MODULE 8:

MARINE AND MIGRATORY BIRDS: OVERVIEW OF POTENTIAL EFFECTS

8.1 Introduction

A variety of marine and migratory bird species occur in the Study Area and adjacent marine and coastal environments, including seabirds, waterfowl, shorebirds, and other avifauna that inhabit the region at specific or extended periods for nesting, breeding, feeding, migration and other activities. Several important areas and habitats have also been identified at locations along the coastline of Eastern Newfoundland and elsewhere (Module #).

Most migratory birds in Canada are protected under the federal *Migratory Birds Convention Act* (MBCA) and its regulations. Further, wildlife in Newfoundland and Labrador (including certain species not protected under the MBCA) are managed under the provincial *Wildlife Act* and regulations. Avian species at risk and their habitats, including some species that are known to or may occur in the Study Area and surrounding environments, are protected by the federal *Species at Risk Act* (*SARA*) and the Newfoundland and Labrador *Endangered Species Act* (NL *ESA*). Marine-associated birds also have intrinsic ecological and socioeconomic value, as they often function near the top of the food chain and may be relatively vulnerable to certain types of environmental disturbance. Some species are also an important resource for recreational and tourism-related pursuits.

8.2 Planned Drilling Activities and Emissions

Potential interactions between offshore exploratory drilling and associated activities and marine and migratory birds, and possible resulting effects on this Valued Component (VC), include:

- Attraction of night-flying birds to artificial lighting or flares on drill rigs and vessels, resulting in possible injury or mortality through strikes, stranding, incineration, disorientation, increased energy expenditure or increased predation;

- Other behavioural effects (bird attraction or disturbance) resulting from other activities and emissions associated with offshore drilling activities (atmospheric noise, waste materials), resulting in possible injury, mortality or health effects;

- Possible injury or behavioural disruptions to birds (particularly diving birds) as a result of exposure to seismic noise within the water column during vertical seismic profiling (VSP) activities;

- Health effects resulting from exposure to or ingestion of environmental emissions from drill rigs or vessels; and

- Changes in the availability or quality of food sources or habitats for marine and migratory birds due to disturbances (noise, light) and emissions (such as drilling fluids, other liquid and solid waste materials).

An overview of the various effects on marine and migratory birds that may result from these interactions (and their interrelationships) is summarized in Table 8.1 below.

Table 8.1 Marine and Migratory Birds: Potential Effects of Planned Drilling Activities and Emissions

Potential Effects	Overview
1) Change in Mortality / Injury Levels and Health	• Offshore drilling and associated activities can result in mortality, injury or sub-lethal health effects on marine-associated avifauna. • These can occur as a result of lighting or flaring, leading to possible effects due to strikes, strandings, incineration, disorientation, increased predation or other interactions. • Other environmental emissions such as the release of waste materials during routine offshore activities may also cause direct contamination of birds, or can affect food sources or habitats (See #3 and #4 below). • Increased levels of mortality, injury and health effects can have resulting implications for the overall presence, density and diversity of avifauna in a region (See #2 below).
2) Change in Avifauna Presence / Abundance and Distributions (Behavioural Effects)	• Potential bird attraction to, or avoidance of, offshore structures and activities (behavioral effects) can influence the overall presence, abundance and distribution of birds in an area. • Some birds may be attracted to drilling activities due to increased food availability (including waste discharges or concentrations of certain prey species) or by disorientation due to lighting. Conversely, some species may avoid the area because of sensory disturbances or other environmental changes (noise, increased presence of predators). • These behavioural changes can also, in turn, have implications for bird mortality, injury or health (See #1 above), particularly if these disturbances occur for extended periods of time, if important and sensitive life history stages are disrupted, or if they result in displacement of birds from important habitats or food sources (See #3 and #4 below).
3) Change in Habitat Use, Availability and Quality	• Offshore exploratory activities and their environmental disturbances can result in the displacement of birds from important habitats due to behavioural (attraction or avoidance) effects (See #2 above), and through direct effects on habitat availability or quality due to planned and routine environmental emissions. • Any such changes in the use, availability or quality of habitats have the potential to affect the health of birds in the affected areas (See #1 above), as displacement from or loss of important habitats can result in increased energy expenditure and other effects.
4) Change in Food Availability or Quality	• Offshore drilling activities and their environmental discharges can also lead to changes in the availability, quantity and quality of food sources for birds. • This can include potential decreases in food availability or quality through the various effects on species (fish or other birds) presence, abundance and health as well as potential increased feeding opportunities due to organic waste released from drill rigs and vessels or other attraction effects. • These increases or decreases in food availability or quality can lead to behavioural effects that affect the presence, abundance and distribution of individuals in an area (See #2 above), as well as potentially affecting the health (See #1 above) of individuals or populations.

Table 8.2 indicates which of the various components and activities that are associated with offshore exploratory drilling and their associated emissions and disturbances are potential contributors to these effects on this VC.

Table 8.2 Potential Contributors to Effects on Marine and Migratory Birds (Planned Drilling Activities and Emissions)

Potential Effects	Potential Contributors: Planned Components and Activities							Potential Contributors: Associated Emissions / Disturbances / Interactions						
	Drill Rig and Associated Equipment	Well Drilling (Exploration and Delineation)	Vertical Seismic Profiling	Other Survey Activities	Well Evaluation and Testing	Well Abandonment or Suspension	Supply and Servicing (Vessels and Aircraft Use)	Presence and Operation of Drill Rig	Lights, Heat and Noise	Underwater Noise	Air Emissions	Drill Fluids and Cuttings	Other Liquid Discharges	Other Waste Materials
1) Change in Mortality / Injury Levels and Health	●	●	●		●		●	●	●		●		●	
2) Change in Presence / Abundance and Distributions (Behavioural Effects)	●		●	●	●		●	●	●	●			●	
3) Change in Habitat Use, Availability and Quality	●							●	●				●	
4) Change in Food Availability or Quality	●	●	●					●	●	●		●	●	

Table 8.3 summarizes current information and knowledge from the literature and other sources on the nature and degree of these potential effects.

Table 8.3 Potential Effects on Marine and Migratory Birds: Summary of Current Knowledge (Planned Drilling Activities and Emissions)

Physical Activities/Components	Potential Effects: Summary of Current Knowledge
Presence and Operation of Drill Rig	• Offshore platforms and vessels have been found to attract marine and migratory birds, primarily due to artificial lighting (Marquenie et al. 2008; Ronconi et al. 2015), with this phenomenon having been shown through various studies (e.g., Tasker et al. 1986; Baird 1990; Wiese et al. 2001). Offshore installations may be used by marine-associated birds as roosting / resting and foraging sites (Fabi et al. 2004; Russell 2005; Bruinzeel and van Belle 2010; Johnson et al. 2011; Burke et al. 2012). • Attraction can result in direct mortality or injury through collisions with infrastructure; through disorientation resulting in increased energy expenditure and/or altered foraging or migration behaviours; increased susceptibility to predation; and/or increased exposure to oil and hazardous environments (Baird 1990; Montevecchi et al. 1999; Wiese et al. 2001; Jones and Francis 2003; Ronconi et al. 2015). • The distance at which offshore lighting may be visible (and thus, its likely zone of influence) may be five kilometers or more (Poot et al. 2008; Rodríguez et al. 2015). Visibility range is often influenced by lighting type, intensity and positioning (Reed et al. 1985; Jones and Francis 2003; Marquenie et al. 2008, 2013) and the highest risk of attraction occurs when poor weather (e.g., fog, precipitation low cloud cover) coincides

Physical Activities/Components	Potential Effects: Summary of Current Knowledge
	with bird migration periods (Wiese et al. 2001; Montevecchi 2006; Ronconi et al. 2015; Davis et al. 2017). • Petrels and shearwaters (Procellariiformes) are the seabirds most likely to be grounded by artificial light and most of these affected seabirds are fledglings grounded during their first flights from their natal nests toward the ocean (Rodríguez et al. 2015, 2017). • Leach's storm-petrel (a species whose breeding colonies in Atlantic Canada have seen significant declines in the last few decades [Hedd et al. 2018]) has been identified as the most commonly found species stranded on vessels in Atlantic Canada during monitoring studies conducted offshore Eastern Newfoundland (Baillie et al. 2005; Ellis et al. 2013; ECCC 2016; Davis et al. 2017) although there is some uncertainty around mortality estimates (Ellis et al. 2013). • Between 2003 and 2014, a total of 2,048 birds of 31 species were recorded in the bird salvage logs of the offshore production facilities and mobile offshore drilling units (MODUs) offshore Newfoundland. Of those birds, 1,986 were seabirds consisting of eleven species and the remainder were landbirds or shorebirds (20 species). Of the seabirds, 86% were identified as Leach's Storm-Petrels or unknown storm-petrel (Davis et al. 2017). These data also indicate strong seasonality to stranding events, with 95% of strandings occurring during September and October (Davis et al. 2017). • It is difficult to quantify the numbers of birds affected through mortality or injury due to interactions with offshore installations and vessels, as it is not known how many birds are killed but not recovered due to scavenging or falling into the sea (Montevecchi et al. 1999; Ellis et al. 2013; Ronconi et al. 2015).
Vertical Seismic Profiling (VSP)	• There are few studies available regarding the effects of seismic sound on marine birds (Lacroix et al. 2003; Pichegru et al. 2017) with limited to no evidence of direct adverse effects. • Pichegru et al. (2017) documented avoidance behavior of African penguins during a two-dimensional seismic survey, which may suggest birds choose to avoid underwater sound disturbances and could therefore benefit from ramp-up mitigation designed to protect marine mammals and sea turtles. • Available literature suggests that the underwater hearing of birds is poorer than in air, given that the middle ear constricts under the increased pressure associated with diving (Dooling and Therrien 2012). • Studies have also found that avian species vary in their susceptibility to hearing damage due to noise exposure, although they are generally more resistant to damage than mammals (Dooling and Popper 2007).
Well Drilling and Associated Marine Discharges	• Routine operational discharges from drill rigs and vessels, including deck drainage, bilge waters, and other substances can, under certain circumstances, lead to hydrocarbon sheens on the water's surface to which marine and migratory birds (especially pelagic seabirds) may be exposed and affected (Butler et al. 1986; Wiese and Robertson 2004; O'Hara and Morandin 2010; Morandin and O'Hara 2016). • Even small amounts of oil from sheens have been shown to affect the structure and function of seabird feathers, which has the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia (O'Hara and Morandin 2010). This in turn can cause a heightened metabolic rate, and can lead to behavioural changes at the expense of foraging and breeding (e.g. increased time spent preening), which can be fatal to seabirds (Morandin and O'Hara 2016). These effects are particularly concerning in the winter months when conditions are colder and thermoregulation is most difficult (Morandin and O'Hara 2016). • Although seabird nestlings would not be directly exposed to hydrocarbons from offshore drilling operations, the transfer of oil could potentially occur through external

Physical Activities/Components	Potential Effects: Summary of Current Knowledge
	contact with fouled plumage of adults, transfer from adults to eggs, or through ingestion of contaminated food (Morandin and O'Hara 2016).
Well Evaluation and Testing	• Flaring during well testing is generally brief (usually one to three days) but, as another source of artificial lighting, can result in bird attraction and mortality (Hope Jones 1980), with nocturnal migrants and other night-flying seabirds (such as Leach's Storm-petrels) being most at risk. • Similar to offshore lighting in general, various factors influence the potential for marine bird interaction with flares, such as the time of year and location (and thus, the likelihood of species presence and movements), time of night and associated bird climb and descent patterns , stack height, and weather conditions (Hope Jones 1980; Wiese et al. 2001). • Available mortality estimates often rely on recovery of birds on platforms and vessels, and it is not known how many birds are killed by flares but not recovered due to incineration, scavenging or landing in the ocean (Hope Jones 1980; Ellis et al. 2013). • During exploration drilling, produced water may be discharged in small volumes during formation flow testing (if not sent to the flare for disposal). • Produced water discharges can vary among reservoirs but can include trace heavy metals, radionuclides, sulfates, treatment chemicals, produced solids and hydrocarbons (Fraser et al. 2006) and under some oceanographic conditions, result in formation of hydrocarbon sheens (ERIN Consulting Ltd and OCL Services Ltd 2003; Fraser et al. 2006; Morandin and O'Hara 2016), which can affect birds through exposure or ingestion.
Supply and Servicing (Vessels and Helicopter Use)	• Vessel and helicopter traffic may disturb marine and migratory birds, particularly seabird nesting colonies located along travel routes. • Reactions of marine birds to aircraft can depend on various factors, including the species involved (Rojek et al. 2007), increase in sound level above background (Brown 1990) and previous exposure levels (habituation), as well the location, altitude and frequency of flights and type of aircraft (Goudie 2006; Hoang 2013). Although noise is the primary stressor, some studies have reported evidence of visual detection (without sound) inducing behavioural responses (Brown 1990; Acosta 2009). • Similar to aircraft disturbance, there are several variables which can influence behavioural responses of birds to vessel traffic including vessel size, speed of travel, distance, approach angle, and traffic density (Bellefleur et al. 2009; Marcella et al. 2017), with differences in reactions observed among and within species (Marcella et al. 2017). • Disturbance effects on birds from aircraft or approaching vessels may induce subtle behaviours (e.g., scanning and/or alert behaviour) from which physiological or ecological implications are not well understood (Brown 1990; Goudie 2006), or more obvious escape reactions/flushing behaviours which could have more obvious physiological and ecological effects (e.g., increase in energy expenditure, lower food intake) and result in temporary loss of useable habitat and/or altered migration patterns (Brown 1990; Larkin 1996; Komenda-Zehnder et al. 2003; Beale 2007). • Flushing of breeding birds from the nest in response to such noises can incidentally result in predation of eggs and chicks and decreased incubation and brooding (Brown 1990; Bolduc and Guillemette 2003; Beale 2007; Burger et al. 2010), as well as accidental knocking of eggs and flightless young from nests (Carney and Sydeman 1999).
Well Abandonment or Suspension	• Potential environmental effects on marine and migratory birds from well abandonment and decommissioning are anticipated to be negligible due to water depth and relative diving range of marine birds. The thick-billed murre is one of the

Physical Activities/Components	Potential Effects: Summary of Current Knowledge
	deepest underwater diving birds, regularly descending to depths of more than 100 m, and occasionally below 200 m (Gaston and Hipner 2000). • Refer to *Presence and Operation of Drill Rig* for more information on potential effects from vessel noise and lights.

8.3 Unplanned Events

The accidental release of hydrocarbons or other materials into the environment has the potential to adversely affect marine and migratory birds and their habitats in offshore, and potentially nearshore, areas. The nature and degree of these potential effects depends on various factors, including the location, magnitude and trajectory of the spill, the time of year, and the presence and abundance of marine and migratory bird species within the affected area.

Accidental events such as oil spills can lead to changes in their presence, abundance, distribution or health of marine and migratory birds at both the individual and population levels. Marine birds are amongst the biota most at risk from oil spills, as they spend much of their time upon the surface of the ocean. In the event of a spill, and depending upon spill and area specific factors, coastal birds may also be at risk on beaches and in intertidal zones. As outlined in Section 8.2, the main potential effects on this VC therefore include:

- Change in mortality / injury levels and health;
- Change in avifauna presence / abundance and distributions (behavioural effects);
- Change in habitat use, availability and quality; and
- Change in food availability or quality

Table 8.4 summarizes current information and knowledge from the literature and other sources on the nature and degree of the potential effects of accidental events on marine and migratory birds.

Table 8.4 Potential Effects on Marine and Migratory Birds: Summary of Current Knowledge (Unplanned Events)

Potential Accidental Event	Potential Effects: Summary of Current Knowledge
Oil Spills (Batch Spills and Blowouts)	• Birds (especially pelagic seabirds) are among the most vulnerable and visible biota to be affected by oil spills (Wiese and Robertson 2004; O'Hara and Morandin 2010; Morandin and O'Hara 2016; Boertmann and Mosbech 2011). • The long lifespan and low fecundity of many seabird species suggests that oil-related effects can have longer term population effects (Wiese and Robertson 2004). • Morandin and O'Hara (2016) reviewed several short- and long-term studies of marine oil spills and confirmed that effects on birds can result in increased mortality rates, physiological impairment, reduced reproductive success and in severe cases, possible long-term population declines. • Effects pathways include external exposure to oil, inhalation of volatile hydrocarbons, and ingestion of oil, with most mortalities related to oiling of plumage (Boertmann and Mosbech 2011). • Most marine birds rely on feathers for flight and insulation, and in some cases, also buoyancy (O’Hara and Morandin 2010). Oiling of feathers can change the weight and microstructure of feathers, thereby affecting thermoregulatory capability (which can lead to hypothermia) and buoyancy (which can lead to drowning) (Clark 1984;

Potential Accidental Event	Potential Effects: Summary of Current Knowledge
	Montevecchi et al. 1999; O'Hara and Morandin 2010). These changes can cause a heightened metabolic rate (and thus, increased energy expenditure), behavioral changes (such as increased time spent preening at the expense of foraging and breeding), and starvation due to increased energy needs to compensate for heat loss resulting from oiling and loss of insulation (Butler et al. 1986; MMS 2001; Lee et al. 2015; Morandin and O'Hara 2016). • Once birds are exposed to oil, even with rescue and cleaning efforts, the chances of survival are often quite low (French-McCay 2009). • The potential effects of oil exposure on birds varies with different types of oil, weather conditions, season, migratory patterns, and other activities (Wiese et al. 2001; Montevecchi et al. 2012), with the timing and location of a spill more directly correlated to seabird mortality and injury rates (Wiese et al. 2001) than actual volume of oil spilled (Burger 1993). • Lethal and sublethal effects on birds can also occur from oil ingestion (Peakall et al. 1981 Morandin and O'Hara 2016). Birds that feed on organisms from affected areas are at heightened risk of contamination with oil ingestion resulting in lethal and sublethal effects (Alonso-Alvarez et al. 2007; McEwan and Whitehead 1980; Butler et al. 1986) which can be compounded by changes in food web structures and a reduction in breeding success (Ainley et al. 1981; Ellis et al. 2013).
Drill Fluids (SBM) Spills	• SBM is a dense, low toxicity fluid which sinks rapidly through the water column (Neff et al. 2000; CNSOPB 2005, 2018). • Effects on marine and migratory birds would be minimal and similar to those described above for authorized drilling discharges (see *Drilling and Associated Marine Discharges*).

8.4 References

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