Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Current	Spatial, Temporal, Altitudinal Distributions	Marine Birds	All	All	All	Flight height	Flight height data for birds when foraging, migrating, and transiting between areas that may overlap with OSW energy developments. Aim to calculate proportion of time spent in rotor swept zone by species and behaviour.	Radar contract (Cornell, end date: March 2025) will provide insight on using weather radar data to monitor large scale biomass movements through the airspace. Biomass monitoring or tracking programs (e.g. devices equipped with accellerometers). Require tags for small aerofauna that can provide flight height data and other behavioral info rmation (e.g., miniaturized tags with barometric pressure sensors, for example). For example, the ATLAS system could enable studies to monitor fine-scale movements of smaller birds/bats within development areas once infrastructure is in place.	Missing or highly variabile flight height metrics may underestimate collision risk.	ECCC* ECCC*: means both “CWS” and “STB”; both branches have contributed their different expertise.
Current	Cumulative effects	Aerofauna	All	All	All	Research	What is the best approach for assessing the cumulative effects of OSW developments, other human activities and natural processes on aerofauna?	Research: Conduct a comprehensive review of Cumulative Effects Analysis approaches from other jurisdictions with mature OSW industries. Synthesize the best practices and propose an analytical strategy for assessing the cumulative effects of OSW and other pressures on aerofauna. Note that this is being advanced through current work between ECCC-STB and the Biodiversity Research Institute (see pre-print of Conceptual Framework: https://www.biorxiv.org/content/10.1101/2024.08.20.608171v1.full	During various phases of OSW industry development (i.e., site selection) decision makers (e.g., Canada's Offshore Energy Boards) will not have a tested, recommended Cumulative Effects Analysis approach to follow. As a result, decisions may not be based on the best available information and analyses, and the delineation of lease areas may not minimize cumulative effects on aerofana.	ECCC*
Current	Cumulative effects	All	All			Research	Identify/develop modelling techniques that enable multiple spatiotemporal data sources to predict a single best-estimate distribution model.	Examples of techniques include ECSAS, tracking, aerial surveys, Motus, etc.	Potential to mis-classify risk due to presentation of incomparable data products.	ECCC*
Current	Cumulative effects	All	All			Research	Identify/develop a method to express uncertainty in distribution/density estimates due to lack of data	Require a method to express to non-technical stakeholders the difference between "no birds predicted/observed", and "no birds". Require a more quantitative assessment of data gaps (i.e., mapping exercise with data by species, known colony locations and sizes, and the proposed development areas).	Potential to mis-classify risk due to data gaps.	ECCC*
Current	Cumulative effects	All	All			Research	Develop data layers to inform cumulative effects assessments	Research: Quantify amount, species composition, and spatiotemporal distribution of fisheries bycatch by fishing gear type. Note: Data layers for petroleum pollution risk, vessel traffic, and artificial light at night are in development, expected by January 2025. This benefit from additional data sources and analytical tools (e.g. VMS data).	Potential to underestimate cumulative pressures, such that the added pressure of offshore wind energy development/operation results in unexpectedly adverse outcomes for one or more seabird populations.	ECCC*
Current	Cumulative effects	Marine Birds	All/priority species			Research - case studies	Pre- and post- OSW installation case study(ies) to detect and understand the impacts of wind farms on vulnerable species.	Research: For select priority species and locations where foraging ranges are expected to overlap a future wind installation. Establish a baseline of foraging distribution (via tracking), population size, reproductive success, diet, and health (e.g., baseline corticosterone, glucose, ketone, triglycerides, cholesterol). Repeat these measurements following the OSW installation. Pre- and post-assessments should each include several years of data to ensure 'natural' inter-annual variations are considered. Potential Leach's Storm-petrel colonies for consideration, based on proposed development areas include Country Island (NS), Middle Lawn Island (NL), and Grand Colombier (SPM).	Inability to accurately anticipate risk of displacement as additional installations are proposed. Inability to conclusively attribute wind farm installations to changes in survival and reproductive success at colonies, if applicable. Data are required to refine cumulative effects assessments and inform project-level Environmental Impact Assessment reviews.	ECCC*
Current	Spatial, Temporal, Altitudinal Distributions	Bats	Silver-haired Bat, Eastern Red Bat, Hoary Bat	Research		Research/Monitoring	Increase understand of spatial and temporal distribution of migrating bats.	Research: Quantify where within the study areas bats are typically migrating, and at what times of year. To be achieved through acoustic surveys as part of the Atlantic See bats at See Program (ships of opportunity, transects, and coastal stationary surveys).	Potential to not understand baseline before industry comes in. Presence of OSW energy development may impact and alter these movements.	ECCC*
Current	Spatial, Temporal, Altitudinal Distributions	Seabirds (including Leach's storm petrel), Common Eiders	All	All	All	Saint Pierre and Miquelon colony data	Breeding location, population density, and distribution of colonial nesting birds in SPM.	Research: Possibility to use Lotek tags that are geo-referenced and automatically initiate a specific duty cycle once at a pre-specified latitude or longitude to avoid gaps in critical locations. Some of these research questions are being tested in the US. Recommend a framework or process for easier/more consistent sharing of research efforts and coordination between US researchers and Canadian research. For example, coordinating/sharing about Common Tern tagging efforts in Canada, the US, and Brazil. Collaboration with St. Pierre Miquelon/French government.	Underestimating population densities and foraging ranges that can overlap with OSW energy developments.	ECCC*
Current	Spatial, Temporal, Altitudinal Distributions	Migratory birds; Bats	Bank Swallows	Landbirds	Summer/Spring/Fall	Foraging ranges, Migration routes	Identification of migration routes to and from NS including timing and potential foraging in the offshore environment. Unidentified swallow species have been detected 40km offshore foraging near wind farms in other jurisdictions.	MOTUS tagging programs; species targeted tracking programs	Potential for development within key migratory routes leading to increased displacement or collision risk; inability to identify potential attraction into the offshore environment	ECCC*

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Anticipated	Spatial, Temporal, Altitudinal Distributions	Migratory birds; Bats	Migratory birds; Bats	Landbirds; Bats	Spring/Fall	Migration routes	Identification of migration routes to and from NL including timing.	Research: MOTUS tagging programs, tower network expansion in NL.	Potential for development within key migratory routes leading to increased displacement or collision risk.	ECCC*
Anticipated	Cumulative effects	Northern Gannet	Northern Gannet		All	Research	How can cumulative effects from OSW and other pressures on **Northern Gannets** be minimized?	Research: Conduct a Cumulative Effects Analysis following the analytical strategy and best practices. The result should indicate where placement of OSW energy developments should be avoided, to minimize cumulative effects. Sydney Collins at Memorial Univeristy is planning gannet tracking and colony monitoring over the next several years. Ongoing annual monitoring of Northern Gannet population at all colonies and annual productivity at key colonies (Baccalieu and Funk).	During various phases of OSW energy development (i.e., site selection) decision makers (e.g., Canada's Offshore Energy Board) will not have a tested, recommended Cumulative Effects Analysis approach to follow. As a result, decisions may not be based on the best available information and analyses, and the delineation of lease areas may not minimize cumulative effects on aerofana.	ECCC*
Future	Displacement	Marine Birds	All	All	All	Noise disturbance	Impact of noise (both underwater and above) including chronic stress, displacement from colonies and foraging grounds.	Research: Monitoring of noise levels and nest abandonment. Adaptive management: Restrictions during sensitive times near colonies.	Inability to accurately anticpate risk of displacement, particularly from colonies or foraging grounds.	ECCC*
Future	Attraction, Displacement	All	Seabirds identifiable by aerial imagery			Research	Does OSW energy infrastructure attract or displace different species of seabirds?	Research: Comparing pre- and post- OSW development seabird locations relative to turbines as in https://www.frontiersin.org/journals/marine-science/articles/10.3389/fmars.2024.1235061/full. Method based on high-resolution aerial imagery with surveys at different times across the breeding season.	Inability to accurately anticipate risk of displacement as additional installations are proposed. Inability to understand potential drivers of changes in survival and reproductive success at colonies, if applicable.	ECCC*
Future	Cumulative effects	Aerofauna	All	All	All	Research/Monitoring	How do the pressures from operational OSW energy developments impact the survival, fitness, and population viability of aerofaunal species or populations?	Research: Establish baseline monitoring of survival, fitness, productivity, and diet at a subset of seabird colonies before, during, and after OSW energy development. Identify species/populations adjacent to proposed OSW energy developments, or that migrate to/through proposed development areas. Prioritize monitoring programs for species/populations that are deemed most sensitive to OSW. Require information on reproductive success and/or occupied burrow density at Corbin, Grand Colombier, Green, Long, and Scatarie Islands for Leach's Storm-petrel.	Limited baseline information with the exception of few key locations. Inability to estimate population trends, population connectivity impacts from OSW energy development, including cumulative effects. Inability to detect OSW energy development impacts on populations as they occur, take corrective action, or mitigate impacts from future developments.	ECCC*
Future	Cumulative effects	Aerofauna, Marine Mammals, Fish, Industry	All	All	All	Research	How can Ecosystem Based Management help to integrate considerations of impacts across environmental (fish, marine mammals, benthos, zooplankton, aerofauna) and economic (fisheries, fishing) sectors? Could this support the planning and management of an offshore wind energy industry that is both economically successful and environmentally sustainable?	Research: Conduct a structured review of approaches used successfully in other jurisdictions (e.g., internationally, DFO) and evaluate the feasibility of building a decision support model that integrates considerations for both migratory birds and fisheries in Atlantic Canada.	Inability to consider ecosystem-based management without consistency and integration of various environmental and economic factors.	ECCC*

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Cumulative effects	Aerofauna	All	All	All	Research	What colony do individuals impacted by specific development projects originate from?	Research: Identify priority species and major colonies/migratory pathways in the Atlantic. Determine a threshold considered to be 'significant' presence in Canadian Regional Assessment waters during each season. Focus on those species in order of vulnerability as assessed by ECCC. For each, determine if tracking data exist for major colonies, or if domestic or international tracking programs would be required. Where data are available for a sufficient number of key colonies, develop Surface Density Models (SDMs) to quantify the percentage of birds present by population at a given time and location. Not that this is currently under development for murres (international), and storm petrels (Canadian, possibly US. This could also potentially be done using genetic or biomarker approaches *if* birds could be captured at sea in potential development areas and at potential colonies of origin. Tissue samples could be analyzed for genetic markers and/or stable isotopes and trace elements, then clustering approaches could be used to assign birds to their colony of origin. Biomarker technique has been piloted on juvenile storm-petrels.	Inability to attribute population-level impacts on Canadian or international colonies to OSW energy development in Canadian waters.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Aerofauna	All	All	All	Research	How much interannual variability in at-sea distribution is there for a given aerofauna species or population? This is a key point for developing a tracking strategy. Knowledge of plasticity is key for understanding the impact of stationary threats like turbines, and also spatiotemporal shifts in prey bases due to climate change and the future suitability of Marine Protected Areas (MPAs).	Note: There will be data coming from tagged waterfowl (puddle ducks and geese) and American Woodcock in the coming years that can contribute to distribution data for these species. Research: Better understanding of prey species (i.e., Sand Lance) and potential impacts that could result from changes to prey availability. Recommend baseline surveys for prey species. Understanding prey distributions, and particularly spawning areas for prey fishes, to help inform siting of wind farms and timing of construction activities. Recommend research similar to the Environmental Studies Research Fund for offshore oil and gas for OSW energy (https://www.esrfunds.org/)	Limited ability to generate accurate species/population-specific density and distribution estimates over time.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Aerofauna	All	All	All	Research	How can interannual variability be incorporated and represented in species distribution models, monitoring and mitigation plans, and Cumulative Effects Analyses?	Research: all baseline research should be conducted over multiple years to account for "natural" variation. Monitoring and mitigation plans should allow for adaptive management based on results. Seasonal variations to be considered in Cumulative Effects Analyses.	Limited ability to generate accurate species/population-specific density and distribution estimates over time.	ECCC*
Future	Mitigation Effectiveness	Aerofauna	All	All	All	Research	What are the actionable measures that can reduce risk of OSW energy developments on migratory aeorfauna?	Assessment of mitigation effectiveness at all phases of development.	Inability to assess mitigation effectiveness and enact adaptive management in response to monitoring results.	ECCC*
Future	Displacement	Aerofauna	All	All	All	Decommissioning	Impacts due to decommissioning remain unknown as few OSW energy developments have been decommissioned. Often assumed that these are similar to construction, but this does not account for partial decommissioning or repowering.	Monitoring and mitigation effectiveness assessment during decommissioning/repowering phases that enable comparison across all development phases.	Underestimation of potential displacement of aerofauna from important habitat such as colonies, foraging areas, and stop over sites.	ECCC*
Future	Mitigation Effectiveness	Aerofauna	All	All	All	Artificial Lighting	More study of behavioural responses to artificial light sources in OSW energy developments.	Research: Monitoring OSW energy development lighting sources for evidence of attraction, reporting strandings or collision (whenever possible) on lit infrastructure. Monitoring during construction and maintenance (with potential stop-work collision limits in place) is equally important as monitoring during operation. Responses to artificial light sources may vary by time of year (e.g., there could be	Underestimation of collision or displacement risk experienced by aerofauna taxa.	ECCC*
Future	Attraction, Discplacement	Aerofauna	All	All	All	Artificial Structures	Species-specific behaviour around maintenance vessels in OSW energy development areas.	Research: Monitoring and reporting species sightings around vessels during maintenance activities, including avoidance and attraction behaviour.	Underestimation of collision or displacement risk experienced by aerofauna taxa.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Common Eiders	All	All	All	South coast of Newfoundland colony data	Location and population density of colonial nesting birds in southern Newfoundland.	Research: Maintain monitoring of historic and current colonies.	Underestimating population densities and foraging ranges that can overlap with OSW energy developments.	Waterfowl team
Future	Spatial, Temporal, Altitudinal Distributions	Colonial Coastal and Seabirds	Colonial Coastal and Seabirds	Coastal; Seabirds	Breeding	Foraging ranges	Maximum and mean maximum foraging ranges from breeding colonies into the offshore environment and stage-specific (incubating vs chick-rearing) foraging estimates.	Research: Species targeted tracking programs prioritizing species and colonies adjacent to proposed/anticiapted OSW energy development areas.	Underestimating population densities and foraging ranges that can overlap with OSW energy developments.	ECCC*

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Spatial, Temporal, Altitudinal Distributions	Woodcock	Gamebird	Game bird	All	Relative Abundance; Coastal Density	Species-specific relative abundance and densities. Extent of range expansion.	Research: Species targeted monitoring programs and surveys.	Inability to identify potential areas of Woodcock migratory corridors that could overlap with OSW energy developments.	Waterfowl team
Future	Spatial, Temporal, Altitudinal Distributions	Horned Grebe	Horned Grebe	Inland and Coastal	Winter/Spring Migration	Non-breeding sites	Identification of overwintering grounds within Atlantic Canada including use of offshore environment.	Research: Species-targeted tracking programs.	Critical habitat currently only includes nesting and foraging habitat on the Magdalen Islands. Lack of protection during non-breeding season.	ECCC*
Future	Cumulative effects	Terns (incl Roseate Terns)	Terns (incl Roseate Terns)	Seabirds	Breeding	Colony nesting sites	What are the cumulative effects of OSW energy developments and climate change impacts on breeding habitats for terns, including endangered Roseate Terns?	Research: Baseline data collection (e.g., survival, productivity, fitness) and tracking.	Inability to predict continued and future impacts on species, including population trends, community assemblages, impacts of invasive species, etc.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Black Guillemot	Black Guillemot	Seabirds	Winter	ECSAS survey	At-sea density and distribution.	Research: Continuation and expansion of ECSAS and species targeted surveys.	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Bonaparte's Gull	Bonaparte's Gull	Seabirds	Spring	ECSAS survey	At-sea density and distribution during spring and fall migration.	Research: Continuation and expansion of ECSAS and species targeted surveys.	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Loons	Loons	Seabirds	Winter	ECSAS survey	Overwinter at-sea density and distribution for both Common and Red-throated Loons.	Research: Continuation and expansion of ECSAS and species targeted surveys.	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Razorbills	Razorbills	Seabirds	Winter	ECSAS survey	Overwinter at-sea density and distribution in the offshore environment.	Research: Continuation and expansion of ECSAS and species targeted survey (see example: https://unbscholar.lib.unb.ca/items/e36151f0-5482-455b-b09b-419c26433404).	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Spatial, Temporal, Altitudinal Distributions	Shearwaters	Shearwaters	Seabirds	Winter	ECSAS survey	Overwinter at-sea density and distribution in the offshore environment.	Research: Continuation and expansion of ECSAS and species targeted survey. Note: ECCC is analysing historic tag deployments; deploying new tags in 2024-25; and working to develop predictive models for Shearwaters.	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Skuas	Skuas	Seabirds	Winter/Spring Migration	ECSAS survey	At-sea density and distribution during the non-breeding season.	Research: Continuation and expansion of ECSAS and species targeted surveys.	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Storm-petrels	Storm-petrels	Seabirds	Winter	ECSAS survey	Overwinter at-sea density and distribution in the offshore environment.	Research: Continuation and expansion of ECSAS and species targeted surveys.	Not possible to estimate species-specific impacts or cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Roseate Tern	Roseate Tern	Seabirds	Spring, Summer, Fall	Foraging ranges, migratory routes	Offshore habitat use during the breeding season around colonies and migratory routes.	Species targeted tracking programs. Note: ECCC is conducting a pilot project on Common Tern itnended to lead to future telentery work on Roseate Tern.	Increased impacts on SAR species, currently considered "Endangered". Lack of protection while moving during critical periods in the offshore.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Migratory birds	Migratory birds	Seabirds; Waterfowl; Shore birds	Spring/Fall	Migration tracks	Tracking data on key species during migratory periods to capture routes.	Species targeted tracking programs. ECSAS targetting the breeding and nonbreeding season to encompass non-breeders and young pre-breeders Note: Preliminary results from Black-legged Gull tracking from Nunatsiavut show they overwinter in the Gulf of St. Lawrence and migrate through the Strait of Belle Isle, potentially passing through Regional Assessment areas in late fall and spring. This species is harvested (eggs and individuals) by Inuit in Labrador and could be at risk to OSW energy development during migration. Note: Additional Northern Gannet tracking is anticipated from the Motevecchi lab at Memorial University (Sydney Collins). Note: Partnership between ECCC and the SEATRACK program is ongoing and providing migration data for Leach's Storm-petrel, Herring Gull, Black-legged Kittiwake, and Atlantic Puffin from Witless Bay, NL.	Potential for development within key migratory routes leading to increased displacement or collision risk.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Shorebirds	Lesser Yellowlegs	Shore birds	Spring	Migratory routes	Northbound migratory routes.	Research: Species targeted tracking programs. For larger seabird species, such as gannets, tracking with agentometers+accelerometers+GPS can be used to map 3D movements to better understand collision risk. For small birds and bats, the priority should be combining new x-band radar technology with acoustic monitoring. Continue to monitor advancements in technologies related to tag types (sunbird, ornitela), tracking systems (ATLAS), and monitoring technology (FaunaScan MR2).	Potential for development within key migratory routes leading to increased displacement or collision risk.	ECCC*

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Spatial, Temporal, Altitudinal Distributions	Shorebirds	Red Knot; Buff-breasted Sandpiper; Lesser Yellowlegs; Hudsonian Godwit	Shore birds	Spring/Summer/Fall	Coastal Densities	Habitat use and movement between sites.	Research: Coastal surveys and species targeted monitoring.	Underestimating population densities and foraging ranges that can overlap with OSW energy developments.	ECCC*
Future	Cumulative effects	Shorebirds	Shorebirds	Shore birds	All	Research	How can cumulative effects from OSW energy development and other pressures on **shorebirds** be minimized?	Research: Conduct a Cumulative Effects Analysis following the analytical strategy and best practices described in "Interim Conceptual Framework for Assessing the Cumulative Effects of Offshore Wind Energy and Other Pressures on Aerofauna". The result should indicate where placement of OSW developments should be avoided, to minimize cumulative effects.	During various phases of OSW industry development (i.e., site selection) decision makers (e.g., Canada's Offshore Energy Board) will not have a tested, recommended CEA approach to follow. As a result, decisions may not be based on the best available information and analyses, and the delineation of lease areas may not minimize cumulative effects on aerofana.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Harlequin Duck	Harlequin Duck	Waterfowl	Year round	Key Habitat Sites	Key habitat sites in the offshore environment; particularly overwintering sites.	Research: Species targeted monitoring programs and surveys. Note: ECCC has large database of historic surveys and has conducted new surveys in 2023/24. Province of NS also has an active survey program.	Potential for development within key overwintering habitats leading to increased displacement or collision risk.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Barrow's Goldeneye	Barrow's Goldeneye	Waterfowl	Year round	Key Habitat Sites	Key habitat sites in the offshore environment; particularly overwintering sites.	Research: Species targeted monitoring programs and surveys. Note: Comprehensive surveys current to 2010. Eastern Habitat Joint Venture may provide an opportunity for winter surveys.	Potential for development within key overwintering habitats leading to increased displacement or collision risk.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Waterfowl	Waterfowl	Waterfowl	Summer	Relative Abundance; Coastal Density	Species-specific relative abundance and densities of waterfowl during the breeding season.	Research: Coastal surveys and species targeted monitoring. For Common Eider, a large-scale telemetry project may be used to identify key sites.	Inability to identify potential areas where waterfowl may be congregating including transit/migratory corridors that could overlap with OSW energy developments.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Waterfowl	Waterfowl	Waterfowl	All	Relative Abundance; Coastal Density	Species-specific relative abundance and densities of waterfowl outside of breeding season and during migrations.	Research: Coastal surveys and species targeted monitoring. For Common Eider, there are existing data sources for regional, year-round tracking and winter aerial surveys. Of high importance is identification of key winter sites and post-breeding moult sites. Some of this work is being done by ECCC through analysis of winter aerial surveys and a G&C with Ducks Unlimited to model telemetry data.	Inability to identify potential areas where waterfowl may be congregating including transit/migratory corridors that could overlap with OSW energy developments.	Waterfowl team

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Cumulative effects	Great Black-backed Gull (GBBG), Herring Gull (HERG), Atlantic Puffin	Great Black-backed Gull (GBBG), Herring Gull (HERG),		All	Research	How can cumulative effects from OSW energy development and other pressures on **other seabird species** be minimized?	Research: Conduct a Cumulative Effects Analyses following the analytical strategy and best practices described in "Interim Conceptual Framework for Assessing the Cumulative Effects of Offshore Wind Energy and Other Pressures on Aerofauna". The result should indicate where placement of OSW developments should be avoided, to minimize cumulative effects.	During various phases of OSW energy development (i.e., site selection) decision makers (e.g., Canada's Offshore Energy Board) will not have a tested, recommended CEA approach to follow. As a result, decisions may not be based on the best available information and analyses, and the delineation of	ECCC*
Future	Cumulative effects	Common Eider and other seaducks	Common Eider and other seadcks		All	Research	How can cumulative effects from OSW energy development and other pressures on **coastal seaducks** be minimized?	Research: Conduct a Cumulative Effects Analyses following the analytical strategy and best practices described in "Interim Conceptual Framework for Assessing the Cumulative Effects of Offshore Wind Energy and Other Pressures on Aerofauna". The result should indicate where placement of OSW developments should be avoided, to minimize cumulative effects.	During various phases of OSW industry development (i.e., site selection) decision makers (e.g., Canada's Offshore Energy Board) will not have a tested, recommended CEA approach to follow. As a result, decisions may not be based on the best available information and analyses, and the delineation of lease areas may not minimize cumulative effects on aerofana.	ECCC*
Future	Mitigation	All	All	All	All	Research	What available and effective compensatory mitigation options exist for migratory aerofauna in Atlantic Canada that are vulnerable to OSW energy developments?	Research: Identify priority species for mitigation, review potential compensatory methods, and develop appropriate metrics based on scientific literature. This work should build on ongoing mitigation reviews and explore frameworks like mitigation banks or in-lieu fee programs. Given that the Bureau of Ocean Energy Management (BOEM) and the US Fish and Wildlife Service (FWS) are conducting similar efforts, a Canadian approach should assess and adapt US findings for Atlantic Canada, avoiding duplication of efforts while ensuring a regionally appropriate strategy.	If available and effective methods are not identified it may not be possible for proponents to achieve no net loss of proposed projects.	ECCC* & BRI
Future		All	All			Research	How can avian vulnerability assessment approaches be coordinated across jurisdictions?	Collaboration: Coordinate avian vulnerability assessment approaches across jurisdictions. Collaboration with key organizations like USGS, USFWS, and Normandeau is essential. This could involve creating a shared database of literature review data for model parameters, potentially through the RWSC bird and bat committee. Additionally, exploring the feasibility of adopting a common modeling approach across regions could enhance consistency. Developing general recommendations for parameterizing vulnerability assessments is also		BRI
Future			Terns (other colonial seabirds?)				What are the post-breeding (and after failed breeding) movements by terns?	Research: Multiple years of tagging mixed tern species to understand post-breeding/post-failure movements and southward migration. Note: Ongoing collaboration with Audubon and others in the Gulf of Maine Seabird Working Group.	Key overlaps (areas) could be missed due to lack of data. Terns could be harmed.	ECCC*
Future	Cumulative effects	All	Terns (other colonial seabirds?)			Research	Forage fish dynamics and movements near key colonies.	Research: Forage fish surveys near key colonies (pre-breeding through chick fledging). Understanding and protecting key spawning areas for forage fish that are prey for seabirds. Focus on key foraging areas as well as colonies to be more inclusive of species that rely on Canadian waters during their nonbreeding season (e.g. Shearwaters). Assess forage fish abundance and composition in an area prior to development and throughout operations.	https://www.sciencedirect.com/science/article/pii/S0025326X11003341	ECCC*
Future	Cumulative effects	All	All			Research	Develop data to estimate cumulative effects.	Research: To estimate cumulative effects, robust population models and bioenergetics models are required. While this is long-term research, it should be prioritized (alongside shorter-term efforts to estimate impacts at individual developments) to understand cumulative effects.	Potential to underestimate cumulative effects.	ECCC*
Future	Spatial, Temporal, Altitudinal Distributions	Shorebirds	All	Migratory routes	Species targeted tracking programs. For larger seabird species, like Gannets, tracking with agentometers+accelerometers+GPS can be used to map 3D movements, useful to better understand collision risk. For small songbirds and bats, the priority should be combining new x-band (not weather) radar technology with acoustic monitoring. Re: tag types (sunbird, ornitela), tracking systems (ATLAS), and monitoring technology	Research/Monitoring	Movement Corridors and Routes	Research: Quantify the areas/times of movements for all migrating shorebirds through the region. This includes resident populations that breed within the region, and those populations breeding in the Arctic. Expand the number of species with tags, while ensuring that relevant breeding populations are targetted. Tags should be chosen and consider the spatial and temporal resolution, collection of altitudinal data should also be prioritized. Program tags to collect the following: More locations (when possible); locations at different times of day; Argos data if only a few GPS locations can be collected; fine-scale GPS if examining altitude/exposure to turbines. Consider tag deployment locations: Tagging across populations is helpful to determine relative exposure to lease areas. Tagging near lease areas may bias estimates of exposure. Tagging is currently biased to southbound migration periods.	Potential to not characterize risk to shorebirds from site-based assessments. Potential to not characterize cumulative effects to shorebirds within the region.	ECCC* & Shorebird Collective

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Spatial, Temporal, Altitudinal Distributions	Shorebirds	All	Migratory routes	Species targeted tracking programs. For larger seabird species, like Gannets, tracking with agentometers+accelerometers+GPS can be used to map 3D movements, useful to better understand collision risk. For small songbirds and bats, the priority should be combining new x-band (not weather) radar technology with acoustic monitoring. Re: tag types (sunbird, ornitela), tracking systems (ATLAS), and monitoring technology	Research/Monitoring	Movement Corridors and Routes.	Collation: Integrate data from Motus, tracking programs, and ACSS to increase potential overlap with shorebirds and PFDAs and PLAs. This includes the work on inland bird movements (Devon de Zwaan and Julie Paquet), post-breeding movement work (Jen Rock), tracking programs (new and existing), and ACSS surveys.	Potential to not characterize risk to shorebirds from site-based assessments. Potential to not characterize cumulative effects to shorebirds within the region.	ECCC* & Shorebird Collective
Future	Spatial, Temporal, Altitudinal Distributions	Shorebirds	All	Migratory routes	Species targeted tracking programs. For larger seabird species, like Gannets, tracking with agentometers+accelerometers+GPS can be used to map 3D movements, useful to better understand collision risk. For small songbirds and bats, the priority should be combining new x-band (not weather) radar technology with acoustic monitoring. Re: tag types (sunbird, ornitela), tracking systems (ATLAS), and monitoring technology	Research/Monitoring	Important coastal areas for shorebirds.	Research: Identification of coastal areas where birds might be staging before migration.	Potential to miss identifying areas where birds are congregating before heading into marine environment. Potential to miss if OSW is affecting where birds are choosing stage. Potential to miss if impacts from other industries or climate change are affecting these habitats.	ECCC* & Shorebird Collective
Future	Spatial, Temporal, Altitudinal Distributions	Bats	Silver-haired Bat, Eastern Red Bat, Hoary Bat	Research		Research/Monitoring	Increase understand of altitude of migrating bats.	Research: Quantify flight altitudes of bats in the offshore environment.	Potential to not estimate collision risk appropriatley	ECCC*
Future	Cumulative effects	Bats	Silver-haired Bat, Eastern Red Bat, Hoary Bat	Research		Research/Monitoring	Understand what breeding populations ATL migrating tree bats are coming from and their movements.	Research: Combination of hair sample collection with tagging programs. Stable isotope analysis to understand where source populations are connected through the region. Terrestrial and offshore Motus receivers and tagged bats to measure movement through offshore areas.	Potential to not evaluating cumulative effects on bats appropriately.	ECCC*

Current, Anticipated or Future	Category	Species/Taxa	Species	Taxa	Season	Data Type	Data & Knowledge Gaps	Suggested Follow-up (Research, Monitoring)	Risks to not addressing the data gap	Where is this idea coming from?
Future	Attraction	Bats	Silver-haired Bat, Eastern Red Bat, Hoary Bat			Research/Monitoring	Understand if and how bats are attracted to offshore infrastucture.	Before-After-Gradient (BAG) studies on bat densities before and after development to understand impacts to bats and whether infrastructure is an attractant.	Potential to not detect changes in movements and survival of migrating bats.	ECCC*

Current, Anticipated or Future	Category	Data/Knowledge Gap	Suggested Follow-up (Research, Monitoring)	Species/Taxa	Risk to not filling gap	Research	Monitoring	Technology	Other	What phase of OSW industry development? Site selection (identifying licensing areas)? Site evaluation (proponent impact assessments)? Regional Assessment (general, broad to support both)?	Where is this idea coming from?
Future	Acoustic Monitoring	Acoustic Monitoring Data	Identify goals and pilot study recommendations for passive acoustic studies. Develop a database and standard data collection protocols.	Bats							Other jurisdictions
Future	Acoustic Monitoring	Bat acoustic data (passive or active), including both records of identified species and raw acoustic files	Develop offshore-specific protocols for passive and active acoustics. NABat has confirmed that it can incorporate contemporaneous local meteorological data and turbine operational status with bat acoustic detection data. Solicit historical acoustic data from coastal and offshore studies for incorporation into NABat.	Bats							Other jurisdictions
Future	Attraction	Does lighting at wind farms cause attraction or disorientation for marine birds or migrants?	Examine if flood lighting, lighting regimes, lighting mitigations on turbines or substations during C, M cause attraction and disorientation for bats.	Bats						Individual Wind Farm Site to Multiple Wind Farm Sites	Other jurisdictions
Future	Attraction	Does lighting at wind farms cause attraction or disorientation for marine birds or migrants?	Examine the degree of nocturnal attraction to offshore wind for turbines that use ADLS.	Birds						Individual Wind Farm Site to Multiple Wind Farm Sites	Other jurisdictions
Future	Attraction	Determining if patterns of bat occurrence, activity, and movements change after construction of offshore wind facilities.	continuing surveys of bat occurrence and activity post-construction to understand if patterns change and continuing to document characteristics of offshore flights. Post-construction studies of this kind may help elucidate whether, and to what degree, attraction to turbines is occurring, and whether siting could be an effective mitigation strategy for future wind projects.	Bats							Other jurisdictions
Future	Baseline Conditions	Understanding baseline conditions of bird populations and bird ecology offshore.	Addressing questions about how distribution patterns, density, and movements vary by time of year, with meteorological conditions, across seasons (i.e., breeding, migration, nonbreeding seasons), by sex, age, and reproductive status, with interannual variation, and especially in the context of global climate change. Understanding distribution and abundance during the breeding season is of particular interest for colonial nesters that may be tied to only a few historic breeding areas. Movement metrics of interest include speed, distance and longevity of flights, flight height, and starting points and destinations	Birds							Other jurisdictions
Future	Baseline Conditions	Understanding baseline conditions of bird populations and bird ecology offshore.	assessing important variables relative to population dynamics (e.g., fecundity, survival, population structure) and interactions among bird species and with prey populations.	Marine Birds							Other jurisdictions
Future	Baseline Conditions	Informing pre-construction risk assessments of potential impacts to birds.	considering exposure of birds to offshore wind development, based on baseline distributions noted above. Collecting data to inform collision risk models and developing these models are also included.								Other jurisdictions
Future	Climate Change	Assessing impacts of construction and operation of offshore wind facilities.	Assessing changes from baseline conditions (e.g., distribution patterns, movements, population dynamics and trajectories, ecological interactions) in the context of climate change and other environmental changes. It also includes documenting collision fatalities, where possible.								Other jurisdictions
Future	Collaboration	Need to conduct and share scientific research and advances, through discussion, coordination, and planning.	Creating a structure in which to collaboratively conduct and share scientific research and advances, through discussion, coordination, and planning.								Other jurisdictions
Future	Collisions	Create model to predict number of predicted collisions at wind farm sites that propoents can use to model impacts.	Create Band collision model that industry can use to predict collisions.	Marine Birds					Yes	Regional	Other jurisdictions
Future	Collisions	How often do avian collisions occur relative to predicted exposure, and what influences vulnerability?	Program to assess species-level frequency of collisions relative to exposure for migrants and marine bird (post-construction)	Aerofauna		Yes	Yes			Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	How often do avian collisions occur relative to predicted exposure, and what influences vulnerability?	Assess environmental covariates, wind farm covariates, and individual-level collision rates to understand what influences the probability of collisions.	Aerofauna		Yes	Yes	Yes		Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	What are the meso- and micro- avoidance rates of birds at offshore wind farm projects, under various behavioural and operating conditions?	Create stochastic Collision Risk Models (CRM) by examining avoidance rates at the meso and micro scale.	Marine Birds		Yes	Yes	Yes		Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	What are the meso- and micro- avoidance rates of birds at offshore wind farm projects, under various behavioural and operating conditions?	Examine and assess what environmental factors influence collision-related behaviours.	Marine Birds		Yes				Across Multiple Offshore Wind Farm Sites	Other jurisdictions

Current, Anticipated or Future	Category	Data/Knowledge Gap	Suggested Follow-up (Research, Monitoring)	Species/Taxa	Risk to not filling gap	Research	Monitoring	Technology	Other	What phase of OSW industry development? Site selection (identifying licensing areas)? Site evaluation (proponent impact assessments)? Regional Assessment (general, broad to support both)?	Where is this idea coming from?
Future	Collisions	What is the relationship between pre-construction exposure and collision risk?	Assess whether ECCC predictive density modelling was able to accuratley predict collisions in offshore wind farms.	Marine Birds		Yes				Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	What are the meso- and micro- avoidance rates of birds at offshore wind farm projects, under various behavioural and operating conditions?	Validate CRMs using field studies from post-construction wind farms.	Marine Birds		Yes				Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	How do bat interactions with turbines different between onshore and offshore farms?	Examine how bats interact with turbines at the micro-scale to know if behaviours are different.							Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	How do bat interactions with turbines different between onshore and offshore farms?	Do bats get attracted to offshore turbines for foraging, roosting or mating?							Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	How comparable are bat mortalities between onshore and offshore wind farms?	Develop and validate technology for detecting collisions offshroe and assess comparibility for mortality estimation.							Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	How comparable are bat mortalities between onshore and offshore wind farms?	Assess numbers and timing of bat collisions occuring at wind farms and compre for pattersn across latitudes.							Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Collisions	Collision models rely on assumptions and associated uncertainties. Need to characterize this uncertainty effectivley.	Improve uncertainty quantification within individual-based models to better characterize and reduce structural and parameter uncertainty								Other jurisdictions
Future	Collisions	CRMs should be evaluated to understand if the models are parameterized correcltly, and if modifying one parameter has larger effect on outputs then others.	Assess sensitivity of collision risk model outputs to variation in input and structural parameters; understand and quantify covariance between parameters used in collision risk models to better quantify and reduce structural and parameter uncertainty								Other jurisdictions
Future	Collisions	Flight hight, speeds, and maneouverabily data is limited for many species.	Improve estimates of flight speed and height for species to better characterize and reduce parameter uncertainty, quantify influence of environmental conditions to better characterize natural variability, and understand how variation in flight speed and flight height is related to behaviour (e.g. commuting versus foraging) to reduce knowledge uncertainty								Other jurisdictions
Future	Collisions	Need more estimates of actualy avoidance rates around wind farms at micro meso and macro scales to help parameritize modelling.	Improve estimates of avoidance rates and partitioned into micro-, meso-, and macro-avoidance to better quantify and reduce structural and parameter uncertainty; improve understanding of the influence of environmental conditions on avoidance to better characterize natural variability; mprove understanding of the contribution of model error to predicted collision rates and the implications of this for estimates of avoidance rates								Other jurisdictions
Future	Collisions	Assessing bat collision risk at offshore facilities.	Until validated and effective collision detection methods are widely available, proxies are necessary to assess collision risk. For bats, acoustic activity, particularly recorded at nacelle height in conjunction with information regarding turbine operational status, may be the best indicator of potential collision risk (Peterson et al., 2021). Assessing bat activity at turbine nacelle height relative to timing, meteorological conditions, turbine characteristics, turbine operational status, and species is an important research goal. (Tracking data may also provide information about movements of non-echolocating bats.) Turbine-mounted cameras and multi-sensor collision detection technologies may be able to provide actual measures of collision risk and fatalities. These data can help in understanding the relative risks to bat populations posed by collisions offshore as compared to fatalities at land-based wind facilities and other threats.								Other jurisdictions
Future	Data Management	Standardization of data workflows, refinement of structures for data sharing, and technological advances.	Standardization of data workflows, refinement of structures for data sharing, and technological advances.								Other jurisdictions
Future	Data Management	Standard databases, data repositories, guidelines and protocols needed.	Maintenance of an up-to-date resource list of recommended standard databases, data repositories, guidelines, and protocols for use by all data collectors.								Other jurisdictions
Future	Data Management	Need clear data standards for monitoring marine birds by multiple agencies, consultants, and industries.	Establishment of an Avian Data Standards Working Group to address gaps in existing data infrastructure (detailed in the table below), including development of recommended protocols/standards where absent, recommendations for the structure/content of new databases, and identification of pilot study parameters where too little is currently known to provide specific methodological guidance.								Other jurisdictions

Current, Anticipated or Future	Category	Data/Knowledge Gap	Suggested Follow-up (Research, Monitoring)	Species/Taxa	Risk to not filling gap	Research	Monitoring	Technology	Other	What phase of OSW industry development? Site selection (identifying licensing areas)? Site evaluation (proponent impact assessments)? Regional Assessment (general, broad to support both)?	Where is this idea coming from?
Future	Data Management	Create data sharing frameworks to address industry-collected data.	Establishment of frameworks for datasets necessary for research (e.g., avian-turbine interaction, micro-avoidance, and collision data; turbine status and local environmental conditions; turbine specifications relevant to placement of monitoring equipment).								Other jurisdictions
Future	Data Management	Other Observational Data	Update eBird mobile app to allow for more detailed recording and retention of quantifiable survey conditions and survey effort in eBird.								Other jurisdictions
Future	Data Management	Other Observational Data	Update eBird platform to support incorporation of outside meteorological data into downloadable data or data products.								Other jurisdictions
Future	Displacement	Are marine birds being displaced from wind farms?	Examine changes in distribution pre- and post- construction of wind farms, and magnitude of changes, and what scale the effect happens.			Yes	Yes			Individual Wind Farm Site	Other jurisdictions
Future	Displacement	How does the degree of displacement vary across the Atlantic Region, and what covariate influence this pattern?	Determine if focal species patterns of displacement change based on where in the region the wind farm is.			Yes	Yes			Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Displacement	How does the degree of displacement vary across the Atlantic Region, and what covariate influence this pattern?	What environmental factors influence the various displacement patterns.			Yes				Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Displacement	Are foraging and local behaviours of marine birds affected by wind farms and to what degree?	Examine if non-transit behaviour (foraging, flight height) change in or near wind farms compared to pre- and post- construction. What wind farm attributes can be associated with this difference?							Individual Wind Farm Site	Other jurisdictions
Future	Displacement	Are transiting and migratory behaviours of marine birds affected by wind farms and to what degree	Asses changes in transit behaviour of birds that repeatedly encounter wind farms and if those changes lead to increased energy expenditure.							Individual Wind Farm Site	Other jurisdictions
Future	Displacement	Are transiting and migratory behaviours of marine birds affected by wind farms and to what degree	Examine pre-migratory dispersal of migratory movements of birds in the vicinity of wind farms to determine the level of displacement .							Individual Wind Farm Site	Other jurisdictions
Future	Displacement	What are the effects of displacement on marine bird fitness	Develop understanding of energy and activity budgets for focal species to understand effects of displacement.							Regional	Other jurisdictions
Future	Displacement	What are the effects of displacement on marine bird fitness	Develop understanding of bird breeding success and survival relative to habitat use and displacement.							Regional	Other jurisdictions
Future	Displacement	What are the population level impacts of displacement for marine birds?	Develop population models to test for specific changes in demographic parameters for marind birds from displacement.							Regional	Other jurisdictions
Future	Displacement	Seasonal differences in displacement affect as it relates to life history strategies of focal species. Displacement will have various impacts on these species at these times of year.	Better understanding and quantification of year-round distributions and impacts of displacement to quantify and reduce uncertainty								Other jurisdictions
Future	Displacement	Seasonal differences in displacement affect as it relates to life history strategies of focal species. Displacement will have various impacts on these species at these times of year.	Better understanding and quantification of predator–prey interactions, relationship between prey density and availability, impacts of offshore wind on prey distributions and availability to quantify and reduce uncertainty								Other jurisdictions
Future	Displacement	Seasonal differences in displacement affect as it relates to life history strategies of focal species. Displacement will have various impacts on these species at these times of year.	Estimate link between displacement effects and changes in demographic rates (productivity and survival) to better quantify and reduce uncertainty								Other jurisdictions
Future	Displacement	Displacement may affects adults vs young-of-year differently, may affect breeding indviduals and non-breeding individuals differently.	Effects of displacement on different age classes, e.g. immatures and non-breeders to better quantify and reduce knowledge uncertainty								Other jurisdictions
Future	Mitigation Effectiveness	Evaluating on-site mitigation strategies.	This could include mitigation activities effective during construction (e.g., noise reduction measures) or operation (e.g., painting turbine blades).								Other jurisdictions
Future	Mitigation Effectiveness	Identifying and evaluating off-site mitigation strategies.	due to the rapid pace of offshore wind development relative to the pace of research on impacts, off-site mitigation could represent an important aspect of offshore wind development, if significant impacts are found. These could be implemented to meet “no net loss” regulatory requirements or involve voluntary conservation offsets providing a net benefit to species.								Other jurisdictions
Future	Mitigation Effectiveness	Collision & Bird-Turbine Interaction Database	Identify goals and pilot study recommendations for collision detection technologies.								Other jurisdictions

Current, Anticipated or Future	Category	Data/Knowledge Gap	Suggested Follow-up (Research, Monitoring)	Species/Taxa	Risk to not filling gap	Research	Monitoring	Technology	Other	What phase of OSW industry development? Site selection (identifying licensing areas)? Site evaluation (proponent impact assessments)? Regional Assessment (general, broad to support both)?	Where is this idea coming from?
Future	Mitigation Effectiveness	Designing and evaluating bat on-site minimization strategies	Assessments of the conditions associated with heightened collision risk (previous bullet) can inform design of efficient, "smart" curtailment strategies for bats, if these methods are deemed necessary to avoid population-level impacts to bats. If determined to be effective in the terrestrial environment, deterrents could also be tested offshore.								Other jurisdictions
Future	Mitigation Effectiveness	Evaluating off-site bat compensatory mitigation strategies	If on-site mitigation measures are deemed insufficient or are cost-prohibitive, off-site mitigation measures could be considered. However, these measures would need to be evaluated carefully to determine if they are realistic and adequate to address negative impacts.								Other jurisdictions
Future	Mortality Surveys	Carcasses and tissue samples	Identify funding and develop additional capacity for carcass and tissue sample storage.								Other jurisdictions
Future	Motus	Tracking via Automated Telemetry	Improve access to historical offshore bird Motus data through a systematic effort to identify relevant past projects and request public access to data if not already available								Other jurisdictions
Future	Motus	Tracking via Automated Telemetry	Develop guidance regarding deployment, metadata, and data storage of local meteorological data associated with telemetry receiver stations to inform timing of bird movements and behavior relative to local weather conditions.								Other jurisdictions
Future	Physical Conditions	Do changes in oceanographic conditions in proximity to wind farms affect marine bird distribution.	Examine changes in stratification, temperature, wind wakes, and other values in and near wind farms at the scale at which these effects occur.							Individual Wind Farm Site	Other jurisdictions
Future	Physical Conditions	Do changes in oceanographic conditions in proximity to wind farms affect marine bird distribution.	Asses if these changes are affecting marine bird distributions.							Individual Wind Farm Site	Other jurisdictions
Future	Population Models	Does the risk of collision predict a potential population level effect for any taxa?	Develop population models to help understand the scope of population level effects from offshore wind that could be detectable.							Regional	Other jurisdictions
Future	Population Models	Population demographics, abundance estimates are needed to help quantify impacts and uncertainty in assessments.	Improve estimates for abundance, productivity, adult and immature survival, carryover effects, and inter-colony movements (including uncertainty in rates) to better quantify and reduce parameter uncertainty								Other jurisdictions
Future	Population Models	Population demographics, abundance estimates are needed to help quantify impacts and uncertainty in assessments.	Empirical estimation of correlation in demographic rates and influence of environmental stochasticity to better characterize natural variability and improve quantification of structural and parameter uncertainty								Other jurisdictions
Future	Population Models	Population demographics, abundance estimates are needed to help quantify impacts and uncertainty in assessments.	Integrated population modelling and model fitting methods to better quantify structural and parameter uncertainty by using all available abundance data to inform estimation of demographic rates; improved models of observation error for abundance estimates to support this								Other jurisdictions
Future	Population Models	Population demographics, abundance estimates are needed to help quantify impacts and uncertainty in assessments.	Sensitivity analyses for PVAs to help prioritize efforts to reduce structural and parameter uncertainty								Other jurisdictions
Future	Population Models	Population demographics, abundance estimates are needed to help quantify impacts and uncertainty in assessments.	Better understanding and quantification of density dependent processes in populations to reduce knowledge uncertainty								Other jurisdictions
Future	Prey Distribution and Abundance	Do changes in underwater communities around turbines affect the long term distribution of marine birds?	Examine changes in in benthic and pelagic communities pre- and post-wind farm construction.							Individual Wind Farm Site to Regional	Other jurisdictions
Future	Prey Distribution and Abundance	Do changes in underwater communities around turbines affect the long term distribution of marine birds?	Assess the long -term changes in abundance, distribution, and diet of marine birds at different trophic levels.							Individual Wind Farm Site to Regional	Other jurisdictions
Future	Prey Distribution and Abundance	How does disturbance to benthic habitat affect marine bird distributions.	Examine effect of benthic prey populations on avian distributions.							Individual Wind Farm Site	Other jurisdictions
Future	Prey Distribution and Abundance	How does disturbance to benthic habitat affect marine bird distributions.	Examine changes in avian diet and reproductive success at breeding colonies.							Individual Wind Farm Site	Other jurisdictions
Future	Prey Distribution and Abundance	Population demographics, abundance estimates are needed to help quantify impacts and uncertainty in assessments.	Understand relationship between demographic rates and prey availability to better quantify and reduce knowledge uncertainty; improve estimates for interactions between demographic rates and climate and other environmental variables to include in population forecasts to better characterize natural variability								Other jurisdictions

Current, Anticipated or Future	Category	Data/Knowledge Gap	Suggested Follow-up (Research, Monitoring)	Species/Taxa	Risk to not filling gap	Research	Monitoring	Technology	Other	What phase of OSW industry development? Site selection (identifying licensing areas)? Site evaluation (proponent impact assessments)? Regional Assessment (general, broad to support both)?	Where is this idea coming from?
Future	Prey Distribution and Abundance	Marine Bird Diet	Develop marine bird diet study database and standard data collection protocols.								Other jurisdictions
Future	Radar Monitoring	Radar and Lidar Data Results	Identify goals and pilot study recommendations for radar/lidar studies. Develop a database and standard data collection protocols.								Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	What are the spatiotemporal (including altitudinal) pattern of exposure for key species of interest?	ECSAS	Marine Birds		Yes	Yes			Regional	Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Collect environmental covariates and create predictive models for exposure using distribution models.	Fifield Models	Marine Birds		Yes	Yes			Regional	Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Assess preconstruction distribution of pelagic and benthic prey species and communities and examine links with the distribution abundance and foraging behavior of marine birds	Anyone doing prey models? DFO? But then need to link to distribution models.	Marine Birds		Yes	Yes			Regional	Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Validate predictive density models to assess accuracy of predictions at the wind farm scale.	Need wind farms - look at predicted density from Fifield against EIA pre-construction surveys.	Marine Birds			Yes			Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Identify environmental factors correlated with differences in bat activity levels offshore.	Create regional monitoring programs to determine when, where, and flight height of abts in the offshore areas of Atlantic Canada	Bats		Yes				Regional	Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	How do wind farms affect the presence of offshore bat species composition and activity?	Compare pre- and post- bat presence, species composition, and behaviour offshore. Determine if the present of offshore wind farms have affected distribution.	Bats		Yes	Yes			Across Multiple Offshore Wind Farm Sites	Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Various datasets, from various agencies and organziations, that could be synthesized to help address knowlege gaps.	Data integration from different sources and seasons for better knowledge of year-round distributions to quantify and reduce uncertainty								Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Spatial models and movement data have spatial and temporal uncertainty, which need to be validated and addressed, and presented in results.	Improving uncertainty quantification in movement and density models								Other jurisdictions
Future	Spatial, Temporal, Altitudinal Distributions	Understanding baseline conditions of bat occurrence, activity, and movements offshore.	assessing species occurrence and relative activity of bats over different areas of the ocean, with particular attention towards whether relative bat activity declines over a gradient from coastal to offshore areas. This also includes documenting characteristics of offshore flights, including timing (time of year, time of night), relationships to meteorological conditions, flight speed, and differences across species, sexes, or ages. These types of data have the potential to inform mitigation efforts. Because of the rapid pace of wind development compared to the pace of data collection, and because it is possible that attraction will lead bats to visit offshore lease areas more frequently once turbines are installed, near-term siting decisions are unlikely to be made based on collection of baseline data.								Other jurisdictions
Future	Surveys	FInd ways to make At-Sea Surveys data as understandble and digestable by non-federal agencies.	Develop a public-facing interface for Seabird Catalog.								Other jurisdictions
Future	Surveys	Other Observational Data	Expand colonial waterbird database to include nesting shorebirds.								Other jurisdictions
Future	Surveys	Other Observational Data	Develop additional monitoring guidance for species not covered by current protocols.								Other jurisdictions
Future	Surveys	Other Observational Data	Solicit additional survey data stored by states and other organizations								Other jurisdictions
Future	Tracking	Tracking via other Tagging Systems	Develop in-depth guidance for non-Motus tagging studies.								Other jurisdictions
Future	Tracking	Tracking via other Tagging Systems	Systematically solicit and compile historical tracking data for birds in coastal and offshore environments into Movebank.								Other jurisdictions
Future	Tracking	Automated VHF/UHF tagging/tracking studies	Improve access to historical offshore bat Motus data through a systematic effort to reach out to relevant past projects and request public access to data if not already available. Develop guidance regarding deployment, metadata, and data storage of local meteorological data associated with telemetry receiver stations to inform timing of bat movements and behavior relative to local weather conditions.								Other jurisdictions
Future	Survival	"No data" from Palmer (1976)		Ruddy Duck						Regional	Other jurisdictions