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Nova Scotia and Newfoundland and Labrador Offshore Wind Impacts

Project Number: 60722350

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Appendix A. Memo: Summary of the Interim The Regional Assessment of Offshore Wind Development in Nova Scotia and The Regional Assessment of Offshore Wind Development in Newfoundland and Labrador (AECOM, June 28, 2024)

List of Abbreviations

In the table below, we provide our list of abbreviated terms and definition as presented in our proposal.

Abbreviation	Meaning
AC	Alternating Current
ANSMC	Assembly of Nova Scotia Mi'kmaw Chiefs
BIWF	Block Island Wind Farm
CNWA	Canadian Navigable Waters Act
CPCAD	Canadian Protected and Conserved Areas Database
CPUE	Catch Per Unit Effort
COMFIT	Community Feed-In-Tariff Program
Committee	Committee for the Regional Assessment of Offshore Wind Development
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPT	Cone Penetrating Test
CMM	Confederacy of Mainland Mi'kmaq
dB	Decibels
DC	Direct Current
DP	Dynamic Positioning
DPD	Detailed Project Description
EMF	Electromagnetic Field
ECCC	Environment and Climate Change Canada
EA	Environmental Assessment
eDNA	Environmental DNA
EIAR	Environmental Impact Assessment Report
ESA	Environmental Site Assessment
FSC	Fish for food, social, and ceremonial
DFO	Fisheries and Oceans Canada
FPIC	Free Prior and Confirmed Consent
GIC	Governor in Council
HDD	horizontal directional drilling
HRIA	Historic Resources Impact Assessment

Abbreviation	Meaning
IA	Impact Assessment
IAA	Impact Assessment Act
IAAC	Impact Assessment Agency of Canada
IS	Impact Statement
IBA	Important Bird Area
IPD	Initial Project Description
km	Kilometre
km/h	Kilometres per hour
KMKNO	Kwilmu'kw Maw-Klusuaqn Negotiation Office
LIDAR	Light Detection and Ranging
m	Metre
m/s	Metres per second
MBCA	Migratory Birds Convention Act
MEK	Mi’kmaq Ecological Knowledge
metmasts	Meteorological masts
MEBO	Mi'kmaw Economic Benefits Office
MHWS	Mean high water springs
NRCan	Natural Resources Canada
NL	Newfoundland and Labrador
NOC	Notice of Commencement
NOD	Notice of Determination
NS	Nova Scotia
ORER	Offshore Renewable Energy Regulations
OSW	Offshore Wind
PAM	Passive acoustic monitoring
PD	Project Description
PAO	Provincial Archaeology Office
PFDA	Potential future development areas
RA	Regional Assessment
ROV	Remotely Operated Vehicle
SARA	Species at Risk Act

Abbreviation	Meaning
SAR	Species at Risk
SOCC	Species of Conservation Concern
TISG	Tailored Impact Statement Guidelines
TOR	Terms of Reference
TC	Transport Canada
UAV	Underwater autonomous vehicle
UWN	Underwater Noise
UK	United Kingdom
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
USA	United States of America
UXO	Unexploded ordinances
WTG	Wind Turbine Generator

1. Background

AECOM Canada Ltd. (AECOM) has been retained by Kwilmu'kw Maw-Klusuaqn Negotiation Office (KMKNO) to provide advisory services related to offshore wind (OSW) development in Atlantic Canada and the ongoing Regional Assessments (RAs) being undertaken in the provinces of Nova Scotia (NS) and Newfoundland and Labrador (NL). The RAs, although separate and tailored to focus on key provincial concerns, have identical Terms of References (TOR) with the primary goal being “to provide information, knowledge and analysis regarding future offshore wind development activities in the Study [Areas] and their potential effects, to inform and improve future planning, licencing and impact assessment processes for these activities in a way that helps protect the environment and health, social and economic conditions while also creating opportunities for sustainable economic development” (Committee for the Regional Assessment of Offshore Wind Development in NS, 2023; Committee for the Regional Assessment of Offshore Wind Development in NL, 2023a).

The RAs are being carried out by two, five-member committees (the Committee[s]) agreed upon by the federal Minister of the Environment, the federal Minister of Natural Resources, the provincial Minister of Natural Resources and Renewables (NS), the provincial Minister of Industry, Energy, and Technology (NL), and the provincial Minister of Environment and Climate Change (NL). The committees are held to requirements listed under sections 97 to 102 of the federal Impact Assessment Act (IAA), which include commitments to consider scientific information and Indigenous knowledge and allow the public to meaningfully participate in the RAs.

In addition to providing opportunities for the general public and Indigenous communities to be consulted in these RAs, three advisory groups have been established by the Committees to support the RAs:

- Indigenous Knowledge Advisory Group
- Scientific Information and Community Knowledge Group
- Fisheries and Other Ocean Uses Advisory Group

AECOM has prepared this report to support KMKNO in its role with the Indigenous Knowledge Advisory Groups for these RAs. This report provides a summary of the framework informing the RAs, followed by a detailed overview of the potential impacts that OSW development in areas of concerned expressed by KMKNO including Indigenous Knowledge, Species at Risk (SAR), Archaeology, and Marine Protected Areas (MPA). This report also includes mitigation measures and best management practices used in North America and globally to mitigate these potential effects.

2. Study Area

Figures illustrating the Study Area limits and “potential future development areas” (PFDA) for the respective RAs are shown below and are pulled from the publicly available Interim Reports issued on March 23 and 22, 2024, for NS and NL, respectively (Figure 1, Figure 2). Each of the Study Areas are comprised of offshore areas where future OSW development activities have been identified as being technically and economically feasible based on current and foreseeable technologies as described in the respective TOR for these RAs. The TORs make clear that the inclusion or exclusion of certain offshore areas does not reflect the future capacity or lack thereof of these areas to support such development.

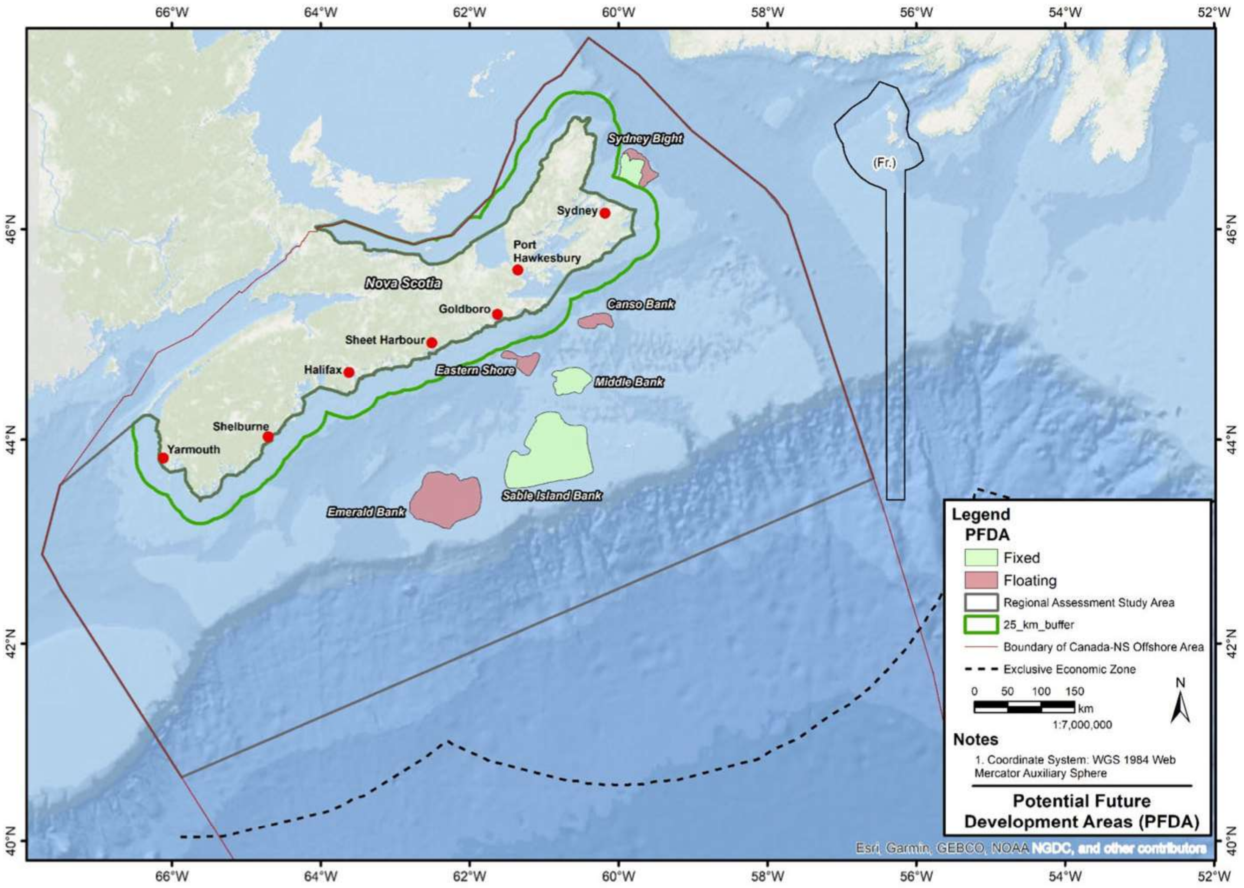

Figure 1. Nova Scotia Regional Assessment Study Area (from Committee for the Regional Assessment of Offshore Wind Development in NS, 2023)

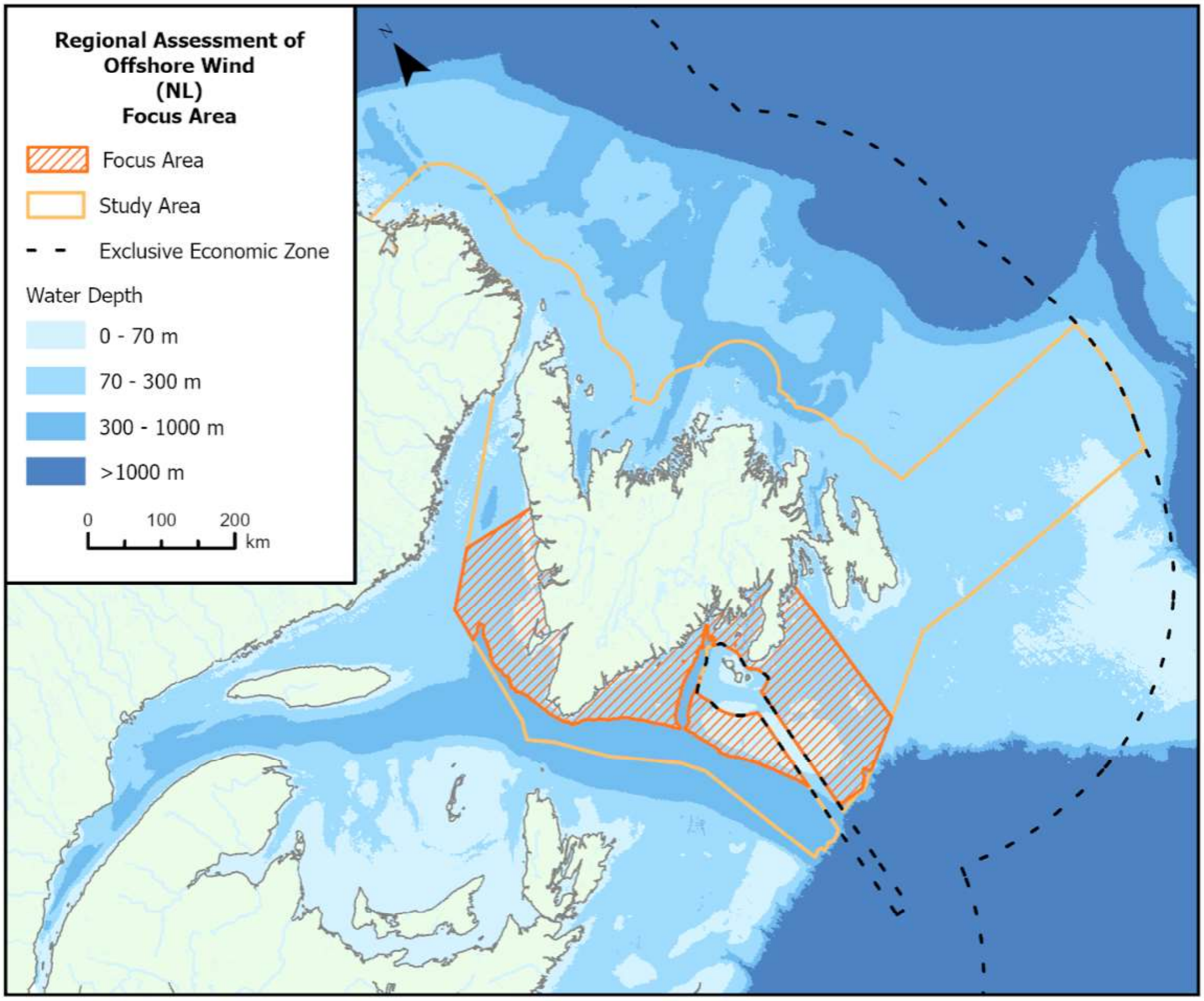

Figure 2. Newfoundland and Labrador Regional Assessment Study Area (from Committee for the Regional Assessment of Offshore Wind Development in NL, 2023a)

3. Regulatory Framework

Environmental legislation applicable to the RAs and potential future projects within their scope includes review and consultation processes that adhere to both Federal and Provincial Legislation. At the Federal level, the scale of OSW development projects being reviewed under the RAs would fall under the Physical Activities Regulation (2019-285), subject to the IAA regulated by the Impact Assessment Agency of Canada (IAAC, 2019). Under this regulation, the primary trigger for designation is “the construction, operation, decommissioning and abandonment in an offshore area or in boundary water of a new wind power generating facility that has 10 or more wind turbines”. At the Provincial level, the onshore and transmission line components of such development would follow a Class II Environmental Assessment (EA) in NS. In NL, it would follow the provincial EA process with input from the Guidance for Registration of Onshore Wind Energy Generation and Green Hydrogen Production Projects document (Department of Environment and Climate Change, 2023) in NL.

A breakdown of these Provincial and Federal processes is provided below. Please note that details have been included that are targeted towards specific projects that would fall within the Environmental Impact Assessment requirements for a Project that may or may not be addressed in RAs.

3.1 Federal Regulatory Requirements

The IAA Process consists of the following five phases:

1. Planning – Projects go through a planning phase where the public and Indigenous Peoples are invited to provide information and contribute to planning the assessment.
2. Impact Statement (IS) – The proponent is provided with clear requirements for the information and studies for an Impact Statement. Western scientific and Indigenous knowledge inform the Impact Statement.
3. Impact Assessment (IA) – Completed by IAAC. The assessment considers potential environmental, health, social, and economic impacts of proposed projects, including benefits. Potential impacts on Indigenous Knowledge are also assessed and consulted on. The Agency or review panel uses the information to develop an impact assessment report.
4. Decision-making – Public interest is at the centre of decisions. The impact assessment report and Crown consultation outcomes inform the Minister or Governor in Council (GIC) decision on whether a project’s adverse impacts are in the public interest. If yes, the Minister must establish conditions for the proponent. Decision statements set out the rationale for the decision, providing transparency and accountability.
5. Post Decision – The Agency will be active in verifying compliance with Decision Statements and correcting non-compliance. There will be greater transparency around follow-up programs, with increased access to key documentation and opportunities for Indigenous and community participation in follow-up and monitoring programs.

Each of these phases have a regulated time period as outlined in **Figure 3**.

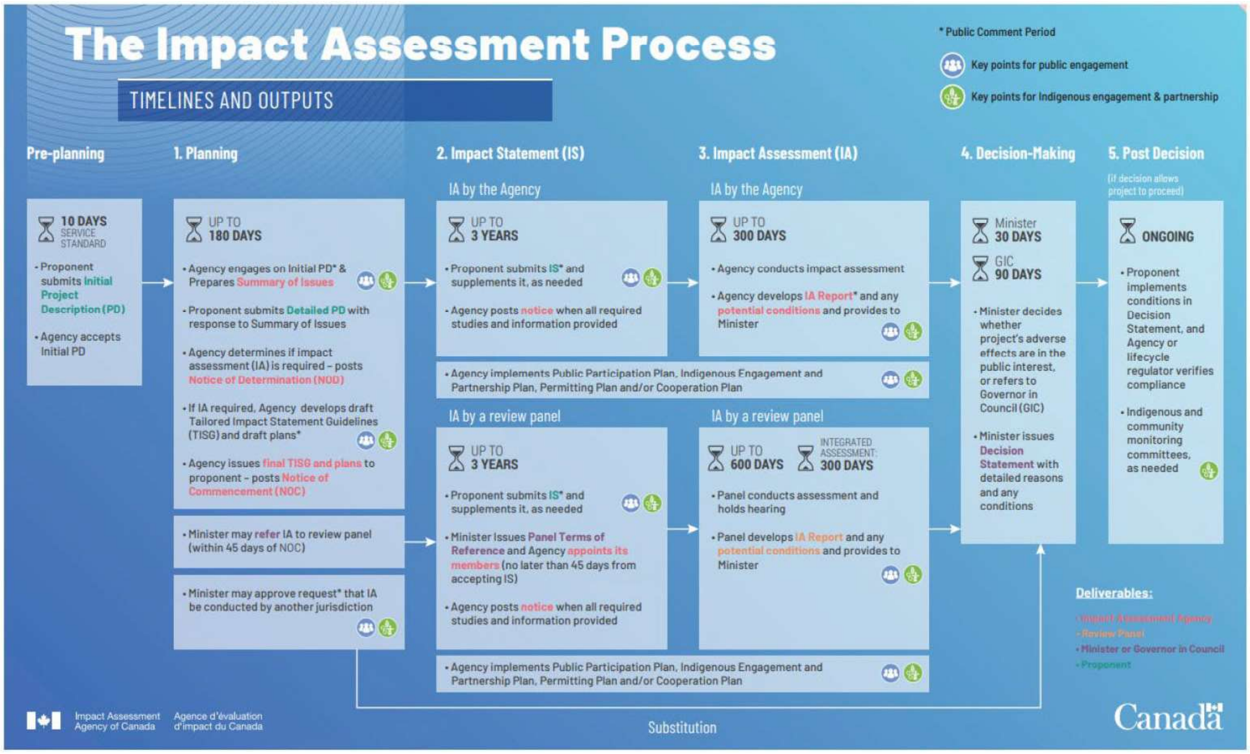

Figure 3. Impact Assessment Process

The 180-day Planning Phase is triggered by the submission of an Initial Project Description (IPD). Following the Agency's acceptance and engagement with the IPD, a draft Environmental Impact Assessment Report (EIAR) scoping document is refined, addressing key issues identified by the Agency and global best practices/lessons learned are reflected in the plan. The final scoping document is ultimately submitted to the Agency as the Detailed Project Description (DPD).

The IAAC will use the content of the DPD as the basis for the Tailored Impact Statement Guidelines (TISG), and associated documents (the Public Participation Plan, Indigenous Engagement and Partnership Plan, Permitting Plan and/or Cooperation Plan). Well ahead of the official guidance of the IS being finalized in the TISG, field studies would be scheduled, consultation initiated with relevant stakeholders and Rightsholders, and continued collaboration with Agency representatives. Once finalized, the combined EIAR chapters will form the IS document, submitted to the IAAC for a review period of up to 300 to 600 days as part of the IA phase (Phase 3 above).

Of note, a judgement on the constitutional challenges to the federal IAA process was released on October 13, 2023, wherein the Court concluded that, in its current form, aspects of the IAA process related to designating projects is beyond the legislative authority of the federal government. Based on our experience, this challenge is unlikely to impact treatment of OSW development projects as oceans are federally regulated. The federal government has indicated that it intends to amend the IAA to align with these findings; however, these changes have not yet been implemented. Based on AECOM's experience with ongoing federal IA projects, it is expected that these changes will, in part, be related to a reduction in focus on timelines outlined in the above IAA process figure.

3.1.1 Other Federal Legislative Considerations

Natural Resources Canada's (NRCan) has recently released guidance "*Discussion Paper on Canada's approach to offshore renewable regulations"* on its upcoming Offshore Renewable Energy Regulations (ORER) under the *Canadian Energy Regulator Act*. The ORER will support Part 5 – Offshore Renewable Energy Projects and Offshore Powerlines of the Canadian Energy Regulator Act.

In the Discussion Paper, NRCan has indicated that they intend to structure the ORER as combination of management-based and'outcome-based' versus performance based prescriptive regulations. NRCan initiative will be built on Canada's experience regulating offshore oil and gas and incorporate best practices from other jurisdictions (NRCan 2024).

Outcome-based requirements in practice are ensuring mitigation measures, including mitigation plans and procedures are developed and followed. This allows for industry to keep up with evolving technologies where "*regulations continue to remain relevant over time, raise the bar on best practices over time, and encourage the industry to innovate to come up with more efficient, economical and effective solutions for ensuring safety and environmental protection*". Outcome based requirements allow for solutions to be tailored to the project's site specific environmental conditions and/or specific types of installations/equipment.

Previously offshore oil and gas regulations was performance based without specifying the mitigation measures or procedures that must be implemented. NRCan's offshore wind regulation guidance is considered a significant advancement and improvement compared to offshore oil and gas.

OSW development will follow the recommendations provided in these RAs and will also be subject to specific Federal Acts. The EIAR components may require approvals through these Acts separate from the IAA process; most relevant among these include:

- *Canadian Navigable Waters Act* (CNWA) - Administered by Transport Canada (TC)
- *Fisheries Act* - Administered by Fisheries and Oceans Canada (DFO)
- *Migratory Bird Convention Act* (MBCA) - Environment Canada
- *Species at Risk Act* (SARA) - Environment Canada and DFO

The *Canadian Energy Regulator Act* and NRCan also play a role in assessing OSW development following the Offshore Renewable Energy Regulations where "any work or activity that is related to an offshore renewable energy project" which would apply to the onshore and transmission line components.

3.1.2 Mi'kmaw Knowledge and Engagement

Meaningful and purposeful consultation with the Mi'kmaq is an essential part of the Federal IAA Process for the EIAR. IAAC has a draft procedure for working with the Mi'kmaq and guidance for collecting and using Mi'kmaw Indigenous knowledge. Each Mi'kmaw Engagement and Knowledge program is unique and ideally designed to be flexible and responsive to the priorities, interests and preferences of the Mi'kmaw communities engaged throughout the project.

Please also see section 6.3 for further discussion of Mi'kmaw Knowledge.

3.2 Provincial Regulatory Requirements

3.2.1 Nova Scotia

Within the provincial context, EAs falling under the RA will likely be regulated by the Nova Scotia Department of Environment and Climate Change under the Environment Act and Environmental Assessment Regulations; however, the RA may clarify the regulatory body that is ultimately responsible. At this time, we have included the typical provincial requirements. Based on the current definitions within the regulations, a project should be characterized as a 'Class I'or 'Class II,' but given the lack of precedence for this type of project in Nova Scotia, we believe there is a strong likelihood that an expert panel or supplemental report may be required following Class II EA.

The onshore and transmission line components are subject to additional Provincial legislations including but not limited to:

- *Renewable Electricity Regulations under Section 5 of the Electricity Act* (NS Regulations 338/2022)
- *Environmental Assessment Regulations* (NS Regulations 328/2022)
- *Endangered Species Act*
- *Energy Resources Conservation Act*
- *Biodiversity Act*
- Department of Communities, Culture, Tourism and Heritage

- *Heritage Property Act*
- Nova Scotia Environment Wetland Designation Policy
- *Provincial Parks Act*
- *Special Places Protection Act*
- *Wildlife Act*
- *Marine Renewable Energy Act*

The various acts and legislation pertaining to Agriculture (Department of Agriculture) may apply should the transmission line and access roads interfere with agricultural resources protected by the Provincial Soils Act and Agricultural Marshland Conservation Act, for example.

Also, inland and coastal waterways may require oversight by both the Federal and Provincial agencies under the Fisheries Act (DFO) and Fisheries and Coastal Resources Act (Department of Fisheries and Aquaculture), including applicable Maritime Provinces Fishery Regulations.

In addition, the Nova Scotia Contaminated Sites Regulation, including Section 15(1) (a) Phase I Environmental Site Assessment (ESA) Protocol (PRO-300) and Section 15 (1) (b) Phase 2 ESA Protocol (PRO-400) and related guidance for the assessment of contaminated sites published by CCME and the province of Nova Scotia, including the Atlantic Risk Based Corrective Action will need to be considered. This legislation and guidance are directly relevant to the Onshore EIAR Specialist topics Ground Condition, Hydrology, Flood Risk and Contamination, including human health and ecological risk assessment (as appropriate to the proposed location for the construction of onshore component and the transmission lines).

3.2.2 Newfoundland and Labrador

Similar within the provincial context, EAs falling under the RA will likely be regulated by the Newfoundland and Labrador Environment and Climate Change; however, the RA may clarify the regulatory body that is ultimately responsible. The onshore and transmission line components are subject to additional Provincial legislations including but not limited to:

- *Environmental Protection Act*
- *Endangered Species Act*
- *Fisheries Act*
- *Professional Fish Harvesters Act*
- *Wild Life Act*
- *Wilderness and Ecological Reserves Act*
- *Energy Corporation of Newfoundland and Labrador Water Rights Act*
- *Historic Resources Act*
- *Provincial Parks Act*

4. Activities and Impacts Associated with Offshore Wind Development

Activities or project phases associated with OSW development can generally be broken down into four categories spanning the life of the project including:

- Pre-construction – includes site investigations, environmental impact studies, regulatory filings, engineering and contracting of key equipment and services;
- Construction – typically includes onshore and offshore installation of project infrastructure including turbines, foundations, electrical equipment, cables, support facilities;
- Operations – regular monitoring of facility and equipment including routine maintenance of infrastructure, including submarine cables, support facilities, cables, turbines, etc.; and,
- Decommissioning – includes the removal of project infrastructure and restoration of disturbed areas.

Within these activity categories, a number of specific tasks have the potential to impact the natural and socioeconomic environments, physical and cultural heritage resources, and health. The following have been identified in consultation with KMKNO as key areas of concern regarding how OSW development may impact them and their communities.

Activity / Project Phase	***Summary of Current Knowledge***
Pre-construction	
Wind measurement	Wind measurement is typically conducted via two primary methodologies – installation of permanent or temporary meteorological masts (metmasts) or installation of Light Detection and Ranging (LIDAR) based buoys. • Meteorological masts (metmasts) are typically installed on fixed bottom foundations typically installed to the projected hub height or higher to collect wind data. • Floating LIDAR systems are installed on floating barges or buoys and are moored and anchored to the seabed. These systems use LIDAR technology to measure wind data, and the installations may also be outfitted with sensors to measure water currents, wave heights, tidal movement, and environmental data (marine mammal movements, bird/bat presence). Wind measurement baseline data collection programs are typically a minimum of one year in length, with many lasting multiple years. Data collected from the site wind measurements systems is typically correlated against broader regional data sets and other relevant data to develop wind resource assessments.
Seabed Soil investigations	Seabed and geotechnical assessments are initially scoped based on a desktop study. This step establishes the scope of the geoscience investigations which involve specialized vessels being deployed to collect a variety of information about the site physical conditions. This data collection allows for the generation of a geological model required to establish engineering parameters and design criteria for turbine foundations, substations, cable burial trenches, and other infrastructure. The geoscience program typically involves 2-3 site field programs with increasing levels of detail. These investigations can each be several weeks in length depending on the size of the site, the scope of the surveys and weather conditions. Specific tools that may be deployed include: • **High-resolution multi-beam sonars:** A type of active sonar system used to map the seafloor and detect objects in the water column or along the seafloor. The multiple physical sensors of the sonar – called a transducer array – send and receive sound pulses that map the seafloor or detect other objects (NOAA n.d.). • **Dual magnetometers:** A magnetometer is a passive instrument that measures changes in the Earth's magnetic field. • **High-resolution towed side-scan sonars:** A category of active sonar system for detecting and imaging objects on the seafloor. The transducer array sends and receives the acoustic pulses that help map the seafloor or detect other objects. (https://oceanexplorer.noaa.gov/technology/sonar/side-scan.html) • **High-resolution/shallow-penetration sub-bottom profilers**: A type of sonar system – a geophysical survey tool that uses sound to map beneath the seafloor. Low-frequency pulses of sound are aimed toward the seafloor, where some pulses penetrate through and are then reflected by subsurface sediment. Sub-bottom profilers can be installed in the hull of a ship or towed behind a moving vessel. (https://oceanexplorer.noaa.gov/technology/sub-bottom-profiler/sub-bottom-profiler.html) • **Medium-penetration single/multi-channel seismic systems**: A lower-frequency system (dominant frequencies between 500 Hz and 5 kHz) capable of penetrating much further beneath the seafloor (up to 100 metres [m]). Uses an induction coil and metal plate to produce acoustic pulse. Typical technologies include a 'boomer' and a 'bubble pulser'. • **Gradiometer:** system consisting of multiple magnetometers in series, ideal for tight transect spacing in evaluating the presence of unexploded ordinances (UXO) • **Seafloor sampling**: To collect a core sample, the corer is lowered down to the seabed on the end of a wire, stopping a set distance above. It is then lowered at a set speed into the sediment to obtain the sample before being raised to the surface. At the surface, it is dismantled and the polycarbonate core liner encasing the sample is removed. (https://noc.ac.uk/facilities/national-marine-equipment-pool/scientific-engineering/seafloor-sampling#:~:text=To%20collect%20a%20core%20sample,encasing%20the%20sample%20is%20removed.) • **Cone penetrating tests (CPTs):** CPTs are versatile devices used for in-situ soil tests, typically the first step in a geotechnical investigation. CPTs capture data continuously or at specified depths on such geotechnical parameters as soil density, shear strength, and consolidation rates. During penetration, the forces on the cone and the unit's friction sleeve and pore pressure transducers are measured and transmitted to topside data-logging software. (https://www.windsystemsmag.com/geotechnical-studies-for-offshore-applications/) • **Boreholes:** Boreholes will normally be drilled from a dedicated geotechnical drilling vessel, using heave-compensated rotary techniques. Sampling and in-situ testing will be performed by means of downhole tools operating through an open drilling bit. Boreholes are typically designed to penetrate greater than the depth of expected foundation penetration and can be 30-50 m or more. (https://www.sut.org/wp-content/uploads/2014/03/subseaguidancenotes.pdf)

Vessel and Equipment Use	A variety of vessels will be used to collect baseline technical and environmental data at the proposed OSW development site in the pre-construction phase. These may include a variety of boats and marine vessels, remotely operated submarine vessels (ROV), underwater autonomous vessel (UAV), drones, and lower altitude planes.
Construction	
Installation of cables	**Export Cables:** • Export cables are installed from the project site to the point of interconnection with the grid. Projects typically install 2-3 export cables either in parallel down the same corridor or to separate points of interconnection. • Export cables are installed either by a pre-trenching process or a simultaneous lay and burial process using tools such as a jet-plow, a mechanical trenching plow, and/or a mechanical cutter. The typical target burial depth of the cable is 1.2 to 1.8 m (4 to 6 feet [ft]), with maximum trench depth of 3 m (10 ft) in most circumstances. • The connection approach through coastal area and to the landing point onshore is typically installed via a trenched or horizontal directional drill (HDD) methodology. • Once onshore, the marine cable will be connected to the terrestrial cable segment at a junction box, which is typically a buried concrete building equipped for maintenance and repair access. • For floating projects, some segments for the export cable may be ‘dynamic’ or floating in the water column. This technology is in development and the construction and installation processes are not fully defined. Export cables can be expected to be buried in the approach to the shore. **Interarray Cables:** • Interarray cables connect turbines to offshore substation platforms or other central electrical systems. Multiple turbines (4-8) are typically connected in a string with array cables. • For fixed bottom projects, at each turbine or platform interconnection point the interarray cable will be pulled into the location via a j-tube below the water. Each cable segment will be buried, and where burial is not viable, other forms of protection such as rock dumping, mattresses, etc., may be installed. Scour protection is installed as necessary for each segment. • For floating projects, interarray cables will generally be ‘dynamic’ or floating in the water column. This technology is in development and the construction and installation processes are not fully defined. **Construction techniques:** • https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/RWF-Scoping-Poster-Cable-Laying.pdf
Installation of fixed bottom foundations	There are a number of fixed bottom technologies available in the OSW sector. Of these technologies, suitability for a specific project will be determined through engineering assessment and will be impacted based on-site conditions (seabed profile, geology, metocean conditions) and available material, fabrication, and installation options. Some common fixed bottom technologies include monopiles, jackets, gravity-based foundations, tripods, and suction buckets. While these foundations each have specific use cases, they can broadly be categorized by the following foundation types and associated installation techniques: • **Monopile style foundations:** Single, large-diameter steel structures which support the entire load of the turbine. These are very large structures, often over 8 m in diameter and over 30 m long, with some of the more recent foundations exceeding 2500 tonnes (Project Cargo Journal, 2023). Depending on the site geology, monopiles will be either driven with a hydraulic hammer or installed into a pre-drilled hole, in both case using installation tools mounted to an installation vessel (jack-up or dynamically positioned [DP]). In some cases, both techniques may be required for a single monopile location. • **Pin piled foundations**: Jackets and tripods are frequently secured to the seabed with multiple, smaller pin piles. While the installation techniques for the pin piles are identical to the monopile (driven or drilled), given the much smaller size (pin piles are typically in the 10s to 100s of tonnes versus the 1000s of tonnes for monopiles), the hammer forces are substantially lower. A fabricated steel template is temporarily placed on the seabed to ensure the alignment of the pin piles to the foundation. After the piles are in place, the template is removed and the foundation (jacket, tripod, etc.) is lowered in place and secured to the piles. Smaller vessels may be used for the installation of the pin piles in some cases given the smaller load requirements for the pin piles and installation equipment. • **Suction buckets:** Jackets, monopiles and tripods can also be installed on suction buckets, which are large suction caissons that are put into place, then secured into position by applying suction to the caissons until they are pulled into the seabed. These systems are relatively new for the offshore wind industry with a limited deployed base but have the advantage of a near silent installation and ability to be fully removed at decommissioning (*Empire Engineering*, n.d.).

	• **Gravity based:** these foundations have a wide, heavy and ballasted base that support the turbine on a single column (*Empire Engineering*, n.d.). Significant site preparation is required prior to installing these systems to ensure the seabed meets the necessary load and flatness requirements. The size of all fixed bottom foundations will typically necessitate the use of very large installation vessels, either jack-ups or DP style. The tops of the foundations typically include transition pieces, which are installed or integrated onto the top of the foundation and provide the installation surface for the turbine, and may also include electrical equipment as well as the necessary infrastructure for the turbine maintenance work (working platforms, access ladders, boat landings, davit cranes, etc.). These are generally painted bright yellow (in the fabrication yard) as required by marine safety requirements. Scour protection is typically installed on the seabed around the base of the foundations to protect the structural integrity of the foundation and prevent the water from undercutting the foundation.
Installation of floating foundations, mooring lines, and anchors	Floating technologies are not yet fully commercialized and there are many unique design concepts being marketed. These diverse concepts can typically be categorized as follows: (*Empire Engineering*, n.d.). • **Semi-Submersibles:** Semi-submersibles consist of multiple columns, to provide hydrostatic stability and multiple pontoons to provide additional buoyancy. The foundation is kept in position by catenary or taut spread mooring lines and drag anchors • **Tension Leg platforms:** A Tension-Leg Platform is a vertically moored platform, which, like a semi-submersible, consists of columns and pontoons. The TLP's unique feature is the mooring system, which consists of taut vertical tendons • **Spars**: A spar is a large deep draft floating cylinder with a low waterplane area, ballasted to keep the centre of gravity below the centre of buoyancy. The foundation is kept in position by catenary or taut spread mooring lines with drag or suction anchors. • **Barges**: Barges are a type of floating structure is usually distinguished by a rectangular annulated-shaped floating substructure with a pool at its center which achieve stability by taking advantage of the large water plane area. Catenary mooring systems are typically used. Floating systems typically differ from fixed bottom systems in that the turbine is frequently installed on the foundation at the construction port, then the finished floater/turbine unit is towed to the project site. Once in location, the floater/turbine unit will be set in place using the appropriate mooring/anchoring system. Typical anchors are drag anchors, piled anchors, suction piles or gravity piles. Most floating structures will have 6 to 12 anchors per unit.
Installation of offshore substations and platforms	Offshore substations are typically installed on a jacket or monopile foundation. Electrical equipment is installed on a steel topside structure, typically in the fabrication yard. The assembled topside with installed electrical equipment will be mounted on the installed foundation using an installation vessel equipped with a large capacity crane.
Installation of turbines	Turbines are installed on the installed foundation structures. For most turbine assemblies, the installation will be conducted in three steps. First the tower will be installed, typically in one, but possibly up to three sections. Once the tower is installed, the nacelle system (containing the generator) will be installed on the top of the tower. After the nacelle is in place, the blades are installed one at a time. The installation for fixed bottom units is typically completed at the project site, using a jack-up vessel equipped with a large capacity crane. For floating projects, the installation of the turbine typically is completed at the port, using a quay side crane system, then the finished units are towed to the project site and anchored in place.
Installation of onshore infrastructure	OSW developments typically include associated onshore infrastructure that will be installed by to the OSW developer or a third party. This infrastructure typically includes: • **Onshore export system:** From the landing point, there will be an export cable to the grid point of interconnection. Typically, this cable is buried, but this design may depend on site-specific requirements. Depending on the specific project electrical design, the onshore infrastructure may also require an onshore substation. • **Construction/marshalling ports**: Ports are typically set up to store, assemble and marshal key equipment ahead of and during the construction phase of the project. These ports are temporary and will be redeployed other projects or uses after the construction works are completed. The port infrastructure typically includes large lay down areas, material handling equipment, and quay sides/berths suitable for the installation equipment. • **Operations ports**: These ports are used as a base for the operations and maintenance activities through the course of the full operational life of the project. This site will typically include appropriate quays or berths for the operations vessels, warehouse space, a control centre, and offices.
Vessels and heavy equipment	Heavy lift vessels: these are used for a variety of purposes including foundation installation, turbine installation, and substation installation. These vessels are typically either: • Jack-up vessels, where once at the installation locations legs are dropped to the seafloor to allow the vessel to become a stable platform for high accuracy lifting operations.

	• DP vessels, which have highly accurate control systems to maintain the vessel's position once at the installation location. Heavy lift vessels are typically equipped with high-capacity cranes and speciality equipment like hydraulic hammers, drilling systems, etc., as required. Heavy transport vessels transported equipment to site using large vessels or even barges. Cables are typically installed with a series of vessels including multipurpose vessels and specific cable laying vessels. Depending on seabed conditions, a variety of tools may be used to clear, trench, lay, and bury the cables, including plows, dumping equipment and, in some cases, dredging equipment. Scour dumping vessels are used to install scour protection around foundations and may be used for rock dumping on cables as required. Service operations vessels are large vessels designed to house construction staff at sea, to store smaller components/consumables, and to enable a safer transit to the foundation platforms. Service operations vessels are typically used where construction or operations crews are housed at sea for extended periods. Crew transfer vessels are used to transport work teams and their tools to the worksite on a daily basis. Additional vessels may include bubble curtain vessel, scouts vessel, guard vessel, environmental monitoring vessels, etc.
Operation	
Presence/operation of turbines	Turbine components include the blades, the nacelle (containing the generator and the rotor hub), and the tower. Turbines typically have three blades made primarily of fiberglass and carbon fiber materials. The largest commercial OSW turbines currently have a rotor diameter greater than 200m, with the largest commercially available turbine coming in at maximum rotor diameter of 292m. (Memija, 2023). The rotation speed is typically capped at a blade tip speed of 99 m/s or 320 km/h ("What's Stopping Even Bigger Wind Turbines?," 2023). The air gap, or vertical distance between the sea level and the blade tip at its lowest point) varies based on regional standards, extreme sea conditions and environmental constraints (i.e., Avoiding the flight paths for low flying birds). In the United Kingdom (UK), the Maritime and Coastguard Agency defines its requirements as "Recommended minimum safe (air) clearances between sea level conditions at mean high water springs (MHWS) and rotor blades on fixed foundation wind turbines, or auxiliary platforms, stipulate that they should be suitable for the vessels types identified in the traffic survey but not less than 22 metres" (MGN_654.Pdf, n.d.). Turbines are typically spaced with 6 to 10 rotor diameters apart.(Stevens et al., 2017). Given current turbine technology, this results in spacing between 1 km and 3 km between units. Turbines, like all mechanical equipment, generate some noise as part of their standard operations. A 2020 study which looked at the sound emitted from 14 different OSW developments of differing capacities and technologies around the world assessed that "overall the turbine noise levels were at least 10–20 decibels (dB) below the received levels measured from ships for the same distance" (Tougaard et al., 2020).
Presence of subsea infrastructure (foundations, cables)	**Foundations:** The physical presence of foundation structures in the water, either fixed bottom or floating, presents a new obstruction in the water. In many cases the entirety of the OSW development is classified as an exclusion zone for non-project vessels for safety reasons, which may restrict access to certain areas for fisheries and other commercial or recreational purposes. These safety-based restrictions will take into account sea conditions and specific local fisheries activities. A recent study (Bonsu et al., 2024) identified the need for the following topics to be addressed to facilitate the co-location of commercial fisheries and OSW developments. • regulatory guidelines on safety of fishing and navigation within the OSW developments; • understanding of potential risks; • insurance regimes and liabilities; • financial support for smooth transitions; and, • adequate compensations for impacted fisheries. For floating technologies, multiple mooring lines may present a significant hurdle to allowing non-project vessels within the project area due to the potential safety risk due to the risk of entanglement. Studies are ongoing to assess the potential impact to marine mammals and to propose potential mitigations as floating wind technologies are commercialized and relevant data is collected (Maxwell et al., 2022), however the early data indicates the overall risk is low. (Harnois et al., 2015). On both fixed-bottom and floating infrastructure, marine growth (ie. algae, aquatic weeds, or marine invertebrates) can be expected on foundations, as well as mooring lines and anchors. **Cables:** Array cables will be installed between turbines and the offshore substation and export cables will be installed from the offshore substation to the onshore grid

	connection point of interconnection. For fixed bottom projects, both inter array and export cables are generally buried where possible. Burial depth varies depending on local requirements, expected vessel traffic and seabed conditions, but is typically between 0.5m and 3m in depth. Where cables cannot be buried, they are typically protected with rock dumping or concrete mattress installation to protect against anchor strikes or other potential damage sources (Carbon Trust, 2015). Subsea power cables can carry either AC (alternating current) or DC (direct current) power and both systems produce magnetic fields. Electromagnetic fields (EMFs) can be suppressed based on shielding and burial (BOEM-Electromagnetic-Fields-Offshore-Wind-Facilities_1.Pdf, n.d.).
Typical maintenance activities	On a regular basis, a number of standard maintenance and inspection activities are performed to ensure the proper operation of the offshore and onshore assets (Offshore-Wind-Guide-June-2013-Updated.Pdf, n.d.). These typically include: • Inspection of interarray and export cables to look for potential damage or monitor burial coverage and ongoing installation of covering systems; • Inspection of foundations and cleaning of marine growth on boat landings, access ladders and working platforms; • Inspection of scour protection and cable entry points on foundations; • Inspection of relevant components and sensors on turbine and foundation components to ensure good working order; and, • General maintenance of turbine electrical and mechanical components. Many of these activities will require staff to be present at the work site (on/in the turbine or divers underwater), however an increasing number of inspection activities are being conducted with autonomous vehicles, either underwater remotely operated vehicles (ROVs) or aerial drones. Personnel transport to the site is typically with crew transfer vessels, however Service Operations Vessels are increasingly used for projects further offshore, with extreme sea conditions to minimize daily travel and increase safety of staff when transferring to the turbines or for more labour-intensive maintenance and repair campaigns. Offshore wind projects are monitored and controlled from an onshore control centre 24/7 to enable response to any emerging issues or emergency situations.
Unplanned maintenance / repairs	Unexpected repairs or component replacements occur throughout the lifetime of the project. These incidents may involve the replacement of major equipment (e.g., cables) or components (e.g., gearboxes). These works are generally beyond the capabilities of the standard operations vessels and may necessitate the deployment of construction style equipment (e.g., cable lay vessels or jack-up vessels) For floating projects, floater/turbine units may be towed back to the operations port for major maintenance works/repairs.
Marine vessel operation and helicopter use	Common vessels and equipment used during the operation phase includes crew transfer vessels, service operation vessels, crew transfer vessels, survey vessels, ROVs, AUVs, drones, and tugboats. In some cases, helicopters will be used for crew transfer or in emergency situations. Jack-up vessels, cable lay vessels, scour protection vessels, etc., will be used if required to address any major site repairs or deficiencies.
Decommissioning	
Asset Life	Offshore wind projects are typically designed for 25 to 30 year lifetimes.
Decommissioning strategies	Different strategies for decommissioning exist, driven by local requirements and philosophies. In some cases, regulators look to return the site to the original conditions or as close to the original condition as possible: this would involve removing the turbine, removing the transition piece, removing the foundation in its entirety, removing the cables, and removing any materials added to the seabed (scour material, mattresses, ballast for gravity-based foundations, etc.). Alternatively, regulators may target a ‘minimal impact to the environment’ decommissioning: remove turbine, remove transition piece, remove foundation to the seabed or just below the seabed and cap any open end, leave cables in place, leave any existing incremental materials on the seabed (mattresses, scour material etc.). No information is yet available with respect to the planned regulatory requirement for offshore wind projects in Canada. Environmental impacts from the decommissioning activities will be dependent on the regulatory requirements, the design details (e.g., type of foundations, etc.) and the developer decommissioning plan. It is common in many jurisdictions for developers to demonstrate their ability to fund the ultimate decommissioning works through a bond or annual payments into an escrow account based on the estimated future costs of the decommissioning works.
Malfunctions and Accidental Effects *Including any attributed to effects of the environment (e.g., extreme weather events, collisions with icebergs etc.) or any other cause (e.g., vessel collisions, equipment malfunctions etc.)*	
Cable failure / damage	The most common major issue in the OSW industry is cable failure due to manufacturing defect, improper installation, or external damage (typically anchor strike). (Offshore Wind Report 2023, n.d.)

	Impacts of these failures involve reduced energy production and need for cable repair or replacement at site.
Vessel collision	European research into the potential for vessel collisions in the North Sea has determined an expected number of annual vessel collisions with turbines to increase to 1.5 to 2.5 times per year by 2030 based on an expected deployment of 2500 turbine units in the North Sea (MARPRO, 2022). Damage resulting from the strike of a vessel against a foundation will be dependent on many factors including the vessel size, speed of travel and angle of strike, as well as the foundation design. In the publicly available materials, historic strikes have resulted in damage to the foundation and vessel to varying degrees, with most incidents being characterized as "this so far has typically involved smaller vessels and is often the result of human error" (*Offshore Wind Report 2023*, n.d.) and one incident found that resulted in catastrophic damage to turbine (Schuler, 2022). Risk mitigation options are being developed to avoid vessel collisions in busy/congested corridors and in extreme weather conditions (MARPRO, 2022).
Fire / Mechanical Fire	Turbine fires can be catastrophic but are rare, with frequency ranging from one fire per 2000 turbines to one fire per 7000 turbines estimated per year among the onshore and offshore turbine fleet (Paznokas, 2023). Once a fire has started, there are limited options to extinguish the fire unless fire suppression systems have been put in place. Given the distance between turbines, the likelihood of fire transferring from one unit to others in the project is exceedingly rare. Fires in OSW turbines would be likely located in the nacelle and might result in falling, potentially melting components landing in the sea, potential discharge of fire suppression foams into the marine environment, and smoke and particulate matter being emitted into the air.
Marine Discharges	An assessment of the environmental impacts of offshore energy activities by the UK department of Business, Energy and Industrial strategy identified the following sources of marine discharge related to OSW infrastructure (BEIS, 2022): a) Introduction and spread of non-native species; b) Potential impacts on flora and fauna of drilling discharge during construction; c) Use of anti-fouling materials; d) Sediment modification and contamination due to drilling discharge during construction; and, e) Contamination by soluble and disperses discharges during drilling activities.

5. Areas of Concern

The following Areas of Concern (AoC) were identified by KMKNO and are therefore the focus of this report. A meeting was held with KMKNO to discuss these AoCs on May 9, 2024.

5.1 Marine Species

Efforts to conserve, protect and enhance marine life and associated habitats include, but are not limited to (Figure 4):

- Marine refuges or fishery closures;
- Identified ecologically and biologically significant areas;
- Marine Protected Areas (MPAs);
- Identification of significant benthic habitat areas; and,
- Federally designated critical habitat for SAR (Figure 5).

The cumulation of these measures are established to promote long-term marine ecosystem health through bylaws as well as by information sharing intended to guide anthropogenic activity planning. The relationship between OSW developments and the activities of the marine environment within the Study Areas, including commercial fishing, wildlife interactions, SAR critical habitat, are further explored in Section 5.1.1 to Section 5.1.3.3.1.

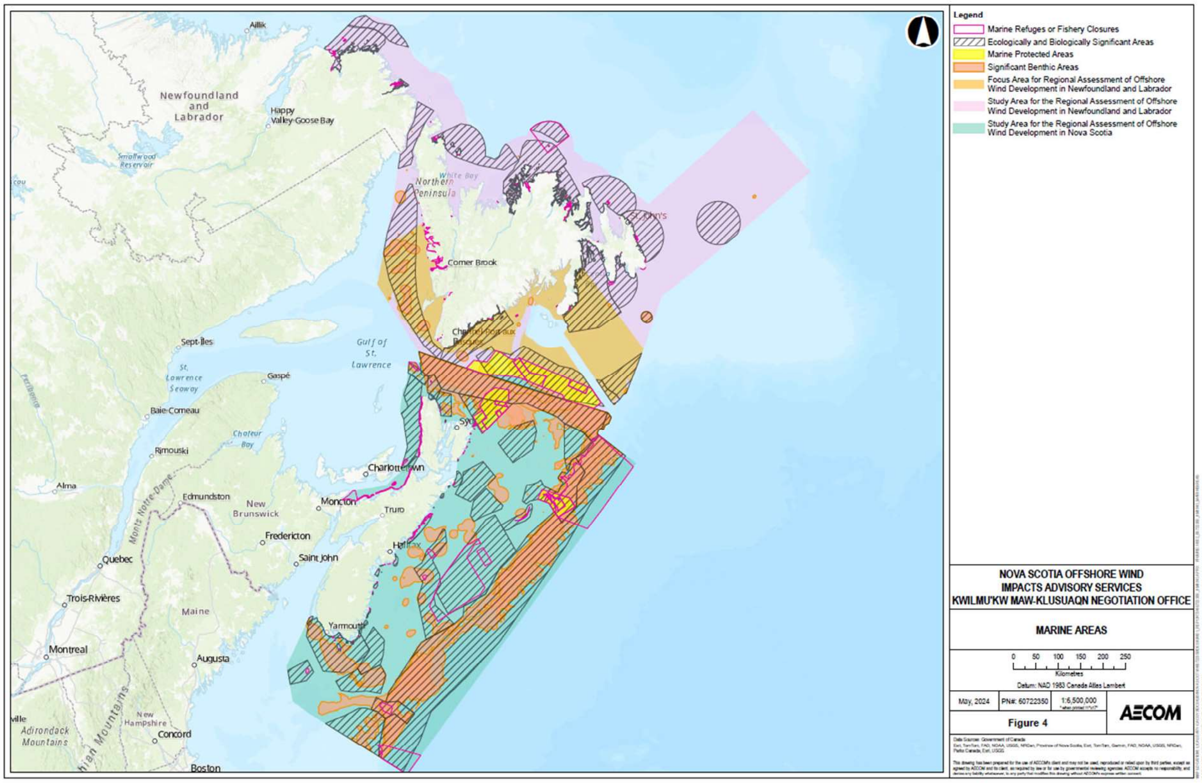

Figure 4. Marine Habitat Important Areas within Study Areas

5.1.1 Potential Positive and Negative Impacts to Marine Species

Direct impacts of OSW development on marine species can generally be categorized into three groups (Gill et al., 2020):

- Artificial reefs effects
- Fisheries exclusion and displacement effects
- Energy landscape effects

A general description of each effect is included below and the impacts to commercial fisheries and marine SAR are detailed in sections 5.1.2 and 5.1.3, respectively.

Artificial Reef Effects

The artificial reef effect is caused by the addition of OSW turbine foundations to a sandy substrate environment. These structures are often surrounded by scour protection consisting of gravel fill and a rock armour layer, typically reaching a radius of up to 20 m (Hammar et al., 2010). The addition of rocky material to an otherwise sandy bottom environment increases habitat heterogeneity and creates artificial reefs around the turbines which are rapidly colonized by habitat-forming invertebrates thereby establishing a food source for higher trophic levels (De Mesel et al., 2015; Raoux et al., 2017). This complex habitat provides opportunities for breeding, recruitment and shelter for a wide range of fish and invertebrate species (Love et al., 2012; Krone et al., 2017) and as a result, they are often observed in at higher densities than surrounding areas (Reubens et al. 2014; Paxton et al. 2020) (estimated up to 55% [Raoux et al., 2017]).

Fisheries Exclusion and Displacement Effects

Fisheries exclusion and displacement effects occur as a result of fishing efforts being excluded from areas surrounding OSW developments (Gill et al., 2020). Fisheries exclusion effects may positively impact areas within OSW developments temporarily during the pre-construction phase (e.g. geo-physical surveys) and construction phase (e.g. turbine installation), or more long term during the operation phase (Roach 2019; Roach et al. 2022). In some cases, the perceived risk to commercial fishers operating within the site acts as a deterrent and in others, there is a physical barrier relating to fishing gear (e.g., trawl nets catching on turbine foundations) (Hooper et al.2015; Haggett et al. 2020). In the UK, additional safety zones are established around the OSW developments during the operational phase, further excluding fishing activities in the area (Hooper et al., 2015). Additionally, OSW development reduces the use of bottom towed gear near the turbines, leading to less disturbance of benthic habitats. This results in increased benthic biodiversity and habitat complexity, which have positive effects on higher trophic levels. (Gill et al., 2020). As a result of fisheries exclusion, OSW developments can act in a similar manner to MPAs (Hooper et al., 2017), with the resulting spill-over effects of increased fish presence within exclusion zones ‘spilling over’ to beyond these boundaries, positively impacting nearby areas (Halouani et al., 2020).

Conversely, fisheries displacement effects may negatively impact areas outside of OSW developments by increasing fishing pressures in those areas and therefore reducing overall fish populations, upsetting the food chain/web by selectively removing significant numbers of certain target species, etc. (Gill et al., 2020). However, a meta-analysis of the effects of MPAs (i.e. fisheries exclusion areas) across 25 countries found overall benefits to commercial fisheries (e.g. increased fish stocks, larger catch individuals, increased catch, etc.) and provide overall benefits to marine ecosystems through the sustainable exploitation of resources (Costello, 2024).

Energy Landscape Effects

The energy landscape effect includes impacts of increased underwater noise (UWN) and EMFs as well as altering water currents and wind wakes (Gill et al., 2020). Increased sound levels have the biggest impact on the marine environment during construction, which usually involves high-intensity impulsive sounds from activities such as pile driving (Mooney et al. 2020). Additional noise can come from laying the undersea cables (route clearance, trenching, backfilling, etc.) and will vary according to substrate, bathymetry, and equipment (Taormina et al., 2018). High-intensity impulsive sound can impact marine fauna through direct physical injury as well as causing alterations in physiology and in behaviour such as avoidance reactions (Hawkins et al. 2015; Popper and Hawkins 2019; Mooney et al. 2020). The sound levels observed during the operations phase are continuous and similar to those of a large commercial ship, which generally do not cause physical injury (Mooney et al., 2020). These sound levels can cause behavioural changes and most often impact marine fauna through auditory masking of biologically relevant sounds such as those used in communication between individuals, predator-prey interactions, and orientation (Popper & Hawkins, 2019; Mooney et al., 2020).

EMFs, on the other hand, have the biggest impact on marine fauna during the operations phase when they are emitted by electricity passing through the submarine power cables connecting turbines and export cables to the mainland (Hutchison et al. 2020; Scott et al. 2021). Many marine species use naturally occurring electric and magnetic fields in a variety of ways, including orientation and migration, hunting and foraging, and detection of predators and conspecifics (Taormina et al., 2018; Hutchison, Secor, et al., 2020; Harsanyi et al., 2022). Anthropogenically introduced EMFs can potentially disrupt these behaviours, resulting in physiological and developmental effects, especially to benthic and demersal (living close to the sea floor) species (Taormina et al., 2018).

The alteration of wind wakes and water currents has the greatest effect on marine species during the operations phase compared to the construction phase. Installation of OSW developments results in changes in tidal currents as they move past the turbines, causing a turbulent wake and increased mixing of the seasonally stratified water column (Carpenter et al., 2016; Floeter et al., 2017). This mixing has the potential to alter nutrient transport, photic zone depth, and distribution of suspended solids, which thereby impacts both primary and secondary producers as well as larval distribution and dispersal (Floeter et al., 2017; Barbut et al., 2020).

The specific impacts of OSW development to commercial fisheries and marine SAR are detailed in the following sections.

5.1.2 Commercial Fisheries

The potential impacts of OSW development to the commercial fishing industry in Canada will be largely dependent on the regulations governing fishing in and around OSW developments. Currently, restrictions to fishing activities within OSW developments vary depending on country and gear type. For example, in European countries such as Belgium, the use of active fishing methods (e.g., trawling) are legally banned within OSW developments. In the UK, active fishing is legally permitted; however, it is entirely restricted due to insurance and liability concerns (Gill et al., 2020). Conversely, the use of passive fishing methods (e.g. setting pots for lobster and crabs) is permitted within OSW development in the UK (Krone et al., 2017). Fishing closures around OSW developments will also depend on whether the turbines are fixed or floating. In the case of floating turbines, active fishing methods are more likely to be in direct conflict due to the potential entanglement of fishing gear or anchors with mooring systems and dynamic cables (Eatough, 2021). Fishing activities are further limited during the construction phase or periods of maintenance by the standard 500 metre (m) safety exclusions zones around turbines and vessels laying cables (FLOWW 2014; Hooper et al., 2015; Michel et al., 2007; SeaPlan, 2018).

In addition to regulatory uncertainty, the loss of fishing grounds may lead to overcrowding of available fishing grounds and subsequently a decrease in harvest and revenues (ten Brink & Dalton, 2018). The addition of OSW developments to the marine landscape may also: increase fuel consumption and emissions by disrupting vessel navigation; increase insurance costs or outright rejection of coverage for fishing within OSW developments due to navigation hazards the turbines and cables present; and lead to damage or loss of fishing gear due to entanglement with turbine foundations (Chaji & Werner, 2023; NSFAEE 2024; SeaPlan, 2018).

Impacts of OSW development to commercially important species and groups are detailed in the following sections.

5.1.2.1 Crustaceans

Commercially harvested crustaceans in the regional assessment areas include, but are not limited to, American lobster (*Homarus americanus*), snow crab (*Chionoecetes opilio*), and northern shrimp (*Pandalus borealis*) (DFO, 2021). The most commercially important crustacean in Atlantic Canada is the American lobster, with the annual Nova Scotia lobster catch valuing $868,790,000 in 2022 (DFO, 2024b). As the OSW industry is relatively new to North America, limited research has been conducted on American lobster and most literature focuses on the European counterpart, the European lobster (*Homarus gammarus*). While it is the same genus as the American lobster, studies of European lobster are not necessarily directly comparable as American lobsters are more migratory than European lobsters which have smaller home ranges (Moland et al., 2011). Additionally, European lobster catches are not directly comparable as commercial fisheries are not excluded from the OSW developments in the United States of America (USA) to the same extent as Europe (Wilber et al., 2024). Despite not being directly comparable, studies of

European lobster have been included in this literature review as research on the effects of OSW development on American lobster are limited.

The commercial crab species of interest in this report is the snow crab which had not been studied in relation to OSW at the time of writing. As a result, research on other species such as the edible crab (*Cancer pagurus*) and Dungeness crab (*Metacarcinus magister*) has been included to demonstrate general effects of OSW development on crabs.

Lobsters, crabs, and other crustaceans are attracted to complex, rocky habitat (Krone et al., 2017) and are found in relatively high abundances at the artificial reefs created by OSW platforms as well as the concrete mattresses used to stabilize and cover the sub-sea cables (Griffin et al., 2016; Hooper and Austen, 2014; Taormina et al., 2020). In Europe, this is well documented in species such as the commercially important European lobster and edible crab (Griffin et al., 2016; Hooper & Austen, 2014; Krone et al., 2017; Roach et al., 2018). Griffin (2016) observed that European lobster was significantly higher in relative abundance adjacent to turbines than in areas 4 km away. Krone (2017) found that the abundance of edible crab was much higher at OSW turbines than in the surrounding soft sediment habitat. It was concluded that OSW turbines act as aggregation sites and nursery grounds with higher abundances observed at turbines with scour protection as opposed to jacket foundations or gravity-based foundations (Krone et al., 2017).

While the construction of turbines with scour protection may be a benefit to crustacean populations, the energy landscape changes may have a negative effect on these bottom-dwelling species. The effects of EMFs emitted by subsea power cables have been studied on various commercial crab and lobster species, with effects varying by species and life stage (Hogan et al., 2023). Studies of European lobsters observed an increase in deformities and reduced swimming ability in larvae exposed to EMF throughout embryonic development, which can potentially impact larval dispersal and recruitment (Harsanyi et al., 2022). Behavioral studies of juvenile European lobster larva in an aquarium setting show no response to EMF (Taormina et al. 2020). Hutchinson (2020) studied adult American lobster in a mesocosm (enclosure in the natural environment) exposed to EMF and observed subtle changes in exploratory behaviour, with the lobsters making significantly more large turns (170-180°) when compared to the control mesocosm (Hutchison et al., 2018).

The effects of EMF on crabs are less studied than those on lobsters. The Harsanyi (2022) study showed that the same larval deformities and reduced swimming abilities occurred in edible crabs that were observed in European lobster. Scott (2018, 2021) found that adult edible crabs were attracted to the source of EMF, disrupting their natural roaming behaviours for feeding and mating, when exposed to EMF of 500 µT or above. A study conducted by Love (2015) showed no difference in the behavior of caged rock crabs (*Meticarcinus anthonyu* and *Cancer productus*) when they were exposed to AC-powered cables. Studies conducted on commercially important Pacific crab species, Dungeness crab and red rock crab (*Cancer productus*), showed that the adult crabs were not reluctant to cross energized cables and the presence of these cables did not reduce catchability of either species (Love et al., 2017). As previously mentioned, no studies were found on snow crab or the genus *Chionoecetes* relating to EMF or OSW development in general.

At the time of writing, no studies have examined how the changes in hydrodynamics and wind wakes resulting from OSW development impact the pelagic life stages of commercial crustacean species (Hogan et al., 2023). Additionally, the effects of sounds on commercial crustacean species are generally not a focus of research; however, Solan (2016) found that Norway lobster (*Nephrops norvegicus*) demonstrated changes in behaviour (e.g., reduced mobility, changes in their ability to feed) when exposed to noise mimicking construction and shipping activities. While not commercial species, both hermit crabs (*Pagurus bernhardus*) and European green crabs (*Carcinus maenas*) showed negative behavioural reactions (decreased mobility and feeding responses) when exposed to sounds imitating pile driving activities (Roberts et al., 2016; Corbett, 2018).

Studies attempting to determine the impacts of OSW development on crustacean fisheries have generally shown that the construction and operation of OSW development are not negatively impacting catch rates and, in some cases, are leading to an increase. A study of European lobster conducted by Roach et al. (2022) observed a short term increase in size and catch rates during the construction phase of a UK OSW developments; however, this was not observed during the operations phase. Surveys conducted in New England by Wilber et al. (2024) showed no negative effects on American lobster catches during construction of OSW development. While a decrease in catch rate was observed during the operations phase, the OSW developments was located in suboptimal lobster habitat compared to the reference site which was deeper and cooler. This aligns with the regional shift of lobster distribution towards deeper, cooler locations, and the study showed no major impacts on lobster catch due to the construction and operation of OSW development (Wilber et al., 2024). Thatcher et al. (2024) used fishing logbooks to compare catch per unit effort (CPUE) of European lobster at OSW turbines with and without scour protection and found that CPUE was significantly higher at the former where this rocky habitat was created. In addition to the positive effects of increased rocky habitat, the temporary exclusion of fishing activities during the construction phase of OSW development off the north-east coast of the United Kingdom resulted in an increase in European lobster size and CPUE. This increase allowed fishers to partially recuperate financial losses incurred as a result of the temporary closure (Roach et al., 2018).

5.1.2.2 Fish

As was the case with crustaceans, the OSW structures meet the criteria of an artificial reef by providing shelter, reproduction, nursery, feeding, and foraging opportunities to a range of fish species (Glarou et al., 2020). The artificial reef effect of OSW development on fish communities has been demonstrated at OSW developments in France (Raoux et al., 2017), Denmark (Stenberg et al., 2015), and the US (Wilber et al., 2022). The invertebrates colonizing the wind farm structures are prey to benthivorous fish which are then predated by higher trophic level piscivorous fish (Degraer et al., 2020). This leads to an overall increase in fish abundance (Wilhelmsson et al., 2006) and may even lead to an increase in fish biomass (J. T. Reubens et al., 2013). The results of a meta-analysis reviewing the effects of OSW development on fish abundance, for both soft-bottom and complex-bottom species indicated a greater abundance of fish within OSW developments compared to reference sites (Methratta & Dardick, 2019). A study of long-term effects of OSW development on fish communities in the North Sea indicated that the structures were large enough to attract fish with a preference for rocky habitat but not large enough to have negative effects on species with a preference for the original soft substrate (Stenberg et al., 2015).

Potential stressors to fish communities resulting from the addition of OSW developments include, but are not limited to, EMFs (Dannheim et al., 2020), UWN (Kikuchi, 2010), particle motion (Sigray & Andersson, 2011), and vibration (Popper et al., 2022). EMFs emitted from submarine power cables have the potential to disrupt the ability of fish to utilize natural EMF for navigation or prey detection (Taormina et al., 2018). The potential impacts of EMF on fish vary depending on life stage. Laboratory studies of the impacts on early life stages indicate that there may be negative effects on development; however, these studies use intensities that are high relative to those typically encountered within a few metres of the submarine power cables (Gill & Desender, 2020; Svendsen et al., 2022). Field studies observing the effects on fish movement and migratory behaviour around existing submarine cables have shown that EMFs have no effect; however, there is a need for species specific studies (Hutchison, Secor, et al., 2020; Klimley et al., 2017; Svendsen et al., 2022; Wyman et al., 2018). In terms of fish abundance, richness, and community composition, studies to date indicate that there is either no or limited negative effects (Dunham et al., 2015; Dunlop et al., 2016; Kilfoyle et al., 2018; M. S. Love et al., 2017; Svendsen et al., 2022). Based on the current studies, and the duration of exposure being in the order of minutes, EMFs are not an area of concern for fish communities (Snyder et al., 2019).

The potential impacts of UWN differ depending on the project phase and are most significant during the construction phase due to activities such as pile driving. High intensity sounds from these activities have the potential to kill or injure fish should they be in close proximity to the source (Popper & Hawkins, 2019); however, these impacts can be avoided through the application of standard noise mitigation measures (e.g., bubble curtains). Lower intensity construction noise has the potential to cause avoidance reactions and behavioral changes impacting foraging success, predator avoidance, and reproductive success (Mueller-Blenkle et al., 2010; Popper & Hawkins, 2019; Wahlberg & Westerberg, 2005). Noise produced during the operations phase does not cause physiological harm to fishes or lead to consistent avoidance reactions; however, it can disrupt intra-species communications through auditory masking (Siddagangaiah et al., 2022; Wahlberg & Westerberg, 2005). Behavioural responses to operational noise has been observed for Atlantic blue fin tuna (*Thunnus thynnus*; Puig-Pons et al. 2021) and Atlantic cod (*Gadus morhua*; van der Knaap et al., 2022) with both species moderately altering their movement patterns. Acoustic studies conducted by Elliot et al. (2019) at an American OSW development showed low sound levels during the operational phase and concluded that the probability of these sound levels causing potential harm to fish was low. The effects of vibration and particle motion, the oscillation of seawater particles, have been less studied than UWN and the long term effects on fish are unknown (Sigray & Andersson, 2011; Svendsen et al., 2022).

The impacts of OSW development to specific to groundfish and pelagic fish, and the potential impacts to their commercial harvest, are detailed in the following sections.

5.1.2.2.1 Groundfish

Groundfish are fish species living on or near the seafloor and may be divided into flatfish (i.e. soft-sediment dwelling species that are laterally compressed as adults), and demersal roundfish (i.e. attracted to rock substrate, living and feeding near the ocean floor). Commercially harvested groundfish in the regional assessment areas include, but are not limited to, Atlantic cod, Atlantic halibut (*Hippoglossus hippoglossus*), haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius virens*), and redfish (*Sebastes sp*.) (DFO, 2021).

The artificial reef effect of OSW developments generally has a positive effect on groundfish (Degraer et al., 2020). Additionally, these artificial reef habitats may be providing important stepping stone habitats which can enhance and restore population connectivity (Gimpel et al., 2023). Atlantic cod is an important benthopelagic commercial species in the regional Study Area and the most well studied groundfish in relation to impacts of OSW development. Atlantic cod are attracted to these artificial structures during both juvenile and adult life stages and show high site fidelity (Reubens et al., 2014; Reubens et al., 2013). This has been observed in the Belgian part of the North Sea (Degraer et al., 2012; Reubens et al., 2013), Netherlands (van Hal et al., 2017), and Sweden (Bergström et al., 2013), demonstrating an increased density of Atlantic cod near the OSW foundations (Bergström et al., 2013). More locally, this was observed at Block Island Wind Farm (BIWF) off the coast of Rhode Island, the first OSW development in North America (Wilber et al., 2022). Along with black sea bass (*Centropristis striata*), the abundance of Atlantic cod was significantly higher within BIWF when compared to a control site (Wilber et al., 2024). While the black sea bass does not currently inhabit Canadian waters, its range is likely to expand northward as a result of climate change (McBride et al., 2018; Miller et al., 2016) and it may become a commercially important species (DFO, 2019). As a result of this increase in abundance, Wilber (2022) found that CPUE at BIWF was significantly higher near the wind farms following turbine installation.

At this time, the impact of OSW development on flatfish populations is not well understood (Buyse, 2023). As flatfish are soft-sediment fish species, the introduction of rocky substrate affects them differently from fish species associated with hard substrates. Studies conducted at BIWF showed no change in flatfish abundance when compared to control sites (Wilber et al., 2018). At an OSW development in the North Sea, Buyse (2023) observed European plaice (*Pleuronectes platessa*) abundance to be four times higher than surrounding sandy areas (Buyse et al., 2021). This difference may be due to the different densities of the rock scour protection at the turbines. At OSW developments where rock density of the scour protection is low, sandy patches develop between rocks and create soft-sediment habitat for rockfish. Plaice are likely resting in the sand surrounding the turbines and feeding at the rocky substrate, taking advantage of the same artificial reefs effects as species associated with hard substrates (Buyse 2023). In Europe, bottom trawling activities are generally excluded from wind farms due to safety regulations or insurance and liability concerns (Gill et al., 2020). As a result, the OSW development are creating areas of refuge which may be benefiting flatfish species populations; however, empirical evidence for this is lacking (Buyse, 2023).

Overall, the negative impacts of OSW development to groundfish species are either temporary (e.g., pile driving noise during construction) or low (e.g., EMFs), and the positive impacts (e.g., creation of artificial reefs and areas of refuge) are more prominent. As a result, the impacts to groundfish commercial fisheries will likely be limited to restrictions on fishing around the turbines.

5.1.2.2.2 Pelagic Fish

This section includes impacts to both forage fish (e.g., Atlantic herring [*Clupea harengus harengus*]) and the large predatory pelagic fish that feed on them (e.g., Atlantic bluefin tuna). Overall, OSW developments appear to either have no effect or a positive effect on the abundance of pelagic fish (species that inhabit the water column). At BIWF in the US, Wilber (2022) observed that abundance of schooling fish species such as Atlantic herring, scup (*Stenotomus chrysops*), and butterfish (*Peprilus triacanthus*) was not impacted by OSW development. While the CPUE effort decreased throughout the study period, this was in line with regional trends and not attributed to OSW operation. At Horns Rev 1 OSW in the North Sea, Stenberg (2015) observed no significant changes in abundance or distribution of pelagic fish between the OSW development and a control site, and no negative long-term effects of OSW development. In Germany, hydroacoustic studies were conducted to assess the effects of altered hydrodynamics on pelagic fish. It was determined that the presence of OSW development did not affect the distribution of pelagic fish in the area (Floeter et al., 2017). Dahlgren (2023) utilized eDNA to assess the use at the at Hywind Scotland OSW development and determined that abundance of herring and mackerel was higher at the windfarm site than the reference site.

The effects of construction noise on fish are well understood (detailed in section 5.1.2.2) however, the effects of operational continuous noise on pelagic fish have received less attention. Studies exposing Atlantic bluefin tuna to operational and vessel traffic noise has been conducted in both the lab and a fixed feeding cage in the ocean (Espinosa et al., 2014; Puig-Pons et al., 2021). In both cases, behavioural changes were observed such as alarm or avoidance responses, changes of position in the water column, and increased speed. However, Atlantic bluefin tuna appeared to become habituated over time and it was noted that the effects on wild tuna are unclear.

As was the case with groundfish, the negative impacts of OSW development to pelagic commercial fisheries will likely be due to restrictions on fishing around the turbines. However, it should be noted that research on this group is limited.

5.1.2.3 Bivalves

Commercially harvested bivalves in the regional assessment areas include, but are not limited to, Atlantic surf clam (*Spisula solidissima*), soft shell clam (*Mya arenaria*), Atlantic razor clam (*Ensis leei*), Stimpson's surf clam (*Mactromeris polynyma*), Icelandic scallop (*Chlamys islandica*), sea scallop (*Placopecten magellanicus*), and blue mussel (*Mytilus edulis*) (DFO, 2015, DFO, 2018c).

At this time, no studies have been conducted on changes in abundance and distribution of clams and scallops following the construction of OSW development (Hogan et al., 2023). Conversely, many reports on European OSW development show increased blue mussel abundance on the hard substrate of the OSW development (Degraer et al., 2020). At BIWF, aggregations were observed under jacket foundations and increased over time, becoming the dominant colonizing species (HDR, 2018; Hutchison, Bartley, et al., 2020).

Regarding the effects of EMFs on bivalves, there is no literature to date on commercial clam and scallop species, however, blue mussels have been studied in a laboratory setting (Hogan et al., 2023). Bochert and Zettler (2004) showed no lethal effects from direct current (DC) magnetic field while Malagoli et al. (2003, 2004) showed immunological and stress protein responses to alternating current (AC) EMFs. Benthic clams (*Limecola balthica*), a non-commercial species, were exposed to AC EMFs exhibited immune responses (Stankevičiūtė et al., 2019). Larger scale impacts of these effects are unknown at this time.

No studies have been conducted on the effects of OSW noise on commercial clam and scallop species; however, sound sensitivity of the giant scallop (*Placopecten magellanicus*) has been studied in a laboratory setting and showed a range of sensitivity to anthropogenic noise. Responses were greatest to lower frequency sounds with juveniles exhibiting a greater stress response than adults (Jézéquel et al., 2023). Research has been conducted on blue mussels showing responses to pile driving noise which would likely impact overall fitness (Roberts et al., 2015). Wale et al. (2019) observed sublethal physiological and behavioral changes to mussels that had been exposed to vessel noise.

Overall, the impact of OSW development on commercial bivalve fisheries relatively unknown and requires further investigation.

5.1.3 Marine Species at Risk

The federal *Species at Risk Act* (SARA) establishes Schedule 1 as the official list of wildlife SAR. It classifies species as Extirpated, Endangered, Threatened, or Special Concern. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an advisory panel to the Minister of Environment and Climate Change Canada (ECCC), which assesses the status of wildlife and their risk of extinction every two years.

Critical habitat is identified for species listed as Endangered or Threatened on Schedule 1 of the SARA. It is habitat necessary for the survival or recovery of a listed wildlife species and identified as the species' critical habitat in the recovery strategy or in an action plan for the species.

Species of Conservation Concern (SOCC) identified within the Study Areas are listed in Table 1 and identified in Figure 5. Conservation status, habitat preferences, and likelihood to occur in the Study Areas are identified for each species. Species with critical habitats identified within the study areas and species with threatened or endangered conservation status with moderate to likely probabilities of occurring in the study areas are further described in the following sections.

Table 1. Marine Species of Conservation Concern with Potential to Occur in the Study Areas

Common Name	Scientific Name	COSEWIC Status	SARA Status	Habitat Preferences	Critical Habitat in Study Areas
Fish					
Acadia Redfish	*Sebastes fasciatus*	Threatened	-	- Live primarily along continental slopes and in deep channels from 150 m to 300 m (DFO, 2023a). - Adults live in cold, deep waters and prey upon other fish; larvae live near surface waters and feed on copepods and fish eggs (DFO, 2023a). **Moderately Likely** to occur in Study Areas	X
American Eel	*Anguilla rostrata*	Threatened	-	- In Canada, found in freshwater, estuaries and marine waters connected to the Atlantic Ocean (DFO, 2023b). - Spawning occurs in the Sargasso Sea (DFO, 2023b). - Eggs and larvae drift/swim in Gulf stream to return to freshwater (DFO, 2023b). **Moderately likely** to occur in Study Areas	X
American plaice	*Hippoglossoides platessoides*	Threatened	-	- Occurs in the Gulf of St. Lawrence, the Scotian Shelf, the Bay of Fundy and Georges Bank (DFO, 2023c). - Eggs and larvae are pelagic; juveniles and adults commonly burrow in sediment Bank (DFO, 2023c). - Preference for depths of 50 m to 200 m Bank (DFO, 2023c). **Moderately likely** to occur in Study Areas	X
Atlantic Bluefin Tuna	*Thunnus thynnus*	Endangered	-	- Highly migratory; feed in Atlantic Canadian waters in summer and migrate to Gulf of Mexico in winter for spawning, larval and juvenile rearing habitats (DFO, 2018a). - Juveniles and adults are opportunistic feeders. Juveniles prefer crustaceans, fish and cephalopods; adults prefer fish (e.g. herring, anchovy, sardine) (DFO, 2018a). **Moderately likely** to occur in Study Areas	X
Atlantic Cod – Laurentian South population	*Gadus morhua*	Endangered	-	- In Canada, occur from Georges Bank and the Bay of Fundy north along the Scotian Shelf toward the eastern shores of Labrador and Baffin Island, Nunavut (COSEWIC, 2010b). - Eggs and larvae occur in upper 50 m of the sea (COSEWIC, 2010b). - Juveniles occur on the sea bottom for 4 years (COSEWIC, 2010b). - Adults have more diverse habitat requirements, following food supply and preferred temperatures (COSEWIC, 2010b). **Moderately likely** to occur in Study Areas	X
Atlantic Cod – Southern population	*Gadus morhua*	Endangered	-		
Atlantic salmon – Eastern Cape Breton population	*Salmo salar*	Endangered	-	- Anadromous species, spawning in freshwater and living as adults in the marine environment of the Atlantic Ocean (COSEWIC, 2010c). - Canadian range extends from St. Croix River at the Canadian/USA border, north to Ungava Bay and eastern Hudson Bay in Quebec (COSEWIC, 2010c).	X
Atlantic salmon – Nova Scotia Southern Upland	*Salmo salar*	Endangered	-		

Common Name	Scientific Name	COSEWIC Status	SARA Status	Habitat Preferences	Critical Habitat in Study Areas
population				- In North America, adults typically return to rivers between May and November, but varies (COSEWIC, 2010c). **Moderately likely** to occur in Study Areas	
Atlantic salmon – South Newfoundland population	*Salmo salar*	Threatened	-		
Atlantic Sturgeon – Maritimes population	*Acipenser oxyrinchus*	Threatened	-	- Occur in rivers, estuaries, nearshore marine environments and shelf regions to at least 50 m depths (COSEWIC, 2011a). - Spawn in freshwater, local ocean range covers southern Gulf of St. Lawrence and Bay of Fundy (ECCC, 2014). - Primary diet of worms, crustaceans, molluscs, small fish and aquatic insects (ECCC, 2014). **Moderately likely** to occur in Study Areas	X
Atlantic Wolffish	*Anarhichas lupus*	Special Concern	Special Concern	- In western North Atlantic waters, occurs along southern Labrador, Strait of Belle Isle, Gulf of St. Lawrence, east and west coasts of Newfoundland, Grand Banks, and the Bay of Fundy. Range extends from Scotian Shelf to Gulf of Maine (COSEWIC, 2012a). - Prefer cold, deep waters of continental shelves and hard sea floors (DFO, 2023d). - Feed primarily on invertebrates (whelks, sea urchins, crabs, etc.) and occasionally fish (COSEWIC, 2012a). **Moderately likely** to occur in Study Areas	X
Basking shark – Atlantic population	*Cetorhinus maximus*	Special Concern	-	- Utilize nearly all coastal temperate waters in Atlantic Canada and are most abundant south of the Newfoundland-Labrador shelf. Commonly observed in the mouth of the Bay of Fundy (COSEWIC, 2018). - Occur where there are concentrations of zooplankton in summer, particularly along headlands, around islands and bays with strong tidal flow, and occasionally in deepwater habitats (>1000 m) (COSEWIC, 2018). **Likely** to occur in Study Areas	X
Cusk	*Brosme brosme*	Endangered	-	- Central abundance in Atlantic Canada in Gulf of Maine and the southern Scotian Shelf off southwest Nova Scotia (DFO, 2023e). - Rare in deep waters along edge of continental shelf off Newfoundland and Labrador (DFO, 2023e). - Prefer rocky ocean floor (boulders, gravel, pebbles) and depths of 150 m to 400 m. Never found nearshore or at depths of less than 20 m to 30 m (DFO, 2023e). **Moderately likely** to occur in Study Areas	X
Deepwater redfish	*Sebastes mentella*	Endangered	-	- Primarily occur along continental slopes and deep channels (350 m to 500 m) (DFO, 2023f). - Larvae prefer surface waters and feed on copepods and fish eggs. Adults live in cold, deep water and feed on fish (DFO, 2023f). **Unlikely** to occur in Study Areas	X

Common Name	Scientific Name	COSEWIC Status	SARA Status	Habitat Preferences	Critical Habitat in Study Areas
Northern Wolffish	*Anarhichas denticulatus*	Threatened	Threatened	- Can be found across North Atlantic from Norway to southern Newfoundland (DFO, 2023k). - Benthopelagic fish. Occurs in cold offshore and continental shelf waters, typically at depths greater than 100 m (DFO, 2023k). - Diet of mainly crustaceans and invertebrates (DFO, 2023k). **Likely** to occur in Study Areas	✓
Porbeagle	*Lamna nasus*	Endangered	-	- In Atlantic Canada, occurs in waters from northern Newfoundland to the Gulf of St. Lawrence and into the Bay of Fundy (DFO, 2023l). - Abundance in Canadian waters strongly linked to seasonal migrations (DFO, 2023l). - Occupies coastal and open sea areas, most commonly found on continental shelves, from depths of 1 m to 700 m (DFO 2023l). **Moderately likely** to occur in Study Areas	X
Roundnose grenadier	*Coryphaenoides rupestris*	Endangered	-	- In Canada, is most abundant in Davis Strait, on the continental slope off Newfoundland and Labrador, and along the edge of the Grand Banks to Georges Bank (DFO, 2023m). - Deepwater fish most commonly found at depths of 400 m to 1,200 m. Prefers habitat with little or no current (DFO, 2023m). **Moderately likely** to occur in Study Areas	X
Shortfin Mako – Atlantic population	*Isurus oxyrinchus*	Endangered	-	- Highly migratory species associated with warm Gulf Stream waters. Occur in Canadian waters in summer and fall along Georges and Browns Bank, the continental shelf of Nova Scotia, the Grand Banks, and in the Gulf of St. Lawrence (DFO, 2023n). - Preference for water warmers makes this species unlikely to reside in Canadian waters for long time periods (DFO, 2023n). **Unlikely** to occur in Study Areas	X
Smooth Skate – Laurentian-Scotian population	*Malacoraja senta*	Special Concern	-	- Occurs from southern Georges Bank to the Labrador Shelf (DFO, 2023o). - Typically occupy depths between 70 m to 480 m on soft mud, but also on sand, shell hash, gravel and pebble substrates (DFO, 2023o). - Primarily eats bottom-dwelling invertebrates (e.g. shrimp, mysids, amphipods) (DFO, 2023o). **Moderately likely** to occur in Study Areas	X
Spiny dogfish – Atlantic population	*Squalus acanthias*	Special Concern	-	- Habitat generalist occurring from Labrador to Cape Hatteras, and most abundant in southwest Nova Scotia in Canadian waters (DFO, 2023q). - Occur from surface waters to depths of 730 m and from near to offshore environments (DFO, 2023q). - Diet comprises mainly fish (e.g. herring, mackerel, sand lance) and invertebrates (e.g. squid, crustaceans, bivalves) (DFO, 2023q).	X

Common Name	Scientific Name	COSEWIC Status	SARA Status	Habitat Preferences	Critical Habitat in Study Areas
				Moderately likely to occur in Study Areas	
Spotted Wolffish	*Anarhichas minor*	Threatened	Threatened	- In the western North Atlantic, occurs primarily off northeast Newfoundland (DFO, 2023r). - Bottom-dwelling in cold, open continental shelf and slope waters between 50 m and 600 m deep (DFO, 2023r). - Preferred substrates include sand or mud bottoms with big boulders nearby (DFO, 2023r). - Diet mainly comprises echinoderms, but also crustaceans, molluscs and fish (DFO, 2023r). **Likely** to occur in Study Areas	✓
Striped Bass – St. Lawrence River population	*Morone saxatilis*			- Spawn in three rivers of eastern Canada: St. Lawrence, Saint John, Annapolis (COSEWIC, 2004). - Spawning in freshwater and brackish water. Immature and adult fish feed in estuaries and coastal waters (COSEWIC, 2004). - Overwinter in rivers (COSEWIC, 2004). **Unlikely** to occur in Study Areas	X
Thorny Skate	*Amblyraja radiata*	Special Concern	-	- Live on ocean bottom from 18 m to 1,200 m depths over substrates such as sand, gravel, mud and shell hash (DFO, 2023s). - Widespread and abundant bottom-dwelling fish species in Canada. Largest concentration along the southern Grand Banks off Newfoundland and on the eastern portion of the Scotian Shelf (DFO, 2023s) **Likely** to occur in Study Areas	X
White Hake – Atlantic and Northern Gulf of St. Lawrence population	*Urophycis tenuis*	Threatened	-	- Occurs on the Scotian Shelf, northern Gulf of St. Lawrences, and southern Newfoundland (COSEWIC, 2013b). - Occur near ocean bottom over fine sediments (mud, sand, gravel) (COSEWIC, 2013b). - Larger fish are typically deeper and further offshore whereas smaller fish are typically shallower and further nearshore (COSEWIC, 2013b). **Unlikely** to occur in Study Areas	X
White Shark – Atlantic population	*Carcharodon carcharias*	Endangered	Endangered	- Typically found in warmer Gulf Stream waters, occurring throughout Atlantic Canada. Seasonal migrants in late summer and early fall (COSEWIC, 2006). - Juveniles commonly occupy coastal habitat and adults move off the continental shelf seasonally. Often occurring at depths of 50 m to 500 m (COSEWIC, 2006). **Unlikely** to occur in Study Areas	X
Winter Skate – Eastern Scotian Shelf - Newfoundland population	*Leucoraja ocellata*	Endangered	-	- Occur from Nova Scotia coast to south of Newfoundland (DFO, 2023t). - Preference for sandy, gravelling bottoms, often found less than 100 m below surface (DFO, 2023t). - Tend to prefer warmer waters on Scotian Shelf (DFO, 2023t). **Unlikely** to occur in Study Areas	X
Winter Skate – Gulf of St. Lawrence population	*Leucoraja ocellata*	Endangered	-		

Common Name	Scientific Name	COSEWIC Status	SARA Status	Habitat Preferences	Critical Habitat in Study Areas
Marine Mammal					
Blue Whale – Atlantic population	*Balaenoptera musculus*	Endangered	Endangered	- Occur in all oceans around the world (COSEWIC, 2012b). - Atlantic population occurs in Canadian waters, including the Gulf of St. Lawrence and off the coasts of eastern Nova Scotia and the southern Newfoundland. Generally migrate south in winter, but may remain in the St. Lawrence (COSEWIC, 2012b). - Inhabit both coastal and offshore waters. Have been observed in estuaries and shallow coastal zones (COSEWIC, 2012b). **Moderately likely** to occur in Study Areas	X
Fin Whale – Atlantic population	*Balaenoptera physalus*	Special Concern	Special Concern	- In Canadian Atlantic, associated with areas of high concentration of euphasiid crustaceans (COSEWIC, 2019). - Occur along continental shelf, deep canyons in Gulf of St. Lawrence as well as shallow waters (COSEWIC, 2019). **Likely** to occur in Study Areas	X
Harbour Porpoise – Northwest Atlantic population	*Phocoena phocoena*	Special Concern	-	- Occur from Bay of Fundy to northern Baffin Island (DFO, 2023g). - Observed in harbours and bays, as well as deep waters (>400 m). Well adapted to cold water (DFO, 2023g). - Generalist diet comprises mainly fishes and squid (DFO, 2023g). **Likely** to occur in Study Areas	X
Killer Whale – Northwest Atlantic/Eastern Arctic population	*Orcinus orca*	Special Concern	-	- Previously common in Gulf of St. Lawrence and St. Lawrence estuary; now more frequently observed in coastal waters of Newfoundland (particularly Strait of Belle Isle) (DFO, 2023h). - Specific habitat requirements not well understood (DFO, 2023h). - Observed feeding on marine mammals and fish (DFO, 2023h). **Likely** to occur in Study Areas	X
North Atlantic Right Whale	*Eubalaena glacialis*	Endangered	Endangered	- Migratory species occupying coastal and shelf waters, largely within the western Atlantic Ocean. Migrations follow food source (copepods) (COSEWIC, 2013a). - Calving occurs over winter in subtropical waters of southeastern U.S. (COSEWIC, 2013a). - Large groups occur Gulf of St. Lawrence since 2015 (COSEWIC, 2013a). **Likely** to occur in Study Areas	✓
Northern Bottlenose Whale – Scotian Shelf population	*Hyperoodon ampullatus*	Endangered	Endangered	- Occurs in deep waters (>500 m) along continental slope off of Nova Scotia and southeastern Newfoundland (COSEWIC, 2011b). - Most reported occurrences from submarine canyons on the Eastern Scotian Shelf (the Gully, Shortland Canyon, Haldimand Canyon). These canyons are identified as critical habitat (COSEWIC, 2011b).	✓

Common Name	Scientific Name	COSEWIC Status	SARA Status	Habitat Preferences	Critical Habitat in Study Areas
				- Diet comprises mainly squid (COSEWIC, 2011b). **Likely** to occur in Study Areas	
Sowerby's Beaked Whale	*Mesoplodon bidens*	Special Concern	Special Concern	- Found only in the northern Atlantic Ocean and limited to deep offshore waters (DFO, 2023p). - Most often sighted along continental shelf edge and slope of deep water environments (DFO, 2023p). - Diet comprises mainly fish and squid (DFO, 2023p). **Unlikely** to occur in Study Areas	X
Beluga Whale – St. Lawrence Estuary	*Delphinapterus l eucas*	Endangered	Endangered	- Occurs mainly in St. Lawrence River estuary during summer and shifts towards the northwestern Gulf of St. Lawrence in the fall and winter (COSEWIC, 2014). - Seasonal movements likely influenced by sea ice, food availability and predation (COSEWIC, 2014). - Diet comprises fishes and invertebrates (COSEWIC, 2014). **Unlikely** to occur in Study Areas	X
Reptiles					
Loggerhead Sea Turtle	*Caretta caretta*	Endangered	Endangered	- Nests primarily on subtropical and tropical beaches in U.S. and Mexico (DFO, 2023j). - At sea range spans most of northern Atlantic Ocean. Found mostly offshore in Atlantic Canadian waters (DFO, 2023j).. - Canadian Atlantic habitat dependent on sea surface temperature; thought to primarily reside along the shelf break and further offshore by the Gulf Stream and Labrador Current (DFO, 2023j). **Unlikely** to occur in Study Areas	X
Leatherback Sea Turtle – Atlantic population	*Dermochelys coriacea*	Endangered	Endangered	- Atlantic Canada has one of the highest densities of foraging groups in the North Atlantic during summer (DFO, 2023i). - Found in coastal, shelf and offshore waters of Canada. Largely occurring above 300 m of depth (DFO, 2023i). - Nest on subtropical beaches (DFO 2023i). - Diet comprises primarily jellyfish, and comb jellies (DFO, 2023i). **Moderately likely** to occur in Study Areas	X

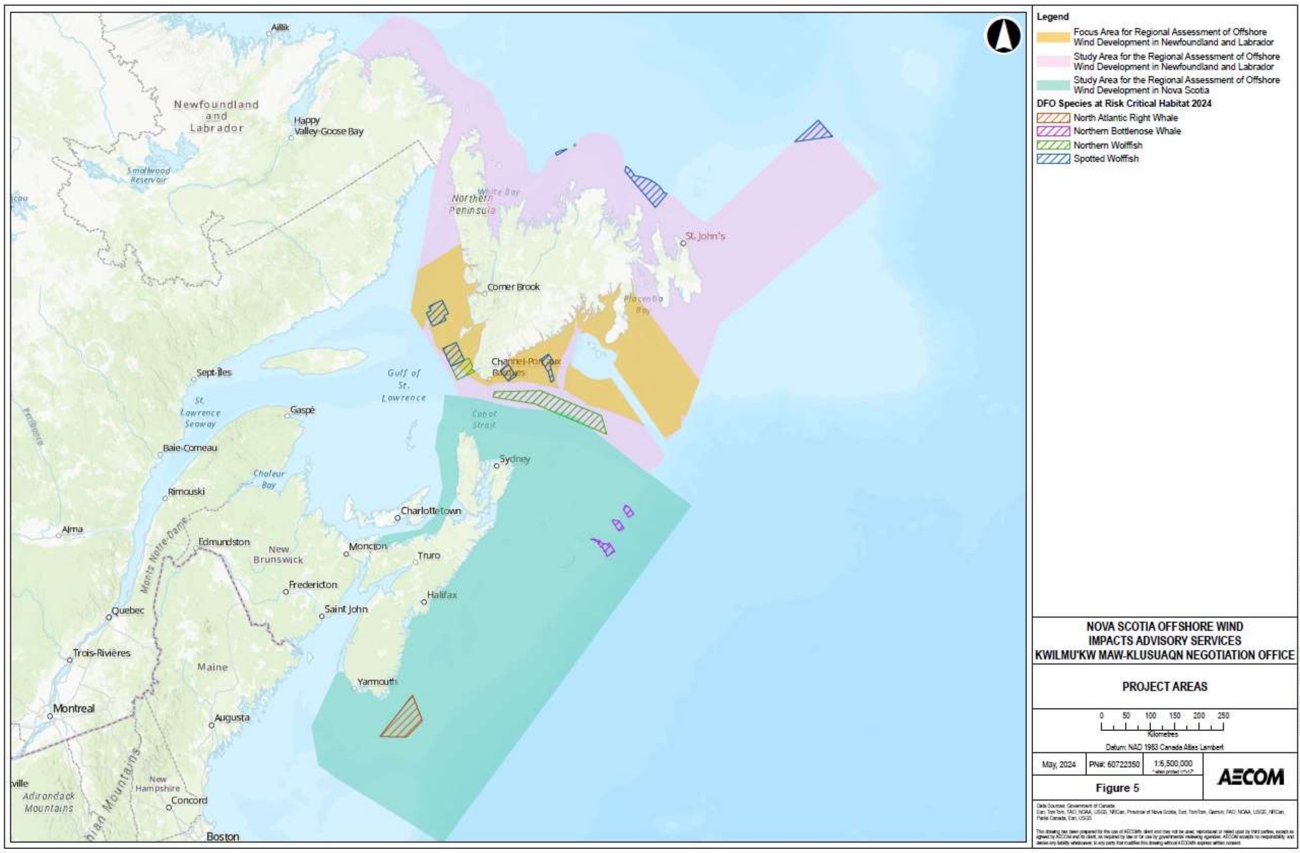

Figure 5. Marine Species at Risk Critical Habitat within the Study Areas.

5.1.3.1 Fish

The general impacts of OSW development on fish populations are outlined in Section 5.1.1. Fish SOCC that are likely or moderately likely to occur in the Study Areas are described in the following sections.

5.1.3.1.1 Groundfish

Groundfish (species living on or near the seafloor) SOCC that are likely or moderately likely to occur in the Study Areas include Atlantic cod, American plaice (*Hippoglossoides platessoides*), northern wolffish (*Anarhichas denticulatus*), spotted wolffish (*Anarhichas minor*), Acadia redfish (*Sebastes fasciatus*), cusk (*Brosme brosme*), and roundnose grenadier (*Coryphaenoides rupestris*).

Atlantic cod (Laurentian South population and Southern population) are identified by COSEWIC as 'Endangered'. Historical exploitation was the primary cause of the dramatic Atlantic cod population decline over the last century (COSEWIC, 2010b). Over-fishing remains a current threat to Atlantic cod population numbers, in addition to increased natural mortality of older cod; the sources for natural mortality are unknown at this time but may involve species interactions and worsening environmental conditions (COSEWIC, 2010b). The effects of OSW on cod have been well studied, and an overall increase in density near OSW foundations has been observed in both North American and European waters (see Section 5.1.2.2). As well, some OSW concept designs incorporate structures to encourage cod habitat interactions (named 'Cod Hotels' or 'Cotels') (Hermans et al., 2020).

American plaice, identified by COSEWIC as 'Threatened', are flat fish which grow to approximately 60 centimetre (cm) in length. American plaice begin life with a typical pelagic fish shape, and it is with maturation that they settle to the ocean floor, the side of the body becomes flat and the left eye moves to the right side of the body (DFO, 2023c). Although eggs and larvae are pelagic, juvenile and adult fish commonly burrow into the sediment, preferring depths of 50 m to 200 m (DFO, 2023c). Studies on the effects of OSW in the offshore waters of Belgian have observed increased European plaice abundance in the soft sediments surrounding turbine scour protection layers, which are typically an open rock field that may provide increased food and shelter opportunities (Buyse et al., 2022). However, another study at BIWF did not find a significant difference in plaice abundance from before, during and/or after construction (Wilber et al., 2018). OSW development is not anticipated to negatively impact American plaice populations.

Northern wolffish and spotted wolffish are identified as ‘Threatened’ by COSEWIC, listed on SARA Schedule 1, and have identified critical habitat within the Study Areas. Northern wolffish are typically found offshore in continental shelf waters anywhere between the surface and 900 m depths (preference is for depths >100 m). Northern wolffish occur in the open sea and feeds on mainly benthic crustaceans and invertebrates (DFO, 2023k). Similarly to the northern wolffish, the spotted wolffish occurs in cold, open continental shelf and slope waters; however, the spotted wolffish occurs between 50 m and 600 m deep over sand or mud bottoms with large boulders in the vicinity (DFO, 2023k). Spotted wolffish feed primarily on echinoderms but also eat crustaceans, molluscs, and fish. Spotted wolffish are found mainly off northeast Newfoundland. The main threat to the northern and spotted wolffish stem from bottom trawling activities and are often by-catch of offshore trawlers (DFO, 2023k). Provided federally identified critical habitat is avoided when planning OSW locations, it is unlikely that OSW activities would adversely impact these species.

Acadia redfish, cusk, and roundnose grenadier are deepwater groundfish species identified by COSEWIC as 'Threatened'. Acadia redfish and roundnose grenadier are typically found in deeper offshore waters along continental slopes, whereas cusk can be found in the Gulf of Maine, the western Scotian Shelf, and along the edge of the Scotian Shelf to Banquereau Bank; cusk are rarely seen in the Gulf of St. Lawrence. Species abundances for these groundfish species have declined with time as they are often bycatch from other fishery industries (COSEWIC, 2003; DFO 2023m, DFO 2023e). These species do not have identified critical habitat within the Study Area, and as their habitats do not reflect the areas likely to be selected for OSW development, are unlikely to be impacted by potential OSW activity.

5.1.3.1.2 Pelagic Fish

Pelagic fish (species that inhabit the water column) SOCC that are likely or moderately likely to occur in the Study Areas include Atlantic bluefin tuna and porbeagle (*Lamna nasus*).

Atlantic bluefin tuna are identified by COSEWIC as ‘Endangered’. The western Atlantic bluefin tuna is highly migratory, feeding in Atlantic Canadian waters in the summer and spawning and rearing young in the Gulf of Mexico over the winter (DFO, 2018a). The largest threat to Atlantic bluefin tuna is fishing mortality, both targeted within commercial fisheries and incidental as by-catch of other fishing efforts (DFO, 2018a). Studies have shown evidence that Atlantic bluefin tuna may be impacted by UWN, however, become habituated with time (Espinosa et al., 2014; Puig-Pons et al., 2021). Additionally, research studying the effects of OSW on pelagic fish in Europe have not found any significant impact (Floeter et al., 2017; Stenberg et al., 2015). These studies, the highly migratory nature of Atlantic bluefin tuna, and their seasonal occurrence in Canadian Atlantic waters suggest there will be little to no impact to these fish as a result of OSW development in the Study Areas. Any potential impact to Atlantic bluefin tuna behaviour may be limited to the construction phase of OSW development due to associated impulsive noise production, and this species auditory capabilities.

Porbeagle is a coastal and oceanic shark identified by COSEWIC as ‘Endangered’. Porbeagle sharks occur in various oceans around the world, and in Canada, from northern Newfoundland to the Gulf of St. Larwrence and Bay of Fundy (DFO, 2023l). Annual migrations shift populations between the Gulf of Maine and the Georges Bank, and between Newfoundland and the Gulf of St. Lawrence (DFO, 2023l). Porbeagle sharks are most commonly found on continental shelves but can be found both closer to shore and in offshore waters. This species can be found in depths from surface to 700 m, likely travelling to remain in cold water (DFO, 2023l). Mating is believed to occur in the Grand Banks, south of Newfoundland and at the mouth of the Gulf of St. Lawrence (DFO, 2023l). Sharks and other cartilaginous fish species are a group of interest with regards to OSW due to their use of EMFs for prey detection. Studies on this relationship in benthic sharks have suggested EMFs produced by submarine power cables mimic those signals produced by prey (Kimber et al., 2011)**.** This resemblance can affect shark foraging behaviours to give preference areas of EMF production from OSW development; however, aquarium studies have also shown that non-reward from lack of prey found at EMF sites could habituate sharks for a short term (<3 weeks) to learn if food was associated with the EMF signal or not (Kimber et al., 2014). Effects of EMFs on sharks and similar species groups (i.e. elasmobranchs) range from attraction, disturbance and indifference depending on EMF characteristics, animal life stage, exposure level and duration (Hermans et al., 2024). There are currently knowledge gaps surrounding how sharks and similar species groups will respond to EMFs produced by OSW development.

5.1.3.1.3 Anadromous Fish

Anadromous fish (species spending a portion their lifecycle in both fresh and salt water) SOCC that are likely or moderately likely to occur in the Study Areas include American eel (*Anguilla rostrata*), Atlantic salmon (*Salmo salar*), and Atlantic sturgeon (*Acipenser oxyrinchus*).

American eels have been assessed by COSEWIC as ‘Threatened’ (DFO, 2023b). American eels occur in freshwater environments, estuaries, and coastal marine waters. Following spawning in the Sargasso Sea, adults die and larvae are widely dispersed by surface currents of the Gulf Stream towards coastal estuaries where they begin to mature (DFO, 2023b). American eels may remain in brackish waters, marine waters, or begin migrating up rivers. The maturation process comes with a change of external colouring, eventually becoming silver when reaching maturity, at which time American eels are able to migrate back to spawning grounds (between 8 and 23 years of age) (DFO, 2023b). The diet of American eels shifts with maturity, beginning with detritus as larvae, then insect larvae and finally a variety of organisms including small fishes, molluscs, insects and crustaceans. Mature American eels do not feed during the spawning migration (DFO, 2023b). American eel fishing (called ‘Elver fishing’) occurs at river mouths near the head of tide and may extend up to 1,000 m upstream of tidal water boundaries; this currently occurs along most of Nova Scotia’s coastline (DFO, 2018b). A study on a Swedish OSW development observed increased eel densities near turbine foundations despite potentially negative effects such as noise or EMF disturbance (Bergström et al., 2013). Conversely, other research has demonstrated *in situ* responses of eels to EMF produced by buried cables. Results from the Baltic Sea showed significantly decreased movement speeds of eels when passing through EMF environments, however, movement patterns did not deviate significantly from typical eel movements (Westerberg & Lagenfelt, 2008). Another *in situ* study by Hutchison et al. (2021) on American eels off the coast of the U.S. showed the opposite effect where eels increased their movement speeds when passing through EMF environments. It was concluded that this response did not constitute a barrier to migration. A laboratory study on the behavioural effects of eels passing through a magnetic field found no apparent response, however, concluded more research would be needed to make further conclusions about this relationship (Orpwood et al., 2015). Overall, research suggests potential impacts of EMF produced by OSW activities to American eels would be minor, and non-life threatening.

The various populations of Atlantic salmon likely or moderately likely to occur in the Study Areas have been identified by COSEWIC as either ‘Threatened’ or ‘Endangered’ (Table 1). Atlantic salmon life histories are plastic and vary by population; however, all populations reproduce in freshwater (COSEWIC, 2010c). Juveniles spend between one and eight years in freshwater before migrating to the North Atlantic to live at sea for one to four years, and eventually return to freshwater again for reproduction. Declining freshwater habitat may be a strong limiting factor in reduced Atlantic salmon population sizes; however, recent declines in marine survival suggest substantial threats are in the marine environment (COSEWIC, 2010c). Maturing Atlantic salmon have been captured in the northern Gulf of St. Lawrence in late summer, off the eastern slope of Grand Bank in the spring, West Greenland in the early fall, while winter distributions are less understood (COSEWIC, 2010c). There are both anadromous and non-anadromous variations of Atlantic salmon, and the anadromous variant is magneto-sensitive, meaning they respond to magnetic signals for navigating in the marine environment (Minkoff et al., 2020). A study on a close relative of Atlantic salmon, late-fall run Chinook salmon (*Oncorhynchus tshawytscha*), in the San Francisco Bay area observed the effects of a magnetic field-producing subsea power cable on the this species’ out-migration (Wyman et al., 2018). The study concluded that although cable activity appeared to have mixed and limited effects on movement and migration of this Chinook salmon population, there was no significant impact to the proportion of successfully migrated fish, or their probability of successful migration (Wyman et al., 2018). Similarities in salmon physiology may predict potentially similar responses of Atlantic salmon to the EMF produced by OSW submarine power cables; however, further research would be required due to the differences in species, mature life stage of marine Atlantic salmon versus younger out-migrating salmon, and the differences in the environment of interest. A study on the effects of UWN on Atlantic salmon using non-lethal impulsive pile-driving play-back noise (below established thresholds for in-water works) in a lab-based setting found no significant effects on either the behaviour or physiology of these fish (Harding et al., 2016). It is therefore expected that UWN generated during the construction and operations phase will not have significant adverse effects on Atlantic salmon.

Atlantic sturgeon are identified by COSEWIC as ‘Threatened’. This species spawns and rears in freshwater and matures at sea and populations have been reported utilizing rivers leading to the Gulf of St. Lawrence (COSEWIC, 2011a). Preferred habitat includes rivers, estuaries, nearshore marine environments, and shelf regions along the North Atlantic coast to depths of at least 50 m. An important habitat for Atlantic sturgeon is rivers with ocean access (COSEWIC, 2011a). Anthropogenic activity resulting in the loss of juvenile nursery habitat in brackish waters is likely a strong limiting factor in river population sizes (COSEWIC, 2011a). Atlantic sturgeon possess small swim bladders that are not connected to the inner ear system, making them less susceptible to impacts from UWN despite having auditory capabilities (CSA Ocean Sciences Inc, 2021). However, Atlantic sturgeon have demonstrated avoidance behaviours in pile driving environments in the Hudson River (Krebs et al., 2016). Due to this species' highly migratory and motile lifestyle, preference for near-shore and river environments, and swim bladder physiology, effects of OSW during construction and operation in the Study Areas are expected to be negligible to minor (CSA Ocean Sciences Inc, 2021).

5.1.3.2 Marine Mammals

Marine mammals have been a point of interest in the effects of OSW on marine life and research has shown the greatest potential impact stems from UWN. OSW developments may produce UWN detectable by marine mammals at vast distances from the noise source. The physiological and behavioural effects of UWN on marine mammals is dependent on the intensity of the sound, audible capabilities of the animal, and distance from the source (Thomsen et al., 2006). The construction phase is likely to have the greatest impact on marine mammals due activities such as pile driving and increased vessel traffic (Dolman & Simmonds, 2010; SEER, 2022). The high intensity sounds produced by these activities can cause injury (e.g., hearing damage), area avoidance, and auditory masking (Madsen et al., 2006; Thomsen et al., 2006). Auditory masking occurs when anthropogenic sounds mask biologically important signals which can impact predator and prey detection, reproductive communications, and the use of biosonar (Southall, 2004).

In contrast to the noise produced during construction phase, the continuous UWN produced during the operations phase is considered low in relation to ambient environmental noise levels, and are therefore not anticipated to have substantial noise-related impacts to marine mammals (Thomsen et al., 2006; SEER, 2022). However, noise effects depend on the degree of noise production, which is partially influenced by surface conditions such as wind speeds, as well as turbine sizes (SEER, 2022). There are knowledge gaps surrounding responses of marine mammals to OSW operations, and more research is required to better understand potential behavioural responses (SEER, 2022).

In contrast to the body of literature on the effects of UWN, there is currently limited research on cetacean response to EMF. Preliminary studies have demonstrated that fin whales (*Balaenoptera physalus*) and long-finned pilot whale (*Globicephala malaena*) are capable of detecting Earth's geomagnetic fields for positioning within a water column (Kirschvink, 1997; Walker et al., 1992). Dolphin species in Atlantic Canada that demonstrated significant sensitivity to Earth's magnetic field include Risso's dolphin (*Grampus griseus*) and Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (Hüttner et al., 2023; Kirschvink, 1997). The scale of detection for EMF by cetaceans has been determined to be substantively less sensitive than that of sharks (Hüttner et al., 2023); however, it has been speculated that whales may be more susceptible to negative impacts such as whale strandings (Valberg, 2005). Further research is required to draw conclusions regarding the effects of OSW EMF production on marine mammals.

5.1.3.2.1 Baleen Whales

Baleen whale SOCC that are likely or moderately likely to occur in the Study Areas are the blue whale (*Balaenoptera musculus*) and North Atlantic right whale (*Eubalaena glacialis*), both of which have been identified as 'Endangered' by COSEWIC and are listed on SARA Schedule 1.

These migratory species are likely to utilize the Study Areas seasonally for feeding prior to returning to subtropical southern waters to mate and birth their offspring. The Atlantic blue whale population is often observed utilizing estuary and coastal habitat where larger concentration of krill, their main food source, are found (COSEWIC, 2012b). North Atlantic right whales seasonally inhabit Canadian coastal and shelf waters where their primary food source, copepods, are likely to occur. Valuable seasonal feeding grounds within the Gulf of St. Lawrence occur within the Study Areas and have been designated as North Atlantic right whale critical habitat (COSEWIC, 2013a). The occurrence of North Atlantic right whales in Canadian waters has shifted in the past ten years, where previously predictable habitat (e.g., in the Bay of Fundy) has shifted to the Gulf of St. Lawrence (COSEWIC, 2013a).

Baleen whales utilize acoustics for communication and navigation. A study modeled the potential effects of noise on baleen whale migration where the parameters of effect included: reduced whale communication, avoidance response to the area of noise production, and lowered inherent navigation information. The researchers found that these variables, either together or independently, lead to increased migration times or even failed migration (Johnston & Painter, 2024). Blue whales and North Atlantic right whales are highly migratory and utilize favourable feeding areas in Canadian Atlantic waters during the summer months. A potential effect of OSW development is the introduction of UWN that may impact migration between valuable habitat for these species for either feeding or calving, depending on the intensity of the noise and the proximity to the source. This potential effect is considered greatest during the construction phase and less during the operational phase.

5.1.3.2.2 Toothed Whales

The only toothed whale SOCC that is likely or moderately likely to occur in the Study Areas is the northern bottlenose whale (*Hyperoodon ampullatus*), which is identified as 'Endangered' by COSEWIC and listed on SARA Schedule 1. The northern bottlenose whale is a beaked whale which prefers deeper, colder waters found further offshore along continental slopes. The deepwater canyons (>500 m) along the continental slopes off the coast of Nova Scotia and Newfoundland are identified as critical habitat for this species, possessing both ideal environmental and dietary conditions (COSEWIC, 2011b). Northern bottlenose whales are observed throughout the year at the entrance of the Gully, a deepwater canyon at the outer edge of the Scotian Shelf and may feed on their preferred prey, deepwater squid (COSEWIC, 2011b). Northern bottlenose whales, like most toothed whales, use echolocation for foraging, which has the potential to be impacted by introduced noise pollution (Moors-Murphy, 2015). However, due to the distance between proposed OSW areas along the Canadian Atlantic coast and the preferred deepwater habitat of the northern bottlenose whale, it is unlikely OSW development would substantively impact this species. Potential impacts may be more likely from increased vessel traffic and potential collisions during whale surfacing than from noise.

5.1.3.3 Reptiles

Potential impacts of OSW development on sea turtles include collisions with construction and maintenance vessels (Foley et al., 2019), EMFs interfering with migration (Irwin & Lohmann, 2005; Lohmann et al., 2008), increased UWN during the construction phase (Lavender et al., 2012; Nelms et al., 2016), and changes to food supply and habitat availability (Kross et al., 2019). Research shows that sea turtles use the Earth's magnetic field during their migrations (Putman et al., 2015); however, there is a significant data gap surrounding the effects of EMF on sea turtles and they appear to be less sensitive to EMFs than marine mammals (Fischer & Slater, 2010). While, little research has been conducted on the impacts of UWN on sea turtles, it is reasonable to assume that vessel movement and pile driving activities would elicit a behavioural response similar to those in marine mammals (CSA Ocean Sciences Inc, 2021).

5.1.3.3.1 Leatherback Sea Turtle

The Atlantic leatherback sea turtle (*Dermochelys coriacea*) is identified as 'Endangered' by COSEWIC and is listed on SARA Schedule 1. This population of leatherback sea turtles range throughout the North Atlantic Ocean for foraging and use southern latitude beaches for nesting (DFO, 2023i). Although the majority of sightings in Atlantic Canada occur around 200 m depths, these turtles have been reported in waters ranging from 2 m to 5,000 m deep and can be found in coastal, shelf and offshore waters (DFO, 2023i). Leatherback sea turtles are highly migratory, and Atlantic Canada hosts the largest number of foraging leatherbacks seasonally each summer, likely due to the concentration of jellyfish prey in these regions (DFO, 2023i). Although direct OSW effects to jellyfish is not known, hydrodynamic changes caused by turbine installation may impact where jellyfish congregate (Paskyabi, 2015). Conversely, the artificial reefs created by turbine foundations may increase leatherback prey availability (Linley et al., 2007) as was observed at oil and gas platforms in the Gulf of Mexico (Gitschlag & Herczeg, 1994; NRC, 1996). Overall, the addition of OSW development in the regional assessment area is not expected to negatively impact leatherback sea turtles (CSA Ocean Sciences Inc, 2021).

5.2 Terrestrial Species

5.2.1 Potential Positive and Negative Impacts to Terrestrial Species

Direct impacts of OSW development on terrestrial species (avifauna and bats) can generally be categorized into three groups (Figure 6; Williams et al., 2024):

- Collision mortality;
- Behavioural responses; and,
- Habitat-mediated effects.

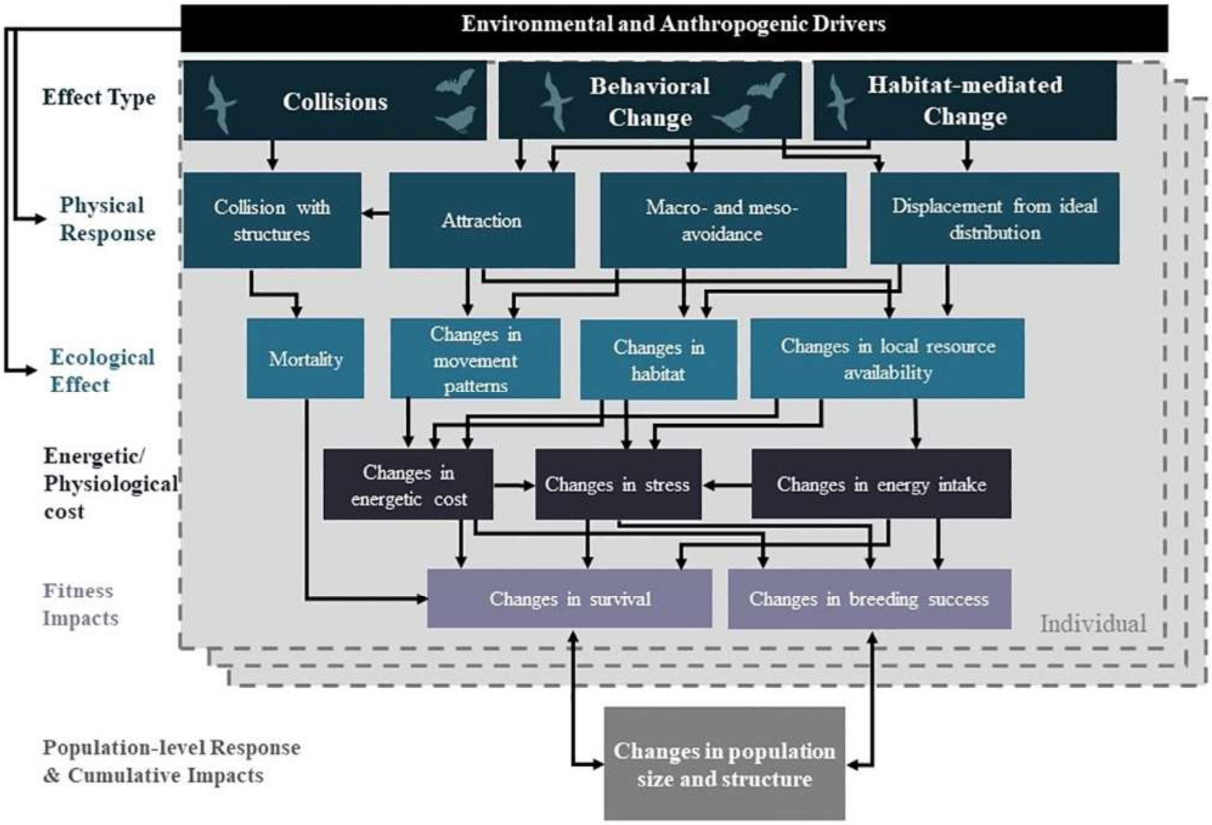

Figure 6. Effects of OSW on Terrestrial Species (Williams et al., 2024)

A general description of each direct effect is included below and the impacts to avifauna (hereby referred to as birds) and bats are detailed in sections 5.2.2and 5.2.3, respectively.

Collision Mortality

Collision with OSW turbines has the potential to cause direct mortality to both birds and bats and is frequently observed at terrestrial wind farms (Williams et al., 2024). It is thought that collisions are less frequent at OSW developments (Cook et al., 2018; Skov et al., 2018); however, collision detection is more difficult in these areas than at their terrestrial counterparts. Additionally, the technology to accurately document collisions at OSW turbines has only recently become available at a great expense. As a result, collision risk models have been used to estimate the annual number of collisions by species; however, there is uncertainty surrounding the accuracy of these numbers and the factors influencing these rates (Williams et al., 2024).

Behavioural Responses

Behavioural responses of birds and bats to OSW developments generally include displacement, avoidance, and attraction responses. Displacement studies have primarily been conducted in Europe and vary greatly by species studied, location, and OSW characteristics (Dierschke et al., 2017). Spatiotemporal displacement (i.e. displacement by both location and timing) can be caused by the physical presence of the OSW structures, increased vessel traffic in the area, and changes in habitat characteristics. Avoidance reactions include the alteration of movement patterns (e.g., flying around OSW development footprints instead of through the area) which can impact feeding or migratory activities (Williams et al., 2024). Conversely, terrestrial species can also be attracted to OSW developments. Birds have been observed using the structures as perching sites (Leopold et al., 2011; Welcker & Nehls, 2016) and bats have been observed using the turbines to roost (Ahlén et al., 2009).

Habitat-Mediated Effects

Habitat-mediated effects are related to the increased prey availability caused by the artificial reef and fisheries exclusion effects detailed in section 5.1.1. This increase in prey abundance, in combination with the addition of roosting or perching opportunities, may attract some birds and bats to OSW developments (Williams et al., 2024).

5.2.2 Birds (Avifauna)

There is extensive literature demonstrating bird avoidance responses to the presence of OSW developments, particularly in Europe where OSW developments are the most established and studied (Fox & Petersen, 2019). It should be noted that this is highly variable, with displacement effects differing between OSW developments and even between species (Petersen et al., 2011). In some cases, birds have been observed to turn around and fly back to shore after seeing turbines (Jensen et al., 2016), and in others they have modified their flight path by up to 3 km to avoid interaction (although typically less than 1 km; Kahlert et al., 2004). Birds have also been observed flying around the periphery of OSW developments as well as flying over the turbines at night (Desholm & Kahlert, 2005). In rarer cases, birds were observed flying through the OSW developments, staying equidistant from the turbines and close to the water (Desholm & Kahlert, 2005). While this avoidance behaviour is effective in minimizing collision risk, it shows that OSW developments can act as a barrier to bird movement and increase energetic costs for migration and foraging (Fox & Petersen, 2019).

For migrating birds (i.e. seabirds, shorebirds, waterfowl, passerines), the potential impacts will be concentrated in the spring and fall during large-scale migrations, especially during the fall when they are at peak abundance following the breeding season. However, as the impact of this increased energetic expenditure is only experienced twice a year during migration, the biological cost is minimal (Fox & Petersen, 2019).

In the case of seabirds, which travel between their onshore breeding colonies and oceanic feeding grounds multiple times a day, the energetic cost of avoiding OSW developments could be more significant (Masden et al., 2009). The extent of this cost is dictated by the distance travelled, frequency of flights, and individual species characteristics (e.g., body mass, flight characteristics). Species with high wing loadings (e.g., cormorants) and species that make frequent trips (e.g., terns) are likely to be the most impacted (Masden et al., 2010). As physical condition relates to survivorship and to breeding success, these additional energy expenditures have the potential to have population-level implications.

Shorebirds predominantly utilize near-shore environments as preferred habitat, and as such, OSW developments positioned a typical distance of at least 25 km away from the coast is believed to be enough distance to allow migrating shorebirds to avoid collisions with wind turbines (IAAC, 2023).

Waterfowl and passerine radar studies on terrestrial and marine environment indicate these bird groups change their flight paths to avoid OSW turbines (Desholm & Kahlert, 2005) which can increase total migration flight paths by an estimated 0.5% (Petersen et al., 2006). The increased energy expenditure from flight avoidance can negatively impact survival (Ballasus & Huppop, 2006) and reproductive success (Newton, 2006). Although birds are able to avoid collision, the increased energy expenditure from flight avoidance can negatively impact survival (Ballasus & Huppop, 2006) and reproductive success (Newton, 2006). As well, changes to migration timing may lead to asynchrony with mating windows, and access to critical resources (Nemes et al., 2023).

The presence of OSW developments also has the potential to displace birds from preferred feeding grounds (Fox & Petersen, 2019). If birds are unwilling to fly within several kilometres of turbines, the entire footprint of the OSW development has the potential to become behaviourally inaccessible (Fox & Petersen, 2019). This was observed at multiple OSW developments in Denmark, where birds were frequently observed foraging in the pre-construction area and were mostly absent post-construction (Petersen & Fox, 2007; Petersen et al., 2006). The relative importance of a feeding area should be understood when planning OSW placement to reduce the impacts to bird populations (Fox & Petersen, 2019).

As is the case with terrestrial wind farms, bird mortality may result from collisions with turbine blades. Birds can also be caught in the vortices created by the spinning blades and become injured (Fox et al., 2006). However, using a variety of detection methods, two large-scale studies in Europe only detected six collisions in 20 months (Skov et al., 2018) and no collisions in 14 months (Tjørnløv et al., 2023). While it is difficult to detect bird mortality at OSW developments (as mentioned in section 5.2.1), the extent of the avoidance behaviours exhibited by migratory and marine birds leads to the conclusion that the risk of birds colliding with OSW developments is low.

Potential adverse effects of OSW developments in the Study Areas may be comparatively greater for SAR with identified critical habitat in the vicinity of the Study Areas because of these species are experiencing population declines or are naturally rare.

5.2.2.1 Bird Species at Risk

Bird SOCC identified within the Study Areas are listed in Table 2. Federal and provincial conservation status, critical habitat necessary for the survival or recovery of federally extirpated, endangered and threatened species in the Study Area, and potential to occur in the Study Area are identified for each species. Species with critical habitats identified within the study areas and species with Threatened or Endangered conservation status with moderate to likely probabilities of occurring in the Study Areas are further described in the following sections.

High value bird habitat areas (i.e. Important Bird Areas, Migratory Bird Sanctuaries and SARA critical habitat) are shown in Figure 7.

Table 2. Bird Species of Conservation Concern Known to Occur in the Study Area

Common Name	Scientific Name	COSEWIC	SARA	Nova Scotia	Bird Group	Critical Habitat in the Vicinity of the Study Areas	Potential to Occur in Study Area
Bank swallow	*Riparia riparia*	Threatened	Threatened	Endangered	Passerine	✓	Moderately Likely
Barn swallow	*Hirundo rustica*	Special Concern	Threatened	Endangered	Passerine	X	Moderately Likely
Barrow's goldeneye	*Bucephala islandica*	Special Concern	Special Concern	-	Waterfowl	X	Moderately Likely
Bicknell's thrush	*Catharus bicknelli*	Threatened	Threatened	Endangered	Passerine	X	Moderately Likely
Bobolink	*Dolichonyx oryzivorus*	Special Concern	Threatened	Vulnerable	Passerine	X	Moderately Likely
Canada warbler	*Cadellina canadensis*	Special Concern	Special Concern	Endangered	Passerine	X	Moderately Likely
Eastern wood-pewee	*Contopus virens*	Special Concern	Special Concern	Vulnerable	Passerine	X	Moderately Likely
Harlequin duck	*Histrionicus histrionicus*	Special Concern	Special Concern	Endangered	Waterfowl	X	Moderately Likely
Horned grebe	*Podiceps auratus*	Endangered	Endangered	-	Waterfowl	✓	Moderately Likely
Hudsonian godwit	*Limosa haemastica*	Threatened		-	Shorebird	X	Likely
Ivory gull	*Pagophila eburnean*	Endangered	Endangered	-	Seabird	X	Unlikely
Leach's storm-petrel	*Hydrobates leucorhous*	Threatened	Under Consideration	-	Seabird	X	Likely
Lesser yellowlegs	*Tringa flavipes*	Threatened	Under Consideration	-	Shorebird	X	Likely
Olive-sided flycatcher	*Contopus cooperi*	Special Concern	Special Concern	Threatened	Passerine	X	Unlikely
Peregrine falcon	*Falco peregrinus anatum/Falco peregrinus tundrius*	Non-active	-	Vulnerable	Raptor	X	Moderately Likely

Piping plover	*Charadrius melodus*	Endangered	Endangered	Endangered	Shorebird	✓	Likely
Red knot	*Calidris canutus*	Endangered	Endangered	Endangered	Shorebird	X	Likely
Red-necked phalarope	*Phalaropus lobatus*	Special Concern	Special Concern	-	Shorebird	X	Likely
Roseate tern	*Sterna dougalii*	Endangered	Endangered	Endangered	Seabird	✓	Likely
Rusty blackbird	*Euphagus carolinus*	Special Concern	Special Concern	Endangered	Passerine	X	Moderately Likely
Savannah sparrow	*Passerculus sandwichensis*	Special Concern	Special Concern	-	Passerine	X	Moderately Likely
Wood thrush	*Hylocichla mustelina*	Threatened	Threatened	-	Passerine	X	Moderately Likely

Sources: Audubon Bird Migration Explorer, 2024; Government of Canada SARA Registry, 2024

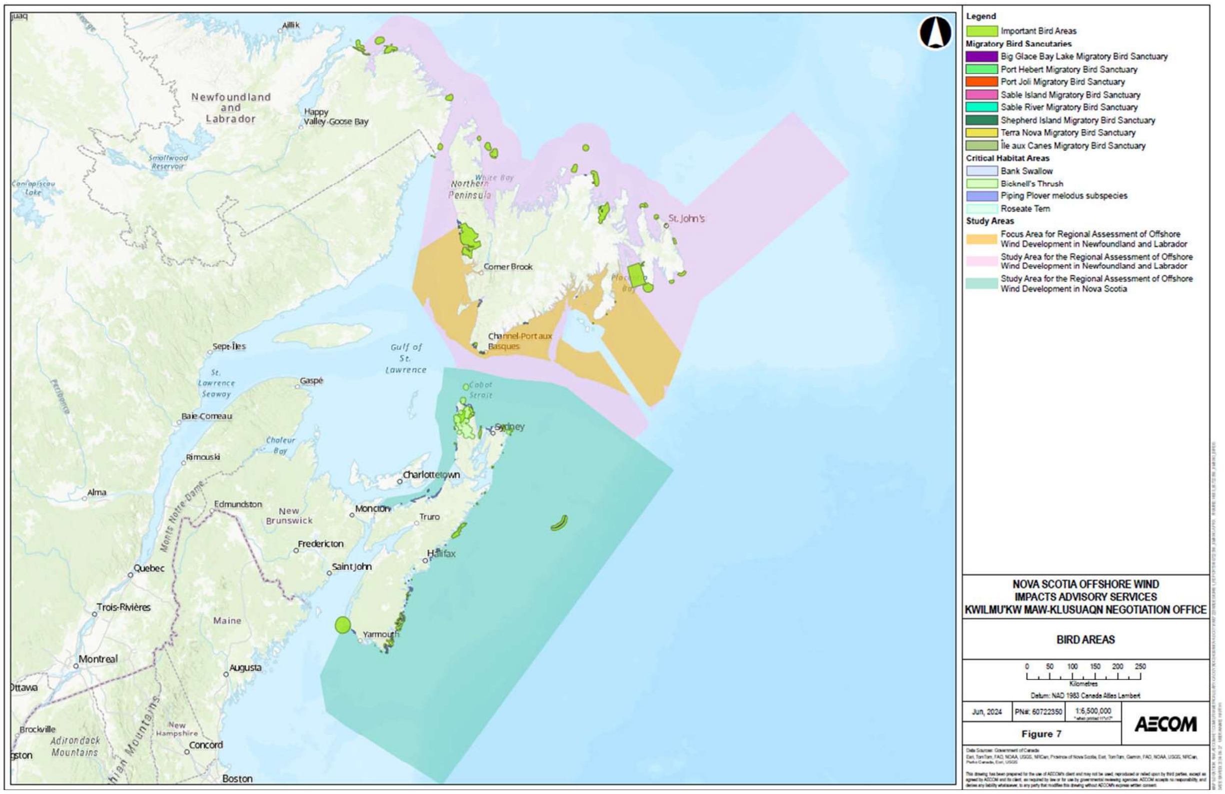

Figure 7. Bird Areas Resources within the Vicinity of the Study Areas

5.2.2.1.1 Seabirds

Seabirds are strongly associated with the marine environment for survival and utilize a variety of behaviours and lifestyles to accommodate these habitat requirements (Tethys, 2024a). Seabird SOCC with potential to occur in the Study Areas include roseate tern (*Sterna dougalii*) and Leach's storm-petrel (*Hydrobates leucorhous*).

Roseate terns nest in colonies along with common (*Sterna hirundo*) and Arctic terns (*Sterna paradisaea*), which assists in predation avoidance (Government of Canada, 2023d). A breeding population of roseate terns occurs on the Magdalen Islands in the Gulf of St. Lawrence and islands off the Nova Scotia coast (ECCC, 2023). Roseate terns tend to forage in waters closer to shore but will travel up to 20 km from their colony for food. Their diet comprises mainly herring and sand lance fish, and they tend to migrate to warmer areas further south in late summer (Government of Canada, 2023d). The presence of roseate tern critical habitat within the Study Areas may imply a potentially greater risk of impact from OSW developments, as they fly multiple times daily to forage during the breeding season and carry out long distance migrations twice a year (Burger et al., 2011).

Atlantic Leach's storm-petrels nest in colonies on small islands off the Canadian Atlantic coast in the summer before migrating south for the winter months (Government of Canada, 2023c). Atlantic Leach's storm-petrel is a surface-feeder and may travel up to 400 km to 800 km from colonies to forage on their preferred prey, bioluminescent lantern fish (Government of Canada, 2023c). Leach's storm-petrel is active nocturnally and there is evidence that this species is sensitive to light attraction which could render them vulnerable to negative impacts from OSW developments if attracted to the rotor swept area by lights on the turbines (Deakin et al., 2022).

5.2.2.1.2 Shorebirds

Shorebirds are characterized as a group of birds that inhabit wet or coastal environments and do not possess webbed feet such as the seabirds (Tethys, 2024b). Shorebirds would be impacted by OSW developments during migratory flights (IAAC, 2023). Shorebird SOCC with potential to occur in the Study Areas include the Hudsonian godwit (*Limosa haemastica*), lesser yellowlegs (*Tringa flavipes*), piping plover (*Charadrius melodus*) and red knot (*Calidris canutus*). All shorebird SOCC have been identified as "Likely" to occur in the Study Areas.

The Hudsonian godwit is a large migratory shorebird which would be present within the Study Areas during spring and fall migration. Populations from the James Bay region would use Nova Scotia as one of their stopover locations where they can be observed wading through shallow coastal waters feeding on insects, crustaceans, and marine worms (Audubon, 2024). The risk of collision with OSW developments is unknown and requires satellite telemetry studies to determine flight heights and corridors through the Study Areas.

The lesser yellowlegs is a medium-sized migratory species of shorebird which would be abundant within the Study Areas in the spring and fall months during migration. Although recent satellite tracking studies have shown that migration routes vary greatly for this species with most individuals taking a mid-continent route, some individuals may be present in the Study Areas as they stopover at nearby coastal salt marshes, estuaries and ponds where they feed on aquatic insects (COSEWIC, 2020). The risk of collision with OSW developments is considered unlikely for this species.

Piping plovers are small migratory shorebirds that nest on sandy beaches and alkali flats of the maritime provinces and the Atlantic coast of the United States (Audubon, 2024). Critical habitat for the piping plover has been identified throughout the Study Areas in Nova Scotia, increasing their risk of impact from OSW developments (Figure 7). This is particularly true in the spring during their northbound trajectories when they are more likely to encounter inclement weather resulting in an increased collision risk with OSW developments in the Study Areas (Loring et al., 2020).

Red knots are medium-size migratory shorebirds observed during migration at stopover sites on Nova Scotia's coastlines as individuals migrate south from the Arctic to the US Atlantic coast in the late summer through fall (Audubon, 2024). Red knots are likely to encounter OSW developments throughout their migration period due to their flight patterns.

5.2.2.1.3 Waterfowl

Waterfowl are birds that have webbed feet and a flat, rounded-tip bill and include ducks, geese, and swans that may live in freshwater and marine environments. Waterfowl SOCC with potential to occur in the Study Areas include the harlequin duck (*Histrionicus histrionicus*) and horned grebe (*Podiceps auratus*) which overwinter near coastal areas.

Harlequin ducks have winter habitat along Nova Scotia as well as Newfoundland, largely localized to the outer coast (Audubon, 2024). Seasonal abundance within the Study Areas is greatest during the winter months as well as during spring and fall migrations to and from northern summer breeding grounds (Audubon, 2024). Harlequin ducks are often associated with offshore islands in the summer months and feed on molluscs and crustaceans during the winter, foraging closer to shore (COSEWIC 2013c). Habitat use within the Study Areas would therefore be anticipated to be low and likely limited to migration; therefore, potential impacts from OSW developments would be expected to be low.

Horned grebes have winter habitat covering the majority of Nova Scotia, as well as a small parcel of summer habitat within the Gulf of St. Lawrence, which has been identified as critical habitat for the Magdalen Islands population (Audubon, 2024; ECCC 2023). Abundance within the Study Areas is greater off the coast of Nova Scotia in the winter and then greatest within the Gulf of St. Lawrence in the summer; therefore, their presence within the Study Areas is year-round, and migrations within the Study Areas occur each spring and fall (Audubon, 2024). Nesting typically occurs in freshwater habitats; whereas, wintering habitat encompasses coastlines where they dive for their preferred prey of aquatic insects, fish, crustaceans and marine worms (Ballasus & Huppop, 2006). Year-round habitat use within the Study Areas and risk from potential OSW development may be comparatively greater than other waterfowl due to the presence of summer critical habitat, as well as the close connection between summer habitat and winter habitat within the Study Areas.

5.2.2.1.4 Passerine

Passerines are known as ‘true perching birds’ which form one of the largest bird orders on Earth (Britannica Encyclopedia, 2024). Passerine SOCC with potential to occur in the Study Areas include the bank swallow (*Riparia riparia*), barn swallow (*Hirundo rustica*), Bicknell's thrush (*Catharus bicknelli*), bobolink (*Dolichonyx oryzivorus*), Canada warbler (*Cadellina canadensis*), rusty blackbird (*Euphagus carolinus*), and wood thrush (*Hylocichla mustelina*). Of these, critical habitat has been identified on land adjacent to the Study Areas for bank swallow and Bicknell’s thrush (Figure 7).

Bank swallow breeding habitat typically involves vertical banks of rivers and lakes where they nest in colonies, and critical habitat for this species has been identified within the vicinity of the Study Areas (Figure 7) (Government of Canada, 2023a). Bank swallows are aerial insectivores that breed throughout Nova Scotia and southwestern Newfoundland (Government of Canada, 2023a) and large concentrations of this species pass through the Study Areas during spring and fall migration (Audubon, 2024). Potential impacts from OSW development would be expected to be during migration and the presence of critical habitat increases their likelihood of impact.

Barn swallow breeding habitat primarily includes anthropogenic structures throughout most of Nova Scotia and southern Newfoundland (Government of Canada, 2023b). Similarly to bank swallows, barn swallows are also aerial insectivores that forage over land and arrive in large concentrations though the Study Areas offshore from Nova Scotia during spring and fall migration (Audubon, 2024). Potential impacts from OSW development would be expected to be during migration and satellite telemetry studies are needed to determine flight heights and corridors through the Study Areas to determine collision risks.

Bicknell’s thrush breeding habitat includes balsam fir (*Abies balsamea*) dominated stands damaged by ice, fire, wind or human disturbance such as in coastal areas; critical habitat has been identified in the vicinity of the Study Areas (Figure 7) (Government of Canada, 2023b). Bicknell’s thrush diet comprises insects, animal matter and berries (COSEWIC 1999). Bicknell’s thrush would be anticipated to breed in designated critical habitat along coastal areas in Cape Breton, Nova Scotia, and would be expected to be found in low abundance in the Study Areas during spring and fall migration (Audubon, 2024). Potential impacts from OSW development would be expected to be minimal and limited to migration routes; however, the presence of critical habitat increases their likelihood of impact.

Bobolink breeding habitat includes open fields and pasture in Nova Scotia and the southwestern tip of Newfoundland (COSEWIC, 2010a). Bobolinks feed mainly on insects and plant matter during the breeding season and seeds during migration and on the wintering grounds (COSEWIC 2010a). Bobolink is expected to be found in low abundance in the Study Areas during spring and fall migration (Audubon, 2024). Potential impacts from OSW development would be expected to be during migration and satellite telemetry studies are needed to determine flight heights and corridors through the Study Areas to determine collision risks.

Canada warbler breeding habitat includes deciduous and mixed-wood forests in Nova Scotia and feed mainly on flying insects and spiders in the forest understory (COSEWIC 2008). Canada warbler is expected to be found in low abundance in the Study Areas during spring and fall migration (Audubon, 2024). Potential impacts from OSW development would be expected to be during migration and satellite telemetry studies are needed to determine flight heights and corridors through the Study Areas to determine collision risks.

Rusty blackbird breeding habitat in Canada includes almost the entire boreal forest in Nova Scotia, Newfoundland and Labrador where they feed primarily on invertebrates, salamanders, small fish, crustaceans and molluscs adjacent to freshwater environments (COSEWIC, 2017a). Migration to summer breeding habitat passes over the Study Areas in late spring and return south in the fall (Audubon, 2024). Rusty blackbird is expected to be found in low abundance in the Study Areas during spring and fall migration (Audubon, 2024). Potential impacts from OSW development would be expected to be during migration and satellite telemetry studies are needed to determine flight heights and corridors through the Study Areas to determine collision risks.

5.2.2.1.5 Raptors

Raptors are carnivorous birds that have a hooked beak and large sharp talons that feed on meat taken by hunting or on carrion. The only raptor SOCC with a likelihood of being found in the Study Areas is the peregrine falcon (*Falco peregrinus anatum/tundrius*).

Peregrine falcon breeding habitat include Arctic tundra, coastal islands, desert canyon and major metropolitan areas from the Alaska interior across northern Canada to Greenland and south through continental North America to Northern Mexico (COSEWIC, 2017b). This raptor breeds in Nova Scotia along the Bay of Fundy and Labrador. Migration occurs along coastal and interior routes in North America and can reach high abundance in the Study Areas during spring and fall migration (Audubon, 2024). Peregrine falcons have readily adapted to perch and hunt from human structures at sea (Whittington, 2014) and have been observed on sailing ships up to 160 km offshore (Bent 1938 in Whittington, 2014). Peregrine falcons may have increased collision risks OSW development if they are attracted to them for perching and foraging (Willmott et al. 2023) or if they encounter them during times of limited visibility during migration.

5.2.3 Bats

Research on terrestrial wind farms has indicated that bats may be attracted to wind turbines (SEER, 2022a). There are a variety of hypotheses for this phenomenon, including bats perceiving these structures as a resource for foraging, roosting and mating (Guest et al., 2022). Although bats are primarily terrestrial animals, they frequently occur over the Atlantic marine environment, particularly during migration (Dowling, 2018; Solick & Newman, 2021). It has been speculated that due to the comparatively featureless landscape of the open ocean, bats may be even more attracted to OSW turbines than those on land due to the prominence of these landmarks, the presence of lights, and occasionally increased foraging opportunities (Solick & Newman, 2021). Bats are well-known to roost on offshore structures and vessels, seeking temporary refuge during long migrations and during adverse weather conditions (Pelletier et al., 2013; Solick & Newman, 2021). In studies based in the Baltic and North Seas, Ahlén et al. (2007, 2009) observed bats roosting on the nacelles of turbines. Additionally, the bats were observed feeding on insects that had accumulated at the turbines, often in close proximity to the blades, and foraging for marine organisms around OSW turbines (Ahlén et al., 2009).

Bat mortalities at onshore wind farms are well documented and are typically caused by fatal collisions with turbine blades or barotrauma (i.e. injury due to air pressure changes) from an abrupt or significant pressure drop behind rotating turbine blades (Parisé & Walker, 2017). Nearly 80% of these fatalities are migratory, tree-roosting species (Allison & Butryn, 2020; Arnett & Baerwald, 2013). Given that bats regularly occur offshore, especially during migration, it is likely that the same effects would occur at OSW developments (Lagerveld et al., 2020). While potential positive effects of OSW developments include increased roosting opportunities and increased prey abundance and availability, these factors also increase the risk of collisions with the blades (Peterson, 2020). Given that insects and bats are most abundant on nights with low wind speeds (Baerwald & Barclay, 2011), risks for migrating bats at OSW developments may also be greatest on days with low wind speeds. Additionally, factors such low cloud ceiling and fog, both common in the marine environment, have been shown to increase collision with anthropogenic structures (e.g., lighthouses and television towers) (Cryan & Brown, 2007; Gelder, 1956). In contrast to what is found with birds, fatal collisions also increase with turbine height (Barclay et al., 2007). OSW turbines are generally taller than their land-based counterparts potentially making OSW developments more hazardous to bats (Musial et al., 2016). Overall, data surrounding the effects of OSW development on bats are limited, especially in North America, and this topic requires further study.

5.2.3.1 Bat Species at Risk

Bat SOCC identified within the Study Areas are listed in Table 3. Federal and provincial conservation status, critical habitat necessary for the survival or recovery of federally extirpated, endangered and threatened species in the Study Area, and potential to occur in the Study Area are identified for each species. Discussion regarding the likelihood of impact of OSW development to each species is detailed in the following sections.

Table 3. Bat Species of Conservation Concern Known to Occur in the Study Areas

Common Name	Scientific Name	COSEWIC	SARA	Nova Scotia	Critical Habitat in Study Area	Potential to Occur in Study Areas
Eastern red bat	*Lasiurus borealis*	Endangered	Under Consideration	-	X	Likely
Hoary bat	*Lasiurus cinereus*	Endangered	Under Consideration	-	X	Likely
Little brown myotis	*Myotis lucifugus*	Endangered	Endangered	Endangered	X	Unlikely
Northern myotis	*Myotis septentrionalis*	Endangered	Endangered	Endangered	X	Unlikely
Silver-haired bat	*Lasionycteris noctivagens*	Endangered	Under Consideration	-	X	Likely
Tri-colored bat	*Pipestrellus subflavus*	Endangered	Endangered	Endangered	X	Unlikely

Bat SOCC that are likely or moderately likely to occur in the Study Areas include the hoary bat (*Lasiurus cinereus*), eastern red bat (*Lasiurus borealis*), silver-haired bat (*Lasionycteris noctivagens*), little brown myotis (*Myotis lucifugus*), northern myotis (*Myotis septentrionalis*), and tri-colored bat (*Pipestrellus subflavus*).

The eastern red bat, hoary bat, and silver-haired bat are frequently observed in the marine environment during their long-distance, seasonal migrations (>1000 km (Cryan & Brown, 2007; Fleming et al., 2003). Eastern red bats have been recorded as far as 44 km from coastal Mid-Atlantic USA flying at over 100 meters above sea level (Hatch et al., 2013) which is within the windswept area of turbines. Hoary bats and silver-haired bat have been observed over 11.5 km and 19.2 km off the mid-Atlantic coast, respectively (Sjollema et al., 2014). Given that these species also make up the majority of fatalities at terrestrial wind farms (72%) (Arnett et al., 2008; Solick & Newman, 2021), they are likely to be negatively impacted by OSW development.

Myotis bats also undertake shorter migrations and are also generally observed within 11.5 km of shore (Sjollema et al., 2014; Solick & Newman, 2021). However, one ship record indicates that dozens of myotis bats, likely little brown bats, landed on their vessel which was 110 km off the coast of Nova Scotia. This highly unusual behaviour is likely due to the large numbers of biting flies in the vicinity of the vessel (Thompson et al., 2015). Provided OSW developments are located over 11.5 km from shore, this species is unlikely to be negatively impacted by OSW development.

Tri-colored bats undertake much shorter migrations (<100 km; Fleming et al., 2003) and offshore observations are rare (Solick & Newman, 2021). In 2018, one individual was opportunistically observed landing on a vessel 103.5 km east of Corolla, North Carolina, within the vicinity of a planned OSW development (Bort Thornton et al., 2023). It is currently unknown if the species regularly travels offshore (Sjollema et al., 2014) and this individual may have been diverted off course by adverse weather (Bort Thornton et al., 2023). Based on currently available information, this species is unlikely to be negatively impacted by OSW development.

5.3 Cultural Heritage and Archaeology

Cultural heritage and Archaeological sites are non-renewable resources that are protected under provincial and federal legislation. This includes the *Historic Resources Act* in Newfoundland and Labrador, Nova Scotia's *Special Places Protection Act* (Special Places Protection Act, 1989), federal land under the *Parks Canada Agency Act* (Parks Canada Agency Act, 1998), and within Marine conservation areas under the *Canada National Marine Conservation Areas Act* (Canada National Marine Conservation Areas Act, 2002). Archaeological studies in Nova Scotia are also guided by KMKNO's Archaeology Research Division (ARD) who have a mandate to protect archaeological resources and burials by the Assembly of Nova Scotia Mi'kmaw Chiefs and provide guidelines on Mi'kmaw protocols for doing archaeology, Principals for Mi'kmaw Ancestral Remains, archaeological resources and are responsible for their Cultural, Heritage and Archaeology Strategic Plan.

Offshore wind developments have the potential to impact archaeological or heritage resources on land, within the intertidal zone and underwater. Sites that are located on land may be impacted by any activity that includes ground disturbance and may include cable landings, onshore infrastructure, transmission lines and access roads. Archaeological resources in the intertidal environment may be impacted by export cables landing points and erosion or unexpected changes to sediment movement. Impacts to underwater heritage resources differ with water depth based on foundation infrastructure, cable design and if an anchoring system is required. The anchoring of construction vessels must be taken in account when considering the impact of the project.

In Nova Scotia and Newfoundland and Labrador there are approximately 1,800 and 5,200 registered terrestrial archaeological sites in the provincial databases, respectively. Registered underwater sites, almost exclusively shipwrecks and some plane crashes, number 5,000 in Nova Scotia and 800 in Newfoundland and Labrador. It is important to note that these are only the recorded sites and the actual number of sites is anticipated to be much higher. Due to isostatic depression (the sinking of the earth's surface due to heavy pressures from glaciers) and rebound (the rise in the earth's surface after the release of the pressure – i.e., after the glaciers melt) both Nova Scotia and Newfoundland and Labrador both have high potential for the presence of prehistoric terrestrial archaeological sites located on submerged paleo-terraces along their shores. This could be assessed using isostatic rebound models and bathymetric mapping.

5.4 Mi'kmaw Rights

The participation of Mi'kmaw communities in Nova Scotia[1] is essential for the long-term success of OSW development and strategy. Their involvement is integral to addressing historical issues, managing current resource challenges, and developing co-management structures. Canada's history of development has frequently led to significant economic disparities for Mi'kmaw communities, resulting in rights infringements, power imbalances, and social tensions within regions. These challenges persist in the fisheries sector, where ongoing tensions exist between Mi'kmaw and non-Mi'kmaw fishers, and the DFO. Ongoing climate change issues pose a challenge to ocean ecosystems in Canada as warmer marine temperatures may cause fish population loss and habitat disturbances. These climate change impacts might instigate stricter resource conservation protections, which may impact fishing and seafood economies in Atlantic Canada (S. C. Government of Canada, 2021)While OSW development may offer significant opportunities, it is important to analyze how it could worsen existing commercial fishing issues. The fishing and seafood industries significantly contribute to Atlantic Canada, and these OSW challenges raise concerns about the future of marine economies.

Nonetheless, OSW development may present significant socio-economic opportunities for Mi'kmaw communities, including job creation, skills training, and equity-sharing. Per the Interim Report of the Regional Assessment of Offshore Wind Development in Nova Scotia, it is anticipated that a wind farm will be operational in Nova Scotia within a period of seven to ten years (Gorman, 2024; IAAC, 2024). The active engagement of Mi'kmaw communities in OSW development is currently paramount to ensure that the development process is in accordance with the long-term vision of Mi'kmaw communities, emphasizing resilience. Mi'kmaw consent and participation are necessary for the legitimacy and legal grounding of OSW developments and its long-term success. Incorporating Mi'kmaw perspectives and knowledge into OSW development can lead to more effective and sustainable project outcomes. This collaborative approach can foster a sense of shared responsibility and mutual benefit, essential for the enduring success of both OSW developments and fisheries co-management in Atlantic Canada.

The following section highlights the potential impacts of marine development in Nova Scotia, including OSW developments, on Aboriginal and treaty rights and cultural practices of the Mi'kmaw communities represented by

KMKNO. Key areas of concern are presented to contextualize the potential impacts of future OSW development activities on Mi'kmaw rights[1]. This information will help inform future planning and Mi'kmaw involvement in development activities that will result in the protection of the health, environmental, and socio-economic well-being of the Mi'kmaq in Nova Scotia. Recommended mitigation approaches and opportunities for meaningful Mi'kmaw involvement in future OSW development activities are presented in Section 6.4.

5.4.1 Peace and Friendship Treaties

Mi'kmaq in Nova Scotia were signatories to Peace and Friendship Treaties with the British Crown in the eighteenth century. Other signatories include Wolastoqey and Peskotomuhkati communities in Atlantic Canada (Callaghan et al., 2021). These treaties, including the Treaty of 1752, recognize Indigenous rights to hunt, fish, and gather in traditional territories for "necessaries" (Harris & Millerd, 2010, p. 10) and benefits that include economic activities (Johnson, 2010). Like other treaties, the Peace and Friendship Treaties are constitutionally protected by Section 35 of the Constitution Act, 1982 (Callaghan et al., 2021).

5.4.2 Food and Social and Ceremonial Purposes

When referencing Mi'kmaw rights to fish, per the Peace and Friendship Treaties, the 1990 *Sparrow* decision by the Supreme Court of Canada is often cited (Harris & Millerd, 2010). This case recognized and upheld that Indigenous Peoples have the right to fish for food and social and ceremonial purposes (FSC), and FSC activities take precedence over other activities, "excluding when conservation is of concern" (Warrior et al., 2022). FSC fisheries are often regulated and managed separately from non-Mi'kmaw commercial and recreational fisheries. The right to fish for FSC needs is an Aboriginal right, and the right to fish for a moderate livelihood is a treaty right of Mi'kmaq, Wolastoqey and Peskotomuhkati communities, and both rights are protected by Section 35 of the Canadian Constitution (Denny & Fanning, 2016), p. 3).

5.4.3 Marshall Decision

R. v. Marshall (1999) is a crucial treaty fishing rights case with significant impacts on Mi'kmaw communities in Nova Scotia and involved the interpretation of an eighteenth-century treaty between the British and Mi'kmaq to specify the limitations and scope of the Peace and Friendship Treaties (Harris & Millerd, 2010; Johnson, 2010). Donald Marshall Jr. of Membertou First Nation was charged in 1993 with illegal eel fishing without a license and fishing during the closed season (Brown, 2018). However, Marshall argued that his treaty rights to fish commercially were not being recognized and fought his charges with the support of Mi'kmaw Chiefs (Johnson, 2010). While initially losing in a Nova Scotia court, the case eventually was brought to the Supreme Court of Canada, where Donald Marshall Jr. was acquitted of charges (Johnson, 2010). The Court acknowledged that Marshall had a right to fish under the Peace and Friendship Treaties and acknowledged that Mi'kmaq and Maliseet Peoples have the right to "gather and earn a moderate livelihood through their treaty rights to hunt and fish" (Brown, 2018, p. 20).

5.4.4 Defining "Moderate Livelihood"

While R. v. Marshall affirmed Mi'kmaw of Nova Scotia's treaty Right to fish, further clarity on the definition and scope of *"moderate livelihood"* and implementation of this treaty right was issued by the Supreme Court of Canada in a subsequent decision known as Marshall II, following conflict and growing tensions between Mi'kmaw and non-Mi'kmaw fishers in Nova Scotia (Callaghan et al., 2021). Marshall II stated that while Mi'kmaw rights to fish commercially would be observed, resources earned would not be unlimited (Johnson, 2010). Marshall II clarified that "*moderate livelihood"* means fishing for *necessaries* or *basics* such as "food, clothing and housing, supplemented by a few amenities" rather than the accumulation of wealth (Callaghan et al., 2021; F. and O. C. Government of Canada, 2021a; Harris & Millerd, 2010). The second decision emphasizes that treaty rights can only be restricted for conservation or other compelling and substantial public objectives (F. and O. C. Government of Canada, 2021b). Furthermore, Marshall II highlights that the Supreme Court of Canada may use economic considerations to justify commercial fishing regulations (F. and O. C. Government of Canada, 2021b). Therefore, while the Supreme Court of Canada affirmed Mi'kmaw treaty rights to fish for a "moderate livelihood," there remains ambiguity around the term and meaning and practical application of the term "moderate livelihood." This ambiguity and difference in

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[1] The information presented in this section regarding Mi'kmaw rights has been thoroughly researched. However, it is essential to acknowledge that KMKNO possesses a more comprehensive understanding and expertise in this field. The inclusion of this section is intended to provide contextual information in support of other sections within this report.

interpretation have led to conflicts between Mi’kmaw fishers and non-Mi’kmaw fishers, as well as with federal and provincial authorities and regulatory officials. Furthermore, the lack of a clear framework that allowed Mi’kmaw fishers to exercise their rights led to issues around fishing access. Due to these challenges, escalated tensions between Mi’kmaw communities and non-Mi’kmaw fishers have led to property damage and violence in Nova Scotia.

In response to ongoing disputes and legal obligations, the Government of Canada has worked to implement moderate livelihood plans with Mi’kmaw communities to provide a structured approach to Mi’kmaw fishers exercising their treaty rights. For example, Sipekne’katik First Nation has developed a fishery plan, which outlines specific licences and tags for members, authorized fishing zones, species and quotas, economic and community benefits, and enforcement and compliance. Sipekne’katik First Nation developed an FSC lobster fishery outside the regulated commercial season in Lobster Fishing Area 34 in Nova Scotia (F. and O. C. Government of Canada, 2021b; Seguin, 2021). Other First Nations in Nova Scotia actively working towards establishing and implementing moderate livelihood plans include Potlotek First Nation, Membertou First Nation, Eskasoni First Nation, Wagmatcook First Nation, We’koqma’q First Nation, Bear River First Nation, Acadia First Nation, Glooscap First Nation, Annapolis Valley First Nation, Paqtnkek Mi’kmaw Nation, Pictou Landing First Nation, and Millbrook First Nation.

Moderate livelihood plans and fishery development remain contentious, as a Mi’kmaw self-regulated moderate livelihood fishery might negatively interfere with DFO regulatory actions. For example, the DFO insists that moderate livelihood fisheries must only operate during commercial seasons and has seized traps and arrested fishers who fish outside of DFO’s regulatory scope (Denny & Fanning, 2016; Elegbede et al., 2023; Withers, 2022). Elegbede et al. (2023) articulated that “the DFO licences commercial communal commercial fisheries. In contrast, the moderate livelihood fishery relates to the rights-based fishery. The rights-based fishery connects to the Marshall decision, allowing the Mi’kmaq to assert their right to develop Mi’kmaw-based certification without the DFO issuing licence” (p. 906). DFO prevents the implementation of moderate livelihood plans by not supporting rights-based fisheries. Ultimately, “Mi’kmaw leaders do not accept Canada has the authority to regulate the treaty fishery” (Withers, 2022, para. 8). Serious issues surround regulatory authority as Mi’kmaw fishers want to harvest fish for a livelihood without infringement by DFO.

5.4.5 Potential Impact of OSW Projects on the Rights of Mi’kmaw Communities

Offshore wind development in Nova Scotia presents both challenges and opportunities for Mi'kmaw communities. On one hand, it can create economic opportunities through job creation, future-building, and potential equity and revenue-sharing agreements. On the other hand, it may impact fishing grounds and marine ecosystems vital to communities; marine-related rights are intrinsic to the Mi’kmaq. Due to Mi’kmaw communities’ reliance on marine resources for “livelihoods, sustenance, and cultural integrity,” marine developments, including OSW, may significantly impede Mi’kmaw rights to fish (Warrior et al., 2022, p. 1299). The following section outlines the potential adverse impacts of OSW by analyzing OSW’s historical impacts on communities and ongoing marine concerns in Mi’kmaw communities. Opportunities are highlighted in Section 6.3 of this report.

5.4.5.1 Governance Impacts

It is important to provide context behind Mi’kmaw governance to contextualize the impacts of OSW development projects on Mi’kmaw communities. The Mi’kmaq have their own governance structures, laws, organizations, institutions, and customs; however, they do not have complete autonomy or decision-making ability to make marine management decisions that apply to all Canadians (Warrior et al., 2022). Instead, Mi’kmaw governance exists within a state-led framework, meaning adherence to Mi’kmaw treaty rights (Warrior et al., 2022, p. 1300). Marine protected areas are established through three federal agencies: DFO, Environment and Climate Change Canada, and Parks Canada (Warrior et al., 2022, p. 1299).

Mi’kmaw governance and knowledge systems are deeply entwined and grounded on Mi’kmaw “beliefs, values, language, and knowledge” (Warrior et al., 2022, p. 1300). Mi’kmaq Ecological Knowledge (MEK) is about the “interaction that the Mi’kmaq have had, and continue to have, with the environment which has provided them with an understanding that may not be found in western science knowledge systems” (Mi’kmaq Ecological Knowledge Study Protocol, n.d., p. 9). *Msit no’kmaq* is an epistemological concept that refers to the interconnectedness between all living and non-living components, where all beings are considered kin (Denny & Fanning, 2016; Warrior et al., 2022). *Netukulimk* is a sustainability principle that “guide[s] individual and collective beliefs and behaviours in resource protection, procurement, and management to ensure and honour sustainability and prosperity for the ancestors, and present and future generations” (Denny & Fanning, 2016; McMillan & Prosper, 2016; Prosper et al., 2011). These two concepts ground Mi’kmaw knowledge systems and are principles inherent to Mi’kmaw governance. The Crown and proponents can refer to MEK to understand Mi’kmaw relationships to land and the potential adverse impacts of developments. However, MEK Studies should not be considered consultation (Mi’kmaq Ecological Knowledge Study Protocol, n.d., p. 9).

Inadequate governance structures and power imbalances between the Canadian government, private corporations, and First Nations can create systemic barriers for Mi’kmaw communities to meaningfully participate and provide consent. Inadequate actions include governance structures that do not provide detailed descriptions of the potential impacts of renewable project developments, failure to provide adequate timelines for Mi’kmaw communities to provide sufficient comments about potential developments, lack of First Nation representation on regional assessment committees, and lack of Nation-to-Nation protocol and inadequate or incomplete regulatory mechanisms (Denny & Fanning, 2016, p. 1305; Warrior et al., 2022, p. 15). These actions, or rather, inactions, create barriers to meaningful consultation. For example, Miawpukek First Nation has commented on the *Regional Assessment of Offshore Wind in Nova Scotia, Newfoundland, and Labrador* and noted their concern that the federal and provincial governments will use the Draft Agreement and TOR document to circumvent Aboriginal rights to advance corporate interests (Miawpukek First Nation on the Regional Assessment of Offshore Wind in Nova Scotia and Newfoundland and Labrador, 2022, p. 11). Without adequate and meaningful consultation protocols, OSW developments could potentially exacerbate Mi’kmaw rights infringements and further worsen power imbalances among Nations and organizations in Canada.

5.4.5.2 Economic Impacts

5.4.5.2.1 Increased Stress on Fishing Rights

Populations of culturally significant marine species are decreasing, and the provincial government is enforcing strict guidelines for conservation efforts for Mi’kmaw and commercial fishers. While the Mi’kmaq have a unique right to fish, members sometimes bypass DFO’s fishing protocols to exercise Aboriginal and treaty rights. This has caused public outrage amongst non-Mi’kmaw fishers. As OSW developments might cause environmental impacts on marine health and habitat, culturally significant, endangered, and high-value marine species might be further impacted. OSW developments might then exacerbate fishing access and availability issues and cause tensions between Mi’kmaw and non-Mi’kmaw fisheries as fishing availability and access diminish.

As issues related to fishery governance remain a source of tension between Mi’kmaw communities and the DFO, any marine infrastructure project in areas in and surrounding Mi’kmaw communities must provide a robust analysis of potential impacts (Denny & Fanning, 2016). Mi’kmaq exercising their treaty rights to fish per the Peace and Friendship Treaties and Marshall Decisions have been ongoing points of contention in Atlantic Canada. The Marshall Decisions and moderate livelihood plans have impacted Mi’kmaq and other Indigenous communities in the Atlantic as Mi’kmaw communities protest that a “moderate livelihood is not considered enough to sustain a family” (Brown, 2018, p. 20). Issues such as access to fishing grounds, resource management, conservation concerns, and individual conflicts with non-Mi’kmaws fishers have arisen. These challenges have led to disputes, protests, and negotiations between Mi’kmaw communities, government authorities, and other stakeholders. While legal and political strides have been made, challenges remain in fully realizing these rights and achieving equitable co-management of fisheries and commercial fishing resources.

With future OSW developments in Nova Scotia, there is an opportunity to support treaty rights as such projects might provide opportunities for compensation due to the loss of fishing availability to communities and impact both available employment opportunities and economic self-sufficiency models (Johnson, 2010; Warrior et al., 2022). Further research, including analysis of DFO’s communal and commercial fishing data, is needed to detail the potential impact that OSW development may have on the fishery economy against the potential economic development benefits such a project may deliver to the region and offer Mi’kmaw communities. These benefits may include employment opportunities, design and construction, training for skilled work, and equity-sharing opportunities.

Fishers have highlighted that OSW development and operations contribute to fishing income, revenue, and livelihood losses. These losses result from limited access to valuable fishing areas and congestion at alternative fishing sites due to displacement and area closures (Chaji & Werner, 2023, p. 7). Fishers have expressed concern about the impact on insurance, such as heightened costs due to offshore wind farm safety risks related to fishing vessel accidents and spill-over effects on aquaculture farms (Chaji & Werner, 2023, p. 10). Other concerns include the loss of traditional fishing areas, issues of security, and the formidable challenge of securing new employment opportunities in light of age and educational constraints, all of which are anticipated to impact the sustenance of fisher communities (Stelzenmüller et al., 2021).

The Regional Assessment of Offshore Wind Development in Nova Scotia's Interim Report emphasized the importance of evaluating how to quantify, calculate, and predict compensation that would be required in case avoidance and mitigation measures do not succeed in preventing a loss (IAAC, 2024, p. 64). The Interim Report emphasizes research areas to identify potential losses, including compensation schemes for financial losses, the type of compensable loss being supported, and insurance markets to underwrite the risks associated with commercial fishing activities within an OSW development area. Compensation plans are important for fishers in Atlantic Canada who may experience losses due to offshore wind development. These plans ensure that fishers are fairly compensated for any disruptions to their livelihoods caused by construction and operation activities. This could include restricted access to fishing grounds and changes in marine ecosystems. The financial support and other forms of compensation provided by these plans help to lessen the negative impacts on the fishing industry, ensuring that fishers can maintain their communities and traditional way of life.

Compensation plans present both opportunities and challenges. Compensation plans should ideally work to minimize direct and indirect losses, maximize monetary and non-monetary benefits (Chaji & Werner, 2023) and reduce the potential impact on fisheries (Stelzenmüller et al., 2021). For example, Vineyard Wind 1 is a US-based offshore wind farm under construction in federal waters and provides annual funding to commercial fishers who face losses attributable to the farm's construction. operations, and decommissioning activities (Vineyard Wind 1 Fisheries Compensation Program, n.d.). Funding is provided to communities through various initiatives aimed at promoting local development and environmental stewardship. Vineyard Wind 1 has established community benefit agreements with local municipalities, directing funds toward infrastructure improvements, educational programs, and workforce development. These agreements are customized to the specific needs of each community, ensuring that the benefits are both relevant and impactful. To ensure fair and effective distribution of compensation, Vineyard Wind 1 has set up specific requirements for fishers who want to access its compensation plans. These requirements are meant to confirm eligibility and make sure that the compensation goes to those who are directly affected by the project. The general requirements include providing proof of impact, documenting losses, registering and obtaining licenses, participating in consultations, following application procedures, and working with fishing associations. Compensation plans offered by organizations like Vineyard Wind 1 may provide funding to account for losses of necessary navigational and safety equipment and insurance costs needed by fishers in OSW fishing areas, but the quantification of losses is needed ahead of time for fishers to participate in compensation planning (Haggett et al., 2020).

Challenges include the difficulty of quantifying the "loss of skills, heritage, and ways of life" (Haggett et al., 2020, p. 42). Other obstacles include building trust between fishers, stakeholders, and government bodies, deciding on the form of payments (lump sum or staggered), and verifying or disproving claims (Haggett et al., 2020).

All in all, compensation plans can provide economic support and reduce the impact of OSW on fishers. Experts suggest that careful consideration must be given to the planning and implementation of these compensation plans. While it remains challenging to quantify the social impact of fishing access, Chaji and Werner provide frameworks to estimate the value derived from specific fishing locations, which ultimately can be used to assess the impacts of displacement and area closures and be used to implement compensation plans (p. 13). However, robust economic modelling techniques remain underdeveloped.

5.4.5.2.2 Conflicts over Fishery Management Due to Resource Availability

In Atlantic Canada, there is a governmental trend to uphold "existing rules, regulations, licensing, and quota privileges" to mitigate public outcry over Mi'kmaq-only marine access (Davis & Jentoft, 2001; Warrior et al., 2022). These existing government structures historically restricted Mi'kmaw commercial fishing access under the pretense of resource conservation and sustainability. For example, disputes between Mi'kmaw and non-Mi'kmaw fishers intensified when new initiatives granted Mi'kmaw fishers unique access to marine protected areas, trap limits, and quotas. These initiatives followed the Marshall Decision I, which allowed Mi'kmaw fishers to fish during closed seasons (Harris & Millerd, 2010). However, moderate livelihood plans and unique access have been curtailed due to tensions between Mi'kmaw and non-Mi'kmaw communities.

Systemic limitations, such as capped quotas, unavailable licenses, and restrictive rules, limit Mi'kmaw entitlements and economic benefits, ostensibly to maintain sustainable marine resource levels (Elegbede et al., 2023). Consequently, concerns about marine conservation restrict Mi'kmaw access to fishing sites, hinder the practice of moderate livelihood plans, and limit Mi'kmaw resource management and ecological systems management. The

Crown and proponents must recognize that OSW development will affect marine ecosystems, potentially leading to increased conservation efforts in Atlantic Canada. Consequently, these marine development projects could negatively impact Mi’kmaq by reducing their moderate livelihood plans and fisheries management, as federal conservation measures and marine protected areas may result in declining fishing access.

Conservation is considered a “valid legislative objective” for treaty rights infringement in Canada, and real or perceived treaty and Aboriginal rights infringements and Nation-to-Nation resource management conflicts can arise from inadequate development plans, consultation, and Mi’kmaw engagement and co-management practices (Denny & Fanning, 2016). Inadequate governance structures and power imbalances between the Canadian government, private corporations, and First Nations create systemic barriers for Mi’kmaq to provide consent, participate in co-management planning, and ultimately, share economic power (Denny & Fanning, 2016, p. 1305; Warrior et al., 2022, p. 15). Under Western epistemologies and scientific modes of analysis, decision-making is generally hierarchical (Denny & Fanning, 2016). This is especially apparent in conservation efforts of culturally significant species in Mi’kmaw communities.

5.4.5.3 Cultural Impacts

5.4.5.3.1 Natural Resource Management Differences

Fundamental differences in belief systems between Mi’kmaw First Nations and the government in Canada stem from contrasting worldviews, values, and approaches to governance, land, and resource management (Warrior et al., 2022). Mi’kmaw communities have distinct cultural traditions and activities (Mi’kmaq Ecological Knowledge Study Protocol, n.d.; Warrior et al., 2022). Conceptual ideas of the connectivity between living and non-living things differ among Mi’kmaw and non-Mi’kmaw communities and organizations (Denny & Fanning, 2016). For example, ecological and epistemological concepts ground sustainable resource management as a core value in governance for the Mi’kmaq. Meanwhile, the Canadian government’s resource management structures have historically prioritized economic interests, industrial development, and profit-driven management of natural resources. There is an opportunity to incorporate Mi’kmaw traditional knowledge systems with Western science on a more equal footing, improving on the imbalanced approach taken in environmental assessments, as noted in the RA.

OSW project developments might instigate resource management conflicts from misaligned epistemologies and resource management systems. There is an opportunity to increase understanding of Mi’kmaw rights, cultures, values, activities, and knowledge systems and how these structures influence harvesting behaviours and practices impact governmental organizations’ interactions with Mi’kmaw communities. For example, assuming that Mi’kmaq would exploit marine resources if conservation structures were not enacted indicates a lack of understanding of Mi’kmaw values (Warrior et al., 2022). Furthermore, renewable energy projects in coastal areas may impact Mi’kmaw communities’ access to traditional knowledge practices, heritage sites and fishing and hunting availability. For example, lobster is culturally significant to Mi’kmaq, and communities have noted that the development phase of OSW projects might negatively impact traditional use areas and cause lobster territory disturbances (Miawpukek First Nation Comments on the Regional Assessment of Offshore Wind in Nova Scotia and Newfoundland and Labrador, 2022, p. 68).

In addition to the previously mentioned potential challenges between Mi’kmaw and non-Mi’kmaw fisheries, additional social tensions might arise from the influx of temporary workers supporting the construction phase of OSW development. Social tensions between Mi’kmaw community members and temporary workers might increase employment issues, crime or social disruption, and negative economic impacts, such as higher living costs in Mi’kmaw communities due to population size changes from large transient workforces. On the other hand, these development opportunities may present a significant opportunity to train and use Mi’kmaw workers for OSW development projects in a variety of functions throughout the project lifecycle.

Due to the transient nature of the marine development construction workforce and increasing levels of racism and violence against Mi’kmaw communities, Mi’kmaw women, girls, and 2SLGBTQQIA+ peoples are targeted in sexual violence, injury, displacement, and death crimes (Federal Pathway to Address Missing and Murdered Indigenous Women, Girls and 2SLGBTQQIA+ People, 2021; Meloney, 2021; Morin, 2020). Man camps, or male-dominant work sites for large infrastructure projects, are linked to violence and human trafficking as outlined by a final report of the National Inquiry into Missing and Murdered Indigenous Women and Girls (Missing and Murdered Indigenous Women, Girls, and 2SLGBTQQIA+ People National Action Plan, 2022). Safety concerns of already vulnerable communities remain high for Mi’kmaw communities, and violence mitigation is considered insufficient. Mi’kmaw communities are forced to find, articulate, and organize violence mitigation solutions (Meloney, 2021). Mi’kmaw Chiefs have expressed concerns about the government and corporate actor's inadequate response to safety protocols and have called for thorough project planning to address safety, violence, and human trafficking risks (Meloney, 2021; Morin, 2020).

5.4.5.3.2 Marine Species

OSW development will impact marine health and habitat, further affecting culturally significant, endangered, and high-value marine species (see sections 5.12, 5.2.1.1, and 5.2.1.2). As mentioned, the Mi'kmaq have traditionally relied on treaty lands for hunting, cultural, and sustenance activities, which include reliance on marine species. Historically, OSW developments have resulted in habitat destruction, displacement of traditional territories, disturbance to marine species, disruption of ecological balances, and visual and aesthetic impacts (Bonar et al., 2015; Lloret et al., 2022). Development projects can pose a risk to the effective implementation of moderate livelihood plans, the practice of traditional and cultural activities, and resource governance of the Mi'kmaq; however, they can also provide economic stability and support habitat development for key marine species, as noted in the sections above. Land and species loss is significant to Mi'kmaw communities as the interconnectedness to living and non-living entities is vital in MEK systems and Mi'kmaw governance structures.

5.4.5.3.3 Cumulative Impacts

During the construction and operation phases of OSW development, marine species are unavoidably affected. OSW development projects should use ecological mitigation measures to avoid and protect sensitive marine habitats, which will reduce the potential of infrastructure disturbing and destroying marine habitats. Furthermore, depending on the scale of OSW developments, visual and vibration disturbances can cause species pattern changes (Bailey et al., 2014; Glasson et al., 2020). Additionally, cumulative effects from marine renewable energy projects include increased human activity in marine areas from shipping, maintenance, and coastal management. These factors contribute to marine injuries, mortalities, or divergent migration patterns, which can impact Mi'kmaw communities due to the reduced availability of marine species and marine site access (Bailey et al., 2014). While the development phase of OSW developments might cause marine health, habitat, and species loss, the construction and operation phases can also reduce Mi'kmaw access to FSC and moderate livelihood plans.

It is important to note that researchers have highlighted that OSW projects might produce positive attributes, such as new sightseeing tours, educational programs, and opportunities for knowledge sharing about wind energy (Stelzenmüller et al., 2021). This presents an economic opportunity for Mi'kmaw to own and operate these programs, as well as an opportunity for cultural knowledge sharing if desired. Additionally, OSW farms can have beneficial environmental impacts by providing artificial reefs that enhance marine habitats and attract fish populations after the construction phase (ten Brink & Dalton, 2018). These positive outcomes can contribute to the local economy by promoting eco-tourism and supporting fisheries, further integrating OSW development into the socio-economic fabric of coastal communities. By leveraging these benefits, OSW projects can foster community engagement, education, and environmental stewardship for knowledge sharing while supporting sustainable economic growth.

5.4.5.3.4 Impacts on Endangered and Culturally Significant Species

The construction and operation phases of OSW projects might impact endangered species and species culturally in Mi'kmaw communities. The loss of culturally significant species can cause acute pressure on Mi'kmaw communities, possibly contributing to cultural heritage practices and identity loss. It may also affect traditional Mi'kmaw subsistence activities, adding additional pressures to food sovereignty and cultural practices; however, regulations have supported conservation efforts. For example, Atlantic salmon, or plamu as known to Mi'kmaw communities, has historically been considered a staple food source due to its dependability, predictability, and availability throughout Nova Scotia (Denny & Fanning, 2016, p. 2). However, due to lack of abundance, salmon is often exclusively used for ceremonial purposes (Denny & Fanning). Atlantic salmon populations have been decreasing since the nineteenth century. They are now designated by COSEWIC as either endangered or of particular concern (Denny & Fanning, 2016, p.5). Conservation efforts for salmon in Nova Scotia are underway.

6. Potential Mitigation Measures

The following sections outline various avoidance and mitigation measures that can be implemented during the pre-construction, construction, operations, and decommissioning phases of OSW development project. This mitigation measures are provided to support KMKNO in pre-planning discussions with potential OSW developers. Pre-planning involvement including community engagement and consultation, TEK, and partnerships should be considered early in the project with OSW developers. A key mitigation to consider at each project phase is compensation that may impact the livelihood of Mi'kmaw communities such as financial compensation to fishers for lost income due to temporary exclusion zones during construction or compensation in data sharing agreements. Additional key mitigation measures from Table 4 are summarized below.

Commercial Fisheries

- Include fishing groups' (i.e., Mi'kmaw and other commercial fisheries) perspectives in the OSW development design components to mitigate effects on adjacent industries which depend on the marine environment and wildlife (Badding, 2021).
- Plan to maximize fishing access during all phases of the OSW development (BOEM, 2014).
- Plan OSW development to reduce conflict with Mi'kmaw and commercial fishing operations (BOEM 2022; Empire Offshore Wind LLC, 2021).

Marine Mammal

- Schedule relevant construction activities to avoid seasonally sensitive periods such as migration.

Avifauna and Bats

- Schedule relevant construction activities to avoid seasonally sensitive periods such as migration.
- Implement deterrent measures at OSW developments (Marques et al., 2014). Examples include;
    - Illuminating turbines with dim ultraviolet light (Gorrensen et al., 2015) and texture coatings (Bennet and Hale, 2018); and,
    - Acoustic deterrents generating high-frequency noise audible to bats (Hein and Straw, 2021).
- During the seasonal migration periods for the SOCC, use radar technologies and/or cameras at OSW developments to detect nearby avifauna and implement operational mitigation measures. Examples include:
    - Adjusting cut
    - -in speeds (minimum turbine blade speed to generate electricity); and,
    - Initiate periodic shutdowns of turbines during predicted SOCC migratory periods or other mass movements (ie. Bats movements during periods of low wind speeds during August and September).
    - Adjustments to turbine operations in periods of low wind velocity when bat species would be more likely to be present at the site. Total bat fatalities can be reduced by 33% for every 1.0 m/s increase in the wind speed at which turbine blades turn to generate electricity (Arnett et al., 2013).
    - During migration periods, turn off turbines overnight to minimize turbine collisions.

Cultural Heritage

- If archaeology sites cannot be avoided, mitigation methods would discussed with provincial regulators and the KMKNO's Archaeology Research Division and would typically include controlled excavation and extensive documentation.

Table 4. Potential Mitigation Measures during OSW Phases for Commercial Fish, Marine Species at Risk, Avifauna and Bats, and Cultural Heritage and Archaeology

Project Phase	Commercial Fish	Marine Species at Risk	Avifauna and Bats	Cultural Heritage and Archaeology
Pre-Construction	**Project Pre-planning phase:** • Include fishing groups' (i.e., Mi'kmaw and other commercial fisheries) perspectives in the OSW development design components to mitigate effects on adjacent industries which depend on the marine environment and wildlife (Badding, 2021). • Work with fishing groups to determine configuration of submarine cables and turbine foundation locations relative to fishing grounds (BOEM, 2014) and provide schedules and prior notice to communities for field surveys, construction and maintenance activities. • Plan to maximize fishing access during all phases of the OSW development (BOEM, 2014). • Plan OSW development to reduce conflict with Mi'kmaw and commercial fishing operations (BOEM 2022; Empire Offshore Wind LLC, 2021). **Cable design:** • Bury cables a minimum depth of 2 m where feasible, ideally utilizing trenchless methods such as Horizontal Directional Drill (HDD) along the shoreline and inter-tidal zones. • Avoid construction techniques that raise the surface of the seabed. • Minimize the use of rock mattresses to as cable protection to avoid snagging of fishing gear and anchors. • Mimic the previous conditions of the area to avoid adding additional obstructions to fishing gear. • Install dynamic cables at depths that will limit entanglement with fishing gear. • Install cables in common corridors to limit overall cable footprint. **Facility design:** • Consolidate infrastructure where possible to reduce project footprint. • Consider larger turbines to reduce the project footprint. • Design transit corridors through the project area and/or separate OSW farms. • Avoid sensitive benthic features such as reefs. • Use nature inclusive designs to maximize fish, crustacean, and bivalve habitat. • Reuse native ocean bottom substrates and shells as scour protection where possible. • Provide turbine locations and cable routes to fishing groups for navigation and fishing purposes (Empire Offshore Wind LLC, 2021).	• Conduct marine wildlife surveying programs to determine baseline conditions of species abundance and use of habitat within the Study Areas to understand the potential scale of effect. Some methods for understanding baseline conditions of marine animal interaction with the Study Areas include: • Visual marine animal surveying – observing animals interacting with habitat; • Animal tagging – attaching a GPS system to an animal to track their movements over time; • Passive acoustic monitoring (PAM) – using sound detection technology to understand ambient noise levels of ocean environment, and marine animal presence; and, • Aerial surveys – observing animals interacting with habitat as seen from an aerial perspective (drones, aircraft). • Establish spatial and temporal exclusion zones where or when work is to be restricted to protect marine wildlife. Examples include: ▪ Avoidance of federally identified critical habitat for SAR (i.e. north Atlantic right whale, spotted wolffish, northern wolffish, northern bottlenose whale); and, ▪ Limit planned pre-construction activities during times of the year when SOCC are likely to occur in greater abundance including field investigations, borehole sampling, field surveys etc.. as majority of SOCC identified in Section 5.1.3 are more likely to occur in greater numbers in summer months.	• Conduct avian wildlife surveying programs to determine baseline conditions of species abundance and use of habitat within the Study Areas to understand the potential scale of effect. Some methods for understanding baseline conditions of avian animal interaction with the Study Areas include: ▪ Visual surveying – observing animals interacting with their habitat; ▪ Passive acoustic monitoring (PAM) for avifauna – Utilizing specialized monitoring equipment to detect and identify the calls of bird and identify echolocation calls of bat species present at the Study Areas; ▪ Animal tagging – attaching a GPS system to an animal to track their movements over time; • Establish spatial and temporal exclusion zones where or when work is to be restricted to protect avian wildlife. Examples include: ▪ Avoidance of federally identified critical habitat for SAR (i.e. Bank Swallows, Bicknell's Thrush, Piping Plover, Roseate Tern); and, ▪ Limit planned construction activities during times of the year when SOCC (ie migration period) are likely to occur in greater abundance ▪ The majority of SOCC identified in section 5.2.2.1 are more likely to occur in greater numbers in the spring and fall months during migration	• Investigative strategies differ depending on the environment of the study area. For OSW projects, we can divide the project study area in three distinct environments: terrestrial, intertidal and underwater. For each of these environments, the ARIA/HRIA, includes background information, infield survey, and a summary of methods and results, and makes recommendations on avoidance or proposed mitigation measures if the archaeological sites cannot be avoided by the project. • Field methods for an ARIA/HRIA may include pedestrian survey, visual assessment, subsurface shovel testing areas of potential with sediment accumulation, geophysical surveys (i.e. Ground Penetrating Radar), side-scan sonar, sub-bottom seismic profiling and the use of remote-controlled submersibles or divers. When sites are either recorded or revisited field documentation will include details relevant to complete site forms including the size, type and affiliation. When artifacts are recovered, they will be collected, cleaned, identified and catalogued. Any artifacts assessed as being unstable will be discussed with our conservator prior to be being transported for conservation. • The final ARIA/HRIA report will follow the requirements defined in the relevant guidelines and legislation and will include a summary of key findings and recommendations for managing any archaeological sites at risk, a project description, the environmental setting, the historical and archaeological context for the project area, field methodology, and the results of the field reconnaissance. The report will include both descriptive, as well as mapped, data on the sites, artifacts, and features identified, as well as detailed information on the nature, content, and significance of the artifacts and features identified. Cultural material recovered will be inventoried, described, and discussed within each report text to aid in evaluation of scientific and interpretive value. The report will also include a cultural heritage resource impact assessment which evaluates site significance, assesses project related effects on the identified sites, the significance of these effects, and presents mitigation options to minimize project effects. • If sites cannot be avoided, mitigation methods would discussed with provincial regulators and the KMKNO's Archaeology Research Division and would typically include controlled excavation and extensive documentation. There is opportunity to require the data to be provided to the regulator and Mi'kmaw to be incorporated as Traditional Ecological Knowledge for future development projects. However governance would be need to be determined on the ownership and use such as a data share agreement for future OSW projects.
Construction	• Provide a publicly available construction schedule updated on a weekly or monthly basis which avoids conflict with fishing activity (BOEM, 2014). This may include consideration of: ▪ Fishing schedules ▪ High-use fishing areas ▪ Seasonal species distributions ▪ Fisheries closures ▪ Fishing groups should be provided with detailed guidelines on safe navigation during the construction phase (BOEM, 2014) including: ▪ Exclusion zones ▪ Public mooring buoys ▪ Potential hazards	• Schedule relevant construction activities to avoid seasonally sensitive periods such as migration. • Foundation technologies with lower noise impacts (ie. Suction buckets, pin piles, gravity foundations) may be selected or if significant pile driving is required, quieting technologies may be employed during construction to reduce the amount of noise, such as: ▪ Bubble curtains; ▪ Soft start for pile driving; ▪ Cofferdams; ▪ Hydro sound dampers; and, ▪ New pile designs (e.g. double-walled pile, lower radial expansion pile). • Establish robust erosion and sediment controls to limit sediment	• Schedule relevant construction activities to avoid seasonally sensitive periods such as migration; and, • Ensure to build the OSW development at least 25 km away from the coast to avoid migrating shorebirds and bats. (IAAC, 2023).	• Since previous reconnaissance should have been done, and the mitigative measures of the pre-construction phase implemented, the construction phase should have little to no impact on cultural heritage and archaeology. However, in the event, that unrecorded sites are discovered during construction, a project specific Chance Find Procedure should be in place. The intent of an Archaeology Chance Find Procedure is to provide staff working on the project with guidelines for the appropriate response to the discovery or suspected discovery of archaeological material or features during the course of the work. Any ground altering activities associated with the Project have the potential of exposing archaeological deposits and this document is to address this potential and ensure that the sites are documented and protected as required.

Project Phase	Commercial Fish	Marine Species at Risk	Avifauna and Bats	Cultural Heritage and Archaeology
	• Work with fishing groups to develop a health and safety plan for use of the area in and around the OSW development (BOEM, 2014), including regular updates of any changes resulting from construction or maintenance activities. • Implement a 500 m dynamic safety zone around active construction (Empire Offshore Wind LLC, 2021). • Consider compensation for losses during construction, particularly for temporary exclusion zones, as well as damaged equipment due to interactions with construction activities.	transport into aquatic habitat and treat on-site water before it returned to the natural environment. • Establish "acoustic exclusion zones" that will be implemented during pile driving activities: ▪ 3,200 m for North Atlantic right whales and 500 m for other cetaceous species, seals, and sea turtles; ▪ These should be monitored by a certified marine protected species observer and passive acoustic monitors; • Piling driving operations should be shut down if a marine mammal or sea turtle enters the exclusion zone and should not be restarted until the animal(s) exits the exclusion zone; • Gradual ramp up procedures should be implemented to allow animals to leave the exclusion area prior to the pile driving; and, • Piling driving activities should not be conducted during periods of low visibility (i.e. fog, heavy precipitation, darkness). • Maintenance of buffer between vessels and marine mammals (DFO, 2024): ▪ Distance for marine mammals under most circumstances = 100 m; ▪ Distance for killer whales = 200 m; ▪ Distance for whales, dolphins and porpoise species with calves or in resting position = 200 m; ▪ Distance for all whales, dolphins and porpoises in parts of the St. Lawrence Estuary = 200 m; and, ▪ Distance for SARA Schedule 1 species = 400 m. • Implement vessel speed restrictions of 10-knots to reduce vessel strikes with marine megafauna. Additional, site-specific restrictions should be identified during baseline data collection in order to protection significant habitat including SAR habitat. • Consideration for OSW development design with comparatively lower potential impact. For example, floating foundation types are anticipated to have a lower noise effect during installation compared to driving monopile foundation into sediments (SEER, 2022). • Use nature-inclusive design to encourage habitat-building by marine life (Nordic Energy Research, 2023). This includes opportunities in the structure of the OSW infrastructure for species to colonize or interact with in a beneficial capacity (i.e., artificial reef construction). For example: • Increase the scour protection layer at the base of the turbine units to have an increased surface area for invertebrate colonization and interstitial spaces for motile species to move between; and, • Constructing additional structures along the turbines which may be used by pelagic fish species – e.g. Cod Hotels (Hermans et al., 2020).		
Operations	• Fishing groups should be provided with detailed guidelines on safe navigation during the operation and maintenance phase (BOEM, 2014). • Implement a defined exclusion zone around each turbine to allow fisheries operations to continue within OSW developments but reduce the risk of entanglement of fishing fear with OSW infrastructure.	• Employ low-noise turbines or other technologies to reduce operational sound effects. • Maintenance of buffer between vessels and marine mammals described in the Construction Mitigation section (DFO, 2024). • Implement vessel speed restrictions of 10-knots to reduce vessel strikes with marine megafauna. • Ensure any noise-producing activities are sufficiently mitigated (see Construction mitigation measures above). • Implement and utilize navigation corridors for vessel traffic to reduce traffic in sensitive habitat areas.	• Implement deterrence/harassment at OSW developments (Marques et al., 2014). Examples include; ▪ Illuminating turbines illuminated with dim ultraviolet light (Gorrensen et al., 2015) and texture coatings (Bennet and Hale, 2018) and, ▪ Acoustic deterrents generating high-frequency noise audible to bats (Hein and Straw, 2021). • During the seasonal migration periods for the SOCC, use radar technologies and/or cameras at OSW developments to detect nearby avifauna and implement operational mitigation measures. Examples include: • Adjusting cut-in speeds (minimum turbine blade speed to generate electricity); and, • Initiate periodic shutdowns of turbines during predicted SOCC migratory periods or other mass movements (ie. Bats movements during periods of low wind speeds during August and September). (de Lucas et al., 2012; Halm,	• Impacts to cultural heritage and archaeology resources are not expected during the operation of the development.

Project Phase	Commercial Fish	Marine Species at Risk	Avifauna and Bats	Cultural Heritage and Archaeology
			2023) • Adjustments to turbine operations in periods of low wind velocity when bat species would be more likely to be present at the site. Total bat fatalities can be reduced by 33% for every 1.0 m/s increase in the wind speed at which turbine blades turn to generate electricity (Arnett et al., 2013). • During migration periods, turn off turbines overnight to minimize turbine collisions.	
Decommissioning	• Construction phase mitigations should be implemented to avoid user conflicts in the area. • Leave foundations in place that provided fish habitat during the operations phase (BOEM, 2014). • Piles should be cut to a depth of approximately 5 m below the sea floor (BOEM, 2014).	• Mitigate noise production from use of support vessels and infrastructure dismantling (described in the Construction Mitigation section). • Salvage and relocate invertebrate species that have colonized OSW structures, where possible (Guida et al., 2017). • Avoiding decommissioning activities during seasonal windows of greater SOCC abundance (i.e., summer). • Decommissioning reclamation and closure will follow appropriate regulatory requirements at that time of decommissioning Discuss decommissioning with relevant regulators to determine what infrastructure should be removed and what can be left in place to continue to provide habitat for marine species.	• Avoiding decommissioning activites during seasonal windows of greater SOCC abundance (i.e., spring and fall migration periods). • Decommissioning reclamation and closure will follow appropriate regulatory requirements at that time of decommissioning.	• Impacts to cultural heritage and archaeology resources are not expected during the decommissioning phase of the developments as long as no new lands will be required and any monitoring requirements are followed, if applicable.

6.1 Opportunities for Mi’kmaw Communities in OSW Development

The following section outlines recommended areas of focus and action to inform and improve the planning and impact assessment processes for future OSW development. These recommended opportunities are grounded in respecting Mi’kmaw consultation policies and practices and enhancing the capacity for Mi’kmaw governance. This section will also outline the capture of socio-economic opportunity and incorporation of Mi’kmaw worldviews into marine development, including the “need for alternative approaches to state-led/top-down governance to improve Mi’kmaq participation and governance in Atlantic Canada” (Warrior et al., 2022, p. 1298).

6.1.1 Corporate Training on Mi’kmaw Knowledge Systems and Histories

There exist deep-seated historical traumas and ongoing challenges endured by the Mi’kmaq due to development projects in Canada (*6 Guidelines for Projects Involving Traditional Indigenous Knowledge*, 2018). Prospective OSW developers, contractors and consultants must take proactive steps to address these issues, such as providing comprehensive education to all employees regarding the complex history of the Mi’kmaq in Canada. Offering Mi’kmaw relations training to OSW developers, contractors and consultants can foster understanding and empathy, enabling employees to engage in respectful and productive interactions with Mi’kmaw communities. Mi'kmaw communities could support these efforts and create economic opportunities by providing corporate training to OSW developers and private companies, particularly given the likely unfamiliarity of the European-owned firms/market entrants with these topics. Moreover, educating employees on the legal implications of UNDRIP underscores the importance of upholding Indigenous rights and obtaining informed consent in project development processes (*6 Guidelines for Projects Involving Traditional Indigenous Knowledge*, 2018). A recommendation, through the RA, to reinforce the critical importance of demonstrating this consideration in all project plans would motivate OSW developers to implement such training systems to better demonstrate their commitment to acknowledging historical injustices and assuming responsibility when undertaking projects that may impact Indigenous Peoples (*6 Guidelines for Projects Involving Traditional Indigenous Knowledge*, 2018; Truth and Reconciliation Commission of Canada: Calls to Action, 2015).

Furthermore, as outlined in Section 5.3.2, to reduce crime rates and violence against women, girls, and 2SLGBTQQIA+ individuals, similarly, Mi'kmaw communities can offer consulting services and training to OSW developers workers to understand their impact on Mi'kmaw communities. OSW development companies must establish protocols that address these issues, invest in social services for potentially impacted communities, listen directly to community concerns about the risks posed by transient workers, and develop appropriate solutions, and Mi’kmaw communities can monetize their support in community safety planning (Federal Pathway to Address Missing and Murdered Indigenous Women, Girls and 2SLGBTQQIA+ People, 2021).

6.1.2 Mi’kmaw Ownership and Governance

Meaningful Mi’kmaw ownership and establishment of Mi’kmaw governance structures within marine development and OSW developments is essential to mitigate negative impacts on Mi’kmaw communities, implement resource management practices, and protect Mi’kmaw cultural traditions. Precise Mi’kmaw ownership and management models can help ease resource management disputes between Mi’kmaw and non-Mi’kmaw groups. Involvement in renewable energy should go beyond providing employment opportunities and financial compensation to include ‘partnership’ and ‘ownership’ roles, which can lead to more profound and long-lasting benefits rooted in reconciliation (Hoicka et al., 2021).

After the Crown and private utilities, Indigenous communities control the most renewable energy assets in Canada. (*Community Ownership of Renewable Energy*, 2023). According to the Institute for Human Rights and Business, Indigenous communities in Nova Scotia and Newfoundland and Labrador have actively participated in successful renewable energy projects (*Community Ownership of Renewable Energy*, 2023). Examples include the following:

- Truro-Millbrook Wind Project is a partnership between the Millbrook First Nation and Juwi Wind Canada Ltd. to establish Truro-Millbrook Wind Limited. Community Wind Farms Inc. is overseeing local development services for the project. It is co-located with another wind project, Truro Heights Community Wind, which will be primarily owned by Eskasoni First Nation. Both projects operate under Nova Scotia’s Community Feed-In-Tariff Program (COMFIT), designed to promote community-based renewable energy initiatives (*Millbrook Energy Project Coming to Life*, 2017). These wind farms bring economic opportunities to the local community and provide the

Millbrook First Nation with a sustainable revenue stream that supports ongoing economic development (*Millbrook Energy Project Coming to Life*, 2017).

- Glooscap Energy Projects is a 100% owned entity of the Glooscap First Nation dedicated to implementing renewable energy initiatives for their community. Positioned as a net exporter of renewable energy, Glooscap First Nation holds majority ownership in the Weavers Mountain Wind Project, a proposed renewable energy facility slated to commence operations by 2026. This initiative exemplifies their commitment to sustainable development, harnessing local resources to drive economic growth while promoting environmental stewardship within their traditional territory.

According to the 2023 Just Transitions report, projects that most successfully align with the principles outlined by UNDRIP involve full "Indigenous consultation and equal decision-making authority" (*Community Ownership of Renewable Energy*, 2023). The Community Ownership of Renewable Energy: How It Works in Nine Countries (2023) report outlines five classifications of ownership arrangements that might contribute to reconciliation:

1. Indigenous Ownership: Individual Indigenous communities with full ownership of projects can fully control management, decision-making, profits, revenues, planning, and employment. Indigenous communities would have access to developers and favourable financial arrangements.
2. General Partnership: Indigenous Coalition, when ownership is split equally among partners. For instance, Three Nations Energy Inc. exemplifies this approach as it represents a partnership between two local First Nations and a Metis association in Alberta focused on solar energy. Such partnerships are advantageous as they enable the pooling of funds for larger investments, allowing the partners to pursue significant projects in renewable energy development collectively.
3. General Partnership: Indigenous Developer, which means when ownership is shared equally between an Indigenous community and a renewable energy developer, sharing decision-making and earnings.
4. Limited Partnership: meaning co-ownership models agreed upon before the project and are highly flexible models that can distribute liability and risks.
5. Equity Ownership: A model where Indigenous communities purchase equity and act as project shareholders. For instance, Indigenous communities could own shares in offshore wind farms or work with developers to build essential infrastructure like ports, transmission lines, or vessel services needed for project operations. Collaborations between Indigenous communities and developers typically include revenue-sharing deals or joint ventures, allowing Indigenous communities to benefit from the economic activities related to infrastructure development.

Furthermore, royalty agreements and Impact Benefit Agreements (IBAs) could effectively address any negative impacts on Aboriginal and treaty rights and resources (IAAC, 2024, p. 21). Additional equitable agreements may include employment quotas, investments in training programs, and others to compensate for fishing losses from OSW development. Additionally, fostering partnerships with Mi'kmaw educational institutions, supporting apprenticeships, and creating pathways for career advancement are essential steps. By integrating these practices, Canadian organizations can help bridge the employment and education gaps, ensuring that Indigenous communities benefit from sustainable economic development and inclusive growth in the labour market.

6.1.3 Adopt Nation-Specific Mi'kmaw Consent Protocols

Potential OSW developments must commit to meaningful consultation practices to protect Aboriginal and treaty rights, prevent project developments from negatively impacting Mi'kmaw communities, and develop meaningful partnerships with Mi'kmaw communities that will provide long-term, sustainable socio-economic benefits for Mi'kmaw communities and businesses.

Following the framework provided by UNDRIP and the Truth and Reconciliation Commission of Canada, Canadian organizations, federal and provincial regulators and private-sector companies are to engage in meaningful consultation and obtain free, prior, and informed consent before proceeding with economic development projects (Truth and Reconciliation Commission of Canada: Calls to Action, 2015). Meaningful consultation involves developing projects that support long-term and stable income for community programs and ensuring a significant percentage of Indigenous ownership in project governance (Warrior et al., 2022). Initiating consultation with Indigenous communities during the early stages of a project allows for meaningful dialogue and consideration of Indigenous concerns. It is essential to follow consultation plans specific to each Mi'kmaw First Nation. Additionally, Canadian governments must treat Mi’kmaw First Nations as equal jurisdictions and collaborators by treating Mi’kmaw communities as partners rather than clients is essential to the consultation process and the ultimate successful implementation of a proposed OSW development.

6.1.4 Respect Mi’kmaq Ecological and Traditional Knowledge

Adopting MEK in resource management planning is crucial for Canadian renewable energy development (Mi’kmaq Ecological Study, n.d.) *Etuaptmumk* or *Two-Eyed Seeing*, coined by Mi’kmaw Elder Albert Marshall, is an approach to using both Mi’kmaw and Western ways of knowing and is used to respect different knowledge systems while informing resource management decision-making (Bartlett et al., 2012; Warrior et al., 2022).

The regulators should outline how to use MEK in consultation planning, enhancing transparency and free prior and informed consent (FPIC) (Warrior et al., 2022). It may be necessary to allocate additional funding to employ Mi’kmaq Ecological Knowledge experts, liaisons, or consultants during project development (*Community Ownership of Renewable Energy*, 2023). OSW developers should include MEK studies and diverse insights to understand the unique impacts Mi’kmaw communities face from development projects and to mitigate issues that can arise from differences in ecological practices and belief systems (No’gmaq et al., 2024).. It is important to note that MEKs do not constitute consultation themselves or replace the need for ongoing consultation with Mi’kmaw communities. MEKs should be fulsome in scope and focus on historical and contemporary use, cultural components, and values (Warrior et al., 2022, p. 1306). Additionally, there should be mechanisms in place for Mi’kmaq Ecological Knowledge to be shared with the Crown in a confidential or protected manner throughout the project’s lifecycle (Miawpukek First Nation Comments on the Regional Assessment of Offshore Wind in Nova Scotia and Newfoundland and Labrador, 2022, p. 27).

6.1.5 Mi’kmaw Training and Employment

It is crucial to prioritize equitable employment and training opportunities to address gaps in Mi’kmaw education and employment and foster inclusive growth in the labour market while promoting sustainable economic development for Mi’kmaw communities. Regulators should include Mi’kmaq have fair and equitable access to employment, training, and educational opportunities at all stages of OSW project development, as emphasized in the Calls to Action (Truth and Reconciliation Commission of Canada: Calls to Action, 2015) in the OSW regulatory framework. This commitment promotes social justice and economic empowerment and contributes to the overall well-being and prosperity of Mi’kmaw communities. Providing equitable opportunities involves implementing targeted recruitment, developing, and promoting skilled training programs, and educational programming for youth, community members and business owners that promote entrepreneurial capacity and financial management to increase opportunity for Mi’kmaw-owned and operated businesses to participate in the region's economic activities. These initiatives must be culturally relevant and accessible to Indigenous youth and community members.

One program that aims to improve Indigenous training and employment in North America is the *Indigenous Skills and Employment Training Strategy* (ISETS), funded by Indigenous Services Canada (*Indigenous Skills and Employment Training (ISET)*, n.d.). This strategy assists Indigenous organizations and communities across Canada in providing training and employment services customized to local needs. Under ISETS, organizations can work together to offer skills development, job readiness programs, and apprenticeships. These efforts have significantly increased Indigenous involvement in various sectors, including renewable energy, construction, and healthcare, by offering culturally appropriate training and linking participants with job opportunities. Similar strategies can be implemented in Nova Scotia by collaborating with Mi'kmaw communities and organizations to create specialized training programs that meet regional economic priorities.

Utilizing models such as the Mi’kmaw Economic Benefits Office (MEBO) and The Confederacy of Mainland Mi’kmaq (CMM) as examples of effective collaboration, Mi'kmaw leaders can demonstrate the feasibility and benefits of partnership approaches. By advocating for these partnerships, Mi'kmaw communities can ensure that initiatives focus on areas critical to their development, such as environmental stewardship, fisheries management, and long-term economic sustainability. This proactive approach can empower Mi'kmaw leadership and ensure that community members are actively involved in shaping and implementing programs that contribute to their economic self-sufficiency and overall well-being.

7. Summary and Recommendations

As the RA process is ongoing and regulatory framework for OSW development projects still in in progress, KMKNO has the opportunity to provide feedback to the RA committee and regulators specifically in relation to KMKNO key areas of concern including but not limited to MEK, SAR, Archaeology, and MPAs, as discussed in this report. Key takeaways include:

- Significant focus will need to be put on the development of fair and equitable compensation structures for both Mi’kmaw and non-Mi’kmaw commercial fisheries.
- **Commercial fisheries -** Further research, encompassing the analysis of DFO’s communal and commercial fishing data, is imperative to clarify the real, anticipated impact of OSW development on the fishery economy. Thorough examination and inclusive dialogue are necessary to design compensation frameworks that promote fairness, transparency, and mutual benefit among all parties involved in OSW development and fisheries management in Atlantic Canada.
- **Marine SAR and MPAs** - The largest potential impacts to fish and marine mammals were determined to be responses to UWN and EMFs. UWN is largely anticipated during the construction phase of the Project whereas EMFs are largely anticipated during the operation phase of the Project. With further research and mitigation measures largely directed at effects of UWN, the anticipated effects of an OSW development in the Study Areas may minimal.
- **Avifauna** - Further information is needed for all coastal bird groups for a full picture about their risk from OSW development. As OSW developments are away from the coast and valuable bird habitat, impacts may be largely limited to flight for most birds.
- **Bats** - Information about bat offshore migration routes is key to understanding the impact of OSW development on bats. Migratory bats have been found to be the most impacted by wind development through mortality from collisions with turbine blades and barotrauma. Some research suggests bats which forage far from shore may be attracted to the OSW development structures and localized increase in insect presence.
- **Cultural Heritage and Archaeology** –Recommend process on the collection of cultural information and potential requirements for developers to share data related to seabed /historical landscape with KMKNO.
- Similar to the Nova Scotia RA recommendations on research on impacts of OSW developments to commercial fisheries, marine SAR, avifauna and bats, there is an opportunity for data share agreement on KMKNO areas of concern with the regulator. In the Nova Scotia RA interim report, one recommendation was baseline studies – further to this recommendations is the opportunity to require the baseline data collected to be provided to the regulator and to Mi’kmaw so the data can incorporated as Traditional Ecological Knowledge for future development projects for all KMKNO areas of concerns including, Mi’kmaw Knowledge, Species at Risk, Archaeology, and Marine Protected Areas. However governance would be need to be determined on the ownership and use such as a data share agreement for future OSW projects.
- **Mi’kmaw rights** - Meaningful consultation and engagement with Mi’kmaw communities are crucial for obtaining social licenses and addressing potential impacts on Mi’kmaw rights (Aboriginal and treaty rights) and interests. Need to assess the potential economic development and social benefits that such projects may provide to the region and the opportunities that may become available to Mi’kmaw communities and community members, including leadership and Mi’kmaw business prospects, employment opportunities, design and construction initiatives, training for skilled work, and potential equity-building. Explore potential for demonstrated engagement with indigenous communities to be incorporated into processes for lease allocation and relevant approvals.
- Forecasting models and methodologies can be adopted to assess the socio-economic benefits of OSW development for Mi’kmaw communities in Nova Scotia. The Cradle-to-Grave model can be used to assess the entire lifecycle of an OSW development, from planning and construction to operation and decommissioning (QBIS, 2020a, 2020b). This model could assess investment costs, economic value-add-ons, housing and community infrastructure opportunities, and job distribution for Mi’kmaq communities. Ultimately, the Cradle-to-Grave model can quantify a specific capacity’s long-term socio-economic benefits and impacts (e.g., 1 gigawatt) (QBIS, 2020a, 2020b). More research is required to determine the necessary policies for effectively supporting Mi’kmaw equity ownership of renewable energy (Hoicka et al., 2021).

An integrated approach to developing regulatory pathways is needed with support from governments, fishers, Mi’kmaw communities, academia, and the private sector (IAAC, 2024, p. 62). With Atlantic Canada's fishery economies already under strain from climate change impacts, active Mi’kmaw involvement in OSW is crucial. By engaging in partnership and governance models that integrate Mi’kmaw perspectives, substantial socio-economic benefits may be achieved. Incorporating Mi’kmaq Ecological Knowledge and future visions can guide OSW project design to ensure positive socio-economic outcomes. The economic gains from OSW can bolster marine economies, offering resilience and growth opportunities for Mi’kmaw communities. Meaningful inclusion and partnership with Mi’kmaw throughout OSW development, from planning to decommissioning, are vital for realizing economic, environmental, and social benefits for the Mi’kmaq of Nova Scotia and ensuring project sustainability in Atlantic Canada.

8. References

6 Guidelines for Projects Involving Traditional Indigenous Knowledge. (2018, July 25). Indigenous Corporate Training INC. https://www.ictinc.ca/blog/6-guidelines-for-projects-involving-traditional-indigenous-knowledge

Ahlén, I., Baagøe, H. J., & Bach, L. (2007). *Bats and offshore wind turbines studied in southern Scandinavia*. Swedish Environmental Protection Agency.

Ahlén, I., Baagøe, H. J., & Bach, L. (2009). Behavior of Scandinavian Bats during Migration and Foraging at Sea. *Journal of Mammalogy*, *90*(6), 1318–1323. https://doi.org/10.1644/09-MAMM-S-223R.1

Allison, T. D., & Butryn, R. (2020). *2nd Edition: Summary of Bat Fatality Monitoring Data Contained in AWWIC*. American Wind Wildlife Institute.

Arnett, E. B., & Baerwald, E. F. (2013). Impacts of Wind Energy Development on Bats: Implications for Conservation. In *Bat Evolution, Ecology, and Conservation* (pp. 435–456). Springer New York.

Arnett, E. B., Brown, W. K., Erickson, W. P., Fiedler, J. K., Hamilton, B. L., Henry, T. H., Jain, A., Johnson, G. D., Kerns, J., Koford, R. R., Nicholson, C. P., O'connell, T. J., Piorkowski, M. D., & Tankersley Jr., R. D. (2008). Patterns of Bat Fatalities at Wind Energy Facilities in North America. *The Journal of Wildlife Management*, *72*(1), 61–78. https://doi.org/10.2193/2007-221

Audubon. (2024). *Bird Migration Explorer*. https://explorer.audubon.org/home?sidebar=collapse&zoom=4&layersPanel=expand

Badding, M. (2021). *Offshore Wind and the Fishing Industry: The Path to Co-Existence*. Kleinman Center for Energy Policy. https://kleinmanenergy.upenn.edu/news-insights/offshore-wind-and-the-fishing-industry-the-path-to-co-existence/

Baerwald, E. F., & Barclay, R. M. R. (2011). Patterns of activity and fatality of migratory bats at a wind energy facility in Alberta, Canada. *The Journal of Wildlife Management*, *75*(5), 1103–1114. https://doi.org/10.1002/jwmg.147

Bailey, H., Brookes, K. L., & Thompson, P. M. (2014). Assessing environmental impacts of offshore wind farms: Lessons learned and recommendations for the future. *Aquatic Biosystems*, *10*(1), 8. https://doi.org/10.1186/2046-9063-10-8

Ballasus, H., & Huppop, O. (2006). Estimating the condition and flight range of short- and long-distance passerine migrants: Are additional flight costs caused by barrier-effects from offshore windfarms a problem? *Journal Für Ornithologie*, *147*.

Barbut, L., Vastenhoud, B., Vigin, L., Degraer, S., Volckaert, F., & Lacroix, G. (2020). The proportion of flatfish recruitment in the North Sea potentially affected by offshore windfarms. *ICES Journal of Marine Science*, *77*. https://doi.org/10.1093/icesjms/fsz050

Barclay, R. M. R., Baerwald, E. F., & Gruver, J. C. (2007). Variation in bat and bird fatalities at wind energy facilities: Assessing the effects of rotor size and tower height. *Canadian Journal of Zoology*, *85*(3), 381–387. https://doi.org/10.1139/Z07-011

Bartlett, C., Marshall, M., & Marshall, A. (2012). Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing. *Journal of Environmental Studies and Sciences*, *2*(4), 331–340. https://doi.org/10.1007/s13412-012-0086-8

Bergström, L., Sundqvist, F., & Bergström, U. (2013). Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. *Marine Ecology Progress Series*, *485*, 199–210. https://doi.org/10.3354/meps10344

Bochert, R., & Zettler, M. L. (2004). Long-term exposure of several marine benthic animals to static magnetic fields. *Bioelectromagnetics*, *25*(7), 498–502. https://doi.org/10.1002/bem.20019

BOEM-Electromagnetic-Fields-Offshore-Wind-Facilities_1.pdf. (n.d.). Retrieved March 6, 2024, from https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/BOEM-Electromagnetic-Fields-Offshore-Wind-Facilities_1.pdf

Bonar, P. A. J., Bryden, I. G., & Borthwick, A. G. L. (2015). Social and ecological impacts of marine energy development. *Renewable and Sustainable Energy Reviews*, *47*, 486–495. https://doi.org/10.1016/j.rser.2015.03.068

Bonsu, P. O., Letschert, J., Yates, K. L., Svendsen, J. C., Berkenhagen, J., Rozemeijer, M. J. C., Kerkhove, T. R. H., Rehren, J., & Stelzenmüller, V. (2024). Co-location of fisheries and offshore wind farms: Current practices and enabling conditions in the North Sea. *Marine Policy*, *159*, 105941. https://doi.org/10.1016/j.marpol.2023.105941

Bort Thornton, J. E., Richlen, M. F., McDonald, T. B., & Bell, J. T. (2023). Opportunistic Offshore Sighting of a Tricolored Bat (Perimyotis subflavus). *Southeastern Naturalist*, *22*(1). https://doi.org/10.1656/058.022.0106

Britannica Encyclopedia. (2024, May 22). *Passeriform*. https://www.britannica.com/animal/passeriform

Brown, T. E. (2018, January). *Reconciling Indigenous governance in marine spaces: Mi'kmaq engagement in tidal energy in the Bay of Fundy, N.S.* https://dalspace.library.dal.ca/bitstream/handle/10222/73881/Brown_T_SubmittedCopy2018%20%282%29%20-%20Copy.pdf?sequence=1&isAllowed=y

Bureau of Ocean Energy Management (BOEM). (2014). *Development of Mitigation Measures to Address Potential Use Conflicts between Commercial Wind Energy Lessees/Grantees and Commercial Fishermen on the Atlantic Outer Continental Shelf Report on Best Management Practices and Mitigation Measures. A final* *report for the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewal Energy Programs, Herndon, VA. OCS Study BOEM 2014-654* (p. 98).

Bureau of Ocean Energy Management Office of Renewable Energy Programs (BOEM). (2022). *Guidelines for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR Part 585*.

Burger, J., Gordon, C., Lawrence, J., Newman, J., Forcey, G., & Vlietstra, L. (2011). Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. *Renewable Energy*, *36*(1), 338–351. https://doi.org/10.1016/j.renene.2010.06.048

Buyse, J. (2023). *Ecological impacts of offshore wind farms on flatfish with emphasis on plaice* Pleuronectes platessa*, a species of commercial interest in the southern North Sea*. Ghent University.

Buyse, J., Backer, A. D., & Hostens, K. (2021). Small-scale distribution patterns of flatfish on artificial hard substrates in a Belgian offshore wind farm. In *Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Attraction, avoidance and habitat use at various spatial scales.* (pp. 69–76). Royal Belgian Institute of Natural Sciences (RBINS) Operational Directorate Natural Environment, Marine Ecology and Management Section. https://pureportal.ilvo.be/en/publications/small-scale-distribution-patterns-of-flatfish-on-artificial-hard-

Buyse, J., Hostens, K., Degraer, S., & De Backer, A. (2022). Offshore wind farms affect the spatial distribution pattern of plaice *Pleuronectes platessa* at both the turbine and wind farm scale. *ICES Journal of Marine Science*, *79*(6), 1777–1786. https://doi.org/10.1093/icesjms/fsac107

Callaghan, J., Westin-Eastaugh, L., & Vanclieaf, D. (2021). *The Indigenous Right to a Moderate Livelihood: A Need for Clarity*. https://www.mcinnescooper.com/publications/the-indigenous-right-to-a-moderate-livelihood-a-need-for-clarity/

Canada National Marine Conservation Areas Act, S.C. 2002, c. 18 (2002). https://laws-lois.justice.gc.ca/eng/acts/c-7.3/FullText.html

Carbon Trust. (2015). *Cable Burial Risk Assessment Methodology: Guidance for the Preparation of Cable Burial Depth of Lowering Specification* (CTC835). https://ctprodstorageaccountp.blob.core.windows.net/prod-drupal-files/documents/resource/public/cable-burial-risk-assessment-guidance.pdf

Carpenter, J. R., Merckelbach, L., Callies, U., Clark, S., Gaslikova, L., & Baschek, B. (2016). Potential Impacts of Offshore Wind Farms on North Sea Stratification. *PLOS ONE*, *11*(8), e0160830. https://doi.org/10.1371/journal.pone.0160830

Chaji, M., & Werner, S. (2023). Economic Impacts of Offshore Wind Farms on Fishing Industries: Perspectives, Methods, and Knowledge Gaps. *Marine and Coastal Fisheries*, *15*(3), e10237. https://doi.org/10.1002/mcf2.10237

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (1999). *Bicknell's Thrush (Catharus bicknelli)*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_bicknells_thrush_1100_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2003). *COSEWIC Assessment and Status Report on the Cusk (*Brosme brosme*) in Canada*. https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/sr_cusk_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2004). *COSEWIC Assessment and Status Report on the Striped Bass (*Morone saxatilis*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_striped_bass_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2006). *COSEWIC Assessment and Status Report on the White Shark (*Carcharodon carcharias*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_white_shark_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2008). *Canada Warbler (wilsonia canadensis)*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_canada_warbler_0808_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2010a). *Bobolink (Dolichonyx oryzivorus)*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Bobolink_0810_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2010b). *COSEWIC Assessment and Status Report on the Atlantic Cod (*Gadus morhua*) in Canada*.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2010c). *COSEWIC Assessment and Status Report on the Atlantic Salmon (*Salmo salar*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Atlantic_Salmon_2011a_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2011a). *COSEWIC Assessment and Status Report on the Atlantic Sturgeon (*Acipenser oxyrinchus*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Atlantic%20Sturgeon_2011_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2011b). *COSEWIC Assessment and Status Report on the Northern Bottlenose Whale (*Hyperoodon ampullatus*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_northern_bottlenose_whale_0911_eng.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2012a). *COSEWIC Assessment and Status Report on the Atlantic Wolffish(*Anarhichas lupus*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_loupe_atl_wolffish_1013_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2012b). *COSEWIC Assessment and Status Report on the Blue Whale (*Balaenoptera musculus*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sas_rorqual_bleu_atl_blue_whale_0912_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2013a). *COSEWIC Assessment and Status Report on the North Atlantic Right Whale (*Eubalaena glacialis*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_North%20Atlantic%20Right%20Whale_2013_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2013b). *COSEWIC Assessment and Status Report on the White Hake (*Urophycis tenuis*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_White%20Hake_2013_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2013c). *Harlequin Duck,Histrionicus histrionicus*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Harlequin%20Duck_2013_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2014). *COSEWIC Assessment and Status Report on the Beluga Whale (*Delphinapterus leucas*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Beluga%20Whale_2014_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2017). *Rusty Blackbird, Euphagus carolinus*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Rusty%20Blackbird_2017_e.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2018). *Basking Shark (*Cetorhinus maximus*)*. https://publications.gc.ca/collections/collection_2020/eccc/CW69-14-2-63-2018-eng.pdf

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). (2019). *COSEWIC Assessment and Status Report on the Fin Whale (*Balaenoptera physalus*) in Canada*. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr-RoqualCommunFinWhale-v00-2019-Eng.pdf

Community Ownership of Renewable Energy: How it Works in Nine Countries |. (2023, February 21). Institute for Human Rights and Business. https://www.ihrb.org/focus-areas/just-transitions/community-ownership-of-renewable-energy-how-it-works-in-nine-countries

Cook, A. S. C. P., Humphreys, E. M., Bennet, F., Masden, E. A., & Burton, N. H. K. (2018). Quantifying avian avoidance of offshore wind turbines: Current evidence and key knowledge gaps. *Marine Environmental Research*, *140*, 278–288. https://doi.org/10.1016/j.marenvres.2018.06.017

Corbett, W. T. (2018). *The behavioural and physiological effects of pile-driving noise on marine species*. University of Exeter (United Kingdom).

Costello, M. J. (2024). Evidence of economic benefits from marine protected areas. *Scientia Marina*, *88*(1), Article 1. https://doi.org/10.3989/scimar.05417.080

Cryan, P. M., & Brown, A. C. (2007). Migration of bats past a remote island offers clues toward the problem of bat fatalities at wind turbines. *Biological Conservation*, *139*(1–2), 1–11. https://doi.org/10.1016/j.biocon.2007.05.019

CSA Ocean Sciences Inc. (2021). *Marine Mammal, Sea Turtle, and Sturgeon Impacts and Underwater Acoustic Assessment. Technical Appendix for South Fork Wind* (p. 112).

Dahlgren, T., Hestetun, J., & Ray, J. (2023). The Use of eDNA to Monitor Pelagic Fish in Offshore Floating Wind Farms. *Oceanography*. https://doi.org/10.5670/oceanog.2023.s1.30

Dannheim, J., Bergström, L., Birchenough, S. N. R., Brzana, R., Boon, A. R., Coolen, J. W. P., Dauvin, J.-C., De Mesel, I., Derweduwen, J., Gill, A. B., Hutchison, Z. L., Jackson, A. C., Janas, U., Martin, G., Raoux, A., Reubens, J., Rostin, L., Vanaverbeke, J., Wilding, T. A., … Degraer, S. (2020). Benthic effects of offshore renewables: Identification of knowledge gaps and urgently needed research. *ICES Journal of Marine Science*, *77*(3), 1092–1108. https://doi.org/10.1093/icesjms/fsz018

Davis, A., & Jentoft, S. (2001). The challenge and the promise of indigenous peoples’ fishing rights- from dependency to agency. *Marine Policy*.

de Lucas, M., Ferrer, M., Bechard, M. J., & Muñoz, A. R. (2012). Griffon vulture mortality at wind farms in southern Spain: Distribution of fatalities and active mitigation measures. *Biol. Conserv.*, *147*, 184–189.

De Mesel, I., Kerckhof, F., Norro, A., Rumes, B., & Degraer, S. (2015). Succession and seasonal dynamics of the epifauna community on offshore wind farm foundations and their role as stepping stones for non-indigenous species. *Hydrobiologia*, *756*. https://doi.org/10.1007/s10750-014-2157-1

Deakin, Z., Cook, A., Daunt, F., McCluskie, A., Morley, N., Witcutt, E., Wright, L., & Bolton, M. (2022). *A review to inform the assessment of the risk of collision and displacement in petrels and shearwaters from offshore wind developments in Scotland*. Scottish Government. https://nora.nerc.ac.uk/id/eprint/534031/1/N534031CR.pdf

Degraer, S., Brabant, R., & Rumes, B. (2012). *Offshore wind farms in the Belgian part of the North Sea: Heading for an understanding of environmental impacts*. Royal Belgian Institute of Natural Sciences.

Degraer, S., Carey, D., Coolen, J., Hutchison, Z., Kerckhof, F., Rumes, B., & Vanaverbeke, J. (2020). Offshore Wind Farm Artificial Reefs Affect Ecosystem Structure and Functioning: A Synthesis. *Oceanography*, *33*(4), 48–57. https://doi.org/10.5670/oceanog.2020.405

Denny, S. K., & Fanning, L. M. (2016). A Mi’kmaw Perspective on Advancing Salmon Governance in Nova Scotia, Canada: Setting the Stage for Collaborative Co-Existence. *International Indigenous Policy Journal*, *7*(3). https://doi.org/10.18584/iipj.2016.7.3.4

Department for Business, Energy and Industrial Strategy (BEIS). (2022). *UK Offshore Energy Strategic Environmental Assessment: Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas and Gas Storage and Associated Infrastructure*.

Desholm, M., & Kahlert, J. (2005). Avian collision risk at an offshore wind farm. *Biology Letters*, *1*(3), 296–298. https://doi.org/10.1098/rsbl.2005.0336

Dierschke, V., Furness, R. W., Gray, C. E., Petersen, I. K., Schmutz, J. A., Zydelis, R., & Daunt, F. (2017). *Possible behavioural, energetic and demographic effects of displacement of red-throated divers*. UK Joint Nature Conservation Committee.

Dolman, S., & Simmonds, M. (2010). Towards best environmental practice for cetacean conservation in developing Scotland’s marine renewable energy. *Marine Policy*, *34*(5), 1021–1027. https://doi.org/10.1016/j.marpol.2010.02.009

Dowling, Z. R. (2018). *NOT GONE WITH THE WIND: Addressing effects of offshore wind development on bat species in the Northeastern United States*.

Dunham, A., Pegg, J. R., Carolsfeld, W., Davies, S., Murfitt, I., & Boutillier, J. (2015). Effects of submarine power transmission cables on a glass sponge reef and associated megafaunal community. *Marine Environmental Research*, *107*, 50–60. https://doi.org/10.1016/j.marenvres.2015.04.003

Dunlop, E. S., Reid, S. M., & Murrant, M. (2016). Limited influence of a wind power project submarine cable on a Laurentian Great Lakes fish community. *Journal of Applied Ichthyology*, *32*(1), 18–31. https://doi.org/10.1111/jai.12940

Eatough, L. (2021). *Floating Offshore Wind and Fishing Interaction Roadmap*.

Elegbede, I., Zurba, M., Hameed, A., & Campbell, C. (2023). Gaps and Challenges in Harnessing the Benefits and Opportunities of Indigenous Certification for a Sustainable Communal Commercial Lobster Fishery. *Environmental Management*, *72*(5), 902–921. https://doi.org/10.1007/s00267-023-01852-7

Elliott, J., Khan, A., Lin, Y., Mason, T., Miller, J., Newhall, A., Potty, G., & Vigness-Raposa, K. (2019). *Field Observations During Wind Turbine Operations at the Block Island Wind Farm, Rhode Island. (Report No. BOEM 2019-028). Report by Bureau of Ocean Energy Management (BOEM). Report for US Department of the Interior (DOI)*. https://espis.boem.gov/final%20reports/BOEM_2019-028.pdf

Empire Engineering. (n.d.). Retrieved March 5, 2024, from https://www.empireengineering.co.uk/wp-content/uploads/2021/08/The_Empire_Engineering_Guide_to_Offshore_Wind_Foundations_eBook-1.pdf

Empire Offshore Wind LLC. (2021). *Fisheries Mitigation Plan for Empire Wind 2*.

Environment and Climate Change Canada (ECCC). (2014). *Atlantic sturgeon (Acipenser oxyrhynchus oxyrhynchus): Species at risk consultation*. https://www.canada.ca/en/environment-climate-change/services/species-risk-public-registry/consultation-documents/atlantic-sturgeon.html

Environment and Climate Change Canada (ECCC). (2023). *Offshore Wind Regional Assessment Requests for Advice: Product Descriptions and Context for Interpretation*. https://iaac-aeic.gc.ca/050/documents/p83514/156019E.pdf

Espinosa, V., Perez-Arjona, I., Puig, V., Soliveres, E., Ordóñez, P., Poveda Martínez, P., Soriano, J., & de la Gándara, F. (2014, August 14). *Effects on bluefin tuna behaviour of offshore wind turbine operational noise*.

Federal Pathway to Address Missing and Murdered Indigenous Women, Girls and 2SLGBTQQIA+ People. (2021). [Report]. https://www.rcaanc-cirnac.gc.ca/eng/1622233286270/1622233321912

Fischer, C., & Slater, M. (2010). *Effects of electromagnetic fields on marine species—A literature review*. Oregon Wave Energy Trust.

Fisheries and Oceans Canada (DFO). (2015, November 16). *Commercial fisheries for Clams (Atlantic surf clam, Soft shell clam, Stimpson’s surf clam, Atlantic razor clam)*. https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/atl-arc/clam-mactre-eng.html

Fisheries and Oceans Canada (DFO). (2018a). *Bluefin Tuna*. https://www.dfo-mpo.gc.ca/species-especes/profiles-profils/bluefin-tuna-thon-rouge-eng.html

Fisheries and Oceans Canada (DFO). (2018b). *Elver integrated fisheries management plan (evergreen)—Maritimes Region*. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/elver-anguille/index-eng.html

Fisheries and Oceans Canada (DFO). (2019, February 1). *Regional Oceans Plan—Scotian Shelf, Atlantic Coast, Bay of Fundy Progress Report*. https://www.dfo-mpo.gc.ca/oceans/publications/oceans-plan/background-contexte/page03-eng.html

Fisheries and Oceans Canada (DFO). (2021). *Fisheries by species—Atlantic, Quebec and Arctic regions commercial fisheries*. https://www.dfo-mpo.gc.ca/fisheries-peches/commercial-commerciale/atl-arc/index-eng.html

Fisheries and Oceans Canada (DFO). (2023a). *Acadian Redfish (Sebastes fasciatus), Atlantic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1096-752

Fisheries and Oceans Canada (DFO). (2023b). *American Eel (Anguilla rostrata)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/891-632

Fisheries and Oceans Canada (DFO). (2023c). *American Plaice (Hippoglossoides platessoides), Maritimes population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1053-720

Fisheries and Oceans Canada (DFO). (2023d). *Atlantic Wolffish (Anarhichas lupus)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/652-391

Fisheries and Oceans Canada (DFO). (2023e). *Cusk (Brosme brosme)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/756-316

Fisheries and Oceans Canada (DFO). (2023f). *Deepwater Redfish (Sebastes mentella), Gulf of St. Lawrence—Laurentian Channel population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1100-757

Fisheries and Oceans Canada (DFO). (2023g). *Harbour Porpoise (Phocoena phocoena), Northwest Atlantic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/147-130

Fisheries and Oceans Canada (DFO). (2023h). *Killer Whale (Orcinus orca), Northwest Atlantic / Eastern Arctic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/598-6

Fisheries and Oceans Canada (DFO). (2023i). *Leatherback Sea Turtle (Dermochelys coriacea), Atlantic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1191-861

Fisheries and Oceans Canada (DFO). (2023j). *Loggerhead Sea Turtle (Caretta caretta)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1090-753

Fisheries and Oceans Canada (DFO). (2023k). *Northern Wolffish (Anarhichas denticulatus)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/667-260

Fisheries and Oceans Canada (DFO). (2023l). *Porbeagle (Lamna nasus)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/810-368

Fisheries and Oceans Canada (DFO). (2023m). *Roundnose Grenadier (Coryphaenoides rupestris)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1032-715

Fisheries and Oceans Canada (DFO). (2023n). *Shortfin Mako (Isurus oxyrinchus), Atlantic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/909-636

Fisheries and Oceans Canada (DFO). (2023o). *Smooth Skate (Malacoraja senta), Laurentian-Scotian population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1186-856

Fisheries and Oceans Canada (DFO). (2023p). *Sowerby’s Beaked Whale (Mesoplodon bidens)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/169-432

Fisheries and Oceans Canada (DFO). (2023q). *Spiny Dogfish (Squalus acanthias), Atlantic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1102-755

Fisheries and Oceans Canada (DFO). (2023r). *Spotted Wolffish (Anarhichas minor)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/669-261

Fisheries and Oceans Canada (DFO). (2023s). *Thorny Skate (Amblyraja radiata)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1181-857

Fisheries and Oceans Canada (DFO). (2023t). *Winter Skate (Leucoraja ocellata), Eastern Scotian Shelf—Newfoundland population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1292-944

Fisheries and Oceans Canada (DFO). (2024a). *Canada’s Marine Mammal Regulations*. https://www.dfo-mpo.gc.ca/about-notre-sujet/publications/infographics-infographies/marine-mammals-regs-mammiferes-marins-eng.html

Fisheries and Oceans Canada (DFO). (2024b, April 2). *Seafisheries landed value by province, 2022*. https://www.dfo-mpo.gc.ca/stats/commercial/land-debarq/sea-maritimes/s2022pv-eng.htm

Fisheries and Oceans Canada (DFO), F. and O. C. (2018c, February 12). *Offshore Scallop*. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/scallop-petoncle/2018/index-eng.html

Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW). (2014). *FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison*. 74.

Fleming, T. H., Eby, P., Kunz, T., & Fenton, M. (2003). Ecology of bat migration. *Bat Ecology*, *156*, 164–165.

Floeter, J., van Beusekom, J. E. E., Auch, D., Callies, U., Carpenter, J., Dudeck, T., Eberle, S., Eckhardt, A., Gloe, D., Hänselmann, K., Hufnagl, M., Janßen, S., Lenhart, H., Möller, K. O., North, R. P., Pohlmann, T., Riethmüller, R., Schulz, S., Spreizenbarth, S., … Möllmann, C. (2017). Pelagic effects of offshore wind farm foundations in the stratified North Sea. *Progress in Oceanography*, *156*, 154–173. https://doi.org/10.1016/j.pocean.2017.07.003

Foley, A. M., Stacy, B. A., Hardy, R. F., Shea, C. P., Minch, K. E., & Schroeder, B. A. (2019). Characterizing watercraft-related mortality of sea turtles in Florida. *The Journal of Wildlife Management*, *83*(5), 1057–1072. https://doi.org/10.1002/jwmg.21665

Fox, A. D., Desholm, M., Kahlert, J., Christensen, T. K., & Krag Petersen, I. (2006). Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. *Ibis*, *148*(s1), 129–144. https://doi.org/10.1111/j.1474-919X.2006.00510.x

Fox, A., & Petersen, I. (2019). *Offshore wind farms and their effects on birds*.

Gelder, R. G. V. (1956). Echo-Location Failure in Migratory Bats. *Transactions of the Kansas Academy of Science (1903-)*, *59*(2), 220. https://doi.org/10.2307/3626963

Gill, A., Degraer, S., Lipsky, A., Mavraki, N., Methratta, E., & Brabant, R. (2020). Setting the Context for Offshore Wind Development Effects on Fish and Fisheries. *Oceanography*, *33*(4), 118–127. https://doi.org/10.5670/oceanog.2020.411

Gill, A., & Desender, M. (2020). *2020 State of the Science Report, Chapter 5: Risk to Animals from Electromagnetic Fields Emitted by Electric Cables and Marine Renewable Energy Devices* (PNNL--29976CHPT5, 1633088; p. PNNL--29976CHPT5, 1633088). https://doi.org/10.2172/1633088

Gimpel, A., Werner, K. M., Bockelmann, F.-D., Haslob, H., Kloppmann, M., Schaber, M., & Stelzenmüller, V. (2023). Ecological effects of offshore wind farms on Atlantic cod (*Gadus morhua*) in the southern North Sea. *Science of The Total Environment*, *878*, 162902. https://doi.org/10.1016/j.scitotenv.2023.162902

Gitschlag, G. R., & Herczeg, B. A. (1994). Sea Turtle Observations at Explosive Removals of Energy Structures. *Marine Fisheries Review*.

Glarou, M., Zrust, M., & Svendsen, J. C. (2020). Using Artificial-Reef Knowledge to Enhance the Ecological Function of Offshore Wind Turbine Foundations: Implications for Fish Abundance and Diversity. *Journal of Marine Science and Engineering*, *8*(5), 332. https://doi.org/10.3390/jmse8050332

Glasson, J., Durning, B., Olorundami, T., & Welch, K. (2020). *Guidance on assessing the socio-economic impacts of offshore wind farms (OWFs)*. 65 pages. https://doi.org/10.24384/AX1S-JR48

Gorman, M. (2024, March 26). New report finds offshore wind development in Nova Scotia could be a decade away. *CBC News*. https://www.cbc.ca/news/canada/nova-scotia/offshore-wind-development-energy-tory-rushton-fishing-1.7155876

Government of Canada. (2023a). *Bank Swallow (Riparia riparia)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1233-894

Government of Canada. (2023b). *Bicknell's Thrush (Catharus bicknelli)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/584-401

Government of Canada. (2023c). *Leach's Storm-Petrel (Oceanodroma leucorhoa), Atlantic population—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/1496-1084

Government of Canada. (2023d). *Roseate Tern (Sterna dougallii)—Species search—Species at risk registry*. https://species-registry.canada.ca/index-en.html#/species/40-42

Government of Canada, F. and O. C. (2021a, March 4). *The Marshall decisions*. https://www.dfo-mpo.gc.ca/fisheries-peches/aboriginal-autochtones/moderate-livelihood-subsistance-convenable/marshall-overview-apercu-eng.html

Government of Canada, F. and O. C. (2021b, April 29). *Implementing the right to fish in pursuit of a moderate livelihood: Rebuilding trust and establishing a constructive path forward*. https://www.dfo-mpo.gc.ca/fisheries-peches/aboriginal-autochtones/moderate-livelihood-subsistance-convenable/surette-report-rapport-mar-2021-eng.html

Government of Canada, S. C. (2021, July 19). *Canada's oceans and the economic contribution of marine sectors*. Statistics Canada. https://www150.statcan.gc.ca/n1/pub/16-002-x/2021001/article/00001-eng.htm

Griffin, R. A., Robinson, G. J., West, A., Gloyne-Phillips, I. T., & Unsworth, R. K. F. (2016). Assessing Fish and Motile Fauna around Offshore Windfarms Using Stereo Baited Video. *PloS One*, *11*(3), e0149701. https://doi.org/10.1371/journal.pone.0149701

Guest, E. E., Stamps, B. F., Durish, N. D., Hale, A. M., Hein, C. D., Morton, B. P., Weaver, S. P., & Fritts, S. R. (2022). An Updated Review of Hypotheses Regarding Bat Attraction to Wind Turbines. *Animals*, *12*(3), 343. https://doi.org/10.3390/ani12030343

Guida, V., Drohan, A., Welch, H., McHenry, J., Johnson, D., Kentner, V., Brink, J., Timmons, D., Pessutti, J., Fromm, S., & Estela-Gomez, E. (2017). *Habitat Mapping and Assessment of Northeast Wind Energy Areas*. Bureau of Ocean Energy Management. https://tethys.pnnl.gov/sites/default/files/publications/Guida-et-al-2017.pdf

Haggett, C., ten Brink, T., Russell, A., Roach, M., Firestone, J., Dalton, T., & Mccay, B. (2020). Offshore Wind Projects and Fisheries: Conflict and Engagement in the United Kingdom and the United States. *Oceanography*, *33*, 38–47. https://doi.org/10.5670/oceanog.2020.404

Halm, I. van. (2023, May 17). Dutch offshore wind farms shut down to allow bird migration. *Power Technology*. https://www.power-technology.com/news/dutch-offshore-wind-farms-shut-down-to-allow-bird-migration/

Halouani, G., Villanueva, C.-M., Raoux, A., Dauvin, J. C., Ben Rais Lasram, F., Foucher, E., Le Loc'h, F., Safi, G., Araignous, E., Robin, J. P., & Niquil, N. (2020). A spatial food web model to investigate potential spillover effects of a fishery closure in an offshore wind farm. *Journal of Marine Systems*, *212*, 103434. https://doi.org/10.1016/j.jmarsys.2020.103434

Hammar, L., Andersson, S., Rosenberg, R., & Dimming, A. (2010). *Adapting offshore wind power foundations to local environment* (6367; p. 86). Swedish Environmental Protection Agency.

Harding, H., Bruintjes, R., Radford, A., & Simpson, S. (2016). *Measurement of Hearing in the Atlantic salmon (Salmo salar) using Auditory Evoked Potentials, and effects of Pile Driving Playback on salmon Behaviour and Physiology: Vol 7 No 11*. Scottish Marine and Freshwater Science. https://data.marine.gov.scot/dataset/measurement-hearing-atlantic-salmon-salmo-salar-using-auditory-evoked-potentials-and-effects

Harnois, V., Smith, H. C. M., Benjamins, S., & Johanning, L. (2015). Assessment of entanglement risk to marine megafauna due to offshore renewable energy mooring systems. *International Journal of Marine Energy*, *11*, 27–49. https://doi.org/10.1016/j.ijome.2015.04.001

Harris, D., & Millerd, P. (2010). Food Fish, Commercial Fish, and Fish to Support a Moderate Livelihood: Characterizing Aboriginal and Treaty Rights to Canadian Fisheries. *Arctic Review on Law and Politics*, *1*(1), 82–107. https://doi.org/10.23865/arctic.v1.2

Harsanyi, P., Scott, K., Easton, B. A. A., de la Cruz Ortiz, G., Chapman, E. C. N., Piper, A. J. R., Rochas, C. M. V., & Lyndon, A. R. (2022). The Effects of Anthropogenic Electromagnetic Fields (EMF) on the Early Development of Two Commercially Important Crustaceans, European Lobster, *Homarus gammarus* and Edible Crab, *Cancer pagurus*. *Journal of Marine Science and Engineering*, *10*(5), Article 5. https://doi.org/10.3390/jmse10050564

Hatch, S. K., Connelly, E. E., Divoll, T. J., Stenhouse, I. J., & Williams, K. A. (2013). Offshore Observations of Eastern Red Bats (Lasiurus borealis) in the Mid-Atlantic United States Using Multiple Survey Methods. *PLOS ONE*, *8*(12), e83803. https://doi.org/10.1371/journal.pone.0083803

Hawkins, A. D., Pembroke, A. E., & Popper, A. N. (2015). Information gaps in understanding the effects of noise on fishes and invertebrates. *Reviews in Fish Biology and Fisheries*, *25*(1), 39–64. https://doi.org/10.1007/s11160-014-9369-3

HDR. (2018). *Benthic Monitoring during Wind Turbine Installation and Operation at the Block Island Wind Farm, Rhode Island. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2018-047* (p. 155).

Hermans, A., Bos, O. G., & Prusina, I. (2020). *Nature-Inclusive Design: A catalogue for offshore wind infrastructure*. The Ministry of Agriculture, Nature and Food Quality. https://tethys.pnnl.gov/sites/default/files/publications/Nature_inclusive_design_catalogue_offshore_wind.pdf

Hermans, A., Winter, H. V., Gill, A. B., & Murk, A. J. (2024). Do electromagnetic fields from subsea power cables effect benthic elasmobranch behaviour? A risk-based approach for the Dutch Continental Shelf. *Environmental Pollution*, *346*. https://doi.org/10.1016/j.envpol.2024.123570

Hogan, F., Hooker, B., Jensen, B., Johnston, L., Lipsky, A., Methratta, E., Silva, A., & Hawkins, A. (2023). *Fisheries and Offshore Wind Interactions: Synthesis of Science*. https://doi.org/10.25923/TCJT-3A69

Hoicka, C. E., Savic, K., & Campney, A. (2021). Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada. *Energy Research & Social Science*, *74*, 101897. https://doi.org/10.1016/j.erss.2020.101897

Hooper, T., Ashley, M., & Austen, M. (2015). Perceptions of fishers and developers on the co-location of offshore wind farms and decapod fisheries in the UK. *Marine Policy*, *61*, 16–22. https://doi.org/10.1016/j.marpol.2015.06.031

Hooper, T., & Austen, M. (2014). The co-location of offshore windfarms and decapod fisheries in the UK: Constraints and opportunities. *Marine Policy*, *43*, 295–300. https://doi.org/10.1016/j.marpol.2013.06.011

Hooper, T., Beaumont, N., & Hattam, C. (2017). The implications of energy systems for ecosystem services: A detailed case study of offshore wind. *Renewable and Sustainable Energy Reviews*, *70*, 230–241. https://doi.org/10.1016/j.rser.2016.11.248

Hutchison, Z., Bartley, M., Degraer, S., English, P., Khan, A., Livermore, J., Rumes, B., & King, J. (2020). Offshore Wind Energy and Benthic Habitat Changes: Lessons from Block Island Wind Farm. *Oceanography*, *33*(4), 58–69. https://doi.org/10.5670/oceanog.2020.406

Hutchison, Z., Secor, D., & Gill, A. (2020). The Interaction Between Resource Species and Electromagnetic Fields Associated with Electricity Production by Offshore Wind Farms. *Oceanography*, *33*(4), 96–107. https://doi.org/10.5670/oceanog.2020.409

Hutchison, Z., Sigray, P., Gill, A., Michelot, T., & King, J. (2021). *Electromagnetic Field Impacts on American Eel Movement and Migration from Direct Current Cables*. Bureau of Ocean Energy Management (BOEM). https://tethys.pnnl.gov/sites/default/files/publications/Hutchison-et-al-2021.pdf

Hutchison, Z., Sigray, P., He, H., Gill, A. B., King, J., & Gibson, C. (2018). *Electromagnetic Field (EMF) Impacts on Elasmobranch (shark, rays, and skates) and American Lobster Movement and Migration from Direct Current Cables*. https://doi.org/10.13140/RG.2.2.10830.97602

Hüttner, T., von Fersen, L., Miersch, L., & Dehnhardt, G. (2023). Passive electroreception in bottlenose dolphins (Tursiops truncatus): Implication for micro- and large-scale orientation. *Journal of Experimental Biology*, *226*(22). https://doi.org/10.1242/jeb.245845

IAAC. (2024). *Regional Assessment of Offshore Wind Development in Nova Scotia—Interim Report*. https://iaac-aeic.gc.ca/050/documents/p83514/156045E.pdf

Indigenous Skills and Employment Training (ISET). (n.d.). Congress of Aboriginal Peoples (CAP). Retrieved June 20, 2024, from https://abo-peoples.org/program/indigenous-skills-and-employment-training-iset/

Irwin, W., & Lohmann, K. (2005). Disruption of magnetic orientation in hatchling loggerhead sea turtles by pulsed magnetic fields. *Journal of Comparative Physiology. A, Neuroethology, Sensory, Neural, and Behavioral Physiology*, *191*, 475–480. https://doi.org/10.1007/s00359-005-0609-9

Jensen, F., Ringgaard, R., Blew, J., & Jacobsen, E. (2016). *Anholt Offshore Wind Farm. Post-construction Monitoring of Bird Migration – Dong Energy Report, Dong Energy, Fredericia, Denmark.*

Jézéquel, Y., Cones, S., & Mooney, T. A. (2023). Sound sensitivity of the giant scallop (*Placopecten magelanicus*) is life stage, intensity, and frequency dependent. *The Journal of the Acoustical Society of America*, *153*(2), 1130–1137. https://doi.org/10.1121/10.0017171

Johnson, N. (2010). *Impact of the Marshall Decision on the Development of a Mi'kmaw Commercial Fishery*. https://www.cbu.ca/wp-content/uploads/2019/08/Impact_of_Marshall_Decision_on_Mikmaw_Commercial_Fishery.pdf

Johnston, S. T., & Painter, K. J. (2024). Avoidance, confusion or solitude? Modelling how noise pollution affects whale migration. *Movement Ecology*, *12*(1). https://doi.org/10.1186/s40462-024-00458-w

Kahlert, J., Petersen, I. K., Fox, A. D., Desholm, M., & Clausager, I. (2004). *Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand: Annual status report 2003*.

Kikuchi, R. (2010). Risk formulation for the sonic effects of offshore wind farms on fish in the EU region. *Marine Pollution Bulletin*, *60*(2), 172–177. https://doi.org/10.1016/j.marpolbul.2009.09.023

Kilfoyle, A. K., Jermain, R. F., Dhanak, M. R., Huston, J. P., & Spieler, R. E. (2018). Effects of EMF emissions from undersea electric cables on coral reef fish. *Bioelectromagnetics*, *39*(1), 35–52. https://doi.org/10.1002/bem.22092

Kimber, J. A., Sims, D. W., Bellamy, P. H., & Gill, A. B. (2011). The ability of a benthic elasmobranch to discriminate between biological and artificial electric fields. *Marine Biology*, *158*, 1–8.

Kimber, J. A., Sims, D. W., Bellamy, P. H., & Gill, A. B. (2014). Elasmobranch cognitive ability: Using electroreceptive foraging behaviour to demonstrate learning, habituation and memory in a benthic shark. *Animal Cognition*, *17*. https://doi.org/10.1007/s10071-013-0637-8

Kirschvink, J. L. (1997). Magnetoreception: Homing in on Vertebrates. *Nature*, *390*, 339–340.

Klimley, A. P., Wyman, M. T., & Kavet, R. (2017). Chinook salmon and green sturgeon migrate through San Francisco Estuary despite large distortions in the local magnetic field produced by bridges. *PLOS ONE*, *12*(6), e0169031. https://doi.org/10.1371/journal.pone.0169031

Krebs, J., Jacobs, F., & Popper, A. N. (2016). Avoidance of pile-driving noise by Hudson river sturgeon during construction of the new NY Bridge at Tappan Zee. In *The Effects of Noise on Aquatic Life II* (pp. 555–563). Springer.

Krone, R., Dederer, G., Kanstinger, P., Krämer, P., Schneider, C., & Schmalenbach, I. (2017). Mobile demersal megafauna at common offshore wind turbine foundations in the German Bight (North Sea) two years after deployment—Increased production rate of *Cancer pagurus*. *Marine Environmental Research*, *123*, 53–61. https://doi.org/10.1016/j.marenvres.2016.11.011

Kross, S., Kennedy, R., & Thomas, L. (2019). *A Framework for Studying the Effects of Offshore Wind Development on Marine Mammals and Turtles*. Massachusetts Clean Energy Center and Bureau of Ocean energy Managememnt. https://tethys.pnnl.gov/sites/default/files/publications/Kraus-et-al-2019.pdf

Lagerveld, S., Noort, C. A., Meesters, L., Bach, L., Bach, P., & Geelhoed., S. (2020). *Assessing fatality risk of bats at offshore wind turbines*. Wageningen Marine Research. https://doi.org/10.18174/518591

Lavender, A., Bartol, S., & Bartol, I. (2012). *A two-method approach for investigating the underwater hearing capabilities of loggerhead sea turtles (Caretta caretta)*. *52*, E102–E102.

Leopold, M., Dijkman, E., & Teal, L. (2011). Local birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ). *Journal of Photochemistry and Photobiology B-Biology - J PHOTOCHEM PHOTOBIOL B-BIOL*.

Linley, E. A. S., Wilding, T. A., Black, K., Hawkings, A. J. S., & Mangi, S. (2007). *Review of the reef effects of offshore wind farm structures and their potential for enhancement and mitigation*. Report from PML Applications Ltd and the Scottish Association for Marine Science to the Department for Business, Enterprise and Regulatory Reform (BERR). https://tethys.pnnl.gov/sites/default/files/publications/Potential_for_Enhancement_and_Mitigation.pdf

Lloret, J., Turiel, A., Solé, J., Berdalet, E., Sabatés, A., Olivares, A., Gili, J.-M., Vila-Subirós, J., & Sardá, R. (2022). Unravelling the ecological impacts of large-scale offshore wind farms in the Mediterranean Sea. *Science of The Total Environment*, *824*, 153803. https://doi.org/10.1016/j.scitotenv.2022.153803

Lohmann, K. J., Luschi, P., & Hays, G. C. (2008). Goal navigation and island-finding in sea turtles. *Journal of Experimental Marine Biology and Ecology*, *356*(1–2), 83–95. https://doi.org/10.1016/j.jembe.2007.12.017

Love, M., Nishimoto, M., Clark, S., & Bull, A. (2015). Identical Response of Caged Rock Crabs (Genera Metacarcinus and Cancer) to Energized and Unenergized Undersea Power Cables in Southern California, USA. *Bulletin, Southern California Academy of Sciences*, *114*. https://doi.org/10.3160/0038-3872-114.1.33

Love, M. S., Nishimoto, M., Clark, S., & Schroeder, D. M. (2012). Recruitment of Young-of-the-Year Fishes to Natural and Artificial Offshore Structure Within Central and Southern California Waters, 2008–2010. *Bulletin of Marine Science*, *88*(4), 863–882. https://doi.org/10.5343/bms.2011.1101

Love, M. S., Nishimoto, M. M., Clark, S., McCrea, M., & Bull, A. S. (2017). Assessing potential impacts of energized submarine power cables on crab harvests. *Continental Shelf Research*, *151*, 23–29. https://doi.org/10.1016/j.csr.2017.10.002

Madsen, P., Wahlberg, M., Tougaard, J., Lucke, K., & Tyack, P. (2006). Wind turbine underwater noise and marine mammals: Implications of current knowledge and data needs. *Marine Ecology Progress Series*, *309*, 279–295. https://doi.org/10.3354/meps309279

Malagoli, D., Gobba, F., & Ottaviani, E. (2003). Effects of 50-Hz magnetic fields on the signalling pathways of fMLP-induced shape changes in invertebrate immunocytes: The activation of an alternative "stress pathway." *Biochimica et Biophysica Acta (BBA) - General Subjects*, *1620*(1–3), 185–190. https://doi.org/10.1016/S0304-4165(02)00531-7

Malagoli, D., Lusvardi, M., Gobba, F., & Ottaviani, E. (2004). 50 Hz magnetic fields activate mussel immunocyte p38 MAP kinase and induce HSP70 and 90. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, *137*(1), 75–79. https://doi.org/10.1016/j.cca.2003.11.007

MARPRO. (2022, March 22). *Crash between wind turbines and ships—Maritime Professionals*. https://maritime-professionals.com/crash-between-wind-turbines-and-ships/, https://maritime-professionals.com/crash-between-wind-turbines-and-ships/

Masden, E. A., Haydon, D. T., Fox, A. D., & Furness, R. W. (2010). Barriers to movement: Modelling energetic costs of avoiding marine wind farms amongst breeding seabirds. *Marine Pollution Bulletin*, *60*(7), 1085–1091. https://doi.org/10.1016/j.marpolbul.2010.01.016

Masden, E., Haydon, D., Fox, A., Furness, R., Bullman, R., & Desholm, M. (2009). Barriers to movement: Impacts of wind farms on migrating birds. *Ices Journal of Marine Science - ICES J MAR SCI*, *66*, 746–753. https://doi.org/10.1093/icesjms/fsp031

Maxwell, S. M., Kershaw, F., Locke, C. C., Conners, M. G., Dawson, C., Aylesworth, S., Loomis, R., & Johnson, A. F. (2022). Potential impacts of floating wind turbine technology for marine species and habitats. *Journal of Environmental Management*, *307*, 114577. https://doi.org/10.1016/j.jenvman.2022.114577

McBride, R. S., Tweedie, M. K., & Oliveira, K. (2018). Reproduction, first-year growth, and expansion of spawning and nursery grounds of black sea bass (Centropristis striata) into a warming Gulf of Maine. *Fishery Bulletin*, *116*(3–4), 323–336.

McMillan, L. J., & Prosper, K. (2016). Remobilizing netukulimk: Indigenous cultural and spiritual connections with resource stewardship and fisheries management in Atlantic Canada. *Reviews in Fish Biology and Fisheries*, *26*(4), 629–647. https://doi.org/10.1007/s11160-016-9433-2

Meloney, N. (2021, June 17). *"Man camp" threat to Mi'kmaw women unchanged since MMIWG inquiry, say advocates | CBC News*. CBC. https://www.cbc.ca/news/indigenous/goldboro-lng-mi-kmaw-women-safety-1.6067577

Memija, A. (2023, December 13). Mingyang Rolls Out "World's Largest" Offshore Wind Turbine in Capacity and Rotor Diameter. *Offshore Wind*. https://www.offshorewind.biz/2023/12/13/mingyang-rolls-out-worlds-largest-offshore-wind-turbine-in-capacity-and-rotor-diameter/

Methratta, E. T., & Dardick, W. R. (2019). Meta-Analysis of Finfish Abundance at Offshore Wind Farms. *Reviews in Fisheries Science & Aquaculture*, *27*(2), 242–260. https://doi.org/10.1080/23308249.2019.1584601

MGN_654.pdf. (n.d.). Retrieved March 6, 2024, from https://assets.publishing.service.gov.uk/media/64637cd60b72d3000c34454c/MGN_654.pdf

Miawpukek First Nation Comments on the Regional Assessment of Offshore Wind in Nova Scotia and Newfoundland and Labrador. (2022). https://registrydocumentsprd.blob.core.windows.net/commentsblob/project-83514/comment-59018/MFN_Offshore%20Wind%20Regional%20Assessment_DA%20and%20ToR_Review_2022.11.22_FINAL.pdf

Michel, J., Dunagan, H., Boring, C., Healy, E., Evans, W., Dean, J., McGillis, A., & Hain, J. (2007). *Worldwide Synthesis and Analysis of Existing Information Regarding Environmental Effects of Alternative Energy Uses on the Outer Continental Shelf. (Report No. MMS 2007- 038). Report by ICF International. Report for US Department of the Interior (DOI).*

Mi'kmaq Ecological Knowledge Study Protocol. (n.d.). https://novascotia.ca/abor/aborlearn/docs/mek%20protocol%20second%20edition.pdf

Millbrook energy project coming to life. (2017, September 30). Saltwire. https://www.saltwire.com/atlantic-canada/federal-election/millbrook-energy-project-coming-to-life-152560/

Miller, A. S., Shepherd, G. R., & Fratantoni, P. S. (2016). Offshore Habitat Preference of Overwintering Juvenile and Adult Black Sea Bass, Centropristis striata, and the Relationship to Year-Class Success. *PLOS ONE*, *11*(1), e0147627. https://doi.org/10.1371/journal.pone.0147627

Minkoff, D., Putman, N. F., Atema, J., & Ardren, W. R. (2020). Nonanadromous and anadromous Atlantic salmon differ in orientation responses to magnetic displacements. *Canadian Journal of Fisheries and Aquatic Sciences*, *77*(11), 1846–1852. https://doi.org/10.1139/cjfas-2020-0094

Missing and Murdered Indigenous Women, Girls, and 2SLGBTQQIA+ People National Action Plan. (2022). https://mmiwg2splus-nationalactionplan.ca/eng/1670511213459/1670511226843

Moland, E., Olsen, E., Andvord, K., Knutsen, J., & Stenseth, N. C. (2011). Home range of European lobster (*Homarus gammarus*) in a marine reserve: Implications for future reserve design. *Canadian Journal of Fisheries and Aquatic Sciences*, *68*, 1197–1210. https://doi.org/10.1139/f2011-053

Mooney, T. A., Andersson, M. H., & Stanley, J. (2020). Acoustic Impacts of Offshore Wind Energy on Fishery Resources. *Oceanography*, *33*(4), 82–95.

Moors-Murphy, H. (2015). Patterning in Northern Bottlenose Whale (*Hyperoodon ampullatus* Click Trains. *Canadian Acoustical Association*, *43*. https://jcaa.caa-aca.ca/index.php/jcaa/article/view/2795

Morin, B. (2020, May 5). *Is resource extraction killing Indigenous women?* Al Jazeera. https://www.aljazeera.com/features/2020/5/5/pipelines-man-camps-and-murdered-indigenous-women-in-canada

Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D., & Thomsen, F. (2010). *Effects of Pile-driving Noise on the Behaviour of Marine Fish. COWRIE Ref: Fish 06-08, Technical Report*.

Musial, W., Heimiller, D., Beiter, P., Scott, G., & Draxl, C. (2016). *2016 Offshore Wind Energy Resource Assessment for the United States* (NREL/TP--5000-66599, 1324533; p. NREL/TP--5000-66599, 1324533). https://doi.org/10.2172/1324533

National Oceanic and Atmospheric Administration (NOAA). (n.d.). *Exploration Tools: Multibeam Sonar*. https://oceanexplorer.noaa.gov/technology/sonar/multibeam.html

National Research Council (NRC). (1996). *An Assessment of Techniques for Removing Offshore Structures*. The National Academies Press. https://doi.org/10.17226/9072

Nelms, S. E., Piniak, W. E. D., Weir, C. R., & Godley, B. J. (2016). Seismic surveys and marine turtles: An underestimated global threat? *Biological Conservation*, *193*, 49–65. https://doi.org/10.1016/j.biocon.2015.10.020

Nemes, C. E., Cabrera-Cruz, S. A., Anderson, M. J., DeGroote, L. W., DeSimone, J. G., Massa, M. L., & Cohen, E. B. (2023). More than mortality: Consequences of human activity on migrating birds extend beyond direct mortality. *Ornithological Applications*, *125*(3). https://doi.org/10.1093/ornithapp/duad020

Newton, I. (2006). Can conditions experienced during migration limit the population levels of birds? *Journal of Ornithology*, *147*(2), 146–166.

No’gmaq, M., Ugpi’ganjig, Gillis, C.-A., Chiasson, B., Gagnon, C.-A., Gosselin, P., Arsenault, L., & Vicaire, J. M. (2024). *A Two-Eyed Seeing approach to describe Gumegwsis (Cyclopterus lumpus) ecology and fisheries interactions in the inner Mawipoqtapei (Chaleur Bay), Canada*. https://doi.org/10.21203/rs.3.rs-3870664/v1

Nordic Energy Research. (2023). *Coexistence and Nature-Inclusive Design in Nordic Offshore Wind Farms*. https://norden.diva-portal.org/smash/get/diva2:1744935/FULLTEXT01.pdf

Nova Scotia Fisheries Alliance for Energy Engagement (NSFAEE). (2024). *Submission to Regional Assessment Committee*. https://aeic-iaac.gc.ca/050/documents/p83514/155763E.pdf

Offshore wind report 2023. (n.d.).

Offshore-wind-guide-June-2013-updated.pdf. (n.d.). Retrieved March 6, 2024, from http://csmres.co.uk/cs.public.upd/article-downloads/Offshore-wind-guide-June-2013-updated.pdf

Orpwood, J., Fryer, R., Rycroft, P., & Armstrong, J. (2015). Effects of AC Magnetic Fields (MFs) on Swimming Activity in European Eels Anguilla anguilla. *Scottish Marine and Freshwater Science*, *6*. http://dx.doi.org/10.7489/1618-1

Parisé, J., & Walker, T. R. (2017). Industrial wind turbine post-construction bird and bat monitoring: A policy framework for Canada. *Journal of Environmental Management*, *201*, 252–259. https://doi.org/10.1016/j.jenvman.2017.06.052

Parks Canada Agency Act, S.C. 1998, c. 31 (1998). https://laws-lois.justice.gc.ca/eng/acts/p-0.4/fulltext.html

Paskyabi, M. B. (2015). Offshore Wind Farm Wake Effect on Stratification and Coastal Upwelling. *Energy Procedia*, *80*, 131–140.

Paxton, A. B., Shertzer, K. W., Bacheler, N. M., Kellison, G. T., Riley, K. L., & Taylor, J. C. (2020). Meta-Analysis Reveals Artificial Reefs Can Be Effective Tools for Fish Community Enhancement but Are Not One-Size-Fits-All. *Frontiers in Marine Science*, *7*. https://www.frontiersin.org/articles/10.3389/fmars.2020.00282

Paznokas, R. (2023, February 15). *Wind-Turbine Fire Risk: The Time to Act is Now | Wind Systems Magazine*. https://www.windsystemsmag.com/wind-turbine-fire-risk-the-time-to-act-is-now/

Pelletier, S., Omland, K., Watrous, K., & Peterson, T. (2013). *Information Synthesis on the Potential for Bat Interactions with Offshore Wind Facilities*.

Petersen, I., & Fox, A. D. (2007). *Hanges in Bird Habitat Utilisation around the Horns Rev 1 Offshore Wind Farm, with Particular Emphasis on Common Scoter. Report by National Environmental Research Institute (NERI). Report for Vattenfall.*

Petersen, I. K., Kj, T., Kahlert, J., Desholm, M., & Fox, A. D. (2006). *Final results of bird studies atthe offshore wind farms at Nystedand Horns Rev, Denmark. Eport by Dong Energy. Report for Danish Ministry of the Environment.*

Petersen, I., Mackenzie, M., Rexstad, E., Wisz, M., & Fox, A. (2011). *Comparing pre- and post-construction distributions of long-tailed ducks Clangula hyemalis in and around the Nysted offshore wind farm, Denmark: A quasi-designed experiment accounting for imperfect detection, local surface features and autocorrelation*.

Peterson, T. (2020). *Predicting and Managing Risk to Bats at Commercial Wind Farms using Acoustics*. The University of Maine.

Popper, A. N., & Hawkins, A. D. (2019). An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes. *Journal of Fish Biology*, *94*(5), 692–713. https://doi.org/10.1111/jfb.13948

Popper, A. N., Hice-Dunton, L., Jenkins, E., Higgs, D. M., Krebs, J., Mooney, A., Rice, A., Roberts, L., Thomsen, F., Vigness-Raposa, K., Zeddies, D., & Williams, K. A. (2022). Offshore wind energy development: Research priorities for sound and vibration effects on fishes and aquatic invertebrates. *The Journal of the Acoustical Society of America*, *151*(1), 205–215. https://doi.org/10.1121/10.0009237

Project Cargo Journal. (2023, February 16). *Sif to build world’s largest monopile foundation manufacturing plant*. Project Cargo Journal. https://www.projectcargojournal.com/offshore/2023/02/16/sif-to-build-worlds-largest-monopile-foundation-manufacturing-plant/

Prosper, K., McMillan, L. J., Davis, A. A., & Moffitt, M. (2011). Returning to Netukulimk: Mi’kmaq cultural and spiritual connections with resource stewardship and self-governance. *International Indigenous Policy Journal*, *2*(4). https://doi.org/10.18584/iipj.2011.2.4.7

Puig-Pons, V., Soliveres, E., Pérez-Arjona, I., Espinosa, V., Poveda-Martínez, P., Ramis-Soriano, J., Ordoñez-Cebrián, P., Moszyński, M., De La Gándara, F., Bou-Cabo, M., Cort, J. L., & Santaella, E. (2021). Monitoring of Caged Bluefin Tuna Reactions to Ship and Offshore Wind Farm Operational Noises. *Sensors*, *21*(21), 6998. https://doi.org/10.3390/s21216998

Putman, N. F., Verley, P., Endres, C. S., & Lohmann, K. J. (2015). Magnetic navigation behavior and the oceanic ecology of young loggerhead sea turtles. *Journal of Experimental Biology*, *218*(7), 1044–1050. https://doi.org/10.1242/jeb.109975

QBIS. (2020a). *Socio-economic impact study of offshore wind*. https://greenpowerdenmark.dk/files/media/winddenmark.dk/document/Technical%20report-Socioeconomic%20impacts%20of%20offshore%20wind-01.07.2020.pdf

QBIS. (2020b, June 24). *Socioeconomic impacts of offshore wind*. https://um.fi/documents/384951/0/presentation-socioeconomic-impacts-of-offshore-wind-24.06.2020-003.pdf/0fb793e9-b144-5691-f9fa-c12e0504985a?t=1593085726899

Raoux, A., Tecchio, S., Pezy, J.-P., Lassalle, G., Degraer, S., Wilhelmsson, D., Cachera, M., Ernande, B., Le Guen, C., Haraldsson, M., Grangeré, K., Le Loc'h, F., Dauvin, J.-C., & Niquil, N. (2017). Benthic and fish aggregation inside an offshore wind farm: Which effects on the trophic web functioning? *Ecological Indicators*, *72*, 33–46. https://doi.org/10.1016/j.ecolind.2016.07.037

Reubens, J., Degraer, S., & Vincx, M. (2014). The ecology of benthopelagic fishes at offshore wind farms: A synthesis of 4 years of research. *Hydrobiologia*, *727*. https://doi.org/10.1007/s10750-013-1793-1

Reubens, J. T., Braeckman, U., Vanaverbeke, J., Van Colen, C., Degraer, S., & Vincx, M. (2013). Aggregation at windmill artificial reefs: CPUE of Atlantic cod (Gadus morhua) and pouting (Trisopterus luscus) at different habitats in the Belgian part of the North Sea. *Fisheries Research*, *139*, 28–34. https://doi.org/10.1016/j.fishres.2012.10.011

Roach, M. (2019). *Interaction between the Yorkshire coast static gear fishery and offshore wind energy development*. https://doi.org/10.13140/RG.2.2.20483.73766

Roach, M., Cohen, M., Forster, R., Revill, A. S., & Johnson, M. (2018). The effects of temporary exclusion of activity due to wind farm construction on a lobster (*Homarus gammarus*) fishery suggests a potential management approach. *ICES Journal of Marine Science*, *75*(4), 1416–1426. https://doi.org/10.1093/icesjms/fsy006

Roach, M., Revill, A., & Johnson, M. J. (2022). Co-existence in practice: A collaborative study of the effects of the Westermost Rough offshore wind development on the size distribution and catch rates of a commercially important lobster (Homarus gammarus) population. *ICES Journal of Marine Science*, *79*(4), 1175–1186. https://doi.org/10.1093/icesjms/fsac040

Roberts, L., Cheesman, S., Breithaupt, T., & Elliott, M. (2015). Sensitivity of the mussel Mytilus edulis to substrate-borne vibration in relation to anthropogenically-generated noise. *Marine Ecology Progress Series*, *538*. https://doi.org/10.3354/meps11468

Roberts, L., Cheesman, S., Elliott, M., & Breithaupt, T. (2016). Sensitivity of Pagurus bernhardus (L.) to substrate-borne vibration and anthropogenic noise. *Journal of Experimental Marine Biology and Ecology*, *474*, 185–194.

Schuler, M. (2022, April 6). *Offshore Wind Accident: Orsted Asks for "No-Sail Zones" After Turbine Breaks Into Sea*. gCaptain. https://gcaptain.com/offshore-wind-accident-orsted-asks-for-no-sail-zones-after-turbine-breaks-into-sea/

Scott, K., Harsanyi, P., Easton, B. A. A., Piper, A. J. R., Rochas, C. M. V., & Lyndon, A. R. (2021). Exposure to Electromagnetic Fields (EMF) from Submarine Power Cables Can Trigger Strength-Dependent Behavioural and Physiological Responses in Edible Crab, Cancer pagurus (L.). *Journal of Marine Science and Engineering*, *9*(7), Article 7. https://doi.org/10.3390/jmse9070776

Scott, K., Harsanyi, P., & Lyndon, A. R. (2018). Understanding the effects of electromagnetic field emissions from Marine Renewable Energy Devices (MREDs) on the commercially important edible crab, *Cancer pagurus* (L.). *Marine Pollution Bulletin*, *131*, 580–588. https://doi.org/10.1016/j.marpolbul.2018.04.062

SeaPlan. (2018). *Addressing Interactions between Fisheries and Offshore Wind Development: The Block Island Wind Farm*. https://doi.org/10.31230/osf.io/3jpxn

Seguin, N. (2021, October 6). In wake of opposition to Mi'kmaw fishery, Sipekne'katik First Nation is studying impact of its lobster season. *CBC News*. https://www.cbc.ca/news/canada/nova-scotia/sipeknekatik-lobster-study-1.6196508

Siddagangaiah, S., Chen, C.-F., Hu, W.-C., & Pieretti, N. (2022). Impact of pile-driving and offshore windfarm operational noise on fish chorusing. *Remote Sensing in Ecology and Conservation*, *8*(1), 119–134. https://doi.org/10.1002/rse2.231

Sigray, P., & Andersson, M. H. (2011). Particle motion measured at an operational wind turbine in relation to hearing sensitivity in fish. *The Journal of the Acoustical Society of America*, *130*(1), 200–207. https://doi.org/10.1121/1.3596464

Sjollema, A., Gates, J., Hilderbrand, R., & Sherwell, J. (2014). Offshore Activity of Bats Along the Mid-Atlantic Coast. *Northeastern Naturalist*, *21*, 154–163. https://doi.org/10.1656/045.021.0201

Skov, H., Heinänen, S., Norman, T., Ward, R., & Méndez, S. (2018). ORJIP bird collision and avoidance study. Report by offshore renewables joint industry programme (ORJIP). *Carbon Trust*.

Snyder, D., Bailey, W., Palmquist, K., Cotts, B., & Olsen, K. (2019). *Evaluation of Potential EMF Effects on Fish Species of Commercial or Recreational Fishing Importance in Southern New England* (BOEM 2019-049). US Department of the Interior (DOI). https://espis.boem.gov/final%20reports/BOEM_2019-049.pdf

Solan, M., Hauton, C., Godbold, J., Wood, C., Leighton, T., & White, P. (2016). Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. *Scientific Reports*, *6*. https://doi.org/10.1038/srep20540

Solick, D. I., & Newman, C. M. (2021). Oceanic records of North American bats and implications for offshore wind energy development in the United States. *Ecology and Evolution*, *11*(21), 14433–14447. https://doi.org/10.1002/ece3.8175

Southall, B. (2004). *Shipping noise and marine mammals: A forum for science, management, and technology. In Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium.*

Special Places Protection Act, R.S., c. 438, s. 1 (1989). https://nslegislature.ca/sites/default/files/legc/statutes/specplac.htm

Stankevičiūtė, M., Jakubowska, M., Pažusienė, J., Makaras, T., Otremba, Z., Urban-Malinga, B., Fey, D. P., Greszkiewicz, M., Sauliutė, G., Baršienė, J., & Andrulewicz, E. (2019). Genotoxic and cytotoxic effects of 50 Hz 1 mT electromagnetic field on larval rainbow trout (Oncorhynchus mykiss), Baltic clam (Limecola balthica) and common ragworm (Hediste diversicolor). *Aquatic Toxicology*, *208*, 109–117. https://doi.org/10.1016/j.aquatox.2018.12.023

Stelzenmüller, V., Gimpel, A., Haslob, H., Letschert, J., Berkenhagen, J., & Brüning, S. (2021). Sustainable co-location solutions for offshore wind farms and fisheries need to account for socio-ecological trade-offs. *Science of The Total Environment*, *776*, 145918. https://doi.org/10.1016/j.scitotenv.2021.145918

Stenberg, C., Støttrup, J., Van Deurs, M., Berg, C., Dinesen, G., Mosegaard, H., Grome, T., & Leonhard, S. (2015). Long-term effects of an offshore wind farm in the North Sea on fish communities. *Marine Ecology Progress Series*, *528*, 257–265. https://doi.org/10.3354/meps11261

Stevens, R. J. A. M., Hobbs, B. F., Ramos, A., & Meneveau, C. (2017). Combining economic and fluid dynamic models to determine the optimal spacing in very large wind farms. *Wind Energy*, *20*(3), 465–477. https://doi.org/10.1002/we.2016

Svendsen, J. C., Ibanez-Erquiaga, B., Savina, E., & Wilms, T. (2022). *Effects of operational off-shore wind farms on fishes and fisheries. Review report. DTU Aqua Report no. 411-2022. National Institute of Aquatic Resources, Technical University of Denmark*.

Taormina, B., Bald, J., Want, A., Thouzeau, G., Lejart, M., Desroy, N., & Carlier, A. (2018). A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. *Renewable and Sustainable Energy Reviews*, *96*, 380–391. https://doi.org/10.1016/j.rser.2018.07.026

Taormina, B., Di Poi, C., Agnalt, A.-L., Carlier, A., Desroy, N., Escobar-Lux, R. H., D'eu, J.-F., Freytet, F., & Durif, C. M. F. (2020). Impact of magnetic fields generated by AC/DC submarine power cables on the behavior of juvenile European lobster (Homarus gammarus). *Aquatic Toxicology (Amsterdam, Netherlands)*, *220*, 105401. https://doi.org/10.1016/j.aquatox.2019.105401

Taormina, B., Laurans, M., Marzloff, M. P., Dufournaud, N., Lejart, M., Desroy, N., Leroy, D., Martin, S., & Carlier, A. (2020). Renewable energy homes for marine life: Habitat potential of a tidal energy project for benthic megafauna. *Marine Environmental Research*, *161*, 105131. https://doi.org/10.1016/j.marenvres.2020.105131

ten Brink, T., & Dalton, T. (2018). Perceptions of Commercial and Recreational Fishers on the Potential Ecological Impacts of the Block Island Wind Farm (US). *Frontiers in Marine Science*, *5*, 439. https://doi.org/10.3389/fmars.2018.00439

Tethys. (2024a). *Seabirds*. https://tethys.pnnl.gov/receptor/seabirds

Tethys. (2024b). *Waterfowl*. https://tethys.pnnl.gov/receptor/waterfowl

Thatcher, H., Stamp, T., Moore, P. J., & Wilcockson, D. (2024). Using fisheries-dependent data to investigate landings of European lobster (*Homarus gammarus*) within an offshore wind farm. *ICES Journal of Marine Science*, fsad207. https://doi.org/10.1093/icesjms/fsad207

Thompson, R., Thompson, A., & Brigham, R. (2015). A Flock of Myotis Bats at Sea. *Northeastern Naturalist*, *22*, N27–N30. https://doi.org/10.1656/045.022.0416

Thomsen, F., Lüdemann, K., Kafemann, R., & Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish*. COWRIE Ltd. https://tethys.pnnl.gov/sites/default/files/publications/Effects_of_offshore_wind_farm_noise_on_marine-mammals_and_fish-1-.pdf

Tjørnløv, R., Skov, H., Armitage, M., Barker, M., Jørgensen, J., Mortensen, L., Thomas, K., & Uhrenholdt, T. (2023). *Resolving Key Uncertainties of Seabird Flight and Avoidance Behaviours at Offshore Wind Farms: Final Report for the study period 2020-2021. Report by Danish Hydraulic Institute (DHI). Report for Vattenfall.*

Tougaard, J., Hermannsen, L., & Madsen, P. T. (2020). How loud is the underwater noise from operating offshore wind turbines? *The Journal of the Acoustical Society of America*, *148*(5), 2885–2893. https://doi.org/10.1121/10.0002453

Truth and Reconciliation Commission of Canada: Calls to Action. (2015). https://ehprnh2mwo3.exactdn.com/wp-content/uploads/2021/01/Calls_to_Action_English2.pdf

U.S. Offshore Wind Synthesis of Environmental Effects Research (SEER). (2022a). *Bat and Bird Interactions with Offshore Wind Energy Development*. National Renewable Energy Laboratory and Pacific Northwest National Laboratory for the U.S. Department of Energy, Wind Energy Technologies Office.

U.S. Offshore Wind Synthesis of Environmental Effects Research (SEER). (2022b). *Underwater Noise Effects on Marine Life Associated with Offshore Wind Farms*. https://tethys.pnnl.gov/sites/default/files/summaries/SEER-Educational-Research-Brief-Underwater-Noise-Effects.pdf

Valberg, P. A. (2005). *Memorandum addressing electric and magnetic field (EMF) questions. Draft*. Cape Wind Energy Project nantucket Sound.

van der Knaap, I., Slabbekoorn, H., Moens, T., Van den Eynde, D., & Reubens, J. (2022). Effects of pile driving sound on local movement of free-ranging Atlantic cod in the Belgian North Sea. *Environmental Pollution*, *300*, 118913. https://doi.org/10.1016/j.envpol.2022.118913

van Hal, R., Griffioen, A. B., & van Keeken, O. A. (2017). Changes in fish communities on a small spatial scale, an effect of increased habitat complexity by an offshore wind farm. *Marine Environmental Research*, *126*, 26–36. https://doi.org/10.1016/j.marenvres.2017.01.009

Vineyard Wind 1 Fisheries Compensation Program. (n.d.). Retrieved June 20, 2024, from https://vw1fisheriescomp.com/

Wahlberg, M., & Westerberg, H. (2005). Hearing in fish and their reactions to sounds from offshore wind farms. *Marine Ecology Progress Series*, *288*, 295–309. https://doi.org/10.3354/meps288295

Wale, M. A., Briers, R. A., Hartl, M. G. J., Bryson, D., & Diele, K. (2019). From DNA to ecological performance: Effects of anthropogenic noise on a reef-building mussel. *Science of The Total Environment*, *689*, 126–132. https://doi.org/10.1016/j.scitotenv.2019.06.380

Walker, M. M., Kirschvink, J. L., Ahmed, G., & Dizon, A. E. (1992). Evidence That Fin Whales Respond to the Geomagnetic Field During Migration. *Journal of Experimental Biology*, *171*(1), 67–78. https://doi.org/10.1242/jeb.171.1.67

Warrior, M., Fanning, L., & Metaxas, A. (2022). Indigenous peoples and marine protected area governance: A Mi’kmaq and Atlantic Canada case study. *FACETS*, *7*, 1298–1327. https://doi.org/10.1139/facets-2021-0128

Welcker, J., & Nehls, G. (2016). Displacement of seabirds by an offshore wind farm in the North Sea. *Marine Ecology Progress Series*, *554*, 173–182. https://doi.org/10.3354/meps11812

Westerberg, H., & Lagenfelt, I. (2008). Sub-sea power cables and the migration behaviour of the European eel. *Fisheries Management and Ecology*, *15*, 369–375.

What’s stopping even bigger Wind Turbines? Blade speed and flexing? More likely manufacturing and installation capacity. (2023, January 18). *Energy Post*. https://energypost.eu/what-stops-us-from-building-even-bigger-wind-turbines-blade-speed-and-flexing-more-likely-manufacturing-and-installation-capacity/

Wilber, D. H., Brown, L., Griffin, M., DeCelles, G. R., & Carey, D. A. (2022). Demersal fish and invertebrate catches relative to construction and operation of North America’s first offshore wind farm. *ICES Journal of Marine Science*, *79*(4), 1274–1288. https://doi.org/10.1093/icesjms/fsac051

Wilber, D. H., Brown, L. J., Griffin, M., & Carey, D. A. (2024). American lobster (*Homarus americanus*) responses to construction and operation of an offshore wind farm in southern New England. *Marine Ecology Progress Series*, *727*, 123–142. https://doi.org/10.3354/meps14482

Wilber, D. H., Carey, D. A., & Griffin, M. (2018). Flatfish habitat use near North America’s first offshore wind farm. *Journal of Sea Research*, *139*, 24–32. https://doi.org/10.1016/j.seares.2018.06.004

Wilhelmsson, D., Malm, T., & Öhman, M. C. (2006). The influence of offshore windpower on demersal fish. *ICES Journal of Marine Science*, *63*(5), 775–784. https://doi.org/10.1016/j.icesjms.2006.02.001

Williams, K. A., Gulka, J., Cook, A. S. C. P., Diehl, R. H., Farnsworth, A., Goyert, H., Hein, C., Loring, P., Mizrahi, D., Petersen, I. K., Peterson, T., Press, K. M., & Stenhouse, I. J. (2024). A framework for studying the effects of offshore wind energy development on birds and bats in the Eastern United States. *Frontiers in Marine Science*, *11*, 1274052. https://doi.org/10.3389/fmars.2024.1274052

Withers, P. (2022, December 19). Mi’kmaq drop civil lawsuit, shift legal tactics in moderate livelihood fishing battle. *CBC News*. https://www.cbc.ca/news/canada/nova-scotia/mikmaq-drop-civil-lawsuit-moderate-livelihood-1.6691261

Wyman, M. T., Peter Klimley, A., Battleson, R. D., Agosta, T. V., Chapman, E. D., Haverkamp, P. J., Pagel, M. D., & Kavet, R. (2018). Behavioral responses by migrating juvenile salmonids to a subsea high-voltage DC power cable. *Marine Biology*, *165*(8), 134. https://doi.org/10.1007/s00227-018-3385-0

Appendix A

Memo: Summary of the Interim The Regional Assessment of Offshore Wind Development in Nova Scotia and The Regional Assessment of Offshore Wind Development in Newfoundland and Labrador (AECOM, June 28, 2024)

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Memo

Subject: Summary of the Interim *The Regional Assessment of Offshore Wind Development in Nova Scotia* and *The Regional Assessment of Offshore Wind Development in Newfoundland and Labrador*

Introduction

As part of the Regional Assessment (RA), the committee has provided their interim reports *The Regional Assessment of Offshore Wind Development in Nova Scotia* and *The Regional Assessment of Offshore Wind Development in Newfoundland and Labrador* for review. As part of our scope of work with Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO), AECOM has reviewed both interim RA reports and prepared this memorandum as a summary. While both RAs have the same Terms of Reference (TOR) as mandated by the federal and provincial Ministers, their approach is slightly different; however, both RAs provide a map of potential offshore wind (OSW) development locations as an end product.

We understand that the interim reports are not final and that KMKNO has the opportunity to provide feedback to the committee on the RAs interim reports. This memo also provides recommendations for KMKNO' s consideration.

Objective and Approach

The main purpose of the RAs for both Nova Scotia (NS) and Newfoundland and Labrador (NL) as described in the TOR is "*to contribute to the efficiency and effectiveness of future impact assessments of projects that are subject to the Impact Assessment Agency (IAA)*." Furthermore, the purpose of the RAs is: "*to provide information, knowledge and analysis regarding future offshore wind development activities in the Study Area and their potential effects, in order to inform and improve future planning, licencing and impact assessment processes for these activities in a way that helps protect the environment and health, social and economic conditions while also creating opportunities for sustainable economic development*".

The approach in each RA is slightly different; however, both RAs provided the end resulting map of potential OSW developments locations. Both RAs used a series of constraints analysis to identify preliminary OSW licencing areas; however, each used different constraints as summarized in the **Table 1**. Key differences include:

- Different environmental constraints parameters considered.
- Different interpretation of the potential impact by OSW development – some areas were considered no go zones and excluded from the OSW development locations while some areas were considered not precluded in these areas; RA recommends mitigation measures to protect area.
- Significant difference in the length of each interim report (i.e. page count 73 vs 257).
- Different engagement approach while the TOR required Indigenous and stakeholder engagement and required advisory committee / groups, the level of engagement is different.

Table 1: Summary of Nova Scotia’s and Newfoundland & Labrador’s Regional Assessment Interim Reports

Topic	**Nova Scotia**	**Newfoundland & Labrador**	**AECOM comments**
Described Purpose and Scope in interim report	Identification of locations within the Study Area that might accommodate OSW development; analysis of potential positive and adverse effects; and recommendations for mitigation and monitoring measures.	Report focuses on information with relevance to and implication for future licencing processes.	Similar purpose and scope of both RAs. Approach slightly different. Results similar in maps of potential OSW development areas of leasing.
Intended interface with Impact Assessment processes	The information obtained from the site assessment work would lead to the filing of an Environmental Impact Statement pursuant to the Physical Activities Regulations of the IAA.	Scope limited to projects of 10 or more wind turbines under Physical Activities Regulations under IAA. No mandate to exclude offshore wind projects for IAA requirements. A key assumption informing the Committee’s approach is that project-level impact assessments would occur following the Regional Assessment.	Both RAs explicitly calls out the view that project specific application approvals and permits would be followed under the environmental impact assessment (EIA) process under IAA.
Differences in Approaches	Assesses the identified zones (from the AEGIR assessment, as well as Department of Fisheries and Oceans (DFO) data), against the key environmental and other constraints.	Looks at the entirety of and the considers development waters (Study area), eliminates technically non-viable areas to create (Focus Area) then assesses the constraints from each potential spatial constraint.	Difference in approach. Developers will appreciate the technical non-viable areas analysis. More work needs to be completed on environmental constraints – excluded areas (no go zones) vs areas that require mitigation measures (specific environmental constraints parameters are provided below).
Other jurisdictions evaluated	United States and Europe referenced, but not specific jurisdictions within.	United Kingdom, United States, Belgium, the Netherlands, France, Denmark, Germany, and Albania.	Lessons learned from other jurisdictions provide valuable insight when multiple perspectives (pros and cons) are documented.
Approach to specific constraints			
Initial physical constraints	Excludes areas based on: • 25km distance from coast. • Water depths > 100m. Assumptions: • 1 Gigawatt (GW) project sizes. • Fixed installations at depths 50m to 70m, floating beyond 70m.	Excludes areas based on: • The likely presence of icebergs. • Water depths > 300m.	Water depth limitations for floating structures are not aligned with current industry expectations. Deeper waters could be considered to allow better accommodation of environmental constraints.

Topic	Nova Scotia	Newfoundland & Labrador	AECOM comments
Critical Habitat	Applicable species of interest: Bank Swallow, Piping Plover, Roseate Tern Approach: Identified zones exclude any critical habitats; however, some zones (Sydney Bight, Sable Island Bank) have nearby coastal environments.	Applicable species of interest: Northern wolffish, spotted wolffish, bank swallow, bobolink, and piping plover. Approach: Critical habitats for fish excluded, 10km coastal buffer added for bird species. Recommends setbacks be included in all OSW project requirements.	Exclusion of Critical Habitats is appropriate and inline with international standards.
Marine Protected Areas (MPAs)	Applicable MPAs: The Gully, St. Anns Bank. Approach: MPAs are excluded from proposed licensing zones.	Applicable MPAs: Laurentian Channel Approach: MPAs excluded from proposed licensing zones Recommends additional buffers be included in project specific reviews.	Exclusion of MPAs is appropriate and inline with international standards.
National Marine Conservation Areas (NMCA)	Applicable NMCA: Western / Emerald Bank Conservation Area. Approach: Sable Island zone overlaps the conservation area and the Emerald Bank zone falls entirely within the conservation zone. The committee proposes that any impacts to the conservation objectives can be mitigated through the design of the windfarm.	Applicable NMCA: Proposed South Coast Fjords area. Approach: Proposed NMCA excluded from proposed licensing zones.	AECOM acknowledges and supports KMKNO's position to avoid development in the NMCAs and note the alignment of the NL recommendations to the position.
Areas Important for Viewscapes	Potentially sensitive viewscapes: Cape Breton Highlands Park, Cape Smokey Provincial Park identified by Committee. Approach: Sydney Bight zone is 29km from identified sensitive viewpoints.	Potentially sensitive viewscapes: Gros Morne (identified as particularly sensitive), Sandbanks Provincial Park, and general community/cottage areas. Approach: 80km zone excluded around Gros Morne, Sandbanks exclusions zone overlaps South Coast Fjords area, 10km coastal exclusion zone for all other areas.	A 10km coastal exclusion zone is generally seen to be insufficient to mitigate viewscape concerns. 25km is more aligned with global standards; however, residents can still likely expect to see turbine tips on the horizon on clear skies days for many/some design cases. Generally, there are limited options to mitigate viewscape concerns beyond increasing distance. We note the significant difference in approach between NS and NL.
Areas Important for Avifauna	Applicable areas: Areas around, but not within the Sydney Bight and Sable	Applicable areas: Avifauna critical habitat / Important bird and	Additional focus needed for migratory routes either ahead of finalization of leasing zones or

Topic	Nova Scotia	Newfoundland & Labrador	AECOM comments
	Island zones. Specific avian species are identified at virtually all zones but limited to quantify impact based on data sets reviewed by the committee. Approach: OSW development excluded in Marine Bird Sanctuaries (MBSs).	biodiversity areas; Bird colonies, key habitat and foraging areas; Possible migration routes for critical seabirds. Approach: Additional 5km exclusion area added around any coastal islands with bird colonies.	through the project specific environmental impact assessment process. European projects have historically mitigated risks for migration risks through site selection, layout design and planned curtailment.
Key Biodiversity Areas (KBAs)	Applicable areas: A number of small coastal KBAs are described in the public datasets, as well as the Sable Island zone. These are all outside of the proposed development zones. Approach: As these areas are outside of development zones, and primarily within the coastal setback, they are not directly applicable to the definition of the zones.	Applicable areas: A number of proposed KBAs were considered. Approach: KBAs were presumed to be excluded based on already incorporated 10km coastal exclusion zone and additional 5km exclusion zone around coastal islands.	While defined biodiversity areas are outside of the OSW development areas, they may be potentially impacted by export cable – the implementation of setbacks or installation / operational requirements should be considered in the development of the final regulations and in the project specific impact assessments. In addition to avoiding registered KBAs, regulations and leasing schemes can incentivize and mandate the implementation of biodiversity schemes as part of the offshore wind developments. Other global developments have assessed the potential integration of oyster beds, artificial reefs, etc.
Ecologically and Biologically Significant Areas (EBSA)	Applicable areas: Relies heavy on DFO marine refuge areas. Approach: EBSAs were not excluded from consideration, but OSW proponents should assess potential impacts to identified species and provide mitigation measures.	Applicable areas: West Coast of Newfoundland, South Coast, Laurentian Channel, Placentia Bay, Southwest Slope. Approach: EBSAs were not excluded from consideration, but OSW proponents should assess potential impacts to identified species and provide mitigation measure.	Aligns with the IAA process for EIA to determine potential impacts to identified species and provide mitigation measures.
Marine Refuge and Fisheries Closures	Applicable areas: Western/Emerald banks conservation area, Western-Sable Island Bank Complex, Sable Island Shoals EBSA – OSW development **not precluded** in these areas; RA recommends mitigation measures to protect these areas.	Applicable: Bay of Islands Salmon Migration closure, 3 Lobster closures Approach: These areas are **excluded** from the proposed leasing zones.	NS and NL differ in approach on marine refuge and fisheries closures areas designated under DFO Fisheries Act. AECOM acknowledges and supports KMKNO's position to avoid development in the marine protected areas (MPAs), which marine refuge and fisheries closure areas may apply in NS.

Topic	Nova Scotia	Newfoundland & Labrador	AECOM comments
Airports, and Inland and Marine Aerodromes	Not Applicable.	Applicable: Deer Lake Regional Airport and Stephenville Dymond International Airport Approach: Committee deemed that the current exclusion zones were sufficient given the airports are inland.	Radar impacts between offshore wind farms and airports will also need to be addressed.
Marine Traffic	Applicable: Marine Traffic routes cross through the northwest portion of the Potential Future Development Area (PFDA) - including the Marine Atlantic ferry route between North Sydney and Port aux Basques, Newfoundland. The addition of OSW activity within these traffic routes would need to be evaluated.	Applicable: Cabot Strait channel, Placentia bay, ferry routes Approach: Placentia Bay Traffic Separation Scheme applied and 500m exclusion zone around major ferry routes.	NS and NL differ in their approach on marine traffic routes.
Submarine Cables and subsea pipelines	Applicable: The committee indicated more needs to be done on siting subsea cables and exclusion zones.	Applicable: The committee indicated that they had insufficient data to assess this constraint. Approach: No exclusions applied.	Assessment can be completed during the IAA process for EIA to determine siting, identify potential impacts and provide mitigation measures.
Military Sites and Unexploded Ordinances (UXO)	Not Applicable.	Applicable: No known UXO sites, waters in focus area used of military manoeuvres. Approach: No exclusions applied.	Assessment can be completed during the IAA process for EIA to determine siting, identify potential impacts and provide mitigation measures.
Significant Benthic Areas	No known significant benthic area within the PFDA.	Applicable: Multiple areas within the Laurentian Channel, South Coast and West Coast of Newfoundland EBSAs Approach: No exclusions applied.	Impacts to benthic habitats may be significantly mitigated /avoided based on foundation and anchor design choices. This should be assessed as part of the project specific EIA.
Areas Important for Commercial Fisheries	Applicable areas: Sable Island PFDA, Middle bank, Canso bank; Sydney Bight Approach: Discussion with commercial fishers. Data does not include vessels under 35 ft.	Applicable: High concentration fisheries zones based on DFO Georeferenced date Approach: The highest 50% of fishing density was excluded.	Absence of data related to lobster fishers is a significant limitation. Dataset currently does not capture data from vessels <35ft based on DFO standards/ AIS requirements. This may introduce bias into the data. Methodology does not currently weight the impacts of difference catches. This should be assessed ahead of finalizing lease zones and

Topic	Nova Scotia	Newfoundland & Labrador	AECOM comments
			considered in the development of compensation schemes.
Aquaculture	Not Applicable: Data from Canadian Centre for Mineral and Energy Technology (CANMET) used. No additional reference to aquaculture in RA.	Applicable: Aquaculture facilities for steelhead trout, Atlantic salmon, blue mussels, and Atlantic cod. Approach: Aquaculture zones are excluded through the application of the 10km coastal exclusion zone.	In addition to avoiding registered aquaculture facilities, regulations and leasing schemes can incentivize the integration of aquaculture facilities within the confines of the OSW developments. Other global OSW developments have assessed the potential integration of cod hotels, kelp farms, etc. This might be investigated as a potential economic opportunity for local communities.
Physical and Cultural Heritage	Not Applicable.	Applicable: Islands of the south coast of Newfoundland were identified by the Miawpukek First Nation as archeologically significant. No datasets available for shipwrecks and other subsea artifacts Approach: No exclusions applied.	Consideration of areas of Indigenous cultural heritage should be evaluated ahead of finalizing the leasing zones. Project specific EIAs will include an assessment of particular zones of archeological interest. KMKNO and other First Nations may want to consider what archaeological data / geological data with respect to historic landforms may be made available through OSW development; how they would like to assess this data, along with how Indigenous knowledge may be applied in the Impact Assessment process, either on a project specific or industry wide basis.

Recommendations

The following general comments and considerations are provided based on our review of the interim RAs reports:

- Consider the impacts of climate change on weather patterns, sea level rise, etc. in the final report.
- Integration of Indigenous knowledge and traditional fisheries into the final report along with the selection of sites for leasing.
- Recommend process on the collection of cultural information and potential requirements for developers to share data related to seabed /historical landscape with First Nations in the final report.
- Consider how KMKNO and its members would like offshore wind development zones to be assigned in relation to the selection methodologies and approach. Consider quantitative/financial assessment vs. qualitative assessment with the consideration of environmental constraints, biodiversity development, fisheries co-existence and First Nation participation.

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