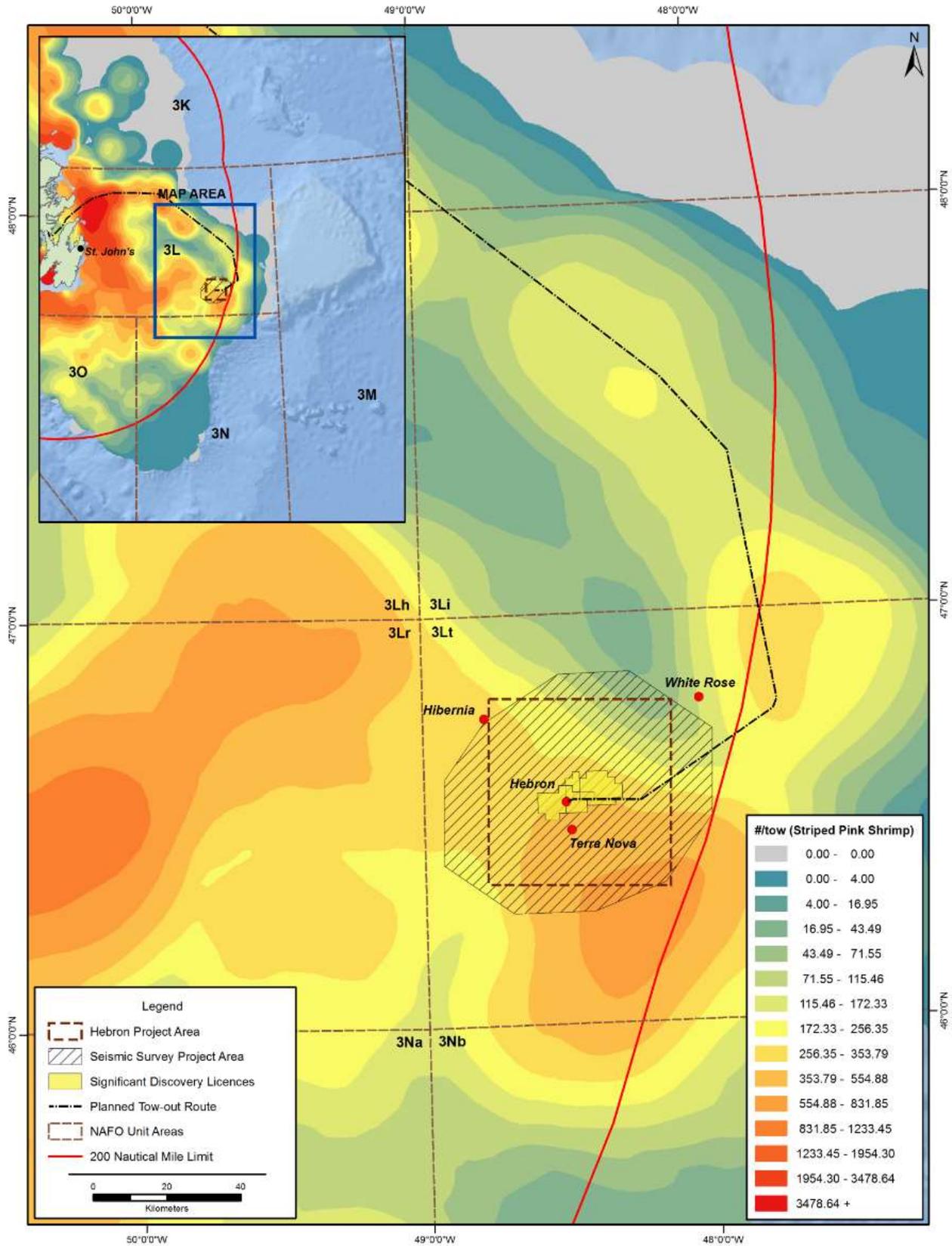


Figure 3-2 Northern Shrimp Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)

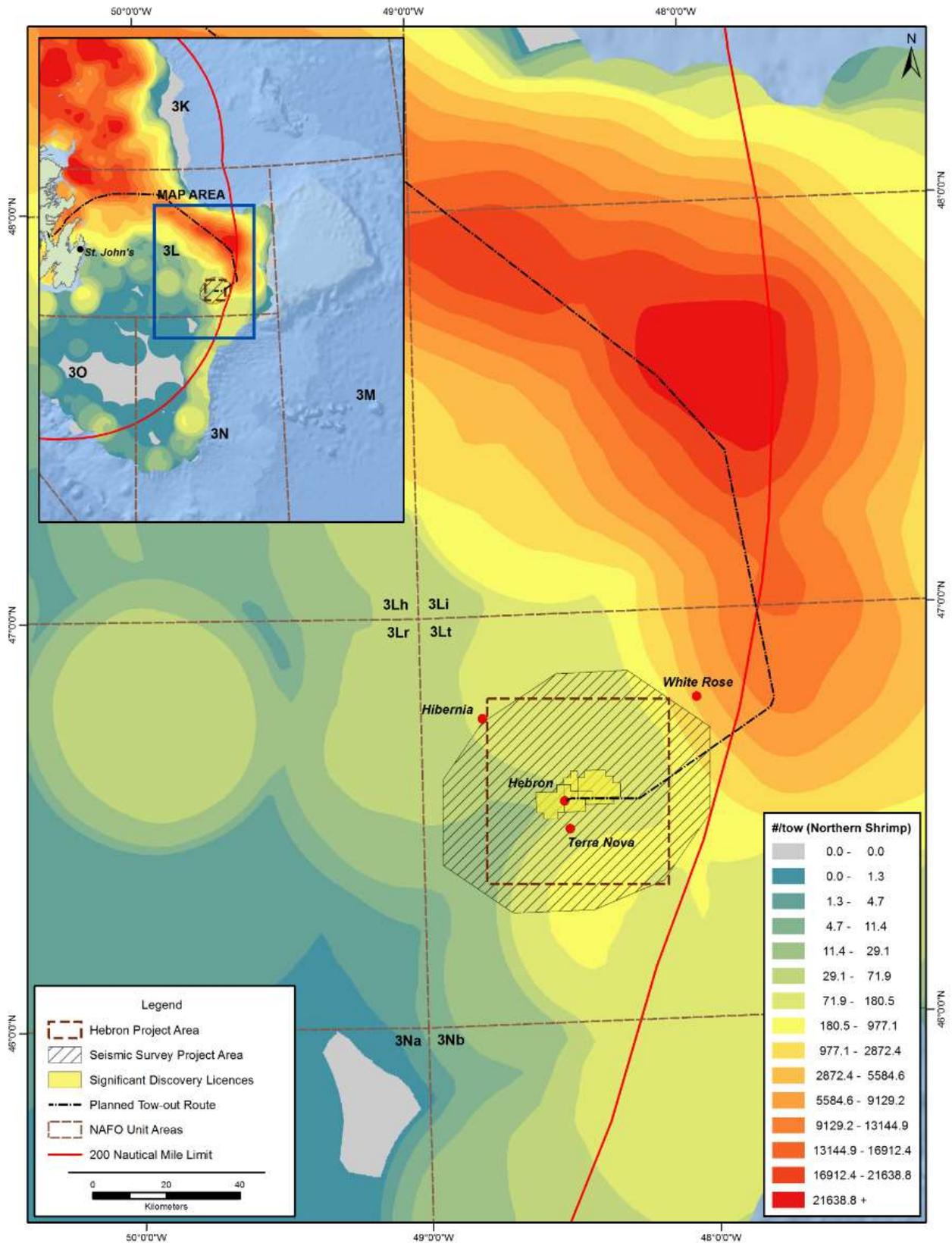
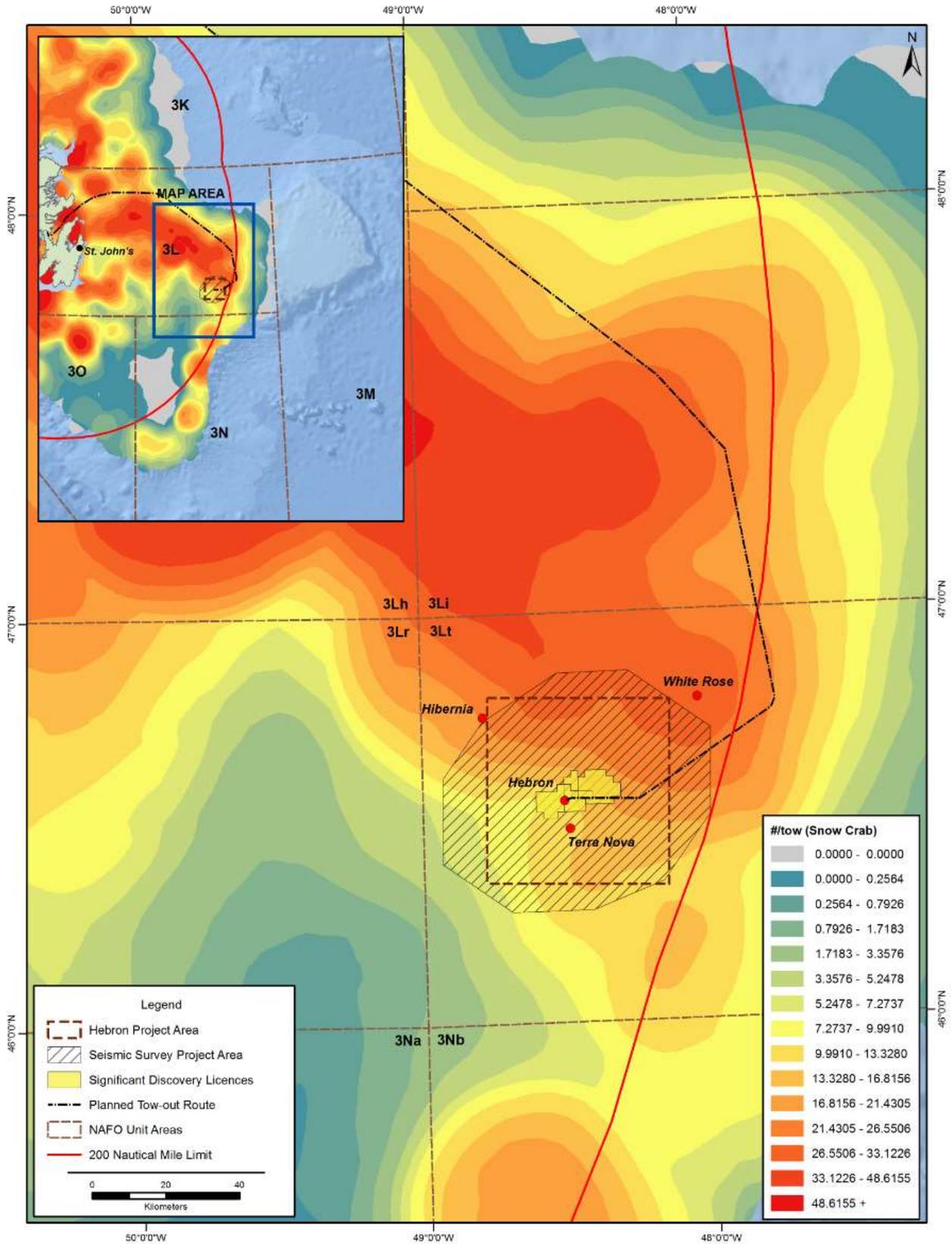


Figure 3-3 Snow Crab Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)



3.2.2 Corals and Sponges

Corals and sponges are key organisms in creating habitat complexities and their presence is a key factor in the presence and abundance of other benthic invertebrates (DFO 2015). Generally, they are long lived organisms that provide refuges (Wareham 2009; Baker et al. 2012), nursery areas (Beazley et al. 2013; DFO 2015), and foraging areas (Baker et al. 2012; DFO 2015) for fish and other macroinvertebrates. Corals and sponges are sessile in nature and therefore, they are particularly susceptible to bottom disturbances or deposition of materials on the seabed. Due to the sensitive nature of corals and sponges and their ecological importance, some areas that are known to be relatively rich with corals and sponges are identified as Ecologically or Biologically Significant Areas (EBSAs) or Vulnerable Marine Ecosystems (VME) and are closed to fishing activities (see Section 3.7 below).

A variety of coral species are found off Eastern Newfoundland in waters deeper than 200 m, with the slopes of continental shelves and canyons being particularly favorable habitats (Edinger et al. 2007; Campbell and Simms 2009; Guijarro et al. 2016). Coral surveys of North Atlantic offshore areas have shown the highest biomass around the slope areas (600-900 m depths) of the Grand Banks and Flemish Pass (Murillo et al. 2011), waters that are considerably deeper than those in the vicinity of the Hebron Project Area. Fewer species of coral inhabit the shallower waters present on the shelf, and those present are primarily soft corals, as was noted in the CSR. Coral species that may be found within or near the Hebron Project Area would therefore be limited to soft coral species (see Table 3-1 and Figure 3-4) based on the results of recent Canadian RV surveys and associated scientific publications (Wareham 2009; Murillo et al. 2011; Baillon et al. 2014; Murillo et al. 2016).

Table 3-1 Corals Occurring on the Grand Banks

Order	Group	Species	Depth Range (m)	Reference
Alcyonaceae	Soft Corals	<i>Duva florida</i>	56-1374	1,2,3,4,5
		<i>Gersemia fruricosa</i>	46-246	1,2,4
		<i>Nephtheidae spp.</i>	-	2,5

Sources: ¹ Wareham (2009); ² Murillo et al. (2011), ³ Baillon et al. (2014), ⁴ Murillo et al. (2016), ⁵ Stantec (2011)

In offshore areas, surveys showed the highest sponge biomass in the Flemish Pass, the Flemish Cap and the tail of the Grand Banks (Murillo et al. 2012). Sponges have been found primarily in water depths ranging from 100-1,500 m, indicating that sponges may be located throughout shelf, slope and deep water habitats (Murillo et al. 2012). However, sponges are not well distributed throughout the Grand Banks area itself (Guijarro et al. 2016) (Figure 3-5).

3.2.3 Finfish

Finfish represent a numerically abundant and ecologically and morphologically diverse group that play a variety of trophic roles. They range from small planktivorous fish such as capelin to large predatory sharks with many of these species are also important ecologically, commercially and/or culturally.

The existing and available information does not indicate that the overall presence and distribution of finfish species has changed in and around the Project Area since the original CSR, in that key species remain the sand lance, mailed sculpin and American plaice. Recent Canadian RV surveys (2008-2012) indicate that sand lance are amongst the most abundant species within the area, while American plaice concentrations are higher in areas north of the Hebron Project Area (Figures 3-6 to 3-8).

**Figure 3-4 Coral Distributions in and Around the Project Area Based on Canadian RV Surveys
(2008-2012)**

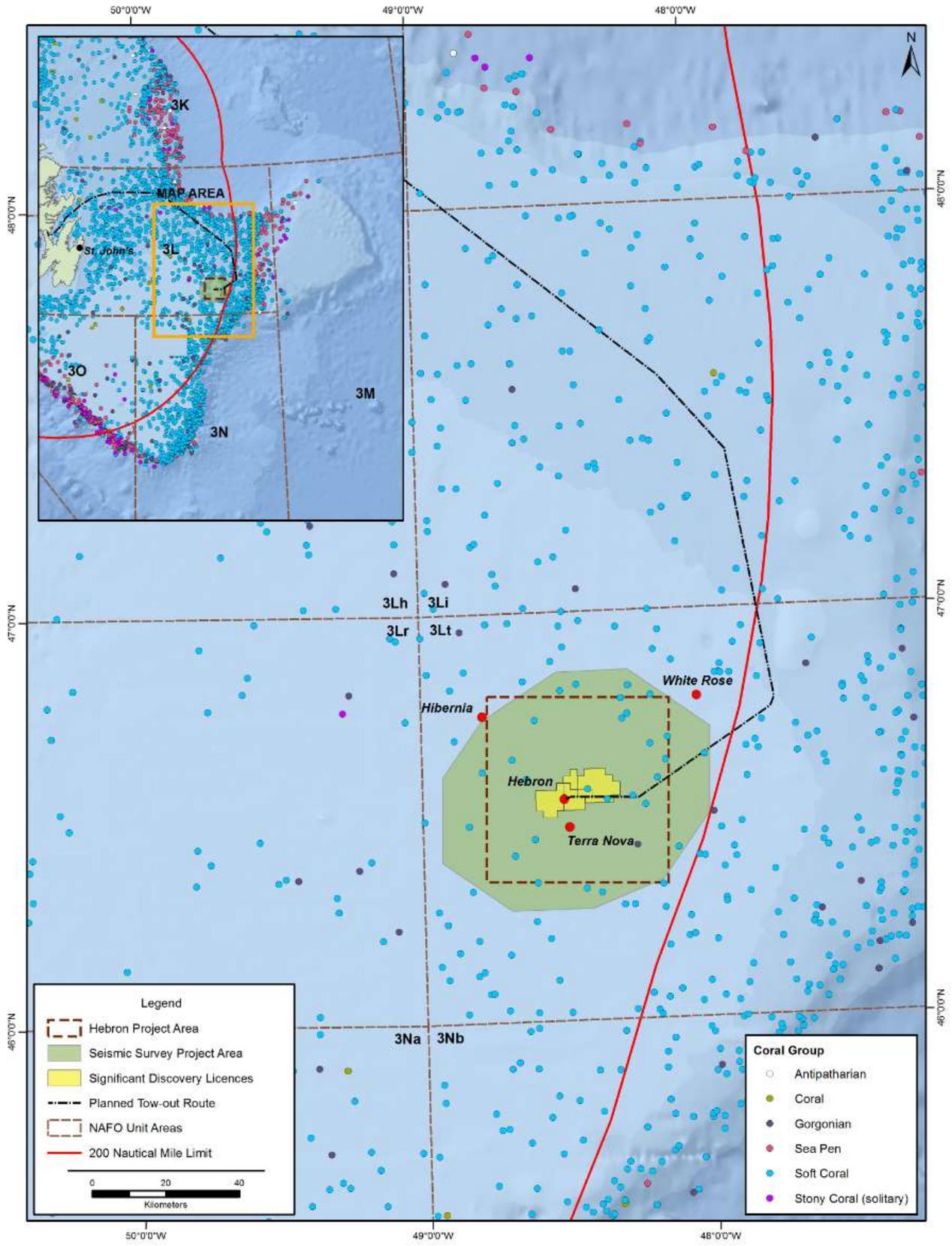


Figure 3-5 Sponge Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)

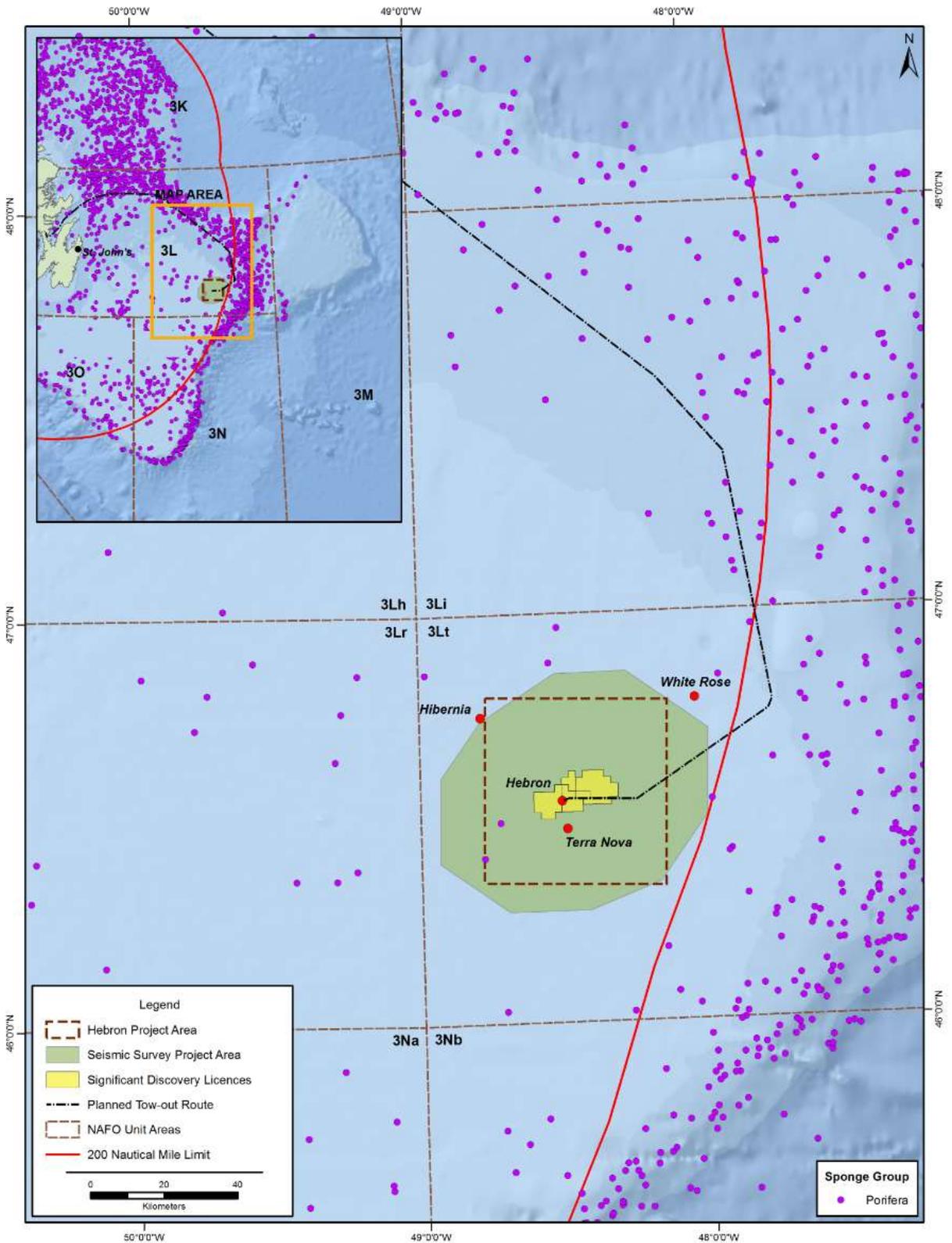


Figure 3-6 Sand Lance Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)

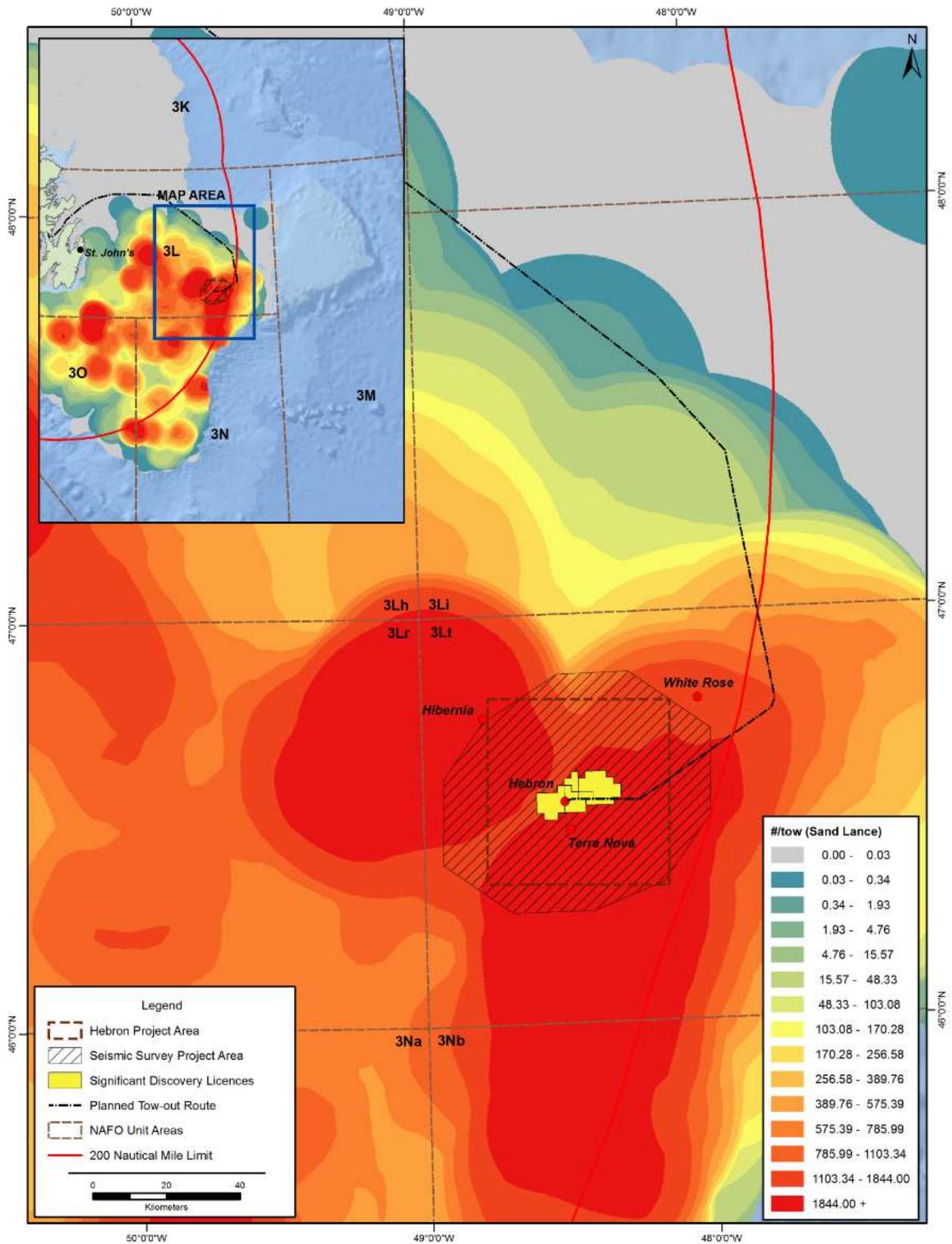


Figure 3-7 Sculpin (*Triglops* sp.) Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)

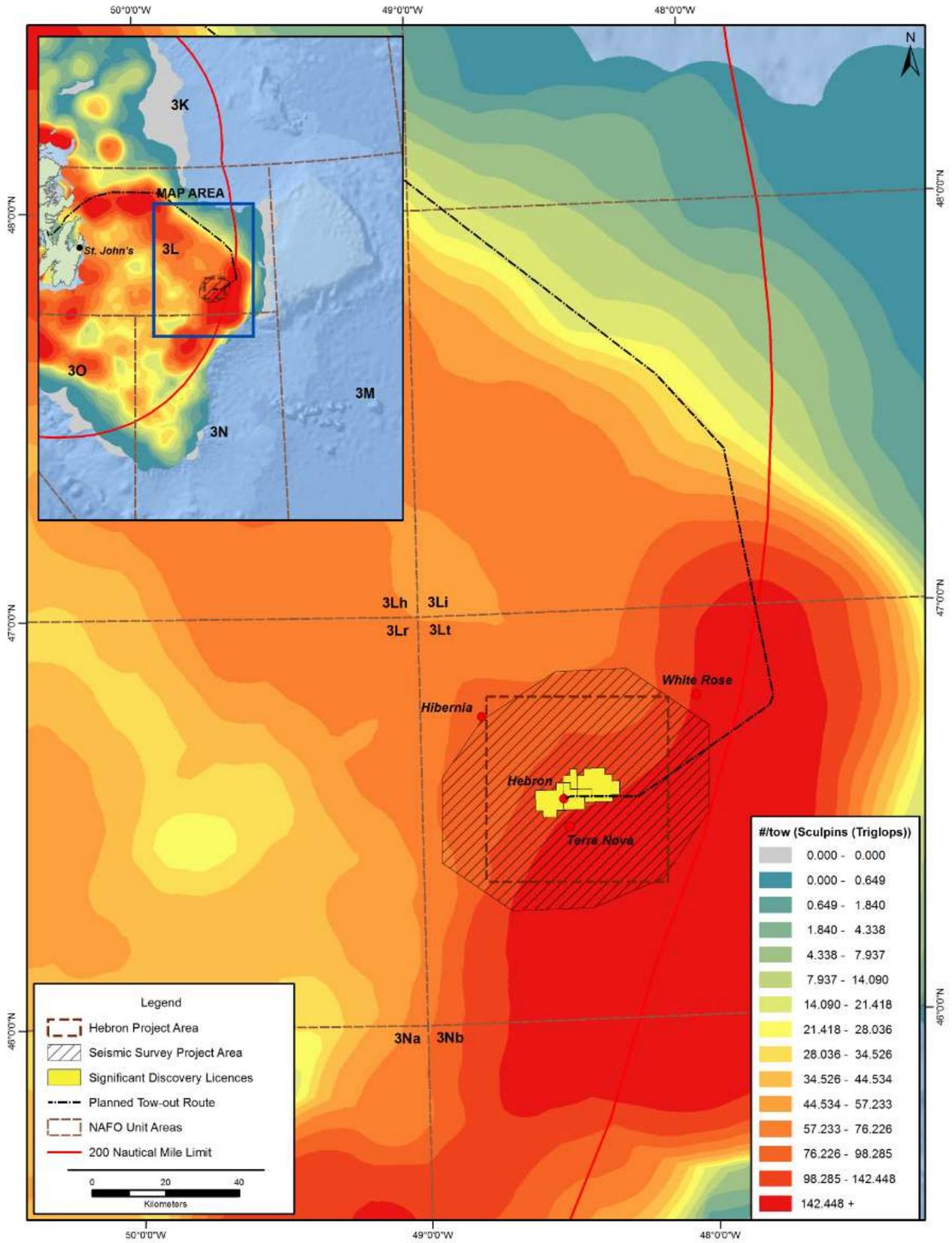
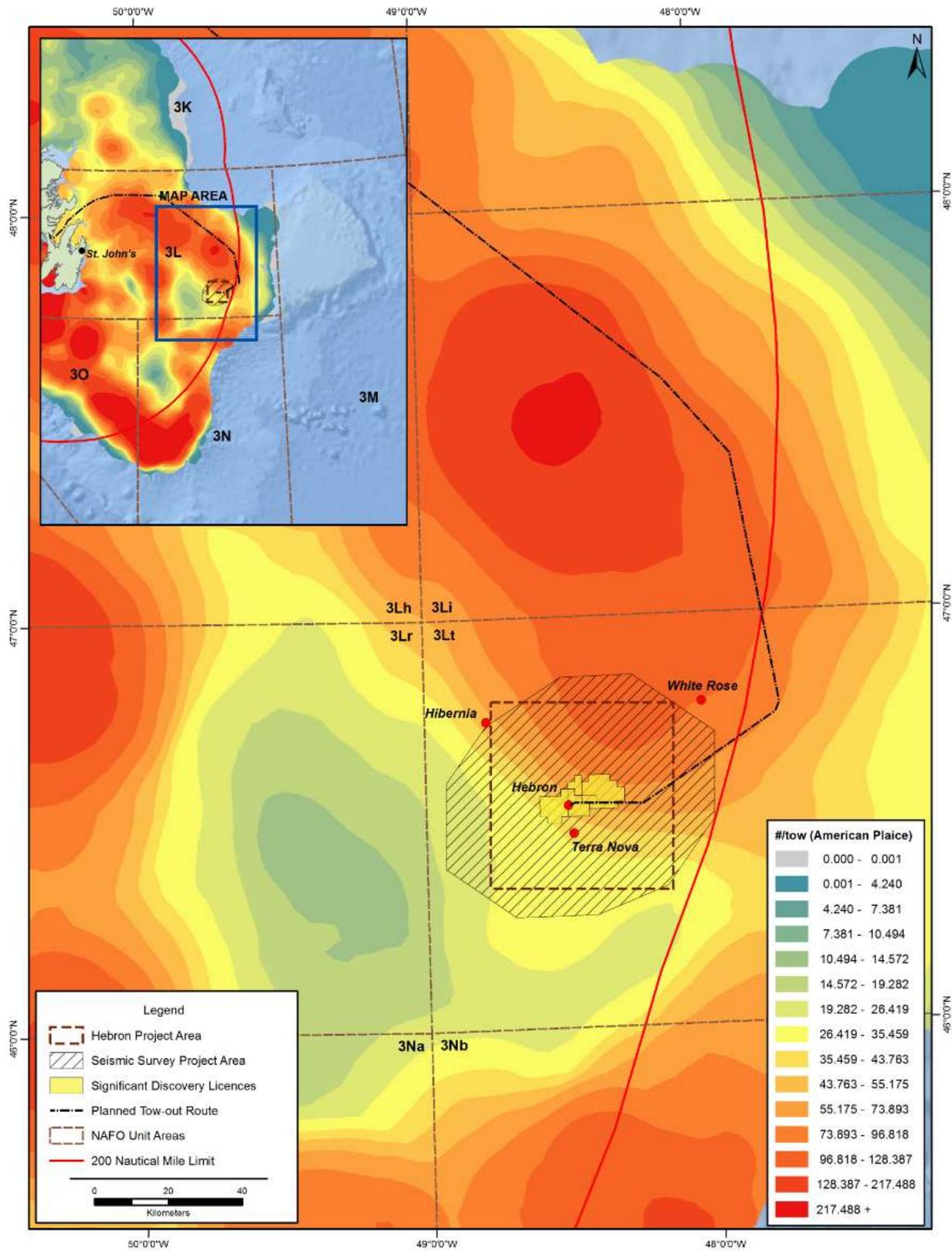


Figure 3-8 American Plaice Distributions in and Around the Project Area Based on Canadian RV Surveys (2008-2012)



3.3 Commercial Fisheries

Fisheries were a key area of focus of the EA review for the Project, and on-going Project planning and implementation have likewise placed a high degree of emphasis on addressing the potential for interactions between Project components and activities and commercial fishing activity within and near the Project Area. The Hebron Project CSR included a detailed description of commercial fisheries in the region based on existing data sources and other information that was available as of the time of EA preparation and submission (see, for example, CSR Section 8.3 and elsewhere). This included fisheries landings statistics and geospatial data up to 2008, with subsequent EA Updates providing fisheries information up to 2014. Commercial fisheries data are currently provided by Fisheries and Oceans Canada (DFO) Statistical Services in Ottawa, ON, including landing (weight and value) statistics and geospatial information on the location and timing of fishing activity. The DFO datasets record and report on domestic and foreign fish harvests that are landed in Canada.

The Hebron (offshore) Project Area is located entirely within North Atlantic Fisheries Organization (NAFO) Division 3L and its associated NAFO Unit Area 3Lt (Figure 3-9), portions of which are located both inside and beyond Canada's 200 nautical mile limit. The most recent fisheries data (up to 2015) available from DFO for this area indicates that approximately 1,981 tonnes of fish were landed in Canadian ports from this NAFO Unit Area in 2015, with an average of 2,067 tonnes being landed per year over the 2010-2015 period. Fish landings from NAFO Division 3Lt in 2015 (all fishing enterprises, for fish landed in Canadian ports) were valued at nearly \$11 million, and had an average annual landed value of \$9.3 million between 2010 and 2015. The available data indicate that the fishery in this area is currently dominated by snow crab, with other species fished including roughhead grenadier, grey sole / witch flounder, Atlantic halibut, Northern shrimp, turbot / Greenland halibut, and others. The main gear types include crab pots and bottom otter trawls. Fishing activity occurs year-round, but is concentrated primarily in the April-July period.

Fisheries mapping information is currently provided by DFO as an aggregated data set which gives a general indication of fishing areas (by species, gear types, fleet and other pre-determined categories and data classes) for individual grid "cells" that are approximately 6 x 4 nautical miles in size. The maps that follow provide an indication of the overall geographic distribution of commercial fishing activity within and adjacent to the Hebron Project Area for the years 2010 up to 2015 (the most recent year for which data are available) within the grid square system described above. This includes Figures that show all recorded commercial fishing activity (Figure 3-9), followed by gear types (fixed or mobile gear, Figures 3-10 and 3-11) and fishing areas for select, key species (see Appendix A) that were fished near the Project Area within that year. As illustrated, the Project Area itself occurs well outside the more intensive commercial fishing areas elsewhere on the Banks and along the shelf.

There are various regulatory jurisdictions that pertain to marine fish and fisheries within and around the Project Area and the various NAFO Divisions and Unit Areas that comprise the Eastern Newfoundland Offshore Area. While the Government of Canada has jurisdiction over fish stocks and fishing activities within the 200 nautical mile limit (EEZ) and for benthic invertebrates (such as crab) across the entire continental shelf, NAFO manages groundfish activities and other resources beyond that 200 mile limit.

Figure 3-9 Commercial Fishing Locations, All Species (2010-2015)

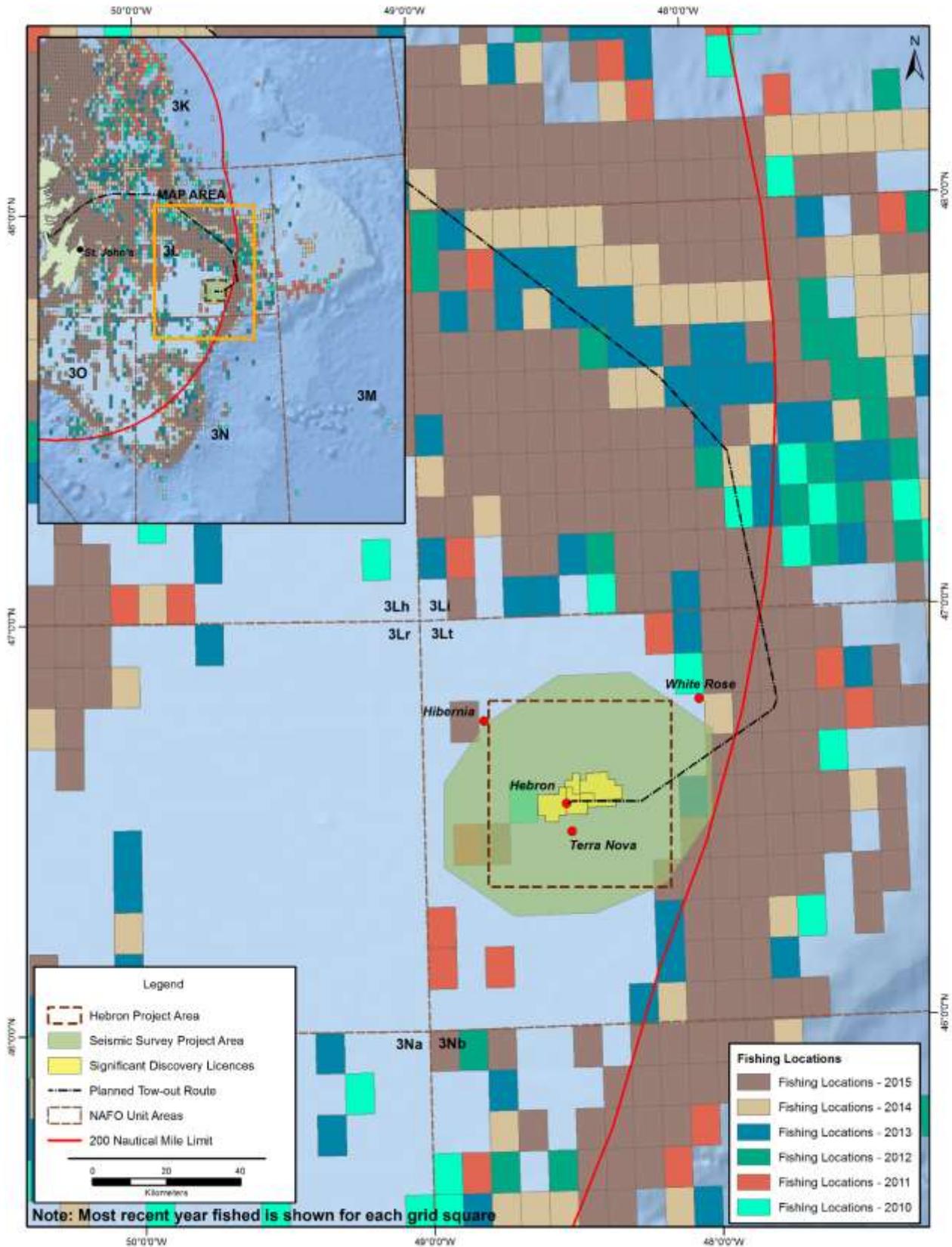


Figure 3-10 Commercial Fishing Locations, Mobile Gear Types (2010-2015)

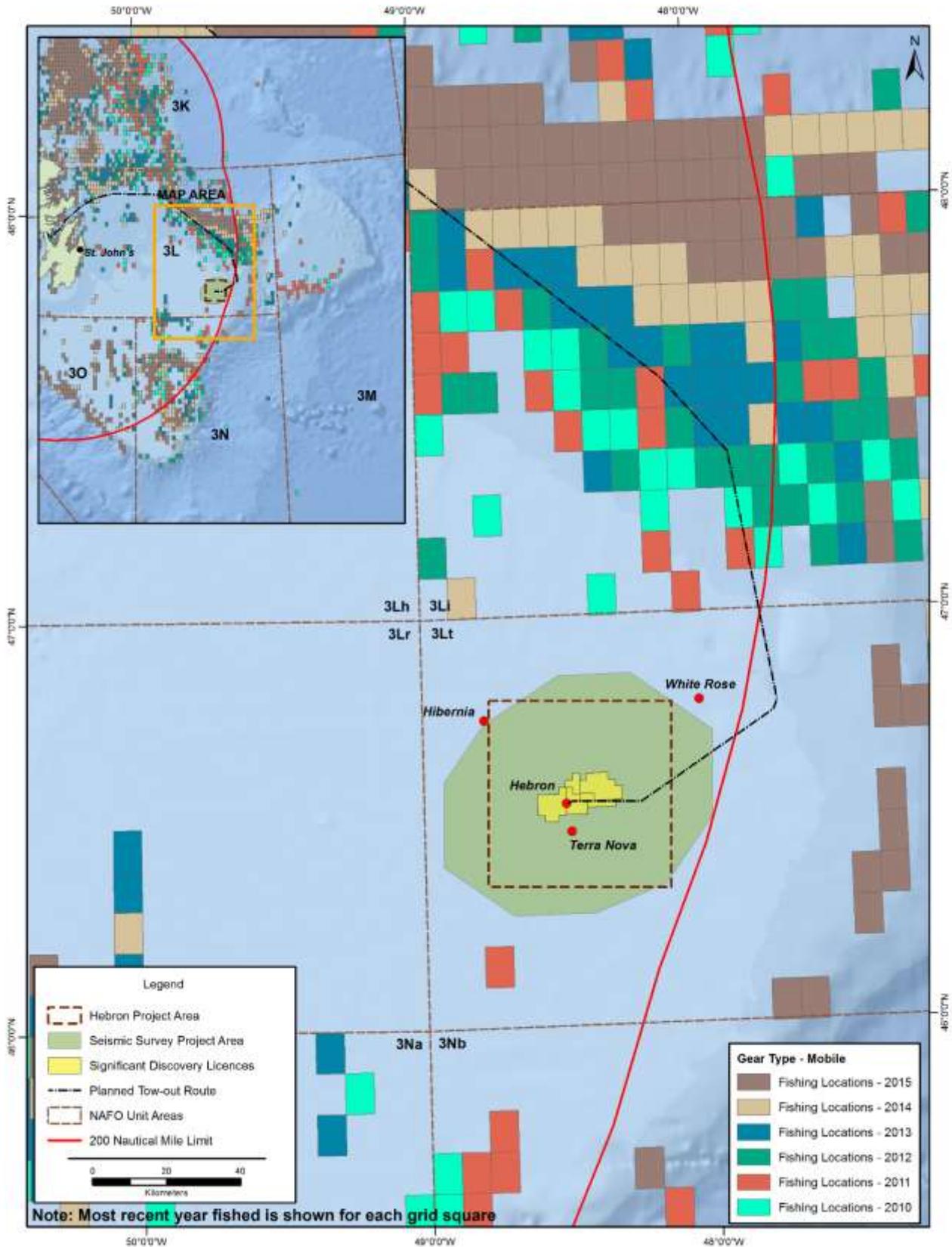
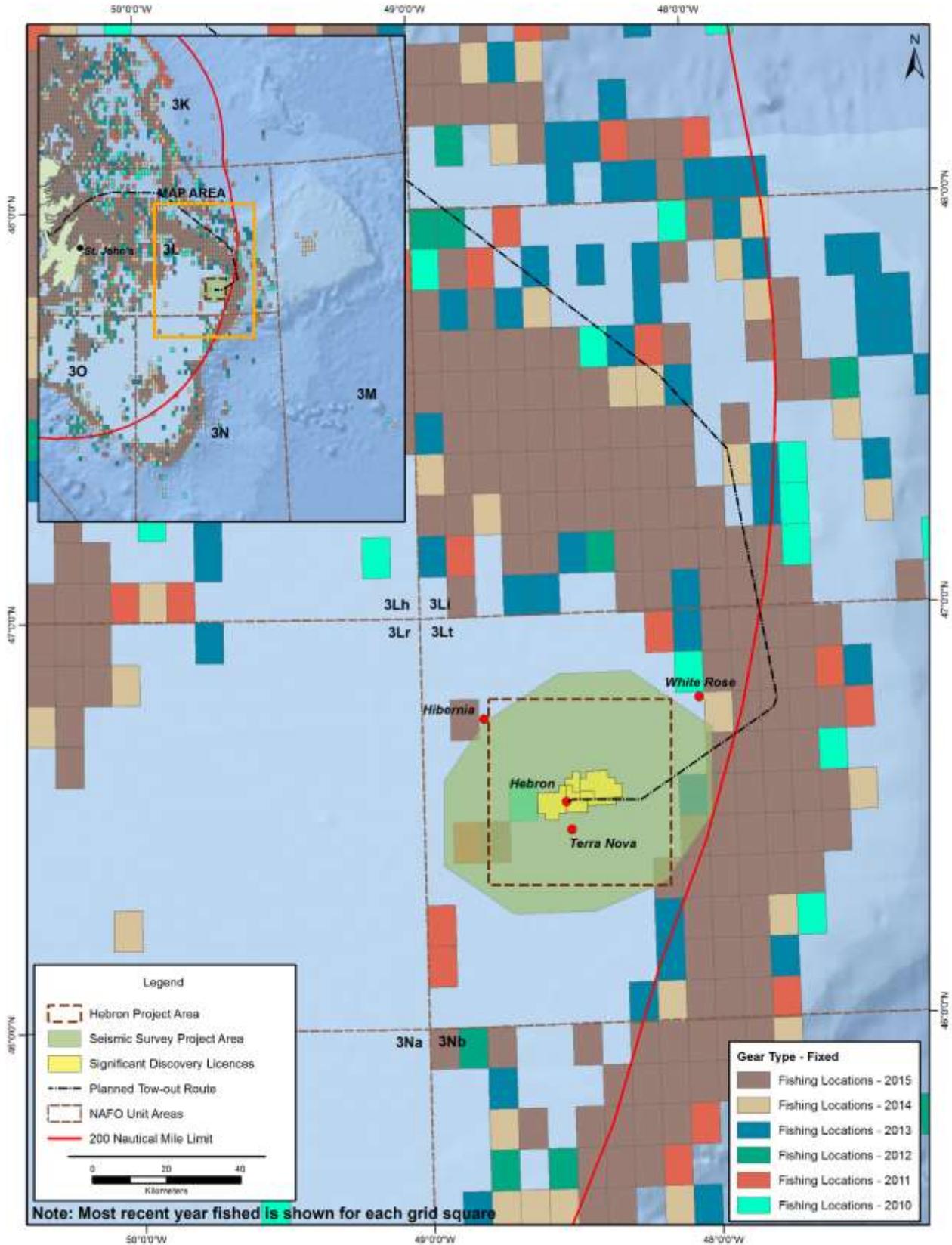


Figure 3-11 Commercial Fishing Locations, Fixed Gear Types (2010-2015)



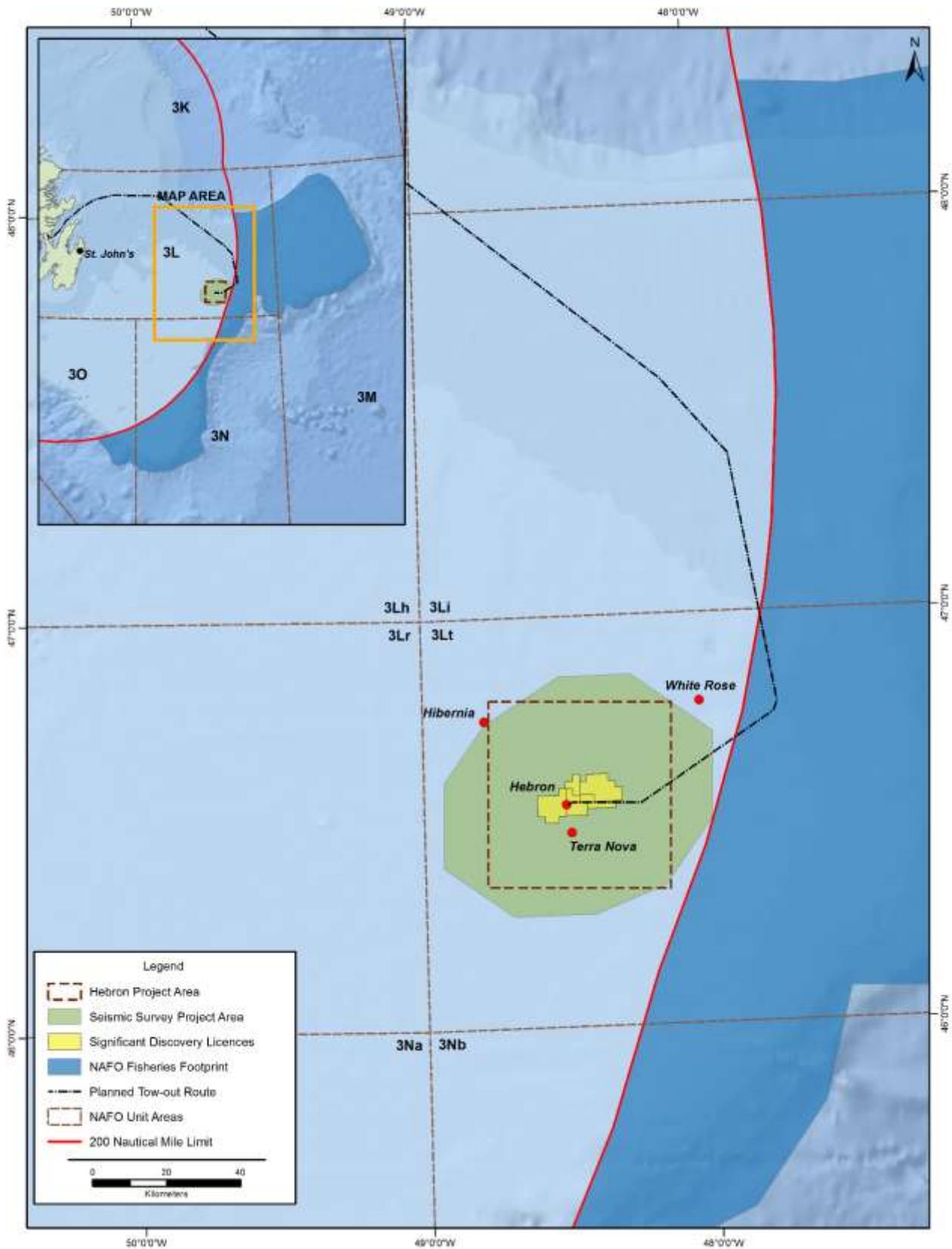
The NAFO Regulatory Area (NRA) is some 2,707,895 km² in size (or 41 percent of the total NAFO Convention Area) and comprises that part of the Northwest Atlantic high seas located adjacent to Canada’s 200 mile EEZ (Amec 2014). Fishing activity in the NRA targets a range of species, including cod, redfish, Greenland halibut, shrimp, skates, and other finfish, and has an approximate landed value of \$200 million annually across all members (NAFO 2017). As a result of the 2007 United Nations General Assembly (UNGA Res. 61/105, paragraph 83) request that Regional Fisheries Management Organizations regulate bottom fisheries, NAFO undertook an exercise to identify bottom fishing areas in the NRA, and in doing so, to identify and map NAFO’s bottom fishing footprint in the area. The NAFO fisheries footprint is 120,048 km² in size, and its location and relationship to the Project Area is illustrated in Figure 3-12.

A number of fisheries survey programs by government and/or industry also occur in parts of the Eastern Newfoundland Offshore Area, including DFO Multispecies Research Vessel (RV) Trawl Surveys, which comprise annual (spring and fall) standardized bottom-trawl surveys to collect information for managing and monitoring fish resources in the Newfoundland and Labrador Region. Table 3-2 shows the (tentative) planned 2017 schedule for DFO’s surveys as obtained from DFO representatives (D. Power, DFO – NL Region, personal communication). EMCP will obtain and verify survey plans with DFO as they are available, and will consider these and undertake associated consultations and communications with DFO in planning and undertaking its activities, as applicable.

Table 3-2 DFO RV Surveys off Eastern Newfoundland (2017)

Vessel	Activity	NAFO Division	Tentative Start Date	Tentative End Date
CCGS Needler	NL Spring Survey	3P	March 31	April 11
		3P	April 12	April 25
		3P+3O	April 26	May 9
		3O+3N	May 9	May 23
		3L+3N	May 24	June 10
	Shellfish Survey	2J+4R	August 31	September 12
	NL Fall Survey	3O	September 13	September 26
		3O+3N	September 26	October 10
		3N+3L	October 11	October 24
		3L	October 24	November 7
3K+3L		November 8	November 21	
		November 21	December 2	
CCGS Teleost	NL Spring AZMP ¹	3L	April 4	April 25
	Capelin Survey	3KL	May 2	May 23
	NL Summer AZMP ¹		July 8	July 29
	NL Fall Survey	2H	October 5	October 10
		2H+2J	October 11	October 24
		2J+3K	October 24	November 7
		3K	November 8	November 21
		3K+3L Deep	November 21	December 5
		December 6	December 20	
¹ Atlantic Zone Monitoring Program Source: D Power, DFO-NL (2017)				

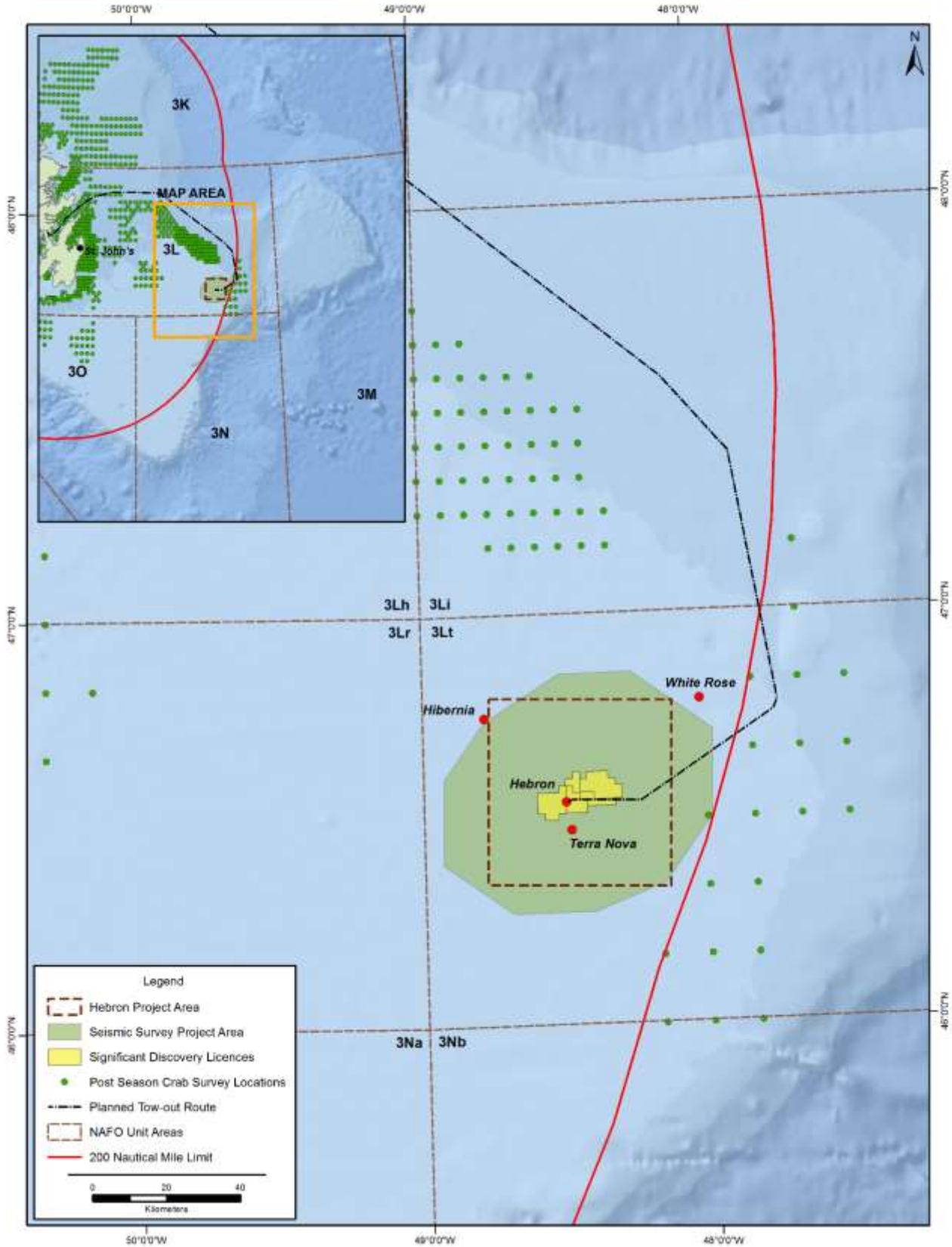
Figure 3-12 NAFO Fisheries “Footprint”



There is also an annual Industry - DFO Collaborative Post-season Trap Survey for snow crab in NAFO Divisions 2J3KLOPs4R, which is conducted using commercial and modified snow crab traps at established trap stations starting in late August or early September after the commercial snow crab season has ended (Figure 3-13). Recent discussions with DFO representatives indicate that the plans for the 2017 surveys are not yet available (D Mullaney, DFO – NL, personal communication). Although, as illustrated in Figure 3-13, the Project Area itself does not overlap directly with any of these established snow crab survey stations, EMCP will obtain and verify survey plans when they are available, and will again consider these in consultation with DFO in planning and undertaking its activities.

Given its location far offshore, the Project Area does not contain or otherwise interact with other fisheries related activities off Eastern Newfoundland, including sealing areas, aquaculture operations, recreational fishing locations, or other human activities and components.

Figure 3-13 Locations of Industry - DFO Post-Season Snow Crab Survey Stations



3.4 Marine Birds

A variety of avifauna species occur within and around the Hebron Project Area and in adjacent marine and coastal regions, including seabirds and other marine-associated birds that inhabit the region at particular or extended periods for breeding, feeding, migration and other activities. A number of important habitats for birds have also been identified at locations along the coastline of Eastern Newfoundland, well outside of the Project Area.

As key components and indicators of ecosystem health, seabirds are often considered to be of high intrinsic ecological importance. Further, they are of socioeconomic importance in Newfoundland and Labrador both in terms of tourism and as a food source. Generally speaking, seabirds are long-lived species with low fecundity, delayed recruitment and relatively low rates of population growth. A diverse assemblage of seabirds can be found in the marine waters off Eastern Newfoundland at all times of year, including gannets, phalaropes, large gulls, kittiwakes, terns, alcids (auks), jaegers and skuas, fulmars, petrels and shearwaters (Amec 2014). The nutrient-rich Grand Banks and Flemish Cap regions off Eastern Newfoundland, for example, serve as a major feeding area for dozens of marine bird species throughout the year, particularly during the summer months. The eastern coast of Newfoundland is also home to several major colonies supporting tens of millions of seabirds, which travel long distances offshore from their nest sites to forage for themselves and their chicks. The region also contains several designated Important Bird Areas (IBAs) which provide important habitat for nationally and/or globally significant numbers of birds and/or for avian species at risk, and there are various other sites of provincial and regional significance to birds (Amec 2014). Although none of these areas or sites occurs within the Project Area itself, some of the bird species that make use of these designated habitats may spend some of their time in the Project Area

The original CSR summarized the distribution and abundance of marine-associated avifauna in the Offshore Project and Study Areas, and describes relevant life history characteristics and areas and times of particular significance to birds that are found within or in proximity to this region. The Eastern Newfoundland SEA (Amec 2014, Section 4.2.2) includes a detailed and updated overview of the presence, life histories, and spatial and temporal distributions of marine avifauna within and around the region. Other existing and available sources such as the current Eastern Canadian Seabirds at Sea (ECSAS) dataset (up to 2017), records from the Atlantic Canada Shorebird Survey (ACSS) and other available literature and datasets that provide additional information and insights on key species, times and locations.

As indicated in the original CSR, a number of marine avifauna have been observed to occur in the Offshore Project Area and Study Area at least seasonally, including large gulls, kittiwakes, dovekies, fulmars, storm-petrels, and others. A review of the most recent available information for the Study Area (including ECSAS data, the IBA database and other sources) indicates that the species presence and distribution has not changed appreciably since the original CSR. No areas of particularly important or sensitive habitat in the area have been identified. Many seabird groups such as cormorants and terns tend to have a more coastal distribution, and are therefore rarely observed this far offshore. Waterfowl occur in large numbers in marine habitats off Eastern Newfoundland, especially during the winter months, but they prefer open water in coastal areas and are thus not likely to frequent the northern and offshore portion of the Study Area (Amec 2014). The most commonly observed seabirds in and around the Project Area year-round are alcids, fulmars and gulls. Shearwaters and storm-petrels are common from spring to fall but less so in the winter months. Gannets, jaegers, skuas and phalaropes are occasionally observed, particularly in the summer and fall. Due to the great distance between this area

and the eastern coastline of the Island of Newfoundland, shorebirds and migrating landbirds are anticipated to be very infrequent visitors to the Project Area (primarily during fall migration). Important Bird Areas and breeding colonies are found in coastal areas and inland, far from the offshore environment that is found within the Project Area; therefore, nesting individuals are unlikely to forage in or around the Project Area with the exception of the Leach's Storm-petrel (*Oceanodroma leucorhoa*) which may make foraging trips of hundreds of kilometres from their breeding grounds (Pollet et al. 2014).

3.5 Marine Mammals and Sea Turtles

The waters off Eastern Newfoundland support a diverse assemblage of marine fauna that includes some 20 marine mammals and several sea turtle species, many of which are considered to be at risk or otherwise of special conservation concern (see Section 3.6). The CSR and subsequent EA Updates have also summarized the distribution and abundance of marine mammals and sea turtles in and around the Project Area, and describe these species' relevant life history characteristics. The Eastern Newfoundland SEA (Amec 2014, Section 4.2.3) provides an updated summary of the distribution and abundance of marine mammals and sea turtles in the overall region.

The existing and available information indicates that marine mammal (cetacean) species that are known or considered likely to occur within the Eastern Newfoundland Offshore Area include a number of mysticetes (baleen whales), odontocetes (toothed whales and porpoises) and pinnipeds (seals), and several sea turtle species have also been observed. These differ considerably in their likelihood of presence and in the particular locations and habitat types that they utilize and the times at which they occur in or pass through the region. Key feeding grounds such as the Grand Banks are of particular importance to marine mammals and turtles, and several EBAs have been identified due in part to their known importance to a number of marine mammal species (Templeman 2007, see Section 3.7 below). Given that a number of these species have been designated as species at risk under Canadian legislation or are otherwise considered to be of conservation concern, they are typically a key consideration in the EA review process for projects and activities off Eastern Newfoundland.

Again, there are a number of existing and available information sources that provide updated information on the characteristics, presence and spatial and temporal distribution of marine mammals and seabirds in and around the proposed Project Area since the original CSR. These are summarized in the Eastern Newfoundland SEA (Amec 2014, Section 4.2.3), and include, for example, the current DFO marine mammal sightings database, other available literature and available (published) marine mammal sightings data collected by operators working in the area. Data are also available from the Ocean Biogeographic Information System (OBIS), which incorporates sightings data from many different sources for a variety of marine taxa for the period between 1913 and 2012.

Although detailed species and site specific survey data are not available for the Project Area itself, and the available DFO sightings database includes limited coverage and observations in this immediate area (see Figures in Appendix A) it is likely that this general region is used by some marine mammals and/or sea turtles during parts of the year. Generally speaking, baleen whales are present in the region throughout the year and most abundant in the summer months; most species are migratory and absent from the region in winter, but common minke whale (*Balaenoptera acutorostrata*) and blue whale (*Balaenoptera musculus*) may occur in the area year-round. Most toothed whales are thought to be year-round residents of the area, with the exception of Risso's (*Grampus griseus*) and common bottlenose (*Tursiops truncatus*) dolphins (present only in the summer months) and beluga (*Delphinapterus leucas*, a rare winter visitor). Pinnipeds are most abundant in the winter, but grey

(*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals may be present year-round. Sea turtles are most abundant in the area during the summer months and are absent between December and April.

3.6 Species at Risk

The Canadian *Species at Risk Act* (SARA) provides for the protection of species at the national level to prevent extinction and extirpation, facilitate the recovery of endangered and threatened species, and promote the management of other species to prevent them from becoming at risk in the future. Designations under the Act follow the recommendations and advice provided by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

There are currently a number of schedules associated with the SARA. Species that have formal protection are listed on Schedule 1, which includes the following potential designations:

Extirpated: A species that no longer exists in the wild in Canada, but exists elsewhere;

Endangered: A species that is facing imminent extirpation or extinction;

Threatened: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and

Special Concern: A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.

Schedule 1 of SARA is the official federal list of species at risk in Canada. Once a species is listed, measures to protect and recover a listed species are established and implemented, including the development of a Recovery Strategy. Action Plans summarize the activities required to meet recovery strategy objectives and goals, and Management Plans set goals and objectives for maintaining sustainable population levels of one or more species that are particularly sensitive to environmental factors.

At the provincial level, the Newfoundland and Labrador *Endangered Species Act (NL ESA)* provides protection for indigenous species, sub-species and populations considered to be endangered, threatened, or vulnerable within the province. These potential designations under the legislation are defined as follows:

Endangered: A species that is facing imminent extirpation or extinction;

Threatened: A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction; and

Vulnerable: A species that has characteristics which make it particularly sensitive to human activities or natural events.

Designations are based on recommendations from COSEWIC and/or the provincial Species Status Advisory Committee (SSAC). Habitat that is important to the recovery and survival of endangered or threatened species can also be designated as critical habitat or recovery habitat, and protected under the NL ESA.

The following Table provides a listing of identified species at risk, as identified and considered in the original CSR and subsequent EA Updates, indicating their current designations under applicable legislation and by COSEWIC. As of November 2016, blue shark (*Prionace glauca*) is no longer designated by COSEWIC. There have been no other relevant designation changes within the past year (i.e., since the 2016 EA Update for the Hebron Project).

Table 3-3 Species at Risk or Otherwise of Special Conservation Concern (Current Designations)

Family	Species		Federal		Provincial
	Common Name	Scientific Name	SARA Status (Schedule 1)	COSEWIC Designation	
MARINE FISH					
Anarhichadidae	Atlantic wolffish	<i>Anarhichas lupus</i>	Special Concern	Special Concern	
Anarhichadidae	Northern wolffish	<i>Anarhichas denticulatus</i>	Threatened	Threatened	
Anarhichadidae	Spotted wolffish	<i>Anarhichas minor</i>	Threatened	Threatened	
Anguillidae	American eel	<i>Anguilla rostrata</i>		Threatened	Vulnerable
Cetorhinidae	Basking shark	<i>Cetorhinus maximus</i>		Special Concern	
Gadidae	Atlantic cod (Newfoundland and Labrador population)	<i>Gadus morhua</i>		Endangered	
Gadidae	Cusk	<i>Brosme</i>		Endangered	
Lamnidae	Porbeagle	<i>Lamna nasus</i>		Endangered	
Lamnidae	Shortfin mako	<i>Isurus oxyrinchus</i>		Threatened	
Lamnidae	White shark	<i>Carcharodon carcharias</i>	Endangered	Endangered	
Macrouridae	Roughhead grenadier	<i>Macrourus berglax</i>		Special Concern	
Macrouridae	Roundnose grenadier	<i>Coryphaenoides rupestris</i>		Endangered	
Phycidae	White hake (Atlantic and Northern Gulf of St. Lawrence population)	<i>Urophycis tenuis</i>		Threatened	
Pleuronectidae	American plaice (Newfoundland and Labrador population)	<i>Hippoglossoides platessoides</i>		Threatened	
Rajidae	Smooth skate (Funk Island Deep Population)	<i>Malacoraja senta</i>		Endangered	
Rajidae	Thorny skate	<i>Amblyraja radiata</i>		Special Concern	
Rajidae	Winter Skate (Eastern Scotian Shelf – Newfoundland)	<i>Leucoraja ocellata</i>		Endangered	
Salmonidae	Atlantic salmon (South)	<i>Salmo salar</i>		Threatened (South)	

Family	Species		Federal		Provincial
	Common Name	Scientific Name	SARA Status (Schedule 1)	COSEWIC Designation	
	Newfoundland Population; Outer Bay of Fundy population)			Newfoundland Population); Endangered (outer Bay of Fundy population)	
Scombridae	Atlantic bluefin tuna	<i>Thunnus thynnus</i>		Endangered	
Scorpaenidae	Acadian redfish (Atlantic population)	<i>Sebastes fasciatus</i>		Threatened	
Scorpaenidae	Deepwater redfish (Northern Population)	<i>Sebastes mentella</i>		Threatened	
Squalidae	Spiny dogfish	<i>Squalus acanthias</i>		Special Concern	
MARINE BIRDS					
Laridae	Ivory Gull	<i>Pagophila eburnea</i>	Endangered	Endangered	Endangered
Scolopacidae	Red-necked Phalarope	<i>Phalaropus lobatus</i>		Special Concern	
MARINE MAMMALS AND SEA TURTLES					
Balaenopteridae	Blue Whale - Atlantic Population	<i>Balaenoptera musculus</i>	Endangered	Endangered	
Balaenopteridae	Fin Whale - Atlantic Population	<i>Balaenoptera physalus</i>	Special Concern	Special Concern	
Balaenidae	North Atlantic Right Whale	<i>Eubalaena glacialis</i>	Endangered	Endangered	
Ziphiidae	Northern Bottlenose Whale - Davis Strait, Baffin Bay, Labrador Sea population; Scotian Shelf population	<i>Hyperoodon ampullatus</i>	Endangered (Scotian Shelf population)	Special Concern (Davis Strait, Baffin Bay, Labrador Sea population); Endangered (Scotian Shelf population)	
Ziphiidae	Sowerby's Beaked Whale	<i>Mesoplodon bidens</i>	Special Concern	Special Concern	
Delphinidae	Killer Whale (Northwest Atlantic / Eastern Arctic population)	<i>Orcinus orca</i>		Special Concern	
Phocoenidae	Harbour Porpoise (Northwest Atlantic population)	<i>Phocoena phocoena</i>		Special Concern	
Dermochelyidae	Leatherback Sea Turtle	<i>Dermochelys coriacea</i>	Endangered	Endangered	

Family	Species		Federal		Provincial
	Common Name	Scientific Name	SARA Status (Schedule 1)	COSEWIC Designation	
Cheloniidae	Loggerhead Sea Turtle	<i>Caretta caretta</i>		Endangered	

3.7 Sensitive or Special Areas

A number of marine and coastal areas within and off Eastern Newfoundland have been designated as protected under provincial, federal and/or other legislation and processes, or have been formally identified through relevant forums and processes as being otherwise special or sensitive due to their ecological, historical and/or socio-cultural characteristics and importance.

Given its location approximately 330 km offshore, the Hebron Project will not occur within, or otherwise interact directly with, any of the existing provincial or federal Parks, Ecological Reserves, Wildlife Reserves, Marine Protected Areas, Migratory Birds Sanctuaries, IBAs or other locations that have been designated as protected on or around the coast of the Island of Newfoundland (Amec 2014). The Project Area likewise does not overlap with any of the identified EBSAs, Preliminary Representative Marine Areas (RMAs), Vulnerable Marine Ecosystems (VMEs) or NAFO Fishery Closure Areas (FCAs) in the offshore environment of Eastern Newfoundland (Figure 3-14).

As illustrated in Figure 3-14, the Project Area is located within the Grand Banks Marine Region, which is one of 29 Marine Regions identified to encompass all of Canada’s coastlines. Parks Canada has stated its long-term goal of establishing at least one national marine conservation area within each Marine Region (Parks Canada 2017).

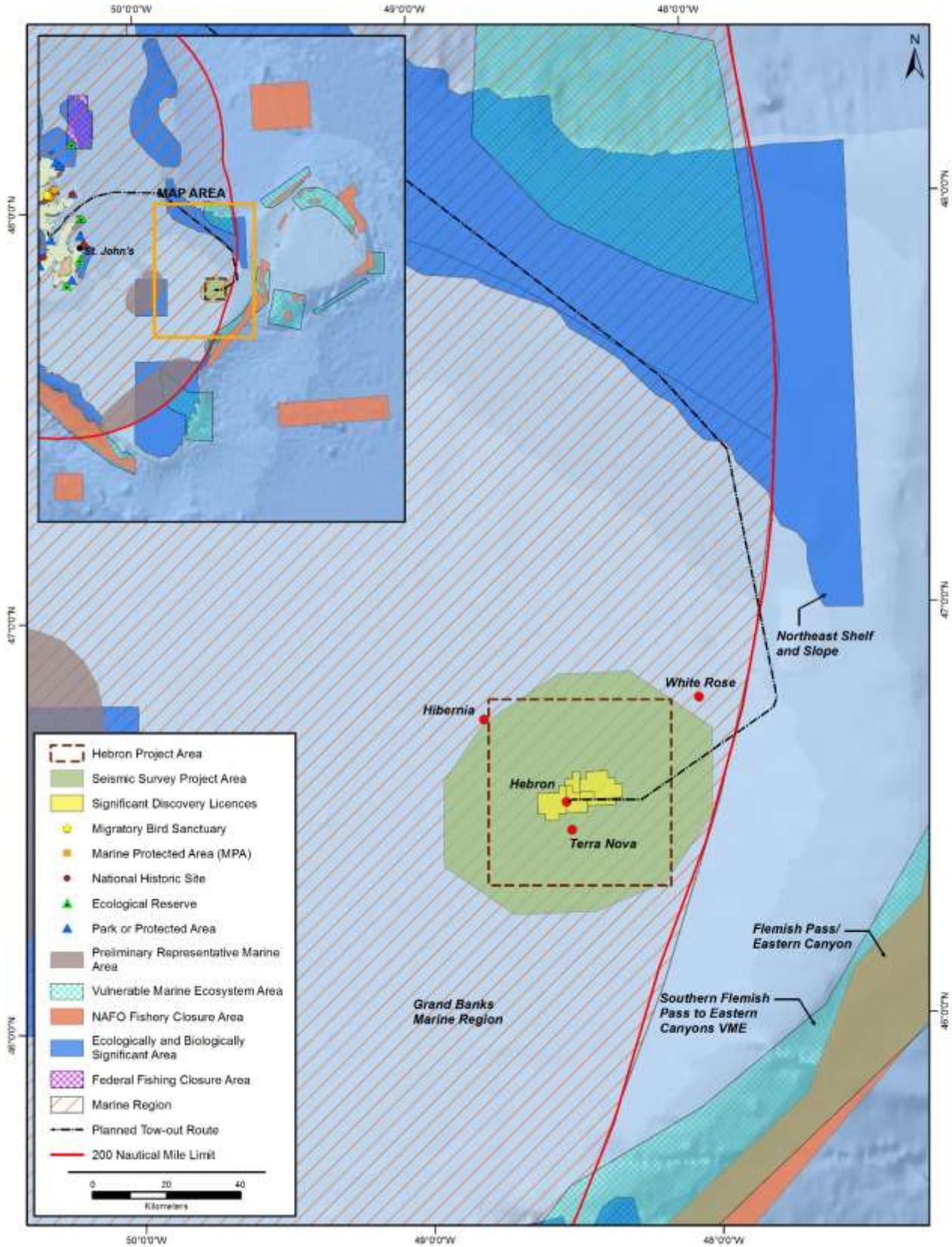
Several types of special areas are located within 100 km of the planned location of the Hebron Platform, as follows (Figure 3-14):

The Northeast Shelf and Slope EBSA is approximately 90 km from the proposed Hebron Platform location. EBSAs are designated under the *Oceans Act* by DFO for their ecological criteria of fitness, aggregations, uniqueness, naturalness and resilience (Templeman 2007; DFO 2013).

The Southern Flemish Pass to Eastern Canyons VME, which has been identified by the NAFO Scientific Council Working Group on Ecosystem Approach to Fisheries Management (WG-EAFM) based on the vulnerability of the habitat and constituent species to bottom contact fishing, is located some 88 km from the planned Hebron Platform location (FAO 2016).

The Flemish Pass / Eastern Canyon FCA, which has been identified by NAFO and legislated by DFO through the *Fisheries Act* to protect VME areas from bottom contact fishing activities, is located approximately 90 km from the site (NAFO 2017).

Figure 3-14 Identified Sensitive and Special Areas off Eastern Newfoundland



4.0 ENVIRONMENTAL EFFECTS ASSESSMENT

The following sections provide an analysis and discussion of any implications of the proposed Project modification (see Chapter 2) for the original EA's environmental effects analysis, associated mitigation, residual effects significance determinations, and thus the overall findings and conclusions of the CSR.

4.1 Air Quality

The proposed modification to the Project (increase in residual chlorine in seawater discharge) will not result in any increased or otherwise different interactions with, or potential effects on, the atmospheric environment as compared to those which were assessed and described in the original CSR.

4.2 Fish and Fish Habitat (Including Species at Risk)

The planned release of liquid discharges, including produced water and cooling water, represents one of the potential interactions with marine fish and fish habitat during offshore operations for both secure and at-risk species. The primary concern and major focus of the liquid discharges in the original CSR related to the produced water component. The produced water component has not changed with respect to those considered and assessed in the CSR. The cooling water discharge, was, however, covered as a component of the liquid discharges.

The original CSR for the Hebron Project states that (Section 7.4.2.2, Operations / Maintenance):

The primary offshore Project activities / components during operations and maintenance that could potentially interact directly or indirectly with marine fish and fish habitat include (but are not limited to):

*Operational discharges (e.g., **cooling water**, storage displacement water, firewater, produced water, grey/black water.*

The CSR also states that (Section 7.5.2, Operations and Maintenance):

Any biocides (Sections 2.6.4.1 and 2.6.4.2; Tables 2-9 and 2-10) used will be screened in accordance with an approved and established chemical management system. All liquid waste discharges from the Hebron Project drilling and production operations will be discharged in accordance with the OWTG. Discharges limits are based on best available technologies and are the focus of continuous improvement programs. Where practicable, use of technology to reduce discharge limits below those in the OWTG will be implemented.

The analysis that follows assesses and evaluates the potential environmental effects of the proposed Project modification that would see a seawater return with an increased concentration of residual chlorine being discharged at sea from the Hebron Platform at 15.5 m depth. Dispersion analysis is used to delineate which components of the fish and fish habitat are most relevant (i.e., pelagic, benthic, etc.).

4.2.1 Residual Chlorine Dispersion Analysis

To provide additional, Project-specific information and analysis related to the nature and extent of the planned liquid discharge resulting from the Project modification, dispersion modelling scenarios of the residual chlorine concentrations were run. Rather than having the dispersion analysis presented as a

stand-alone document, the methods and results of the model have been incorporated into this assessment with supplemental information provided in Appendix B. The results of this modelling are presented below and utilized herein to assess potential effects on pelagic fish habitats and biota. As the original Hebron CSR has already assessed the potential effects of a residual chlorine concentrations of <0.5 ppm, the focus of this analysis was to characterize and delineate the portion of the discharge plume that was above the 0.5 ppm threshold. Although residual chlorine in the seawater will react and produce a number of secondary and tertiary by-products that are also potentially detrimental to marine life (Abarnou and Miosses 1992), the residual chlorine concentration is used as a tracer for this work which is in agreement with most information in the literature (Abarnou and Miosses 1992; Agus et al. 2009).

Model Overview

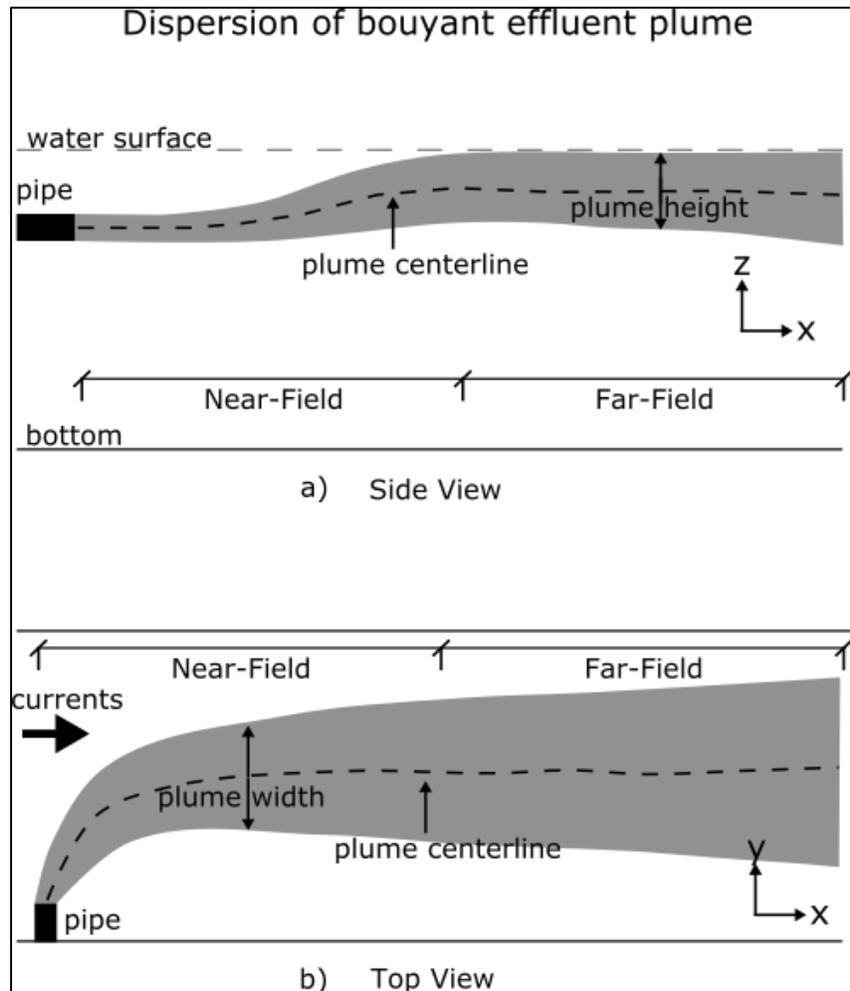
As the effluent is discharged from a pipe, it becomes diluted as it mixes with the ambient seawater on the Grand Banks. The manner in which it interacts with the surrounding seawater is influenced by factors such as the density difference between the effluent and ambient water and thus temperature and salinity of the fluids, the momentum of the effluent, ambient currents, the initial momentum of the effluent, and the depth at the discharge site. The hydrodynamics of the effluent continuously discharging into the ambient seawater can be conceptualized in two separate regions (Figure 4-1).

The region where the initial momentum of the discharge and the buoyancy flux dominates the mixing process is referred to as the near-field mixing zone. As the plume moves away from the discharge source, the characteristics at the source become less important and the ambient conditions have more influence on the fate of the discharge plume. This is referred as the far-field region. The plume disperses both laterally and vertically with distance and time. The envelope of the plume is estimated to have about 37 to 46% of the centerline plume concentration (Doneker and Jirka 2007). In the near-field, the centerline distance of the plume is considerably larger than the associated plume width.

The focus of this study is in the near-field mixing region where the effluent experiences the greatest reduction in concentration and is the key region when attempting to minimize the effluent discharge footprint. It is the operator-designed and implemented discharge characteristics such as pipe design, effluent flow rate, and initial pollutant concentration that have the greatest effect in the near-field.

The CORMIX modelling software was used for the residual chlorine dispersion analysis. The CORMIX modelling suite is widely used as a tool to quantify these processes. Its hydrodynamic simulation system contains a collection of regional flow models based upon integral, length scale, and passive diffusion approaches to simulate the hydrodynamics of near-field mixing zones. It consists of a rule-based expert classification system about mixing zone analysis. The rule base provides a rigorous, descriptive, and documented analysis of mixing processes, based on over 2,000 scenarios to analyze the spatial and technical requirements for regulatory mixing zones. The program was initially designed by the US Environmental Protection Agency for the analysis, prediction and design of aqueous pollutant discharges into diverse marine water bodies. The focus of the model is on the geometry and dilution characteristics of the initial mixing zone as well as predicting the behaviour of the discharge plume at larger distances. The CORMIX 1 module was used for this modelling application as it is designed for single port discharges.

Figure 4-1 Conceptual Illustration of a Dispersion of a Buoyant Effluent Plume: a) Side View and b) Top View



Model Set Up and Inputs

The model inputs are listed in the two tables below for the two seasonal scenarios (summer, winter). The two scenarios were run to capture the differences in the plume regime related seasonal changes in currents and thermocline.

Table 4-1 Ambient Conditions for the CORMIX model

Parameter	Value (Summer/Winter)	Source
Depth (m)	94	Stantec (2011)
Mean surface Currents (m/s)	-0.1 SSE/-0.1 SE	Stantec (2011)
Mean Wind speeds (m/s)	6.7/11.5	Oceans (2010)
Mean Temperature	8.9/-0.53	Amec (2010)
Mean Salinity	32.3/33.0	Amec (2010)
Mean Surface Water Density (kg/m ³)	1024.22/1026.48	Amec (2010)
Mean Bottom Water Density (kg/m ³)	1026.72/1026.78	Amec (2010)
Stratification Type	2/1	Amec (2010)

To capture the range of potential results, scenarios were run for summer (Aug) and winter (Feb)

Table 4-2 Discharge Parameters for the CORMIX Model

Parameter	Value
Discharge Depth (m)	-15.5 (78.5 above bottom)
Discharge Pipe Diameter (m)	0.76 (30" pipe)
Discharge Angle (° vertical)	0 °
Discharge Angle (° horizontal) in relation to mean surface current (summer/winter)	195 °/172.5 °
Discharge Residual Chlorine Concentration (ppm)	2
Discharge Temperature (°C)	30
Discharge Salinity	33
Discharge Flow rate (m ³ /s)	1.11

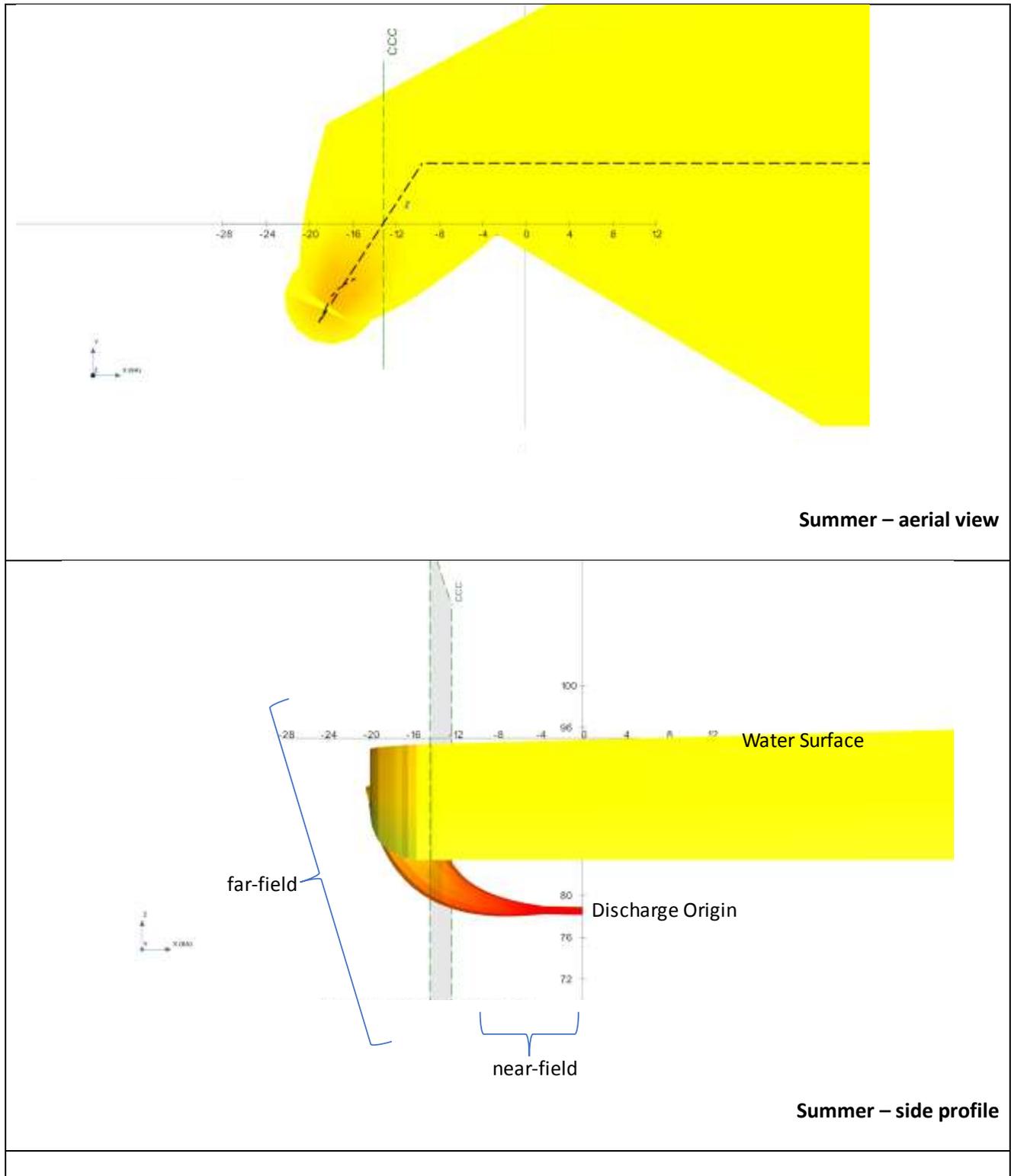
To be conservative, the model uses a 2 ppm residual chlorine discharge. In reality, the continuous discharge concentration would typically be lower, between 1.0 to 1.5 ppm. In addition, this model treats the residual chlorine as a conservative tracer, however, a portion of the residual chlorine would also be consumed by the ambient dissolved organic matter in the receiving environment (Abarnou and Miossec 1992; El Din et al. 2000). Solar radiation also increases the consumption rates of the chlorine (El Din et al. 2000). Therefore, the actual residual chlorine concentrations would likely be less than predicted by the model.

Model Results

This EA Amendment is assessing a change in residual chlorine concentrations at the discharge point of the cooling water from <0.5 ppm to 2 ppm. The model interpretations are thus again focused on the portion of the plume that are above 0.5 ppm. The analyses determined the distances from the discharge point where the dilution rates of less than 0.5 ppm are expected to be reached. The concentrations given are representative of the centerline of the plume unless otherwise noted.

Figures 4-2 and 4-3 illustrate the residual chlorine plume for summer and winter, respectively. The plume discharges in the direction of the flow as far as 20-25 m away from the platform. As the prevailing surface currents are in an opposing direction of the discharge stream (Table 4-2), the discharge flows have more influence than the ambient currents in the near-field region of the plume. All of the residual chlorine concentrations that are more than 0.5 ppm are in proximity of the near-field region of the model and this region is therefore the focus assessment. Outside the near-field, the ambient currents are more influential on the plume direction and dispersion and therefore plume reverses direction in this area and streams back towards the platform. The model does not capture the boundary conditions around the platform but the concentrations at that point are well below 0.5 ppm (<0.1 ppm) and therefore are not considered further.

Figure 4-2 CORMIX Plume Dispersion Model Results for Summer for Aerial (top panel) and Side-profile (bottom panel)



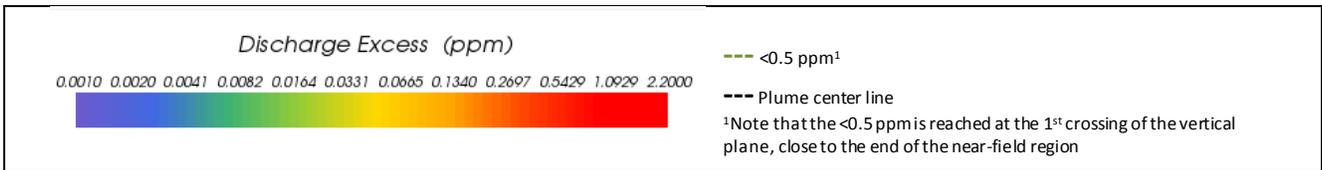
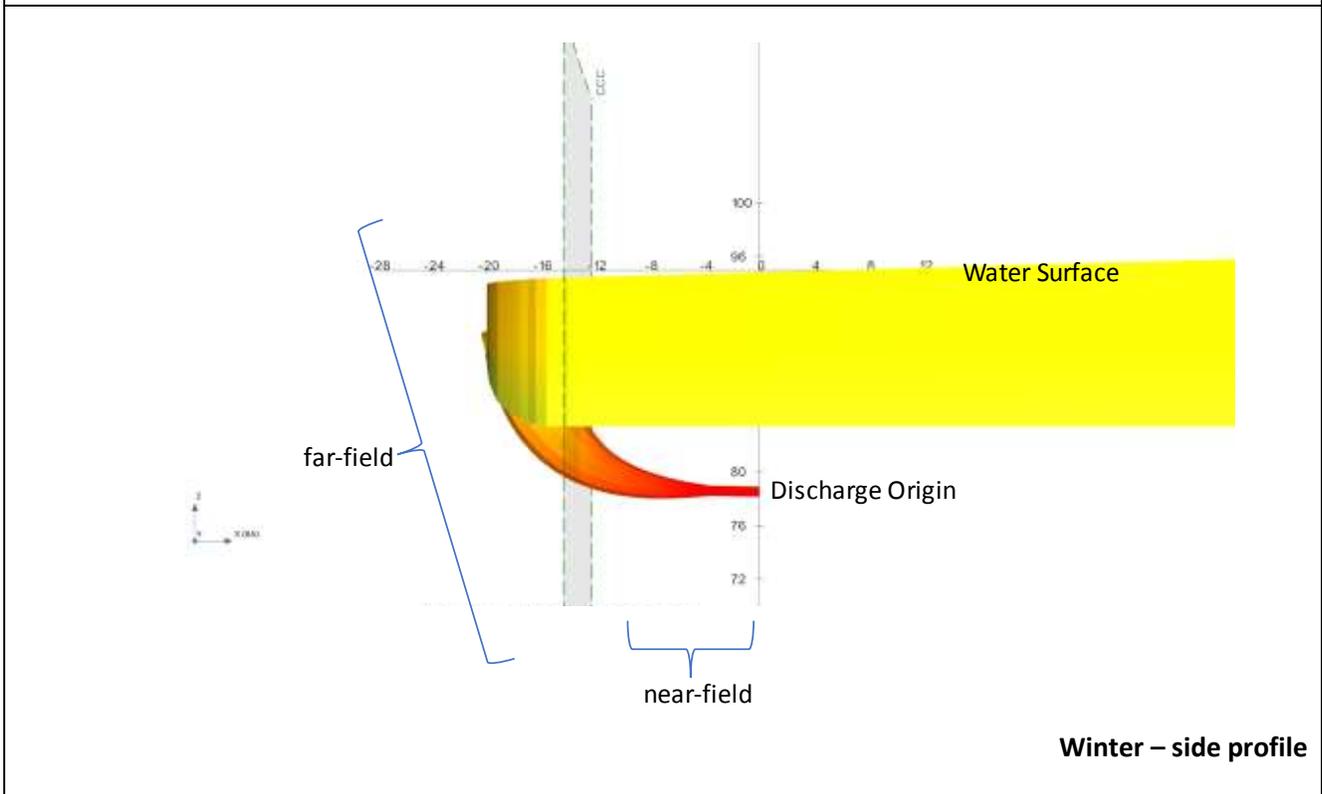
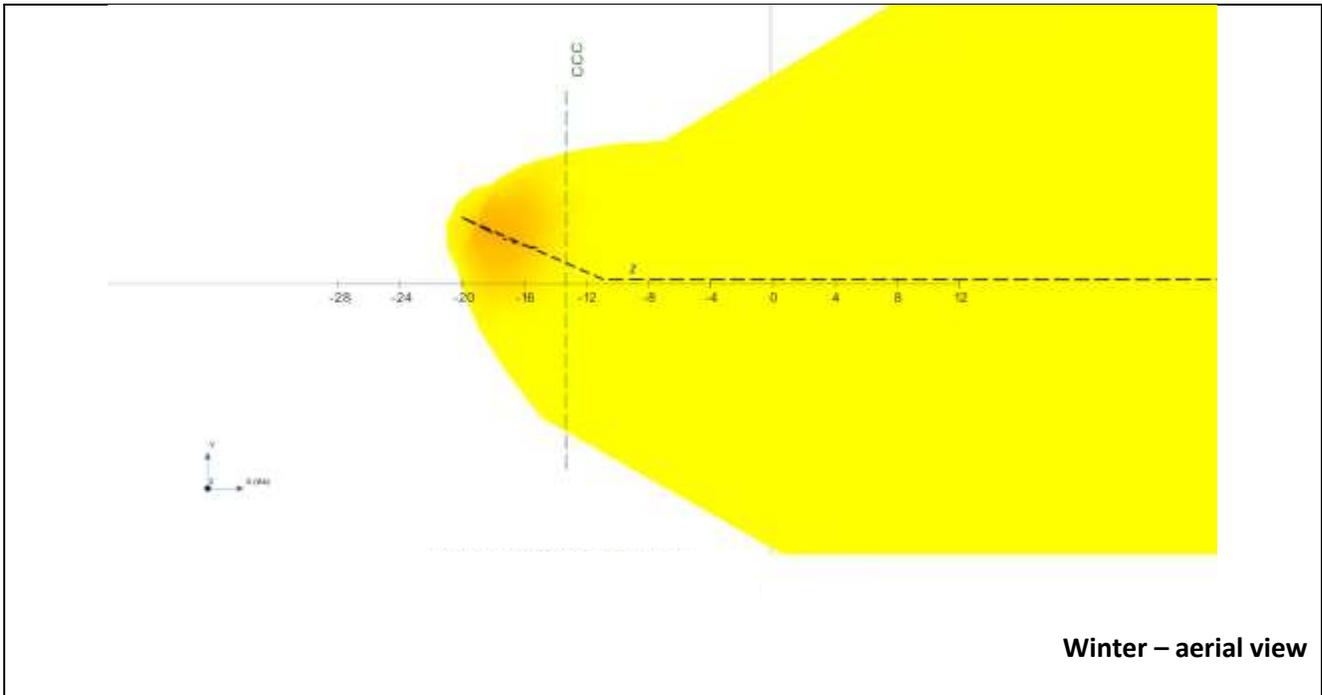
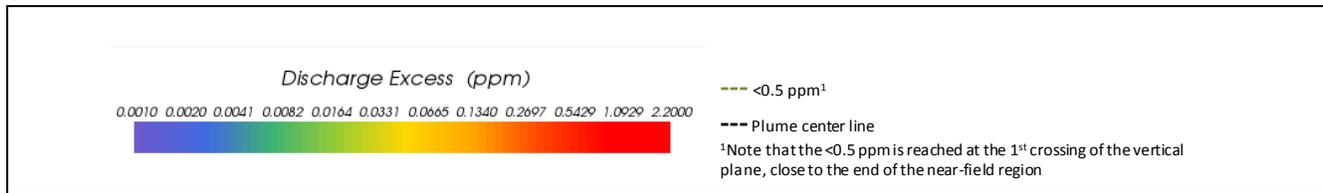


Figure 4-3 CORMIX Plume Dispersion Model Results for Winter for Aerial (top panel) and Side Profile (bottom panel)





The results for the summer scenario are summarised in Table 4-3 and illustrated in Figure 4-2. In general, the model predicts the plume will not sink below its initial depth (15.5 m below the surface) at the discharge point and as the plume is positively buoyant, will tend to rise towards the surface. The model predicts that the plume reaches concentrations of less than 0.5 ppm residual chlorine at a distance of 13.7 m from the discharge port. The shallowest depth that the plume reaches more than 0.5 ppm residual chlorine is 9.8 m below the surface. The plume itself is not predicted to reach the seawater surface until 17.8 m horizontal distance from the discharge at a concentration of 0.4 ppm.

The results for the winter scenario are summarised in Table 4-3 and illustrated in Figure 4-3 and show comparable results. In general the model predicts the plume will not sink below its initial depth (15.5 m below the surface) at the discharge point and the plume will rise towards the surface. The model predicts that the plume reaches concentrations of less than 0.5 ppm residual chlorine at a distance of 13.6 m from the discharge port. The shallowest depth that the plume reaches more than 0.5 ppm residual chlorine is 9.6 m below the surface. The plume itself is not predicted to reach the seawater surface until 17.3 m horizontal distance from the discharge at a concentration of 0.2 ppm.

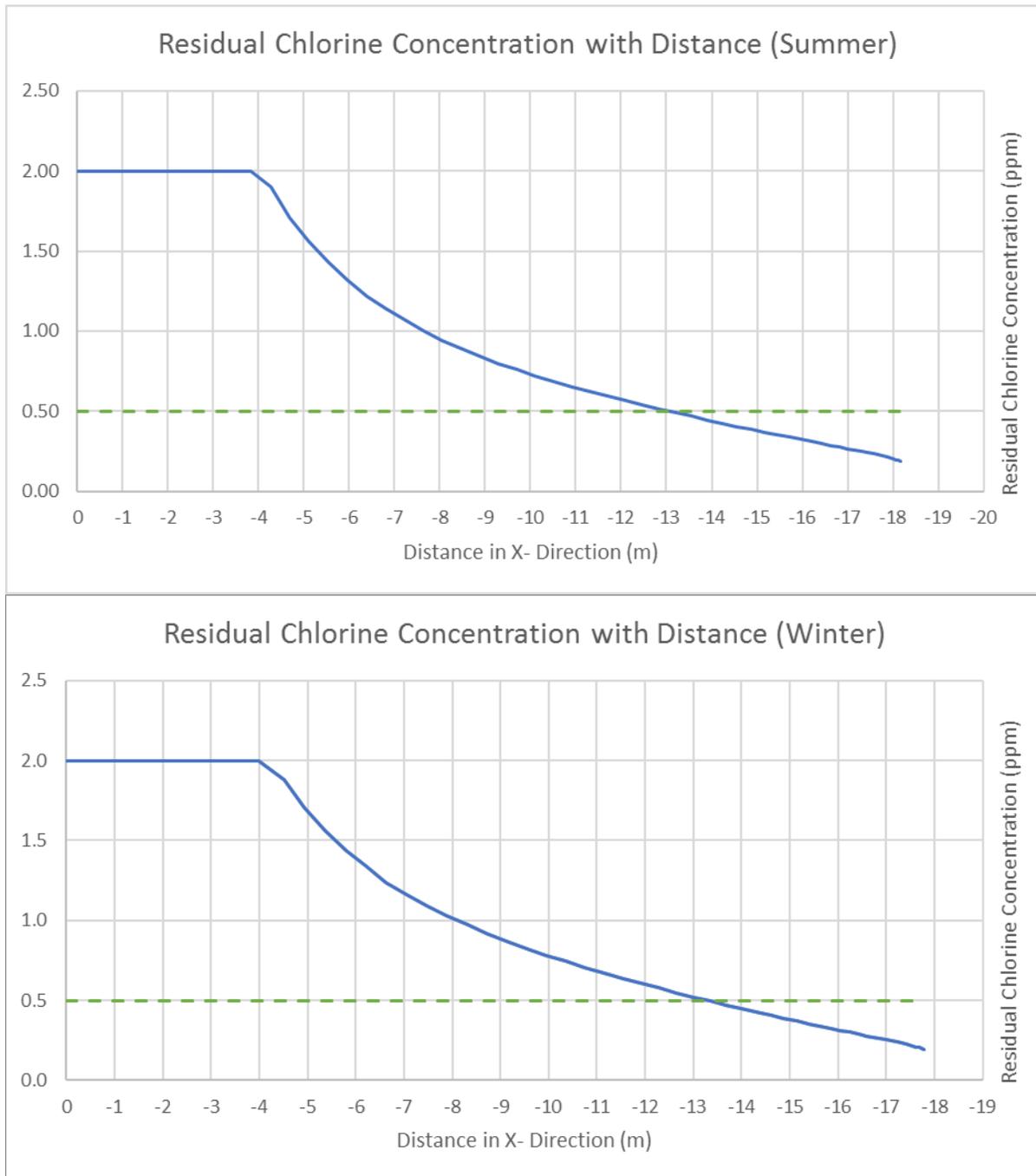
Table 4-3 Distance and Time Calculated for Plume to reach a Concentration of 0.5 PPM

Parameter	Summer	Winter
Maximum Depth (m) of plume >0.5 ppm	-15.5 (source)	-15.5 (source)
Horizontal Distance (m) to reach 0.5 ppm	13.7	13.6
Minimum Depth (m) of plume >0.5 ppm	-9.8	-9.6
Distance (m) and concentration (ppm) for plume to reach surface	17.8/0.4	17.3/0.2
Maximum half-width (m) of plume >0.5 ppm	2.1	2.0

Summary

In summary, the models for both scenarios (summer, winter) predict that the residual chlorine concentration in the receiving environment drops below 0.5 ppm within 15 m of the discharge point (Figure 4-4). Neither the sea surface nor the seafloor is exposed to chlorine >0.5 ppm and therefore, these findings are not outside the scope of the original CSR assessment. Therefore, the focus of this assessment is on the potential effects of the volume of water between 0.5 and 2 ppm, all of which falls within the water column that is between 10 and 15 m deep and within 15 m of the discharge point.

Figure 4-4 CORMIX Plume Dispersion Model Results Residual Chlorine Concentration with Distance from Source (in X-direction) for Summer (top panel) and Winter (bottom panel). Dashed green line represents the 0.5 ppm.



4.2.2 Potential Biological Effects

Residual chlorine may be toxic to marine fish with prolonged exposure (Venkatnarayanan et al. 2017), however, the combination of the rapid plume dilution and avoidance behaviours of fish, mitigate potential effects on free-swimming fish (Tierney 2016). Fish have also exhibited avoidance behaviours to chlorine in particular (Hall et al. 1983), further reducing potential effects. Other taxa, that occupy the water column such as plankton, have lower capacity for avoidance and therefore have relatively higher potential for interaction with the higher residual chlorine concentrations and chlorine product oxidants at the discharge source. Therefore, this review focusses on the effects of an increased residual chlorine concentration on plankton; including phytoplankton (unicellular algae such as diatoms), zooplankton (copepods, meroplankton including fish and invertebrate larval life stages) as discussed in the Chapter 7 of the original CSR. Residual chlorine levels beyond 0.5 ppm are not predicted to interact with benthic environments and this issue is therefore not discussed further.

The majority of studies reviewing the effects of residual chlorine discharges in the marine environment relate to the cooling water systems of coastal electric power stations and desalination plants (Thiyagarajan et al. 2000; Bamber and Seaby, 2004; Poornima et al. 2005, Ma et al. 2011). These plants and stations are coastal and often in semi-enclosed seas or bays with less water turnover than at the Hebron offshore site. These site discharges are comparable to this Project in terms of overall trends, however, their results are likely more amplified as they are in a less dynamic marine environment.

Residual chlorine in seawater is known to affect various metabolic and physiological processes in phytoplankton relating to cellular damage, leakage of intracellular material, and reduction in chlorophyll and photosynthesis in general (Virto et al. 2005). Lethal and sublethal concentrations of residual chlorine for phytoplankton are species specific. For example, *Chlamydomonas* sp., a green flagellated unicellular algae, had a lethal response with a 10 minute exposure of 37-42°C at chlorine concentrations 1.5-2.3 ppm. Conversely, *Skeletonema costatum*, a diatom was not irreversibly damaged at 20 ppm residual chlorine (Hirayama and Hirano 1970). Other studies have found sensitivities among other species of diatoms when exposed to 1.0 ppm hypochlorite for 20 minutes that resulted in recovery of a pennate diatom species (*Navicula* sp.) but not a centric diatom (*C. lorenzianus*) Both species however, recovered from lower level exposure of 0.5 ppm (Venkatnarayanan et al. 2017).

Laboratory exposure studies on zooplankton effects from residual chlorine discharges copepods and amphipods have found lethal concentrations ranging from 0.01 to 3 ppm for these taxa (Abarnou and Miossec 1992). Effects are species-specific and highly varied. For example, one study found significant mortality for the copepod, *Acartia tonsa* and shrimp (*Crangon crangon*) with no effect on lobster larvae (*Homarus gammarus*) for 1 ppm 7-minute residual chlorine exposure (Bamber and Seaby 2004). Within the same species, younger development stages are typically more sensitive than adults except for eggs, which have a higher resistance due to their membranes (Abarnou and Miossec 1992). In summary, the residual chlorine concentrations in the literature for mortality of plankton are within the range of values expected at the discharge point.

The plankton, therefore, that are within the immediate area of the plume at the discharge point have the potential for lethal and sublethal effects. As the quantity of plankton affected is likely to be limited, potential adverse effects from residual chlorine are not predicted for plankton at a population or regional level.

The potential biological effects of liquid discharges for this Project are primarily relevant to the produced water discharges. The CSR concluded that the effects from produced water are expected to be limited to within 500 m of the platform. At 500 m, the model predicts the residual chlorine concentration in the plume to be less than 0.06 ppm. Therefore, the zone of influence of the cooling water plume will be within any areas already affected by the produced water plume. The rapid dilution also indicates that relatively high residual chlorine of more than 0.5 ppm is short lived and is not expected to have potential effects on fish habitat.

The proposed modification to the Project (change in residual chlorine discharge from <0.5 to 2 ppm) will therefore not result in any increased or otherwise different effects on Fish and Fish Habitat as compared to those which were assessed and described in the original CSR. The proposed Project modification therefore does not change the results of the original environmental effects assessment for this VEC, and the Project is still not likely to result in significant adverse environmental effects on Fish and Fish Habitat.

Therefore, although pelagic fish species are potentially located within the area of planned discharge point from the Hebron Platform, it is not anticipated that the quantity and duration of release (see Section 2.2) combined with the low toxicity of the material will have any adverse effects on fish and fish habitat, and specifically, will not alter the effects predictions made in the original CSR (Section 7.5.6).

The table excerpts (Table 4-4) below reproduce the relevant sections of the environmental interactions and effects summary tables included in the original CSR for the Fish and Fish Habitat VEC¹. Overall, the discharge of residual chlorine and tertiary products into the marine environment is predicted to have adverse effects on fish and fish habitat that are low magnitude, within a 10 km² area, relatively frequent, lasting more than 72 months, but reversible and in an area of existing environmental effects (Table 4-5). Potential residual effects for the operations and maintenance activities and cumulative effects are predicted to be not significant with a high level of confidence (Table 4-6).

Table 4-4 Potential Project-related Interactions: Fish and Fish Habitat

Project Activities, Physical Works Discharges and Emissions	Potential Environmental Effects			
	Habitat Quantity	Habitat Quality	Habitat Use	Fish Mortality
Offshore Operations and Maintenance				
Wastewater (produced water, cooling water, storage displacement water, etc.)		x	x	

¹ Please note that these updated CSR Tables are provided for this VEC only, for illustration, and given that the nature of the proposed Project modification is such that it and its potential effects are only relevant to Fish and Fish Habitat, as assessed and described in the other VEC sections that follow.

Table 4-5 Environmental Effects Assessment: Operations and Maintenance

Project Activity	Potential Environmental Effect	Mitigation	Evaluation Criteria for Assessing Residual Adverse Environmental Effects ^A				
			Magnitude	Geographic Extent	Duration / Frequency	Reversibility	Ecological / Socio-economic Context
Wastewater (produced water, cooling water, storage displacement water, etc.)	<ul style="list-style-type: none"> Change in Habitat Quality Potential Mortality 	<ul style="list-style-type: none"> Use of best practices, continuous improvement programs Adherence to discharge limits as per OWTG^B 	1	2	5/6	R	2
<p>Key</p> <p>Magnitude 1 = Low: <10 percent of the population or habitat will be affected 2 = Medium: 11 to 25 percent of the population or habitat will be affected 3 = High: >25 percent of the population or habitat will be affected</p> <p>Geographic Extent 1 = <1 km² 2 = 1-10 km² 3 = 11-100 km² 4 = 101-1,000 km² 5 = 1,001-10,000 km² 6 = >10,000 km²</p> <p>Frequency 1 = <11 events/year population or habitat in the 2 = 11-50 events/year Study Area will be affected 3 = 51-100 events/year 4 = 101-200 events/year population or habitat in the 5 = >200 events/year Study Area will be affected 6 = continuous</p> <p>Duration 1 = < 1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = >72 months</p> <p>Reversibility R = Reversible I = Irreversible</p> <p>Ecological / Socio-economic context 1 = Area is relatively pristine or not adversely affected by human activity 2 = Evidence of adverse environmental effects</p> <p>A Where there is more than one potential environmental effect, the evaluation criteria rating is assigned to the environmental effect with the greatest potential for harm B OWTG has prescribed performance targets for certain liquid discharges (produced water, displacement water, etc.) but not for cooling water</p>							

Table 4-6 Residual Environmental Effects Summary: Fish and Fish Habitat

Phase	Residual Adverse Environmental Effect Rating ^A	Level of Confidence	Probability of Occurrence (Likelihood)
Operation and Maintenance	NS	3	N/A
Cumulative Environmental Effects	NS	2	N/A
<p>Key</p> <p>Residual Environmental Effects Rating S = Significant Adverse NS = Not Significant Adverse Environmental Effect</p> <p>Level of Confidence in the Effect Rating: 1 = Low Level of Confidence 2 = Medium Level of Confidence 3 = High Level of Confidence</p> <p>Probability of Occurrence of Significant Environmental Effect: 1 = Low Probability of Occurrence 2 = Medium Probability of Occurrence 3 = High Probability of Occurrence</p> <p>^A As determined in consideration of established residual environmental effects rating criteria.</p>			

The fate of environmental discharges associated with operations at the Hebron production field will be monitored and evaluated through the Hebron Environmental Effects Monitoring (EEM) Plan (ECMP 2016). The EEM plan is designed to detect any changes in the receiving marine environment that may be associated with offshore drilling and other activities at the Hebron Program. This includes a comprehensive analytical suite of chemical, toxicity and biological assays for sediment, water and biota that has been curated over more than two decades of offshore EEM programs on the Grand Banks and are common to other production fields on the Grand Banks such as the Hibernia Platform, the Hibernia Southern Extension excavated drill centre, and the Terra Nova production field (DeBlois et al. 2014a; HMDC 2015).

In addition, the Hebron EEM Plan includes a biological survey to compare the abundance and condition of a commercial flatfish species, American plaice (*Hippoglossoides platessoides*), around the Hebron field as well as at a distant reference area. Fish tissue samples will also be analyzed for concentrations of metals, PAHs, and alkylated-PAHs in liver and tissue as well as bioassays including EROD, tissue histology and blood analysis. Taste testing panels are also performed on fillet samples. Overall, if any changes occur beyond the predictions of the CSR the objective of the EEM program is to detect them and inform adaptive management procedures as required and relevant.

4.3 Commercial Fisheries

The presence and operation of the Hebron Platform has the potential to interact with commercial fisheries in a number of ways, including through direct interference by making parts of the Project Area unavailable for fishing activities (through the associated safety zone), as well as potentially damaging fishing gear, vessels and equipment in the unlikely event of a direct interaction. The presence and operation of the Project may also lead to changes in the abundance, location and/or quality of marine resources due to the associated underwater noise, emissions, drill cuttings, etc., which may in turn affect their availability and use by commercial fishing enterprises. Any Project-related biophysical effects to fish or other marine resources could therefore result in a subsequent change in the nature, quality and/or value of one or more of the marine activities that utilize or depend upon them.

Potential effects on commercial fishing as a result of direct interference or potential gear damage due to the presence and conduct of Project activities in the offshore marine environment were fully assessed in the original CSR, and the potential for, and nature and degree of, these potential interactions will not increase or otherwise change as a result of the proposed modifications (increasing concentration of residual chlorine discharge) that are being assessed here.

As assessed and described in some detail in the preceding section (Fish and Fish Habitat), the proposed discharge of liquid discharges is not expected to result in different (and certainly, not significant) adverse effects upon marine fish or their habitats. Although these discharges have the potential to interact with marine biota, as discussed above, residual chlorine is not a primary concern associated with liquid discharges. Any disturbance to fish or their habitats due to increased chlorine concentrations will be localized and reversible, and well within the immediate vicinity of the Project itself, in an area that will not be subject to commercial fishing activity due to the presence of the surrounding safety zone referenced above.

It is therefore unlikely that marine resources will be affected in a manner and to a degree that would then translate into effects on the overall availability or quality of any marine resource, and thus, on the overall nature, intensity or value of commercial fishing activity in this region. The proposed modification to the Project (increased residual chlorine concentration in seawater return) therefore does not change

the results of the original environmental effects assessment for this VEC, and the Project is still not likely to result in significant adverse environmental effects on Commercial Fisheries.

As described above, the Hebron EEM Plan includes a commercial fish survey that will assess the abundance and condition of a commercial flatfish species, American plaice (*Hippoglossoides platessoides*), along with assessing the concentrations of metals, PAHs, and alkylated-PAHs in liver and tissue as well as bioassays including liver enzyme assays, tissue histology and blood analysis consistent, which are similar to the design of biological sampling program of the Terra Nova production field (DeBlois et al. 2014b).

4.4 Marine Birds (Including Species at Risk)

There are no anticipated direct interactions between secure and at-risk marine birds and the currently planned discharge of cooling water discharge from the Hebron Platform. Section 9 of the Hebron CSR assessed the potential effect of operational discharges on marine birds but the main focus was on produced water and oil slicks. As the liquid discharge will be released at 15.5 m below the surface, any interaction with birds on the waters surface is considered unlikely. In addition, the results of the model indicate that the shallowest point for the cooling water at the <0.5 ppm original residual chlorine concentration will not be within 5 m from the surface. It is possible that diving birds could potentially come in contact with the cooling water plume but the probability would be low and the contact time would be short without any adverse effects to their health. The avoidance behaviours of fish to the residual chlorine plume may also reduce foraging opportunities for birds in the immediate area and potentially reducing diving behaviours in the area of the plume. The rapid dilution of the plume and resulting limited spatial extent of the potential effects further limits interactions with marine birds. Therefore, the effects on birds (either directly, or through effects on the availability or quality of their food sources) will not occur.

The proposed modification to the Project (increased residual chlorine concentration in the seawater return) therefore does not change the results of the original environmental effects assessment for this VEC, and the Project is still not likely to result in significant adverse environmental effects on Marine Birds.

4.5 Marine Mammals and Sea Turtles (Including Species at Risk)

The primary potential environmental interactions between secure and at-risk marine mammals and sea turtles and offshore drilling and associated marine discharges relate to possible changes in health (contaminants). Adverse effects of marine discharges on the health of marine fish may have secondary effects on the quality of marine mammal and sea turtle prey. With the implementation of mitigation measures (as identified and committed to in the CSR) an increase in the residual chlorine concentration of the cooling water from <0.5 to 2 ppm is not expected to result in a change in health conditions for marine mammals and sea turtles.

Although treated marine discharges can result in a localized and temporary reductions in water quality, these are not likely to result in adverse effects on this VEC. If a marine mammal or sea turtle came in contact with that portion of the plume, the exposure would be short term and have no effect on these taxa. These discharges are therefore expected to have little or no environmental effect on marine mammals and sea turtles, including consideration of potential effects on prey species (see Section 4.3). The likely avoidance of the area immediately surrounding the Platform by some species due to Project

related noise and other disturbances will likely further reduce the potential for direct or indirect interactions between liquid discharges and the various species that comprise this VEC.

As described in Section 3.5, a review of recent data indicates that the offshore Project Area is not known or likely to be used by species that were not considered and addressed in the original CSR, nor have any new areas of particularly important or sensitive habitats been identified that overlap with the Project Area. The modified Project activities considered in this EA Amendment are therefore not expected to increase the potential for, or degree of, environmental interactions and effects. This includes no new (not previously considered) interactions, and no closer proximity of planned Project activities to identified important areas and times for these species off Eastern Newfoundland.

The proposed modification to the Project (increased residual chlorine concentration in the seawater return) therefore does not change the results of the original environmental effects assessment for this VEC, and the Project is still not likely to result in significant adverse environmental effects on Marine Mammals and Sea Turtles.

4.6 Sensitive or Special Areas

Environmental interactions between offshore oil and gas activities and identified sensitive and special areas may be both direct and indirect in nature and cause. The conduct of such activities directly within or near such areas may, for example, have adverse implications for these locations and their important and defining ecological and socio-cultural characteristics. These interactions may occur through the possible presence of oil and gas production equipment, personnel and activities in the area, as well as the associated routine emissions and resulting disturbances that may occur in nearby environments. Biophysical effects resulting from oil and gas or other human activities within the region may also “spread” to adjacent protected and otherwise important and sensitive areas by affecting the marine fish, birds, mammals or other environmental components that move to and through the area. Any resulting decrease in the real or perceived integrity of these areas in the short or long term may also affect their ecological and/or societal importance and value.

A description (and mapping) of marine areas off Eastern Newfoundland that have been designated as protected or identified as otherwise special or sensitive was provided in Section 3.7. The existing and available information indicates that the Project Area is located 50 km or more from any of these areas, and they will therefore not be subject to direct overlap or interaction with the Project in general, nor the currently planned discharge of the cooling water from the Platform in particular. The very small and localized environmental zone of influence of seawater return plume above the 0.5 ppm will mean that their effects will not extend to or otherwise affect these areas, and the implementation of the various environmental protection measures and procedures outlined in the CSR and in this EA Amendment including those designed to avoid or reduce Project-related discharges and/or disturbances and their associated environmental changes and resulting effects, will also serve to help address any direct or indirect potential environmental effects that may have implications for overlapping or adjacent Special Areas. The Project will therefore not adversely affect the ecological features, processes and integrity of any marine or coastal locations that are designated as special or sensitive areas, nor their human use and societal value.

The proposed modification to the Project (increase of residual chlorine level from <0.5 to 2 ppm) therefore does not change the results of the original environmental effects assessment for this VEC,

and the Project is still not likely to result in significant adverse environmental effects on Sensitive or Special Areas.

5.0 SUMMARY AND CONCLUSION

The Hebron Project was subject to a detailed and comprehensive EA review pursuant to the requirements of the CEAA. The project is currently under development, with first oil planned for later in 2017. This EA Amendment describes and assesses a proposed modification to the Project as compared to that which was assessed, approved and implemented pursuant to the original EA review and approval process. This planned modification relates to the current requirement to increase the residual chlorine concentration in the cooling water from the Hebron Platform to 2.0 ppm from the <0.5 ppm which was assessed in the original CSR. This increase is required and requested in order to achieve the following objectives: 1) Prevent marine growth and biofouling in firewater and seawater piping and 2) Reduce seawater propensity to foaming in the water injection system which is a primary causal factor in the Minox system's inability to meet the specification of water required for injection.

The environmental implications associated with a regulatory limit of 2 ppm total residual chlorine are considered low. Normal operating concentrations are expected to be below this limit and will vary as organic loading varies with time of year and sea state. Residual chlorine dispersion analysis indicates that the plume area above the 0.5 ppm is predicted to be within 15 m of the discharge point and therefore limited to the immediate area around the discharge outlet. In addition, there is a water sampling and biological component of Hebron's EEM Program to assess any changes to the water column or the fish in the area, respectively.

Potential discharges such as the two highlighted above are detailed in the C-NLOPB's OWTG, and a monitoring plan (for chlorine) has been developed as part of the Environmental Compliance Monitoring Plan, a component of the Environmental Protection Plan for operations.

The proposed Project modifications described and assessed herein do not result in any changes in the original environmental effects predictions, required mitigation or effects significance evaluations for any component of the environment. The amended Project is therefore not likely to result in significant adverse environmental effects.

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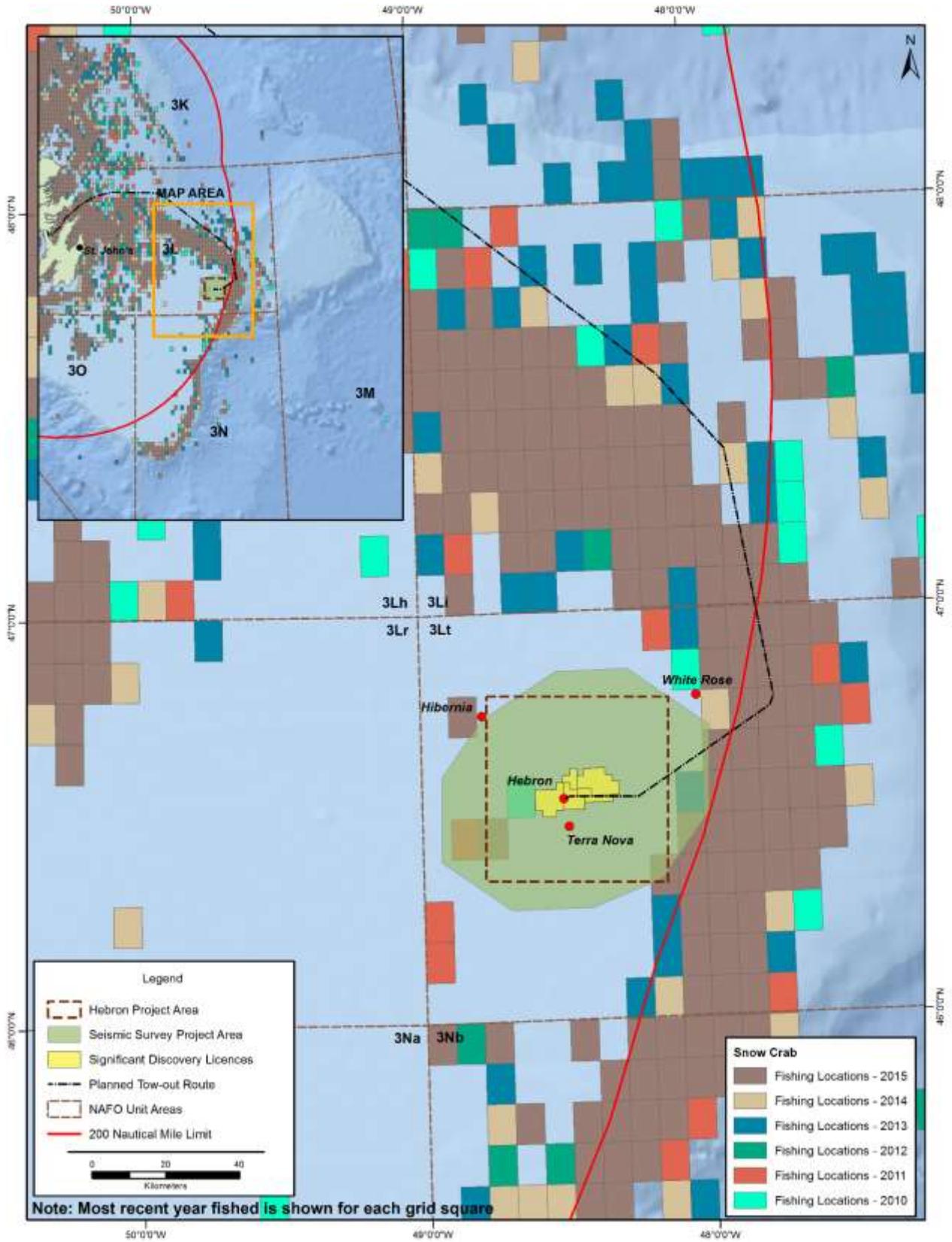
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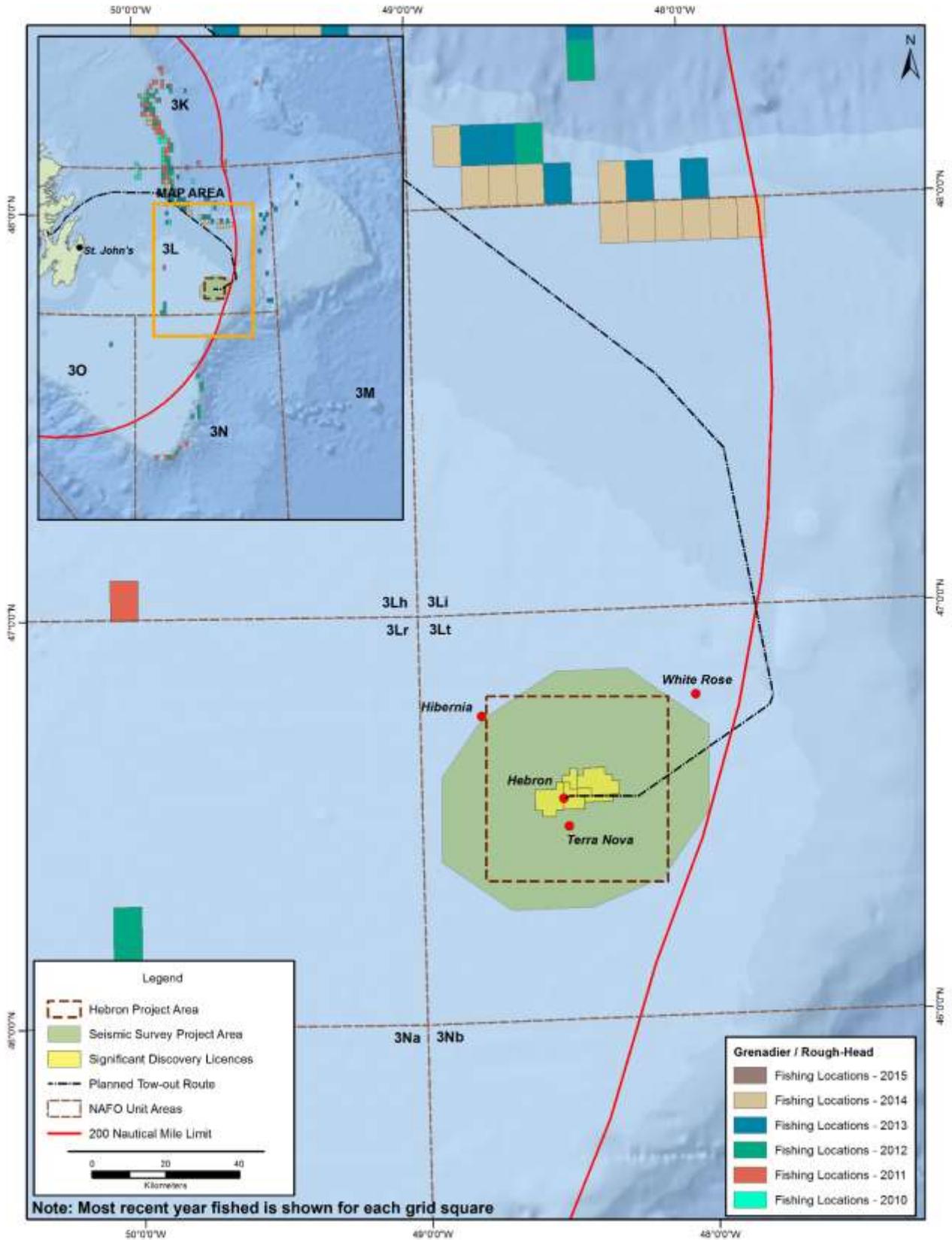
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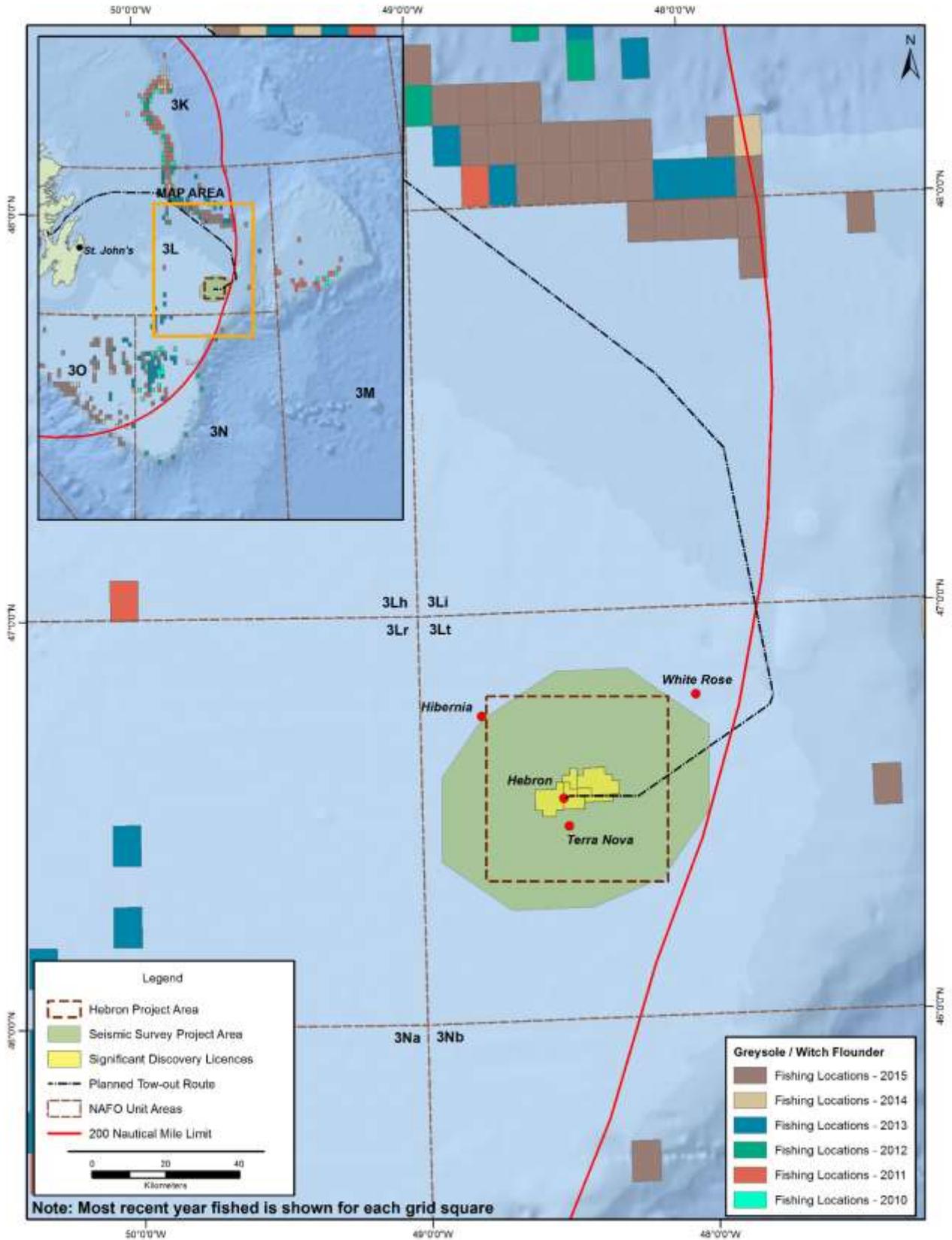
APPENDIX A

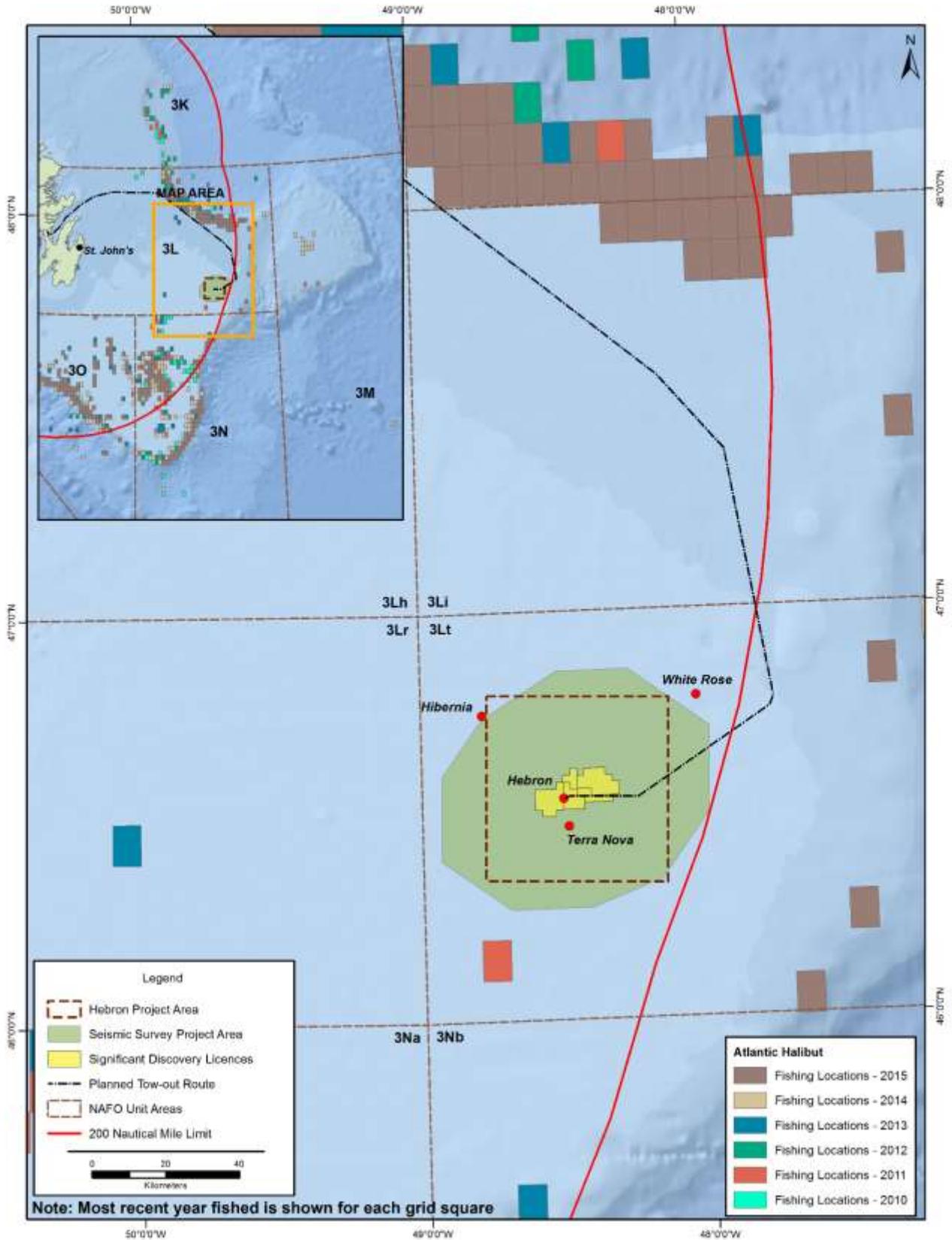
Additional Mapping

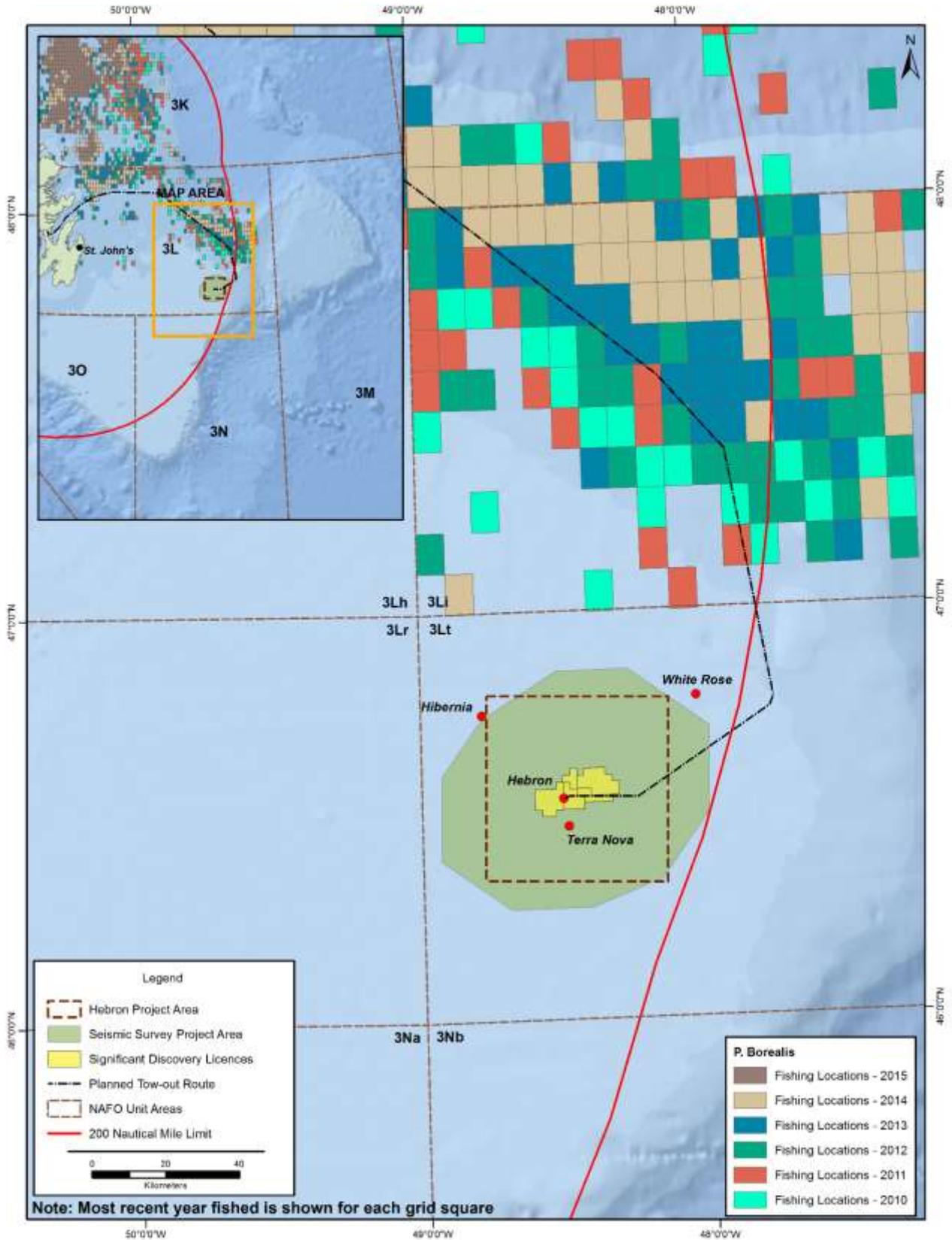
Fisheries (By Key Species) and Marine Mammals and Sea Turtles

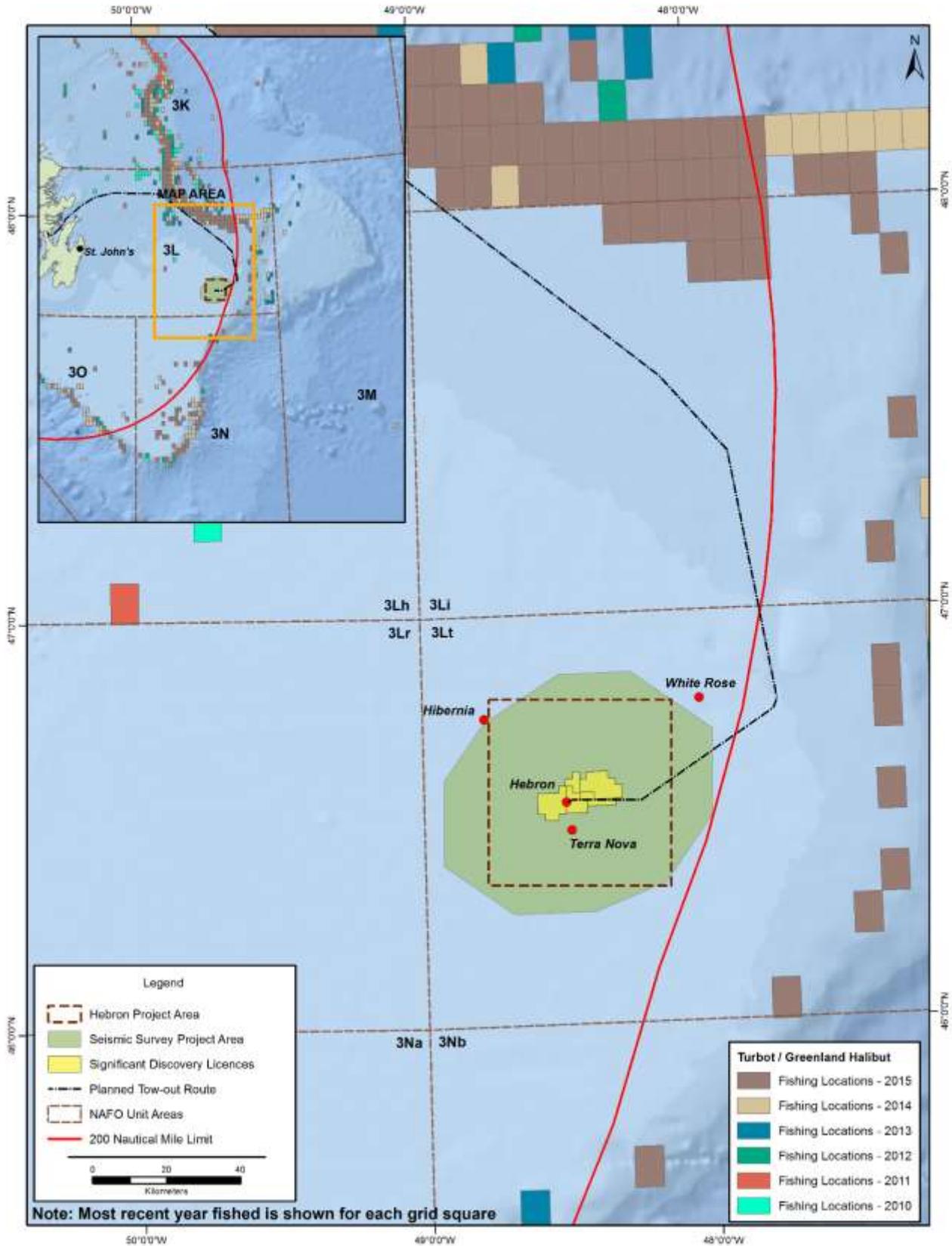


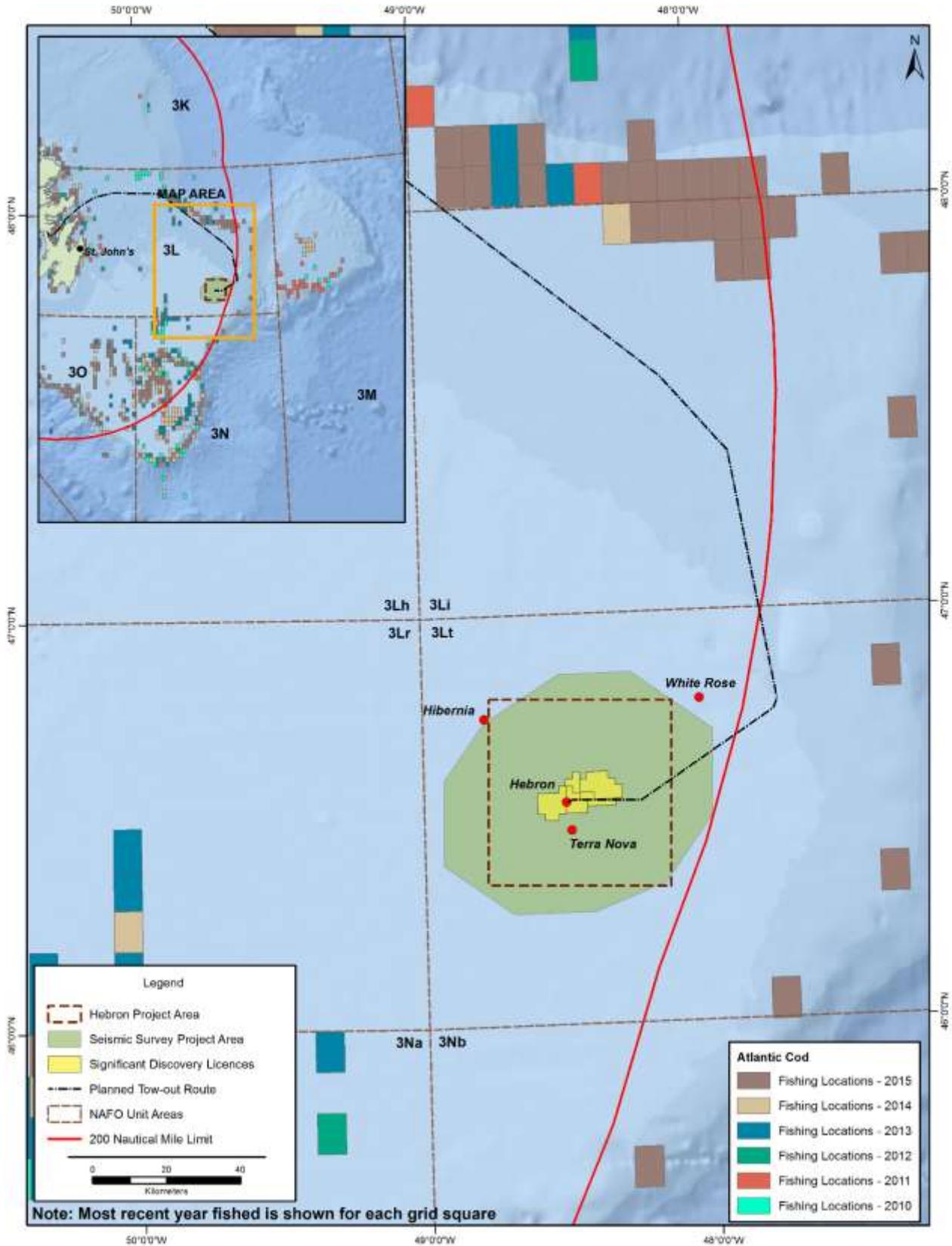


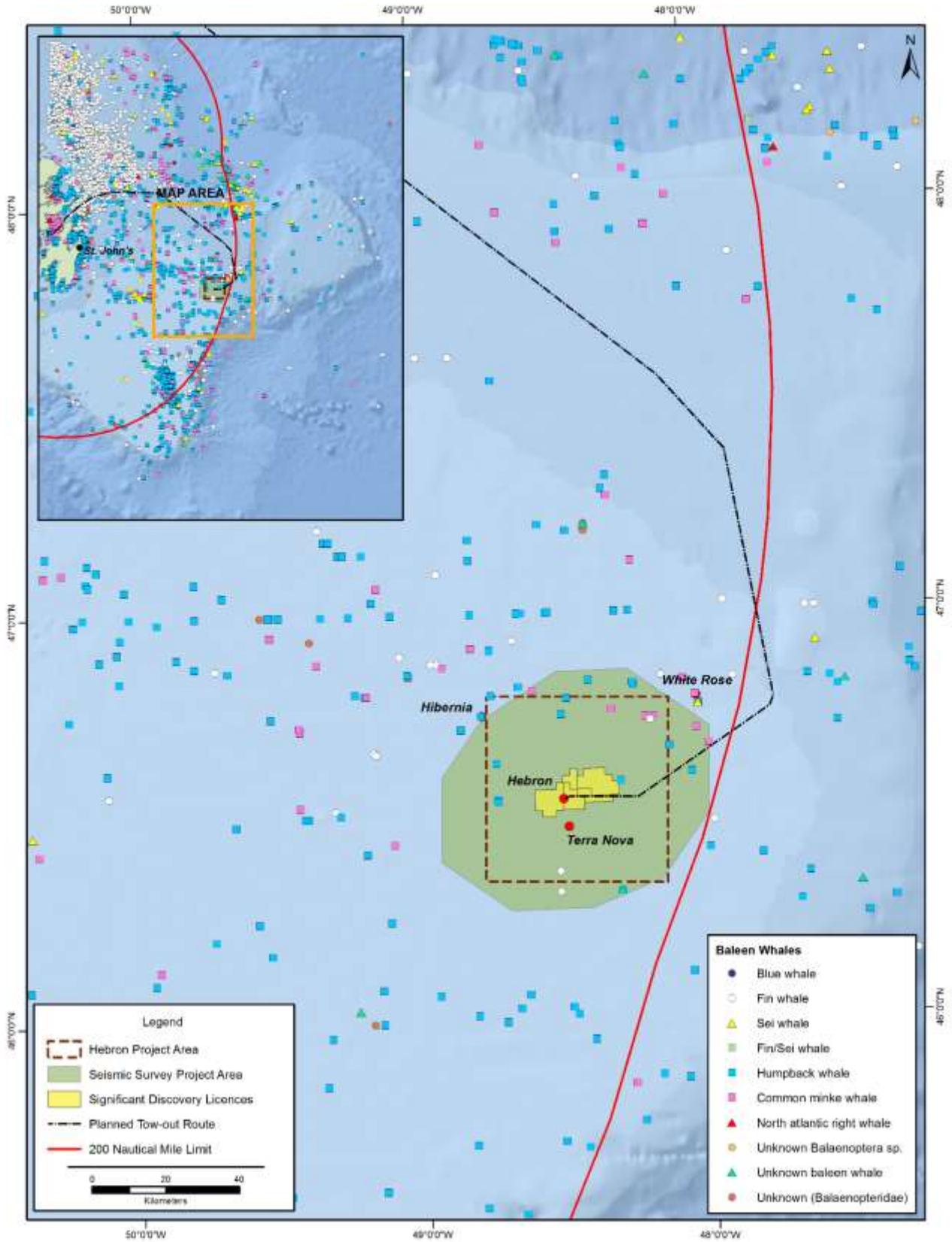


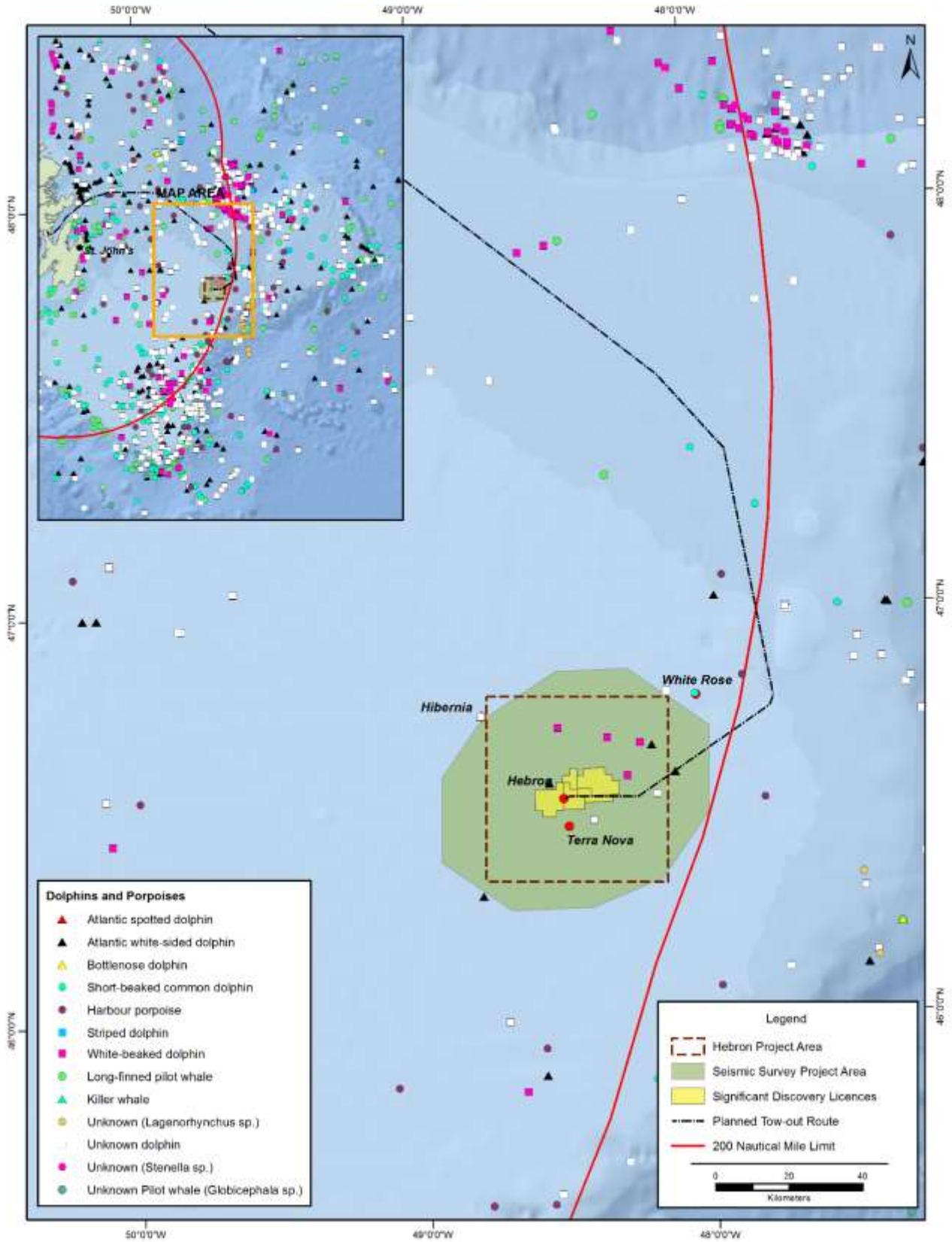


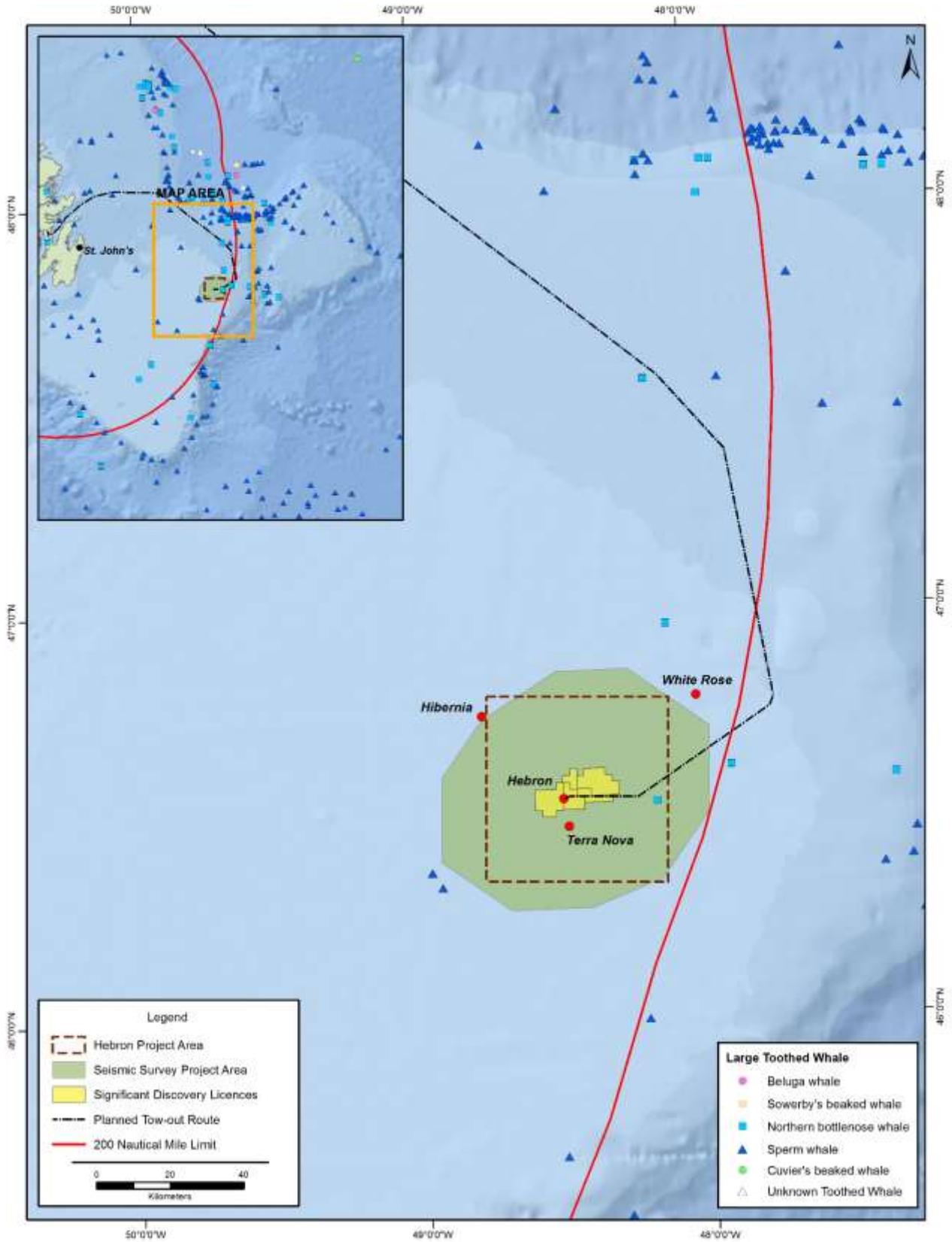


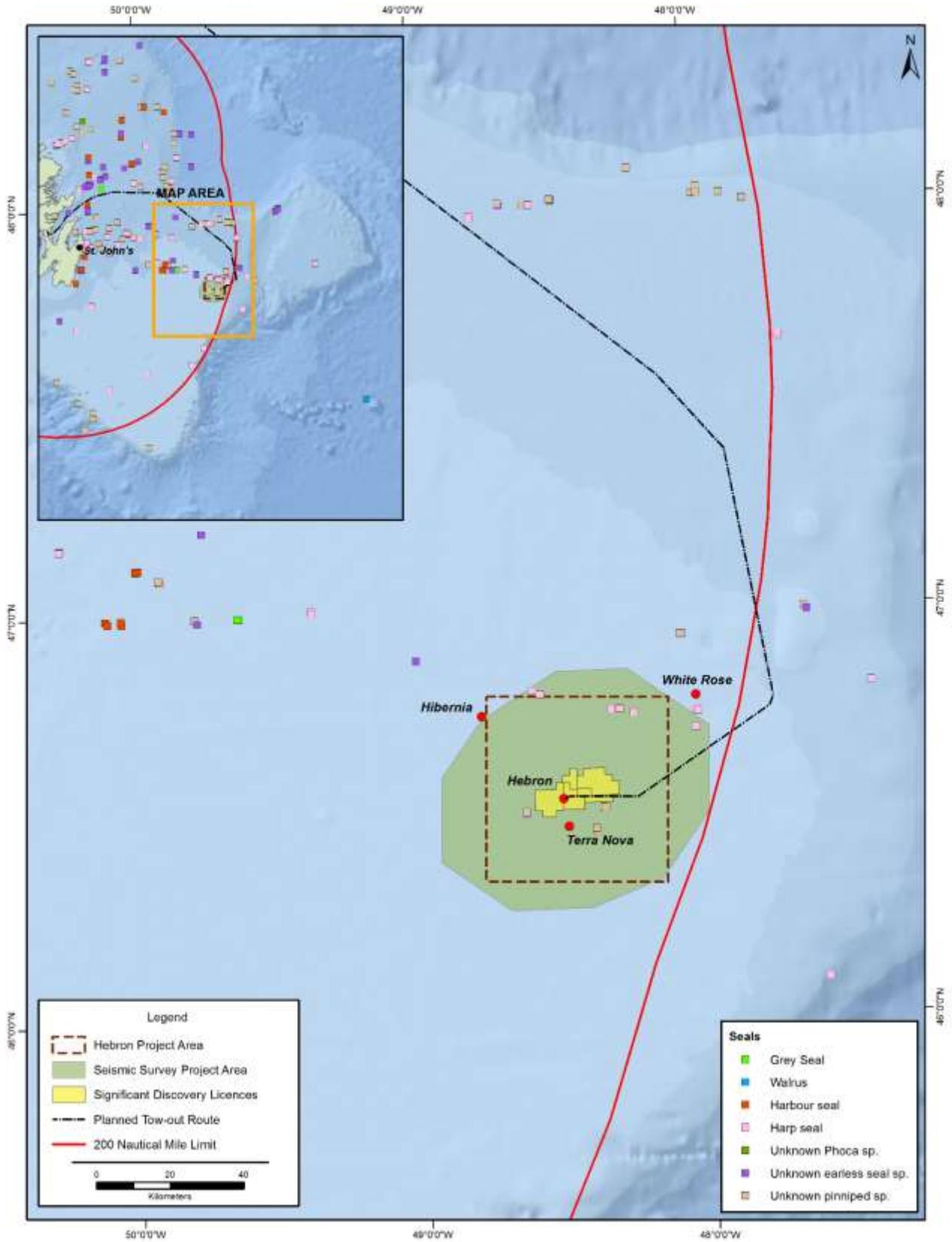


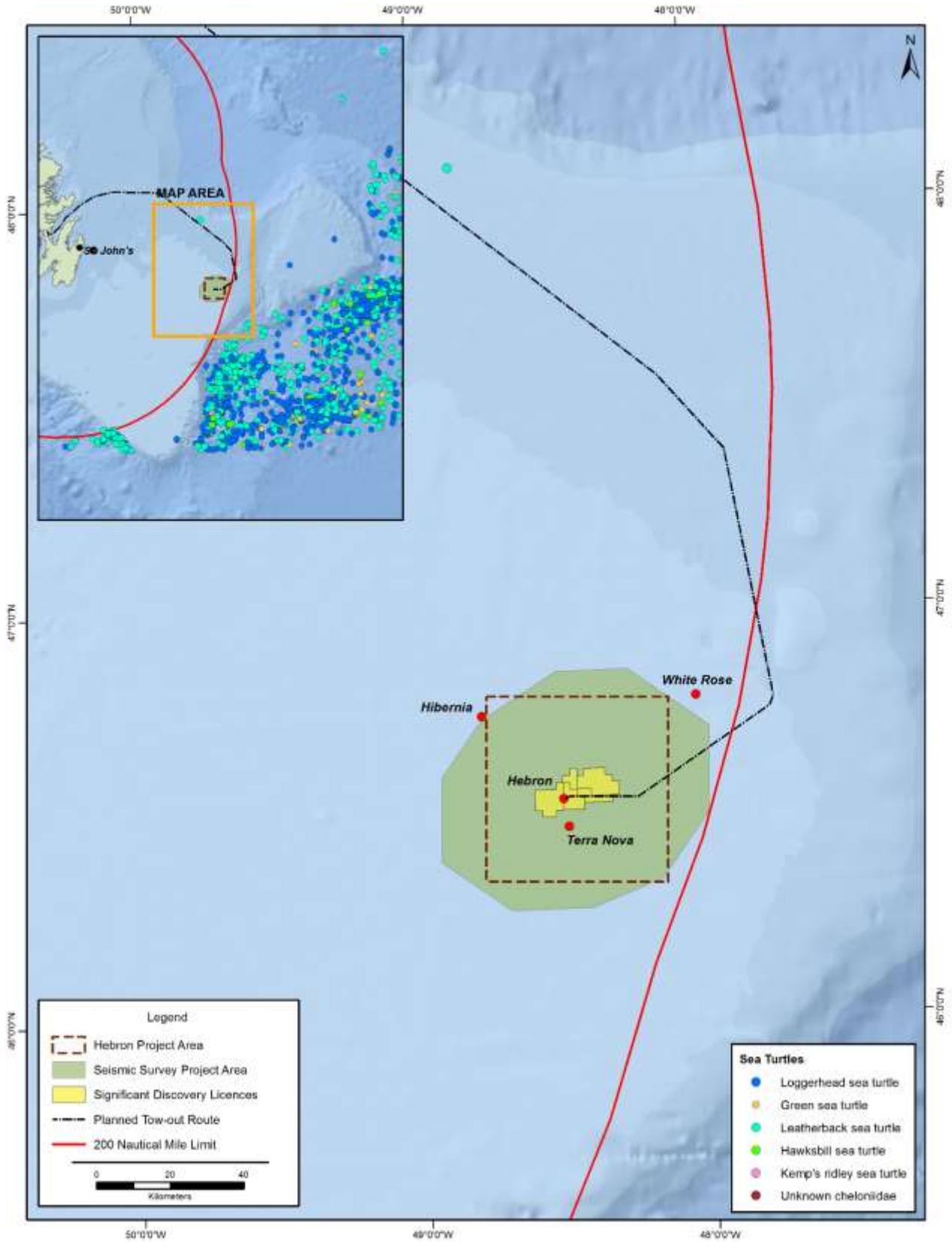












APPENDIX B

**Residual Chlorine Dispersion Analysis:
Supplemental Technical Information**

CORMIX SESSION REPORT: SUMMER SCENARIO
CORMIX MIXING ZONE EXPERT SYSTEM
CORMIX Version 10.0GT
HYDRO1: Version-10.0.1.0 April,2017

SUMMARY OF INPUT DATA:

 AMBIENT PARAMETERS:

Cross-section = unbounded
 Average depth HA = 94 m
 Depth at discharge HD = 94 m
 Ambient velocity UA = 0.1 m/s
 Darcy-Weisbach friction factor F = 0.0069
 Calculated from Manning's n = 0.02
 Wind velocity UW = 11.5 m/s
 Stratification Type STRCND = A
 Surface density RHOAS = 1024.22 kg/m³
 Bottom density RHOAB = 1026.72 kg/m³

 DISCHARGE PARAMETERS: Single Port Discharge

Nearest bank = left
 Distance to bank DISTB = 100000 m
 Port diameter D0 = 0.76 m
 Port cross-sectional area A0 = 0.4536 m²
 Discharge velocity U0 = 2.45 m/s
 Discharge flowrate Q0 = 1.11 m³/s
 Discharge port height H0 = 78.5 m
 Vertical discharge angle THETA = 0 deg
 Horizontal discharge angle SIGMA = 195 deg
 Discharge density RHO0 = 1020.23 kg/m³
 Density difference DRHO = 5.2400 kg/m³
 Buoyant acceleration GP0 = 0.0421 m/s²
 Discharge concentration C0 = 2 ppm
 Surface heat exchange coeff. KS = 0 m/s
 Coefficient of decay KD = 0 /s

 DISCHARGE/ENVIRONMENT LENGTH SCALES:

LQ = 0.67 m Lm = 16.48 m Lb = 55.62 m
 LM = 8.97 m Lm' = 99999 m Lb' = 99999 m

 NON-DIMENSIONAL PARAMETERS:

Port densimetric Froude number FR0 = 12.54
 Velocity ratio R = 24.47

 MIXING ZONE / DILUTION ZONE / AREA OF INTEREST PARAMETERS:

Toxic discharge = yes
 CMC concentration CMC = 0.5 ppm
 CCC concentration CCC = 0.5 ppm
 Water quality standard specified = given by CCC value
 Regulatory mixing zone = yes
 Regulatory mixing zone specification = distance
 Regulatory mixing zone value = 10000 m (m² if area)
 Region of interest = 5000 m

SUMMARY OF INPUT DATA:

 AMBIENT PARAMETERS:

Cross-section		= unbounded
Average depth	HA	= 94 m
Depth at discharge	HD	= 94 m
Ambient velocity	UA	= 0.1 m/s
Darcy-Weisbach friction factor	F	= 0.0069
Calculated from Manning's n		= 0.02
Wind velocity	UW	= 11.5 m/s
Stratification Type	STRCND	= A
Surface density	RHOAS	= 1026.48 kg/m ³
Bottom density	RHOAB	= 1026.78 kg/m ³

 DISCHARGE PARAMETERS: Single Port Discharge

Nearest bank		= left
Distance to bank	DISTB	= 100000 m
Port diameter	D0	= 0.76 m
Port cross-sectional area	A0	= 0.4536 m ²
Discharge velocity	U0	= 2.45 m/s
Discharge flowrate	Q0	= 1.11 m ³ /s
Discharge port height	H0	= 78.5 m
Vertical discharge angle	THETA	= 0 deg
Horizontal discharge angle	SIGMA	= 172.5 deg
Discharge density	RHO0	= 1020.23 kg/m ³
Density difference	DRHO	= 6.4000 kg/m ³
Buoyant acceleration	GP0	= 0.0602 m/s ²
Discharge concentration	C0	= 2 ppm
Surface heat exchange coeff.	KS	= 0 m/s
Coefficient of decay	KD	= 0 /s

 DISCHARGE/ENVIRONMENT LENGTH SCALES:

LQ = 0.67 m	Lm = 16.48 m	Lb = 67.86 m
LM = 8.12 m	Lm' = 99999 m	Lb' = 99999 m

 NON-DIMENSIONAL PARAMETERS:

Port densimetric Froude number	FR0	= 11.35
Velocity ratio	R	= 24.47

 MIXING ZONE / DILUTION ZONE / AREA OF INTEREST PARAMETERS:

Toxic discharge		= yes
CMC concentration	CMC	= 0.5 ppm
CCC concentration	CCC	= 0.5 ppm
Water quality standard specified		= given by CCC value
Regulatory mixing zone		= yes
Regulatory mixing zone specification		= distance
Regulatory mixing zone value		= 10000 m (m ² if area)
Region of interest		= 5000 m
