Pelagic Aerofauna Overlap with Potential Development Areas

Product Objective

This series of figures summarizes the overlap between key components provided by ECCC-CWS-Atlantic and the Potential Development Areas (PDAs; Figure 1) described in the Regional Assessment of Offshore Wind Development in Nova Scotia Draft Final Report. These products highlight the spatial and temporal distributions of regional pelagic aerofauna to facilitate the identification of potential future lease areas. Summaries are provided for each PDA across the following seasons: Spring (April–May), Summer (June–August), Fall (September–October), and Winter (November–March). In cases where year-round data are not available, the specific period under consideration is indicated.

Summaries by PDA are available for the following products:

- Pelagic Bird At-Sea Seasonal and Annual Modeling
- Collision and Displacement Vulnerability Models
- Colonial Bird Theoretical Foraging Radii
- Breeding Seabird Foraging Distributions
- Movement Models and Migration Tracks

Note that this is an updated document based on changes to the boundaries of the previous Potential Future Development Areas (PFDAs) defined in the NS Interim Report, as well as the addition of two new PDAs. The document also includes overlap of movement models and migration tracks for the Committee's consideration, which were not available at the time of the previous document version.

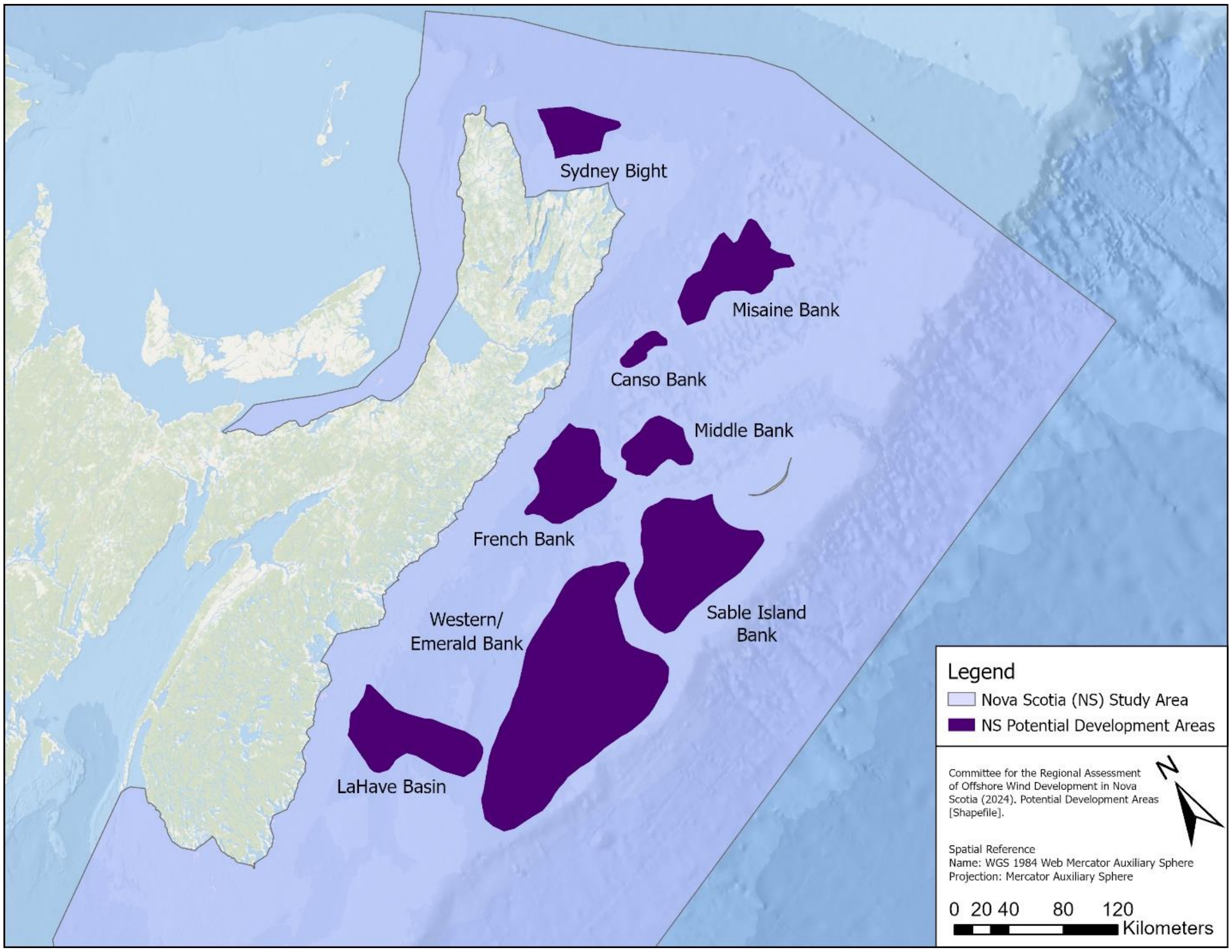

Figure 1. Potential Development Areas identified in the Nova Scotia Draft Final Report.

At-Sea Seasonal and Annual Modeling – Pelagic Birds

The density surface models used boat-based Eastern Canada Seabirds at Sea (ECSAS) surveys and environmental variables to predict the density of seabirds across the Atlantic region over four seasons (2006-2022). Models were built by Fifield et al., (2022) for 14 seabird taxa within the NS Regional Assessment study area. Of note, some species are combined into broader taxa if species-level identification could not be established (e.g., Shearwaters). For each season and taxa, the average predicted density of birds was calculated both within each PDA and across the Nova Scotia study area (Figure 1). To avoid including species with low predicted density that are not expected to be present in a PDA, any species with a predicted density lower than 0.001 bird/km^2 was set to 0. Following this, the predicted density for each species within a PDA was summed to provide an estimated number of individuals. Any species with a summed PDA density of less than 5 individuals was considered to be effectively absent from the PDA and the average density for that species was set to 0. Then, the ratios of densities inside the PDAs and the NS study area were calculated. A ratio greater than 1 relates to an above average species density within the PDA. A ratio less than 1 relates to a below-average density within the PDA relative to the NS study area.

Density classes were assigned based on the following ratio values: Low ≤ 1; Medium > 1 and ≤ 2; and High > 2. An example of the seasonal variations across species densities within a PDA is shown in **Error! Reference source not found.**2. The remaining plots are available in the accompanying folder. A summary of species with high relative density within each PDA across seasons is provided in **Error! Reference source not found.**.

Interpretation

Ratio plots (Figure 2) present seasonal variation of the density ratios for each species within a PDA. Color bands indicate ratio classes: Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2). Each point within a species grouping represents a different season. **Error! Reference source not found.** lists species with higher density within the PDA compared to the rest of the NS study area, indicating potential density hotspots for that species. A high-density ratio class indicates a given species may be disproportionately impacted by potential OSW energy developments in the PDA. For example, Middle Bank overlaps with higher species densities in spring (e.g., Razorbill and Murres) and fall (e.g., Black-legged Kittiwake, Dovekies, and Northern Gannet) compared to the NS study area (Figure 2). Conversely, Middle Bank overlaps with lower densities compared to the NS study area for most species in winter.

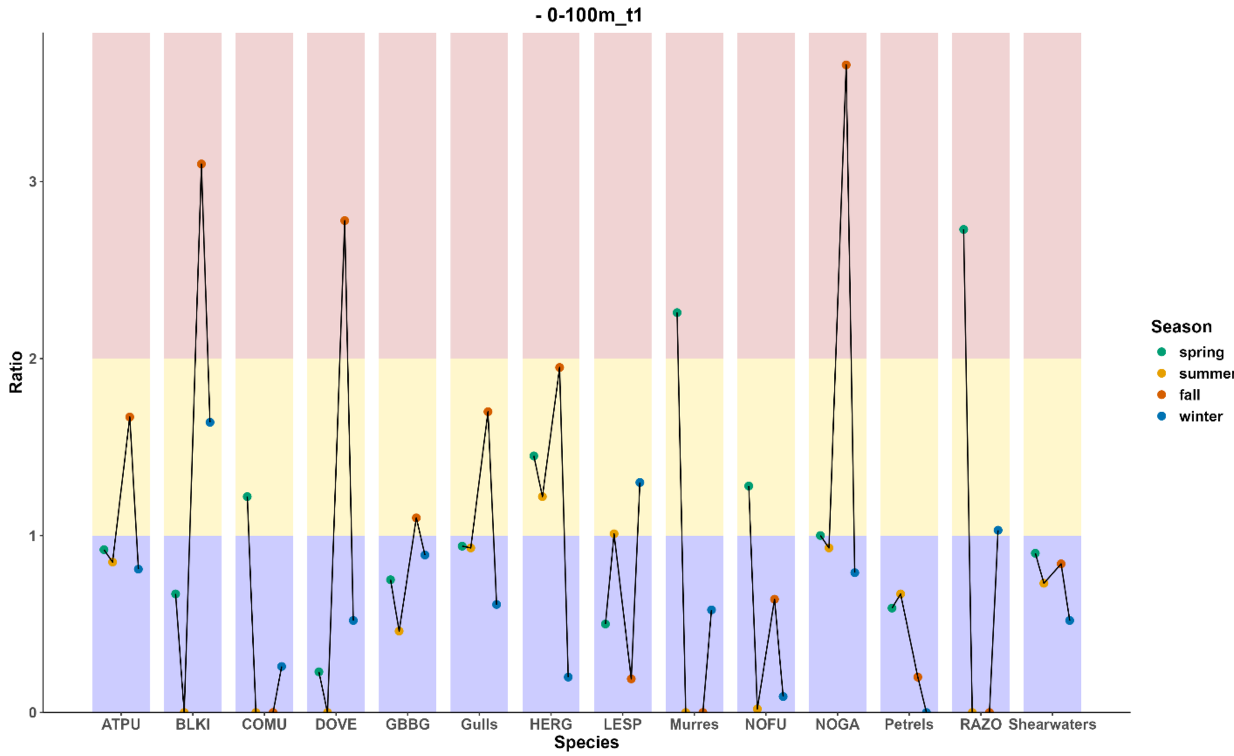

Figure 2. Ratio of predicted species density within the Middle Bank PDA compared to the Nova Scotia study area. Points indicate the ratio for each season and color bands indicate Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2) ratios. Four-letter codes are provided for the following species: ATPU = Atlantic Puffin, BLKI = Black-legged Kittiwake, COMU = Common Murre, DOVE = Dovekie, GBBG = Great Black-backed Gull, HERG = Herring Gull, LESP = Leach's Storm Petrel, NOFU = Northern Fulmar, NOGA = Northern Gannet, RAZO = Razorbill.

Table 1. Predicted high-density species within each PDA compared to the Nova Scotia study area across seasons.

Region	Depth	Spring	Summer	Fall	Winter
Canso Bank	60 – 100 m	Murres, Razorbill	Dovekie, Northern Gannet	Atlantic Puffin, Black-legged Kittiwake, Dovekie, Northern Gannet	-
French Bank	60 – 300 m	Razorbill	-	Gulls, Herring Gull, Northern Gannet	-
LaHave Basin	100 – 250 m	-	Great Black-backed Gull, Gulls, Herring Gull, Northern Gannet	-	Common Murre, Dovekie, Murres
Middle Bank	0 – 100 m	Murres, Razorbill	Dovekie	Black-legged Kittiwake, Dovekie, Northern Gannet	-
Misaine Bank	60 – 140 m	Black-legged Kittiwake, Common Murre, Gulls, Herring Gull, Mures, Northern Gannet, Razorbill	-	Atlantic Puffin, Black-legged Kittiwake, Dove	Leach's Storm Petrel, Shearwaters
Sable Island Bank	0 – 100 m	Shearwaters	-	-	Leach's Storm Petrel, Shearwaters
Sydney Bight	0 – 300 m	Black-legged Kittiwake, Northern Gannet	Atlantic Puffin, Black-legged Kittiwake, Northern Gannet	Black-legged Kittiwake, Murres, Northern Gannet, Razorbill	-
Western/ Emerald Bank	0 – 300 m	-	-	-	Dovekie

Update from previous version:

- There are no changes to overlap with predicted high-density species for the PDAs included in the previous Interim Report.
- For LaHave Basin: There is a high density of Gulls, including Great Black-backed Gull, and Herrring Gull, as well as Northern Gannet in the Summer. There is high density of Common Murres, Dovekies, and Murres in the winter.
- For Misaine Bank: There is high density of Atlantic Puffin, Black-legged Kittiwake, and Dovekie in the Fall; Black-legged Kittiwake, Common Murre, Gulls, Herring Gull, Murres, Northern Gannet, and Razorbill in the Spring; Black-legged Kittiwake and Murres in the Winter.

Assumptions and Caveats:

- This work is based on density surface models that are preliminary and subject to change.
- This work is based on the ECSAS survey database and can be influenced by survey effort gaps from that product, especially during winter months (December to March).
    - See the Pelagic Bird Survey Effort product for potential data gaps.
- For both the plots and summary table, a high-density ratio does not imply that the actual density of the species/taxa is high. A high-density ratio indicates that those species aggregate more in this area than in the rest of the study area. Potential OSW development could pose a disproportional risk to those species, and further exploration is warranted.
- Results are presented in relation to the Nova Scotia study area and may not represent the whole Atlantic region.
- Seasonal estimates can be biased by the temporal presence of birds, especially in winter (November to March). This may include density estimates based on late remaining and/or early arriving individuals when the species would otherwise be mostly absent during the rest of the season.

References

Environment and Climate Change Canada. 2023. Atlas of Seabirds at Sea in Eastern Canada 2006 - 2020 (50 km hex update). Unpublished internal data.

Fifield D, Gjerdrum C, Wong S, Beaumont M, Bolduc F, Miller D. 2023. Unpublished data from study: Density Surface Modeling of seabird abundance in NW Atlantic and Eastern Canadian Arctic.

Collision and Displacement Vulnerability

These products summarize the collision (CV) and displacement (DV) vulnerability risks for all pelagic bird species inside each of the current PDAs. Species-specific metrics were developed to assess vulnerability of colliding with or being displaced by offshore wind energy development (ECCC-CWS, 2024a). Two series of products were created using these values:

- **Density-weighted models**: CV and DV scores were multiplied across the predictive pelagic bird density surface model rasters (Fifield *et al.*, 2023) to generate spatial estimates of vulnerability weighted by bird density.
- **Normalized models**: density surface model rasters were first normalized (rescaled between 0 and 1) and then CV and DV scores were applied.

These steps were repeated for each species and then summed to produce all-species rasters for collision and displacement vulnerability. These vulnerability rasters were produced with a resolution of 15 km x 15 km and summarized into quintiles within the Nova Scotia study area to represent collective vulnerability in each cell. Vulnerability values were classed as follows: Low (0-20%), Low-moderate (20-40%), Moderate (40-60%), Moderate-high (60-80%), High (80-100%). Each cell within the PDA was assigned a ranking. The proportion of each ranking was then calculated for each PDA by risk type and product (collision and displacement; normalized and density-weighted) across seasons.

Summary plots are presented for the normalized (Figure 3) and density-weighted (Figure 4) vulnerability rankings relative to the study area. Absolute seasonal average vulnerability scores are also provided to inform how vulnerability changes between seasons for normalized (Figure 5) and density-weighted (Figure 6) scores.

Interpretation

These products demonstrate the seasonal variation of species-specific collision and displacement vulnerability scores within each PDA. In Figures 3 and 4, lighter colors indicate the proportion of high vulnerability scores overlapping with a PDA while darker colors indicate overlapping with lower vulnerability scores. For example, the LaHave Basin PDA has a higher displacement score during the winter than the Sydney Bight PDA. Figures 3 and 4 present vulnerability proportions relative to the entire NS study area. A high proportion of high vulnerability does not necessarily equate to a high vulnerability score. Therefore, Figures 5 and 6 present the absolute seasonal variations in vulnerability scores. Score values are influenced based on whether the products are density-weighted or normalized.

Density-weighted scores consider the estimated number of birds present and provide higher scores in areas where more birds can be found (e.g., Sable Island Bank). These values are influenced by species with high density estimates. Normalized scores standardize density values between zero and one, which creates a product that is more easily comparable across species.

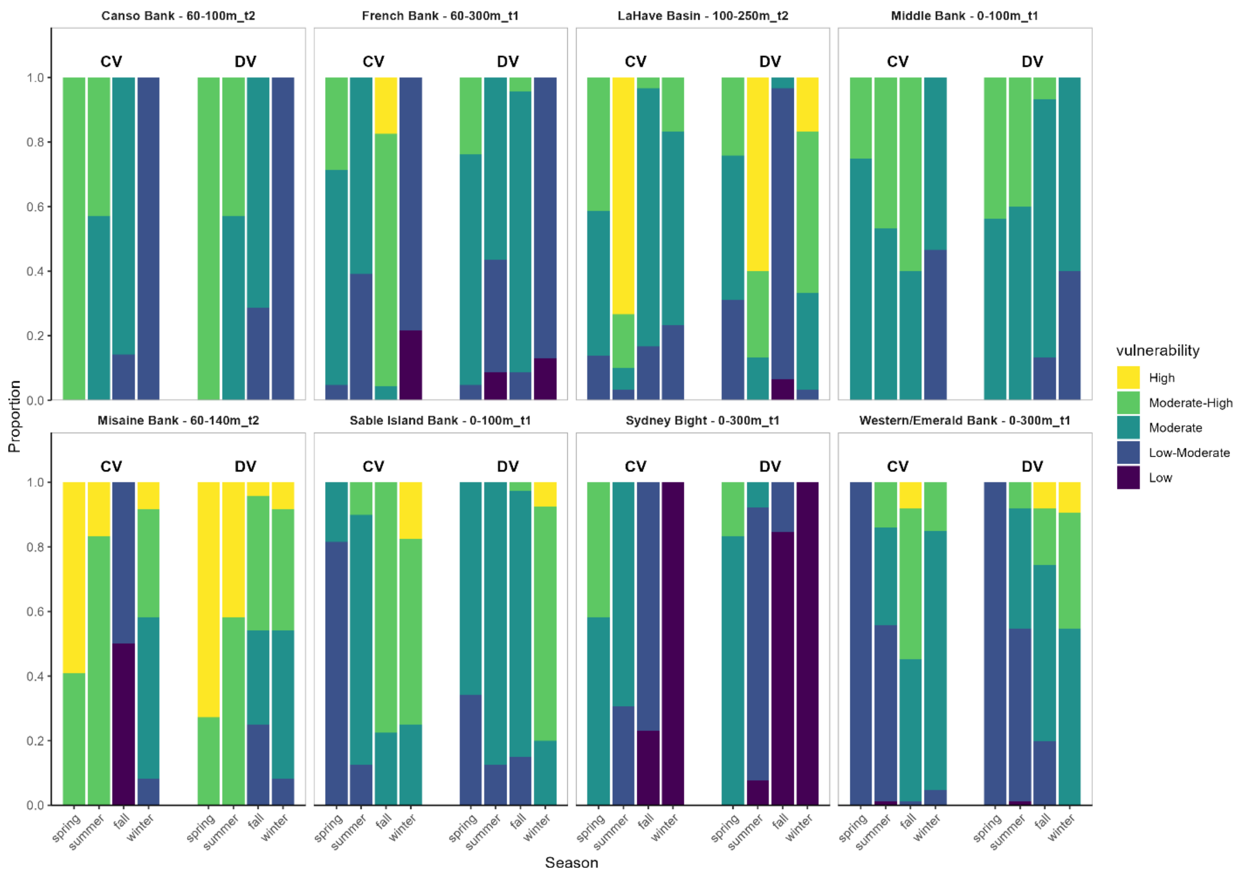

Figure 3. Seasonal proportion of normalized collision vulnerability (CV) and displacement vulnerability (DV) scores within each Potential Development Area (PDA).

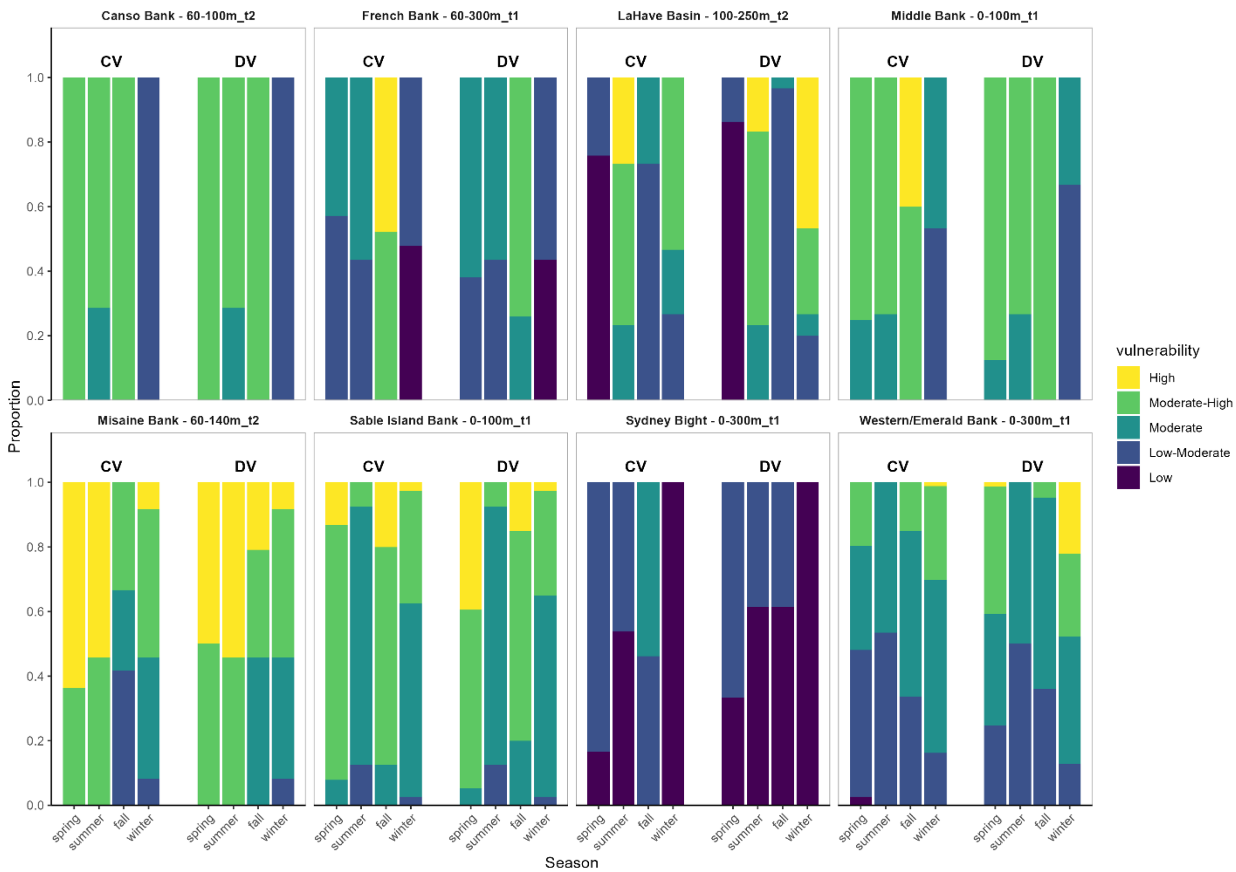

Figure 4. Seasonal proportion of density-weighted collision vulnerability (CV) and displacement vulnerability (DV) scores within each Potential Development Area (PDA).

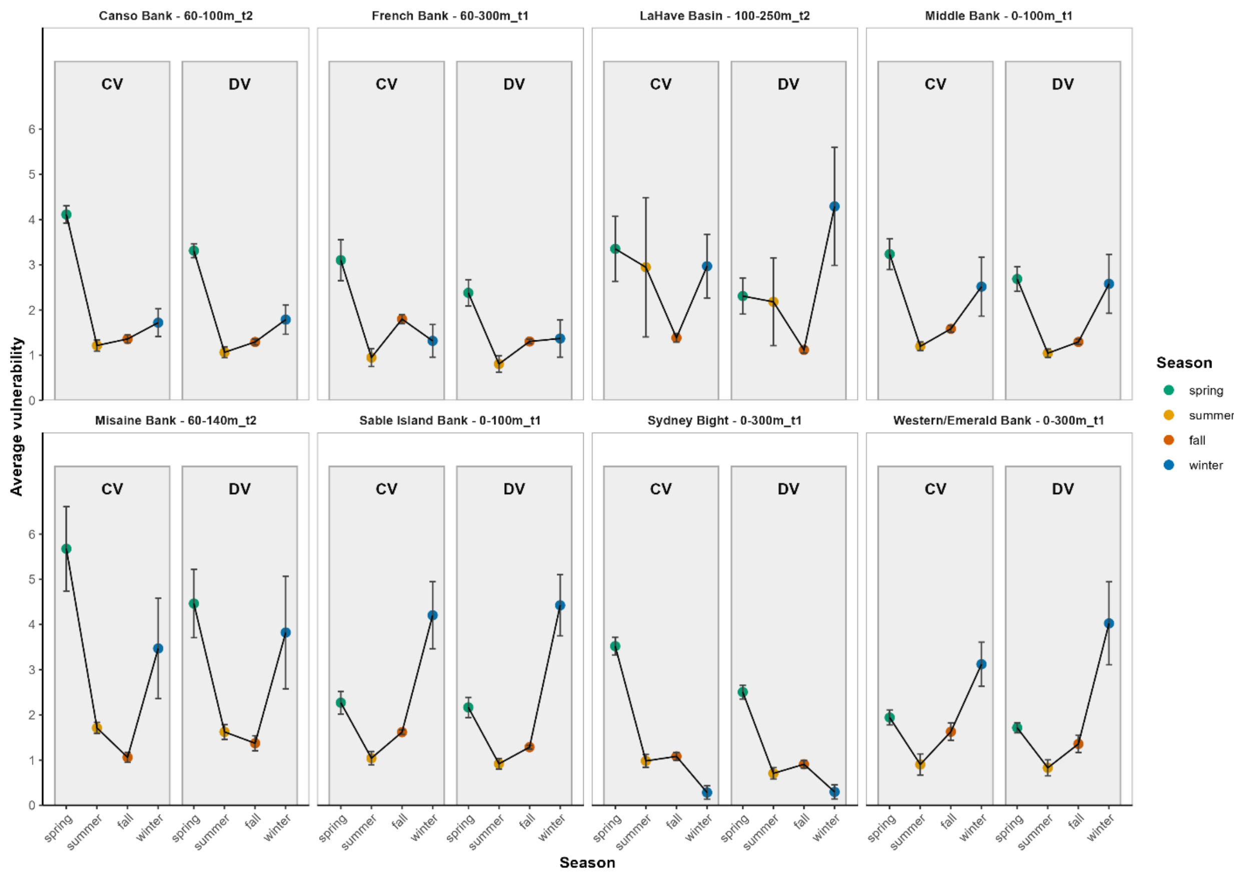

Figure 5. Normalized seasonal average collision vulnerability (CV) and displacement vulnerability (DV) scores inside each Potential Development Area (PDA).

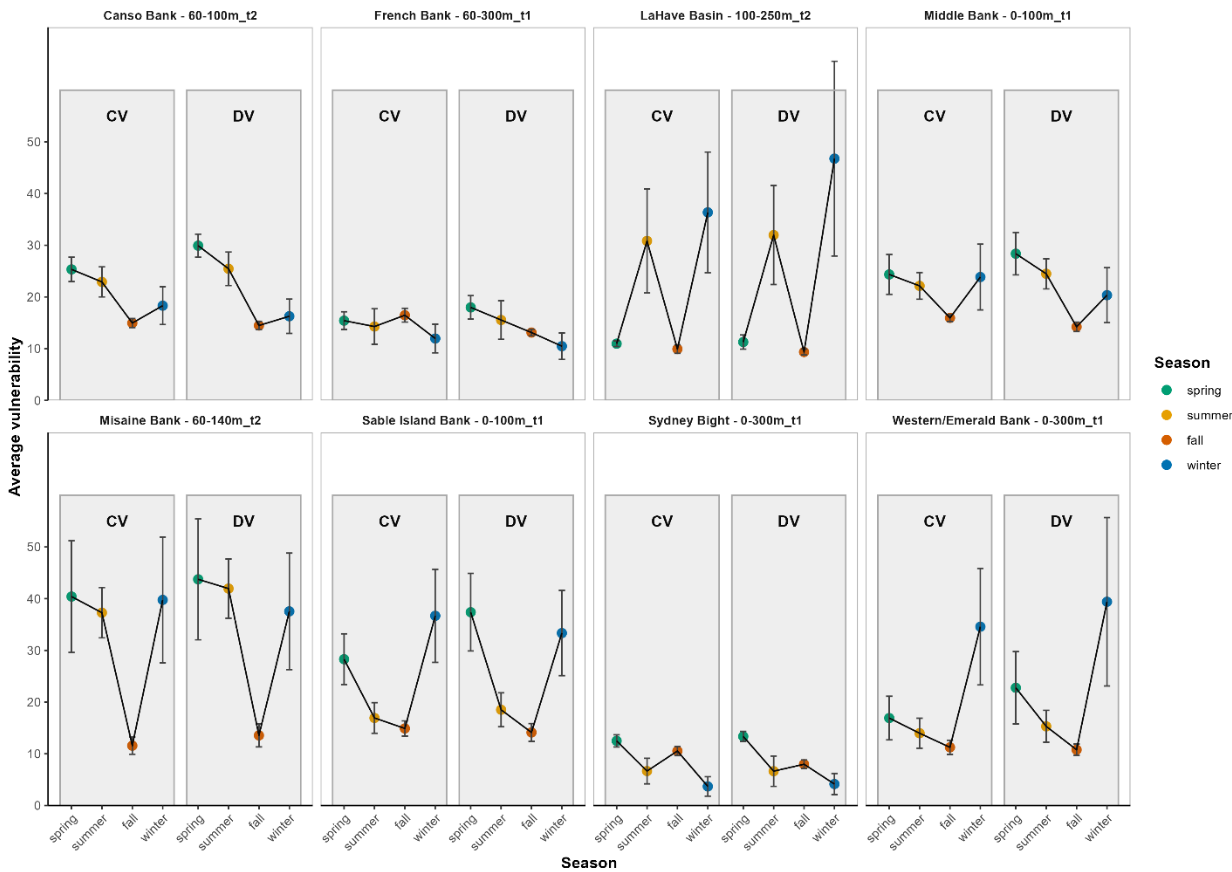

Figure 6. Density-weighted seasonal average collision vulnerability (CV) and displacement vulnerability (DV) scores inside each Potential Development Area (PDA).

Updates

Based on Figure 4, which outlines the density-weighted regional vulnerability and collision risk, the following updates are summarized for each PDA:

- Canso Bank: Moderate-High collision and displacement vulnerability in spring, summer, and fall.
- French Bank: High collision vulnerability and moderate-high displacement vulnerability in fall.
- LaHave Basin: High collision vulnerability in summer and high displacement vulnerability in summer and winter.
- Middle Bank: High collision vulnerability in fall and moderate-high collision and displacement vulnerability in spring, summer, and fall.
- Misaine Bank: High collision vulnerability in spring, summer, and winter, and high displacement vulnerability across all seasons.
- Sable Island Bank: High collision and displacement vulnerability in spring, fall, and winter.
- Sydney Bight: Moderate collision vulnerability in fall, low collision and displacement vulnerability across most seasons.
- Western/Emerald Bank: High collision and displacement vulnerability in winter.

Assumptions and Caveats

- The density surface models used to inform this work are preliminary and will be updated to correct erroneous predictions. This includes a known overestimation of Leaches Storm-petrel densities in winter.
- The scores are presented in relation to the Nova Scotia study area and might not represent the Atlantic region.
- Proportions and classifications in Figures 3 and 4 are relative to the season. This helps identify areas of risk during a particular season. However, this does not indicate an absolute increase or decrease in risk. For absolute risk changes, refer to Figures 5 and 6.
- The products present scores aggregated for all species. Vulnerability scores can differ at the species level and may not follow the patterns presented here.
- These products only consider pelagic aerofauna species. Information on other vulnerable aerofauna species that may be present, such as migrating landbirds and shorebirds, is not included. Additional consideration for these species groups will be required for siting decisions.

References

Fifield D, Gjerdrum C, Wong S, Beaumont M, Bolduc F, Miller D. 2023. Unpublished data from study: Density Surface Modeling of seabird abundance in NW Atlantic and Eastern Canadian Arctic.

Environment and Climate Change Canada, Canadian Wildlife Service (ECCC-CWS). 2024a. Relative Collision and Displacement Vulnerability of Marine Birds to Offshore Wind Development. Submitted to the Nova Scotia Committee for Offshore Wind Energy Development in Atlantic Canada.

Colonial Bird Theoretical Foraging Radii

Foraging radius models were developed for 23 bird species with known colonies within Atlantic Canada, following the work of Critchley et al., (2018). Using species-specific mean maximum foraging estimates, buffers were mapped and weighted by 50% of the maximum historic population estimate at each colony from 1974 to 2024. The resulting product represents a theoretical density-weighted foraging radius that estimates where individuals might forage at the highest densities (birds/km^2) during the breeding season. More details are available in the Colonial Foraging Range submission (ECCC-CWS, 2024b). For each species and foraging guild, the average predicted density of foraging birds was calculated both within each PDA and across the Nova Scotia study area. A summary of the ratio between the PDA and the regional average predicted densities was then calculated. A ratio greater than 1 represents an above-average bird density within the PDA relative to the NS study area, while a ratio less than 1 represents a below-average density within the PDA relative to the NS study area. Density classes were assigned based on the following ratio values: Low ≤ 1; Medium > 1 and ≤ 2; and High > 2.

Interpretation

Ratio plots represent the density ratios for each species (Figure 7) or foraging guild (Figure 8) inside a given PDA during the breeding season. Colored bars indicate ratio classes: Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2). A high-density ratio class indicates a given species may be disproportionately impacted by potential OSW energy developments within a PDA. Species with similar foraging behaviour will likely demonstrate similar traits, such as flight height, while searching for prey. These behaviours link directly to the risk of collision by placing birds within the rotor-swept zone. A summary of the species found within each foraging guild is presented in Table 2. Of note, neither the coastal nor benthic foraging guild summaries are presented as they do not include species with foraging ranges that overlap the current PDAs.

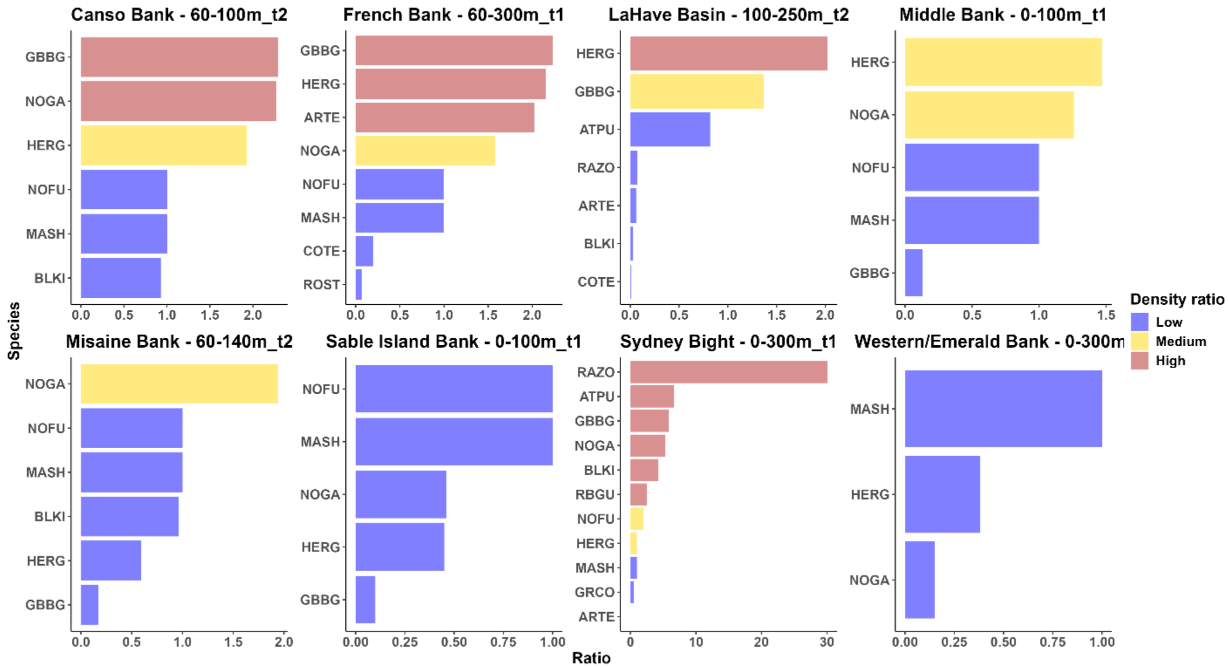

Figure 7. Ratio of the predicted density of foraging birds during the breeding season within each PDA compared to the Nova Scotia study area for each species using a theoretical foraging radii approach. Colors indicate whether the ratio is considered Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2). Four-letter codes are provided for the following species: ARTE = Arctic Tern, ATPU = Atlantic Puffin, BLKI = Black-legged Kittiwake, COMU = Common Murre, COTE = Common Tern, GBBG = Great Black-backed Gull, GRCO = Great Cormorant, HERG = Herring Gull, MASH = Manx Shearwater, NOFU = Northern Fulmar, NOGA = Northern Gannet, RAZO = Razorbill, RBGU = Ring-billed Gull.

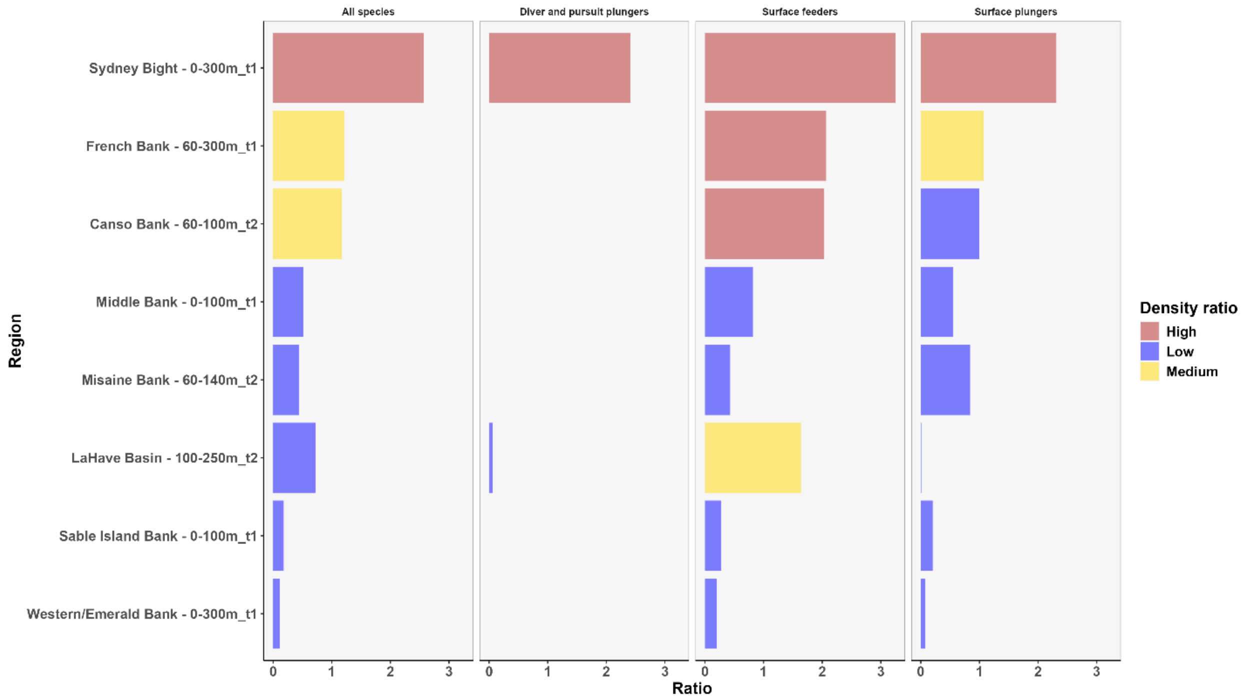

Figure 8. Ratio of the predicted density of foraging birds during the breeding season within each PDA compared to the Nova Scotia study area, summarized for all species combined and by foraging guild using a theoretical foraging radii approach. Colours indicate whether the ratio is considered Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2). Species included in each foraging guild are highlighted in Table 2.

Table 2. Summary of species that comprise each foraging guild. Note: not all species within a given foraging guild have individual buffers that overlap with current PDAs; those species with current overlap are indicated in bold with an asterisk (*). The remaining species may need to be considered for foraging buffer overlap if additional PDAs are proposed.

Foraging Guild	Species
Diver and Pursuit Plungers	**Atlantic Puffin*,** Black Guillemot, **Common Murre***, Double-crested Cormorant, **Great Cormorant*, Manx Shearwater*, Razorbill***, Thick-billed Murre
Surface Feeders	Black Tern**, Black-legged Kittiwake***, Glaucous Gull, **Great Black-backed Gull*, Herring Gull***, Laughing Gull**, Northern Fulmar*, Ring-billed Gull***
Surface Plungers	**Arctic Tern***, Caspian Tern, **Common Tern*, Northern Gannet***, **Roseate Tern***

Updates

- French Bank: Arctic Terns have increased from medium to high ratio, which indicates there is an above average density of birds foraging in this PDA. Roseate Terns now overlap with French Bank at a low-density ratio.
- LaHave Basin: Herring Gulls forage at disproportionately high densities and Great Black-backed Gulls forage at moderate densities in this PDA compared to the rest of the NS Study Area.
- Misaine Bank: Northern Gannets forage at moderately high densities in this PDA.

Assumptions and Caveats

- Ratios provide the relative density compared to the entire Nova Scotia study area. These do not indicate the absolute density of birds overlapping with a given PDA.
- Density ratios are limited to the breeding season, during which half of the population are assumed to stay at the nest. As the breeding season progresses, the estimated density of birds is likely to increase in the offshore due to both parents foraging simultaneously and chick fledging. Therefore, density ratios may underestimate the overlap with PDAs during the dispersal period.
- Maximum colony population estimates between 1974 – 2024 were extracted to capture variation in survey methods and the cyclic nature of populations. The density ratios may not reflect the most current population estimates. However, these ratios represent a precautionary approach to species densities.
- Ronconi et al., (2022) generated estimates from predictive density modelling that incorporated environmental variables (see below). As a result, the Ronconi et al. estimates will be more robust and colony specific for single-species applications or regional conservation measures.

References

Critchley, E. J., Grecian, W. J., Kane, A., Jessopp, M. J., Quinn, J. L. (2018). Marine protected areas show low overlap with projected distributions of seabird populations in Britain and Ireland. Biological Conservation, 224: 309–317

Environment and Climate Change Canada, Canadian Wildlife Service (ECCC-CWS). 2024b. Colonial Bird Theoretical Foraging Radii. Submitted to the Nova Scotia Committee for Offshore Wind Energy Development in Atlantic Canada. https://iaac-aeic.gc.ca/050/documents/p83514/159035E.pdf

Breeding Seabird Foraging Distributions

Ronconi et al., (2022) built colony-centered foraging distribution models using tracking data (GPS/PTT/VHF) and environmental variables for 14 species of seabirds breeding at colonies in Atlantic Canada. Species were tracked from various colonies within the region using tags deployed on breeding adults. This approach used machine-learning models to further predict foraging distributions at un-sampled colonies.

To create a complementary comparison to the theoretical foraging radii (above), average predicted density of foraging birds was calculated both within each PDA and across the Nova Scotia study area. A summary of the ratio of average predicted density between the PDA and the regional densities was then calculated. A ratio greater than 1 relates to an above-average density within the PDA relative to the NS study area, while a ratio less than 1 relates to a below-average density within the PDA. Density classes were assigned based on the following ratio values: Low ≤ 1; Medium > 1 and ≤ 2; and High > 2.

Interpretation

Ratio plots represent the density ratios for each species (Figure 9) within a given PDA during the breeding season. Coloured bars indicate ratio classes: Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2). A high-density ratio class indicates a given species may be disproportionately impacted by potential OSW energy developments within a PDA. However, ratios do not indicate absolute density. Low and medium density ratios indicate that a given species is found at a lower or similar average density to the entire NS study area. High numbers of these species may still overlap with a PDA.

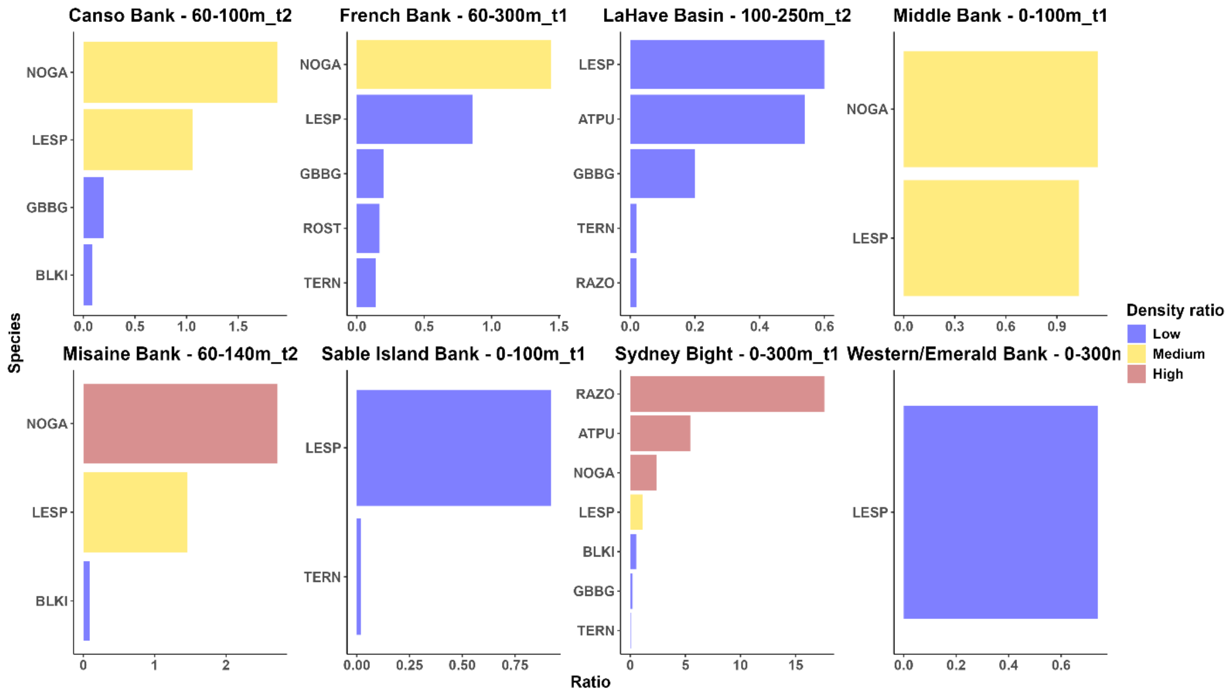

Figure 9. Ratio of the predicted density of foraging birds during the breeding season within each PDA compared to the Nova Scotia study area for each species using predictive density distribution models. Colours indicate whether the ratio is considered Low (blue, ≤ 1), Medium (yellow, > 1 and ≤ 2), or High (red, > 2). Four-letter codes are provided for the following species: ARTE = Arctic Tern, ATPU = Atlantic Puffin, BLKI = Black-legged Kittiwake, GBBG = Great Black-backed Gull, LESP = Leach's Storm-Petrel, NOGA = Northern Gannet, RAZO = Razorbill, TERN = Terns (Arctic tern and Common tern).

Updates

- French Bank: Northern Gannets have been reduced from high to medium density ratio, indicating these birds forage at a moderately high density compared to the rest of the region. Roseate Terns are now considered to forage within this PDA at a low-density ratio.
- LaHave Basin: No species are considered to forage at medium or high densities in this PDA. Leach's Storm-petrel, Atlantic Puffins, Great Black-backed Gulls, terns, and Razorbills forage at low densities.
- Misaine Bank: Northern Gannets forage at disproportionately high densities and Leach's Storm-petrel forage at moderate densities compared to the rest of the study area.

Assumptions and Caveats

- The initial analysis was limited to tracking data collected during the breeding seasons. The resulting ratios represent only the comparison of foraging bird densities during that same period.
- Ratios do not indicate the absolute density of birds overlapping with a given PDA.
- These maps were developed only for species with sufficient tracking data, as per Ronconi et al., 2022. For species with limited tracking data, the theoretical foraging radii (above) should be applied to fill those knowledge gaps.

References

Ronconi, R.A., Lieske, D.J., McFarlane Tranquilla, L.A., Abbott, S., Allard, K.A., Allen, B., Black, A.L., Bolduc, F., Davoren, G.K., Diamond, A.W. and Fifield, D.A. (2022). Predicting seabird foraging habitat for conservation planning in Atlantic Canada: Integrating telemetry and survey data across thousands of colonies. Frontiers in Marine Science, 9, p.816794.

Movement Models and Migration Tracks

These products summarize habitat use by pelagic avian species within each PDA based on movement models. Movement models were created using tracking data to identify spatial and temporal distributions of aerofauna in the Regional Assessment study area (ECCC-CWS, 2024c). Habitat utilization distribution maps were then created based on the tracking technology used. Products summarized for each PDA are:

- Kernel density utilization distributions created using light level geolocators (GLS). All tracking locations were used to create these models, and the result was then cropped to the Nova Scotia study area.
- Dynamic Brownian bridge movement models (dBBMM) created using GPS or Argos platform transmitters (PTT) trackers. These models were created using only tracking locations occurring inside the Nova Scotia study area.

For each method, utilization contour levels of 50%, 75%, and 95% were calculated, representing high, medium, and low usage, respectively. For each species-specific seasonal movement model, the proportion of the PDA area found in each class was calculated. Species with high usage inside a PDA in each season were compiled in Table 3. High usage was defined as having at least 20% of the PDA area in the "high" habitat use category and at least 50% of the PDA area in "medium" or 'high" categories.

Furthermore, migration tracks were summarized by counting the number of tracks intersecting with each PDA. The probability of a PDA occurring within a migration corridor was assessed by comparing the number of migration tracks going through the PDA compared to the total number of migration tracks available for the whole region. The following classes of probability were defined:

- Low data: if less than 10 migration tracks have been collected inside the Nova Scotia study area
- Potential: If more than 10 tracks are available inside the region, but less than 50% of those are inside the PDA.
- Probable: If more than 10 tracks are available inside the region, and at least 50% of those are inside the PDA.

Interpretation

Movement models

These products highlight the seasonal variation of species-specific habitat use inside each of the PDAs. Habitat use is presented as the proportion of the PDA area found in each habitat use class – low (purple), medium (teal) or high (yellow). An absence of result means that habitat use given by the movement models for that species do not overlap with the PDA. An example of Great Shearwater using dBBMM can be found in Figure 10. The remaining plots are available in the accompanying folder.

Table 3 lists species with high habitat use within the PDA compared to the rest of the NS study area, indicating potential habitat use hotspots for those species. This table combines results from both the kernel density (italic) and dBBMM (bold) methods.

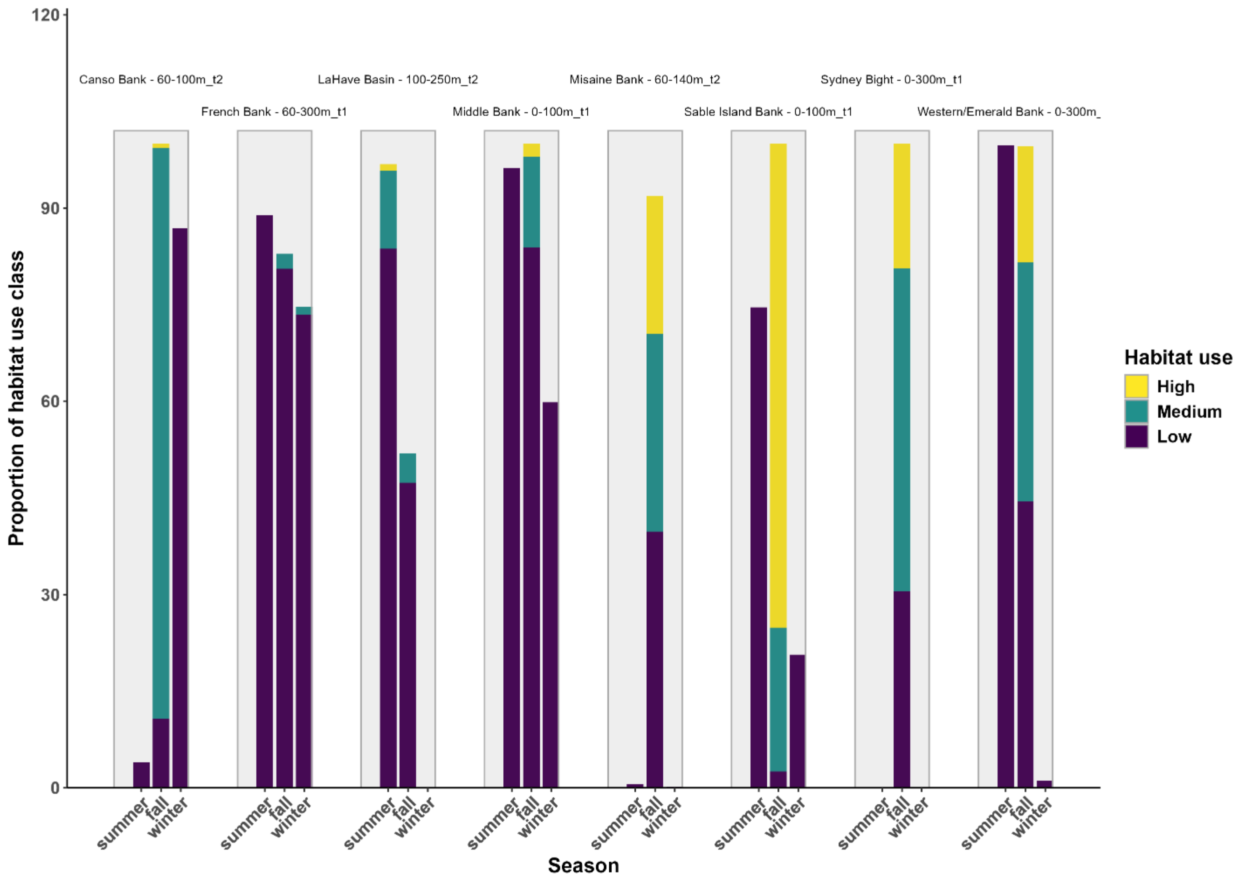

Figure 10: Seasonal proportion of habitat use inside each PDA for Great Shearwater (GRSH) using dynamic Brownian Bridge Movement Models (dBBMM)

Table 3 Species with high usage inside a PDA according to movement models. High usage was defined as having at least 20% of the PDA area in the "high" habitat use category and at least 50% of the PDA area in "medium" or 'high" categories. In bold are species whose habitat use was determined by dynamic Brownian bridge movement models and in italic by kernel density utilization distributions. Species in bold and italic gave the same result with the two approaches. Four-letter codes are provided for the following species: BLGU = Black Guillemot GRSH = Great Shearwater, HERG = Herring Gull, NOGA = Northern Gannet, WTTR = White-tailed Tropicbird.

Region	Depth	Spring	Summer	Fall	Winter
Canso Bank	60 – 100 m	*BLGU, NOGA*	*BLGU*	**NOGA**, *WTTR*	-
French Bank	60 – 300 m	*BLGU,* **HERG**	*BLGU*	*BLGU,* **NOGA**	*BLGU*
LaHave Basin	100 – 250 m	-	-	*BLGU,* **NOGA**	**NOGA**
Middle Bank	0 – 100 m	*BLGU, NOGA*	*BLGU*	*BLGU, NOGA*	-
Misaine Bank	60 – 140 m	*BLGU,* ***NOGA***	-	**GRSH,** *NOGA, WTTR*	-
Sable Island Bank	0 – 100 m	*BLGU, NOGA*	*BLGU*	**GRSH**, *BLGU, NOGA*	-
Sydney Bight	0 – 300 m	-	-	*NOGA, WTTR*	-

Western/ Emerald Bank	0 – 300 m	*BLGU*	*BLGU*	*BLGU, NOGA*	NOGA, *BLGU*

Migration tracks

An example for the French Bank PDA is presented in Figure 11. The remaining plots are available in the accompanying folder. These figures present the percentage of a species' migration tracks in function of the total number of this species migration tracks inside the entire Nova Scotia study area. Data for spring and fall migrations are presented. In addition, colored areas are presented which represent the following:

- **Blue – Low data**: species for which less than 10 migration tracks are available inside the whole region. Not enough data is available to make a conclusion, yet the area is used at least by some individuals. Additional research is required.
- **Yellow - Potential**: species for which less than 50% of the migration tracks are found inside the PDA. The PDA is used as a migration corridor for at least some individuals. Additional research is still warranted to ensure the sampling effort is representative of the target PDA.
- **Red - Probable**: species for which at least 50% of the migration tracks are inside the PDA. The PDA is on the migration path of most of the tagged individuals of this species. For example, of all the tagged species who have migration data available, only Northern Gannets are classified as probable migrants in the French Bank PDA (Figure 11).

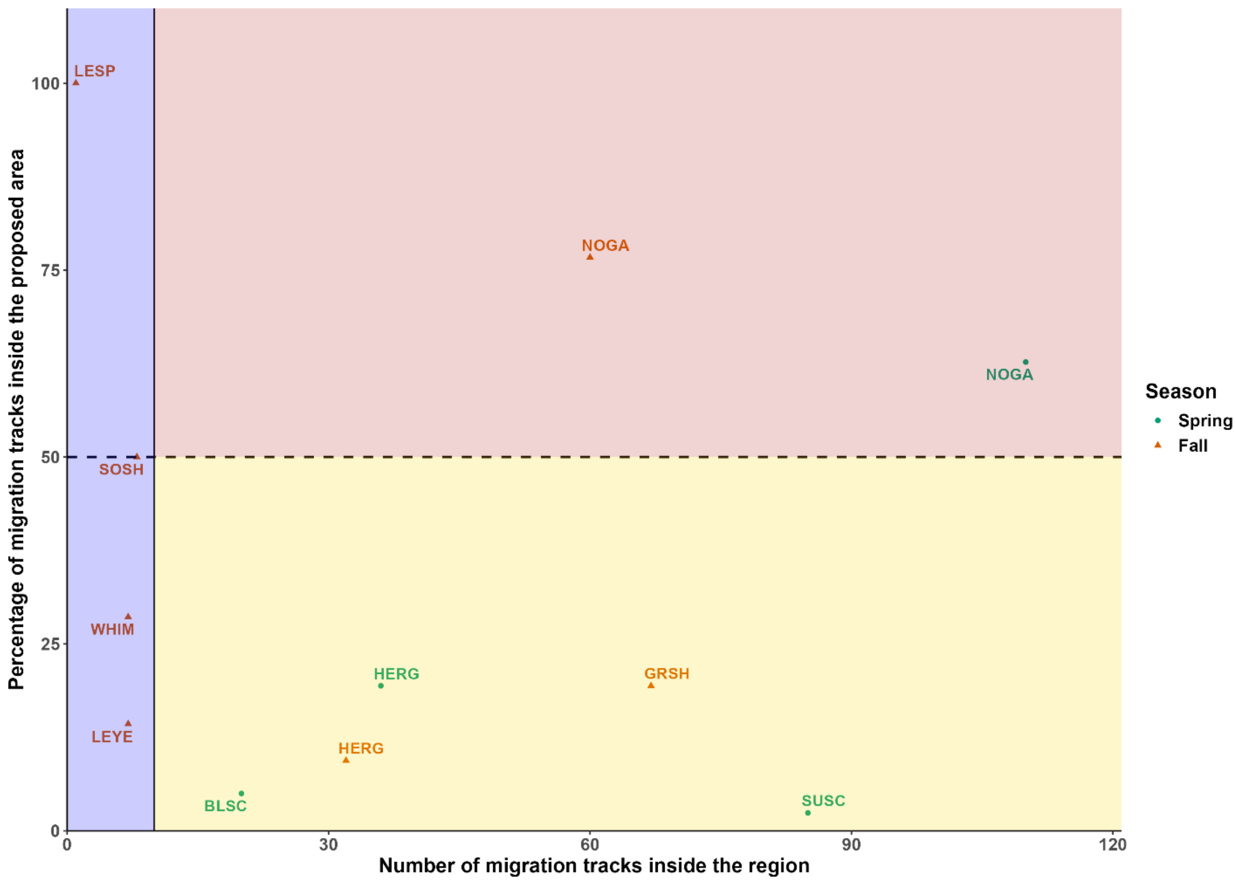

Figure 11: Percentage of seasonal migration tracks of a species inside the French Bank PDA as a function of the total number of this species migration tracks inside the entire Nova Scotia study area. Spring (green dots) and Fall (orange triangles) migrations are represented. The blue area represents low data species for which less than 10 migration tracks are available inside the whole region. The yellow area indicates a potential corridor and regroups species for which less than 50% of the migration tracks are found inside the PDA. The red area indicates a probable corridor and includes species for which at least 50% of the migration tracks are inside the PDA. The dashed line represents the 50% separation line. Four-letter codes are provided for the following species: BLSC = Black Scoter, GRSH = Great Shearwater, HERG = Herring Gull, LEYE = Lesser Yellowlegs, LESP = Leach's Storm-Petrel, NOGA = Northern Gannet, SOSH = Sooty Shearwater, SUSC = Surf Scoter, WHIM = Whimbrel.

Update

- Canso Bank: Species with high usage of Canso Bank PDA include Black Guillemot in the spring and summer, Northern Gannet in the Spring and Fall, and White-tailed Tropicbird in the Fall.
- French Bank: Species with high usage of French Bank PDA include Black Guillemot across all seasons, Herring Gull in the spring, and Northern Gannet in the Fall. Northern Gannets are probable migrants through this area in both the spring and fall.
- LaHave Basin: This PDA overlaps with high use areas of Northern Gannet in the fall and winter, and Black Guillemot in the fall. Probable migrants through this area include Northern Gannets in both the spring and fall, and Great Shearwaters in the fall.
- Middle Bank: Species with high usage of Middle Bank PDA include Black Guillemot in the spring, summer, and fall, and Northern Gannets in the spring and fall.

- Misaine Bank: This PDA overlaps with high use areas of Black Guillemot and Northern Gannet in the spring, and Great Shearwater, Northern Gannets, and White-tailed Tropicbird in the fall.
- Sable Island Bank: This PDA overlaps with high use areas of Black Guillemot in the spring, summer, and fall, Northern Gannets in the spring and fall, and Great Shearwater in the fall.
- Sydney Bight: Species with high usage of Sydney Bight include Northern Gannet and White-tailed Tropicbird in the fall. Northern Gannets are probable migrants through this area in both the spring and fall.
- Western/Emerald Bank: Black Guillemot exhibit high usage of this PDA across all seasons, and Northern Gannets exhibit high usage during fall and winter. Great Shearwater are probable migrants through this area during the fall.

Assumptions and Caveats:

- As dynamic Brownian Bridge movement models have been rerun to only include location inside the Nova Scotia region, results and species' list can differ from the Regional Assessment movement models product. This was done to better highlight the eventual challenges that could be encountered at the regional scale.
- These products are based on the movement models developed for the Regional Assessment (LINK) and are therefore submitted to the same limitations. In particular, habitat use can vary between individuals, especially in wide-ranging species (Gutowsky et al. 2015). Without a large enough number of tracked individuals covering a wide period of time, movement models will describe only the habitat use of the tracked individuals, and inference to the whole population should be limited.
- Absence of movement in an area does not indicate that no birds are present, only that we could not detect any habitat use with the tracking data available. Conversely, the presence of a high usage area with a low number of tracked individuals does not automatically mean that this area is heavily used by all birds of that species. However, it can help detect trends of habitat use that could be useful for follow-up studies.
- Kernel density products are based on GLS data that have a large error data. While these products can provide valuable information on the presence of a species in a large area, at a lower spatial scale, higher resolution products such as dBBMM based on devices with higher accuracy such as GPS/PTT should be preferred. If no data is available, follow-up studies are warranted.
- Migration tracks Products are based on limited available tracking data for both the spring and fall migration and may not cover all species present in the area or not be representative of all the individuals passing through the area.

References

Environment and Climate Change Canada, Canadian Wildlife Service (ECCC-CWS). 2024c. Avian Movement Models in Support of the Regional Assessments for Offshore Wind Energy Development. Submitted to the Nova Scotia Committee for Offshore Wind Energy Development in Atlantic Canada. https://iaac-aeic.gc.ca/050/documents/p83514/159391E.pdf

Gutowsky, Sarah E., Marty L. Leonard, Melinda G. Conners, Scott A. Shaffer, and Ian D. Jonsen. 2015. "Individual-Level Variation and Higher-Level Interpretations of Space Use in Wide-Ranging Species: An Albatross Case Study of Sampling Effects." *Frontiers in Marine Science* 2 (November). https://doi.org/10.3389/fmars.2015.00093.