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Summary: Important Marine Habitat Areas for Migratory Birds in Eastern Canada

Karel Allard, Al Hanson, Matthew Mahoney

Atlantic Region

Canadian Wildlife Service
Technical Report Series Number 530

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Executive Summary

Marine habitats are important for a large proportion of the migratory bird species that occur in Eastern Canada. Many of these species are integral components of marine ecosystems, spending most of their existence in the marine environment, coming to shore or inland only to breed. Until recently, conservation efforts directed at these species in Eastern Canada, more specifically in the area of protected area establishment, have been limited to nesting areas, colonies and other terrestrial environments. In order to extend these efforts to the marine environment, availability and consideration of species distribution information is critical to all aspects of conservation planning, including integrated management and protected area planning. Awareness of important areas, status of present knowledge, and information gaps, can serve to direct ongoing and future monitoring and collaborative, multi-jurisdictional marine planning initiatives, especially in response to anticipated or known development hot spots and/or activities. In this project, important areas for species and species guilds were identified by generating relative abundance maps of both landscape-scale habitat and population monitoring data, independently of interannual and seasonal variation. Additional information on data sources and, importantly, data gaps is provided in this report. The large spatial area analyzed helps to emphasize locations at the bioregional scale where important congregations of marine birds have occurred and consequently where they may be most vulnerable to impacts.

The first objective of this report is the creation and presentation of a comprehensive list of available large-scale data sources that can be used to describe bird distribution and abundance within Eastern Canada's marine habitats. A related goal is to increase awareness of and promote access to important federal government datasets.

The report's second objective is the creation and presentation of a comprehensive suite of distribution and relative abundance maps to illustrate the spatial coverage of relevant datasets and help describe important marine habitat sites for marine birds in Eastern Canada, across marine habitat types. The mapping approaches used to identify important marine habitats in this report are neither all-encompassing nor exhaustive and represent only a few of many possible depictions of the data. In all cases, these mapping efforts aim to be science-based, transparent and based on best-available data.

The third objective involves assessment of the depth and extent of knowledge of marine bird distribution and abundance across the region. Specifically, this will help Environment Canada's Canadian Wildlife Service and other agencies identify gaps (spatial, temporal and species-specific), with the related goal of potentially directing future monitoring efforts.

The fourth objective of this report is to inform marine spatial planning efforts in coastal, inshore and offshore habitats. It also may inform environmental assessment and environmental effects monitoring related to marine tenures, hydrocarbon extraction, aquaculture, wind energy development, marine mining, and related environmental emergency response programs.

Introduction

Canada has the longest coastline in the world and is known internationally for coastal, inshore and offshore sites that host important congregations of breeding, migrating and wintering birds. These sites include islands, coastal cliffs, beaches, salt marshes, intertidal mud flats, rock reefs, eelgrass beds (*Zostera marina*), estuarine and inshore shallows, offshore banks, shelf breaks, and seamounts. These sites sustain large numbers and a broad diversity of birds, as well as the ecosystems of which they are an integral part. Within ecosystems, birds are considered useful ecological and environmental indicators, and are considered among the most useful indicators of overall biological diversity. It generally is accepted that conservation efforts directed toward indicators of biological diversity, and the sites that host them, can benefit many other species. Physiographic characteristics of habitats themselves provide the foundation for diversity, and protection of a representative range of habitats can indirectly lead to protection of species biodiversity and abundance. The protection of representative marine habitats potentially increases overall resilience to broad oceanographic changes. To maximize the ecological benefits of conservation efforts in the short and long term, large-scale conservation planning exercises are required that identify biodiversity hot spots and otherwise help guide fine-scale conservation investments.

The distribution of birds in the marine environment varies spatially and temporally according to biological and environmental factors. Biological factors typically include prey distribution (e.g., nutrients, primary production, forage species), predator distribution (e.g., raptor nesting sites, migration routes) and species' requirements (e.g., breeding, foraging, moulting, migration and wintering sites). Environmental factors can include weather (e.g., wind, temperature, insolation) and physiographic characteristics of the environment (e.g., ice cover, water depth, tidal currents, salinity, substrate characteristics). Relationships among biological and environmental factors, and bird distribution and abundance, include both predictable and stochastic components. Improved survey methods and techniques used to describe temporal and spatial distribution (modern ship-based survey techniques, satellite tags, geolocation tags, radio-telemetry, etc.), development of datasets, Geographic Information System-based spatial analyses tools, together with better understanding of marine ecosystems, have made it possible to better study and understand spatial habitat-use patterns of marine birds at broad geographic scales.

Rationale and objectives

Most efforts to identify, protect, conserve and manage important habitats have focused on terrestrial, freshwater aquatic, wetland and shoreline ecosystems. Although early efforts were undertaken to consider protection of marine areas as extensions of

adjacent lands, more recent national and international attention is being directed at important marine habitats and ecosystems independently, with concentrated attention on coastal, inshore and offshore areas. Initiatives related to offshore areas rely on identification of important areas for marine life and characterization of habitats. Areas protected from disturbance and commercial exploitation can be established as a means to achieving conservation objectives. However, the dynamic nature of some marine ecological processes can make identification of important marine areas and creation of marine protected areas challenging, especially in the face of recent and anticipated effects of climate change. Therefore, formal designation of areas for protection may best be based on enduring, spatially predictable, oceanographic processes and features for which ecosystem values are more likely to persist over time.

Though strategies to identify spatially predictable ecological hot spots centred on expert opinion have been adopted in certain areas, a systematic, science-based, data-driven approach to identification of important marine ecosystem sites is warranted where data are sufficient to support the process. This project to identify important marine habitat sites for migratory birds in Eastern Canada constituted a joint undertaking by the Atlantic and Quebec Regions of the Canadian Wildlife Service of Environment Canada (hereafter EC-CWS). It is important to note that in this project and associated documents, “key” and “important” habitats are designated on the basis of current *and* historical records in a way that effectively highlights their *potential* to host important numbers, proportions of populations or assemblages of birds.

Process

This report aims to identify important marine habitat sites for the broad suite of migratory “marine” bird species that regularly use marine habitats. In this report, the term “marine birds” includes species in the following orders: Charadriiformes (gulls, terns, alcids and shorebirds), Pelecaniformes (gannets, pelicans and cormorants), Procellariiformes (shearwaters, fulmars and storm-petrels), Anseriformes (geese and ducks), Gaviformes (loons), Ciconiiformes (herons) and Podicipediformes (grebes).

Identification of species hot spots can be achieved through creation of individual species data layers within a GIS (e.g., bird relative abundance and distribution). Identification of multi-species hot spots can be similarly achieved. However, approaches to identify multi-species hot spots using GIS depend heavily on the initial selection of data layers, subsequent scaling of data layers, weighting of data layers and the various algorithms used in combining them. Each of these decisions can be presented in a transparent manner so that any unintentional bias is documented. Advancements in statistical methods that explore species-habitat associations, and that explain the probability of presence at a location given a set of environmental conditions, are providing new opportunities to make use of sparse data toward identification of locations potentially important to individual species and species assemblages.

Bio-physical habitat properties and characteristics can be used as surrogates of overall biodiversity. The identification and protection of habitats known to have high ecological value (e.g., eelgrass and salt marsh habitats, offshore banks, and upwelling sites) can lead to conservation of species and systems for which limited distribution, presence/absence or abundance information exists. Further, protecting large “representative” portions of each habitat type within a bioregion can contribute to achievement of biodiversity conservation objectives as well as enhancing the long-term resiliency of the greater ecosystem to effects of climate change. Decision-support toward identification of sites that could be protected while still meeting multiple and sometimes conflicting objectives (multiple species, habitats, representation, threats, social values, economic values, etc.) can be achieved through statistical multi-dimensional analyses that present possible “optimal” scenarios.

The emphasis on relative abundance mapping of marine bird “hot spots” in this report both emulates and complements existing threshold-based schemes (e.g. Important Bird Area [IBA] thresholds). Measures of relative abundance over Eastern Canada’s marine region were used whereby sites need not reach or exceed thresholds to be considered important, especially at the regional level. Though not constrained by thresholds, many sites highlighted (especially coastal sites) can be expected to already have been identified as IBAs, with some already designated as federal or provincial protected areas. Maps presented in this report show a continuum of sites rather than presenting only sites reaching a certain threshold or otherwise deemed “important.” Sites of “intermediate” importance are presented, as they can contribute to understanding connectivity, a consideration that may be especially important given potential effects of habitat fragmentation, especially along coastlines, and anticipated effects of climate change. Further, consideration of intermediate values can present advantages when combining information layers in GIS overlays in conservation planning. Ultimately, although the approach adopted here strives to remain transparent, intuitive, conceptually simple and comprehensive, it is neither exhaustive nor definitive. A combination of the strategies and resources outlined above may be warranted to complete the process of identification of important habitat areas and increase resolution to the site level.

This report is aimed at informing landscape-/seascape-level conservation processes, including planning of protected area networks and designation of new protected areas. It is designed to present a visual synopsis rather than a selection of locations based on thresholds that could be expected to vary among initiatives. It is not designed to present an exhaustive inventory of locations and descriptions of locations important to birds, or a critical analysis of years of raw data. Consequently, the report contains essential practical background information that is focused in scope, textually brief and easy to read. All maps, figures and additional resources are contained within the accompanying full report .pdf files.

Limitations of analyses

The best available data at the bioregional scale were used in the analyses, recognizing the potential influence of spatial and/or temporal data gaps. It should also be noted that the maps constitute a few of many possible depictions of the data. As such, it should be emphasized that areas not identified as “important” should conservatively be assumed to have “unknown” rather than “no” ecological value. One criticism of the “hot spot” approach is that it tends to emphasize some sites, while implying that sites not identified are ecologically poor. Further, formal decisions resulting from this report and other similar efforts should be cautiously limited to regional rather than local scales. Data for specific locales from provincial and academic sources are often available to complement the data presented in this report, constituting important additional steps in the process of describing individual sites at finer spatial scales.

Study Area and Habitats

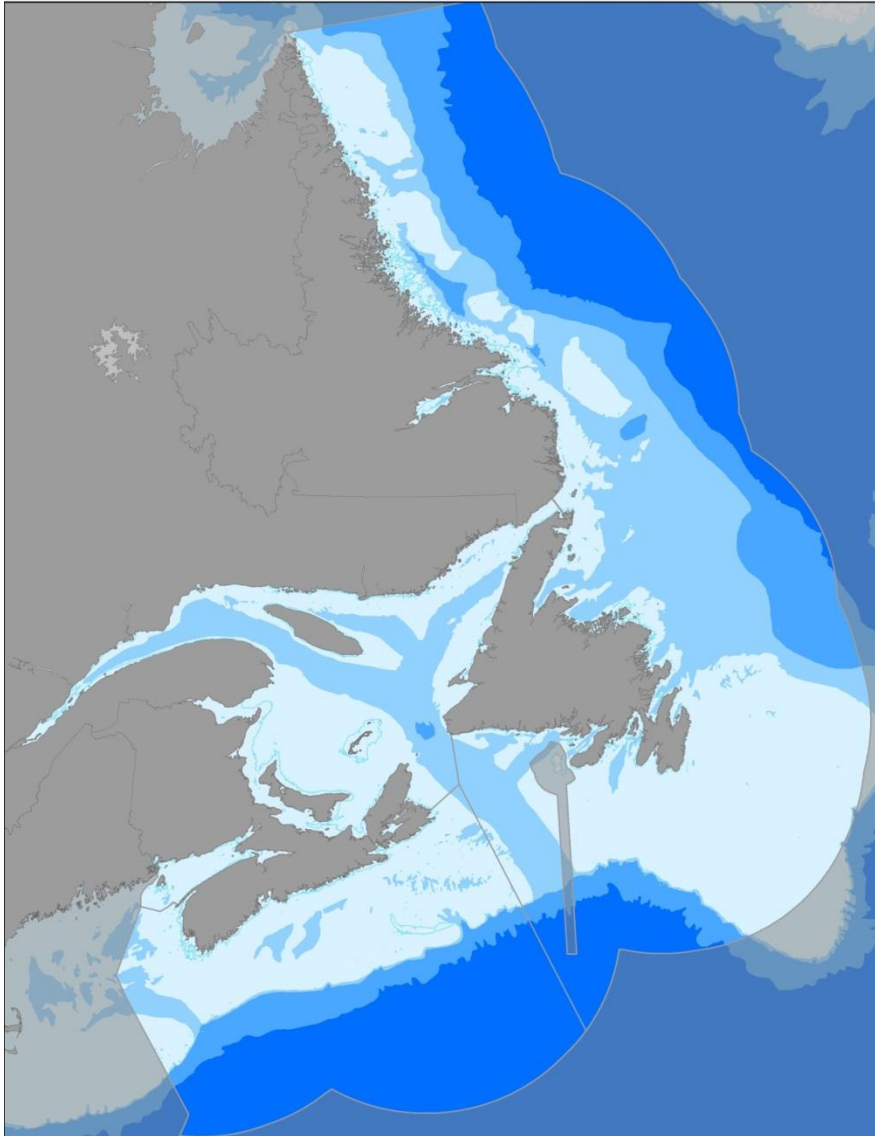
Important marine habitats for marine birds were assessed in Eastern Canada. Marine habitat was defined broadly to include coastal, inshore and offshore components, from the higher high-water large tide line out to the 200-nautical-mile limit of Canada’s Exclusive Economic Zone. Also considered were coastal supratidal habitats used by marine birds for breeding (e.g., coastal cliffs, islands). Nesting habitat is important for the conservation of marine biodiversity, although it can be easily overlooked due to its supratidal location and jurisdictional constraints.

Marine bioregions of Eastern Canada

Chapters in this document largely correspond to marine bioregions of Eastern Canada. Although partitioning of information corresponds to these ecologically meaningful entities, where possible, spatial distribution and abundance data were mapped and scaled over the entire area of interest. A map showing the study area and corresponding marine bioregions is presented in Figure 1.

Biogeographic boundaries remain subject to change as a result of evolving knowledge and understanding of marine processes and priorities. Marine bioregions are defined according to geological, physical oceanographic and biological characteristics, and exclude geopolitical (provincial) and/or socioeconomic considerations.

Eastern Canadian marine bioregions are characterized as follows:
1) Gulf Marine Bioregion; 2) Scotian Shelf Marine Bioregion; and 3) Newfoundland-Labrador Shelves Marine Bioregion.



Depth (m)

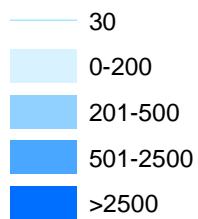


Figure 1 - Marine bioregions of Eastern Canada

The Gulf Marine Bioregion is polygon 1, the Scotian Shelf Marine Bioregion is polygon 2 and the Newfoundland-Labrador Shelves Marine Bioregion is polygon 3. Lighter shades of blue represent shallower waters, with dark blue representing deeper troughs and basins. The 200-nautical-mile economic exclusion zone, represented by the concentric grey line, forms the seaward perimeter of these three bioregions.

The marine habitats included in this project begin with terrestrial extensions of marine habitats that are essential to nesting and roosting marine birds (coastal cliffs, inshore and offshore islands), transitioning to marine-influenced habitats also used for nesting, roosting and foraging (salt marshes, dunes and barrier islands), then to intertidal coastal habitats, continuing with inshore marine habitats from shallowest and most protected to deeper, more-exposed offshore waters. Characterizations of marine habitats of Eastern Canada used by marine birds are presented below.

- 1) Colony-coastal island habitat: Though colony-coastal island habitat is essentially terrestrial, in Eastern Canada it is intimately linked to the marine environment via its avifauna and as such constitutes a critical terrestrial extension of the greater marine ecosystem. Colony-coastal island habitat includes coastal cliffs for which access by most terrestrial predators is difficult, and isolated island land masses that similarly host fewer terrestrial predator species. It also includes dynamic, if not ephemeral, semi-permanent barrier islands and other supratidal areas shaped by the sea that similarly can be used for nesting and/or roosting by colonial bird species. Low-lying inshore and offshore islands (e.g., barrier islands) are often used by nesting and/or roosting colonial bird species (e.g., Common Eider, herons, gulls, terns, cormorants and Piping Plover).
- 2) Salt marsh: Salt marsh habitat typically consists of sheltered coastal wetlands with extremely variable salinity determined largely by tidal action and freshwater outflow. Salt marsh habitats also include barachois ponds and the vegetated intertidal littoral component of estuaries. Although these particular areas can be subject to salt spray and storm tides, they typically are inundated only at the highest spring tides. At its upper limits, salt marsh habitat merges with terrestrial habitat. This habitat is often associated with dabbling ducks and herons, shorebirds, and some passerines (e.g., Nelson's Sharp-tailed Sparrow). Flora includes Tall Cordgrass (*Spartina alterniflora*), which forms solid marginal walls, with root systems that intermingle with blue mussels and debris.
- 3) Beach: Beach habitat includes supratidal as well as backshore and foreshore intertidal areas with sand substrate, including small cobble (<30 cm diameter). This particular habitat is associated with species including the Piping Plover, and others such as the Caspian Tern. Flora in the primary dune includes Beach Grass, Sea-rocket and Beach Pea, while the backshore hosts Ghost Crab and beach fleas. The foreshore area hosts Coquina Clams, Mole Crabs and members of the Pelecypod-Annelid Biome. Other inhabitants of unconsolidated beach sediments include bivalve molluscs, polychaete worms (annelids), as well as interstitial fauna such as amphipods, flatworms, gastrotriches and tardigrades.

- 4) Mud flat: Mud flat habitat includes intertidal areas with muddy substrates of estuarine silts and clays that may include some eelgrass (extensive eelgrass beds are treated as a separate habitat). Mud flat habitat hosts important numbers of migratory birds, in particular shorebird species that are attracted to mud flat invertebrate prey (e.g., biofilm, small marine worms and marine amphipods such as *Corophium* sp.). Other burrowing inhabitants of unconsolidated sediments include representatives of the Pelecypod-Annelid Biome (e.g., polychaete worms) and bivalve molluscs (e.g., Soft Clam, Quahog and clam worms).
- 5) Rock: Rock habitat is characterized by rock substrate and encompasses the intertidal zone, including large cobble (≥ 30 cm diameter). Rocky coasts also have relatively clear intertidal zonation. Flora typically is dominated by tenacious rockweed (*Ascophyllum* sp.). The spray zone constitutes a transition from terrestrial to marine ecosystems and is wetted by spray from wind and wave action only. It varies in height and extent according to exposure and hosts mainly salt-tolerant lichens and plants. Next, the upper littoral fringe forms the upper margin of the rocky upper intertidal zone and is submerged during spring tides only. It hosts slippery blue-green algae and periwinkles. The lower margin of the upper intertidal zone constitutes a transition to balanoids (barnacles) and thallophytes (seaweeds). The mid-littoral zone, or middle intertidal zone, is defined as the area between mean high and mean low tides. Barnacles in particular thrive in this zone, as do blue mussels and dogwhelks. The lower intertidal zone is often covered in thick beds of seaweeds (rockweed, knotted wrack), and then red seaweeds at its lower margin. Finally, the subtidal zone is often submerged, and is dominated by red and brown algae, and periwinkles and urchins. Rocky intertidal fauna are analogously capable of attaching themselves to the substrate. Depending on tidal fluctuation, this habitat can host species including Common Eider, Harlequin Duck, Purple Sandpiper and Black Guillemot.
- 6) Eelgrass: Eelgrass habitat is characterized by the presence of the perennial angiosperm, *Zostera marina* (eelgrass), occupying both coastal intertidal and inshore subtidal areas. Eelgrass beds are treated separately, as they are known to be particularly productive and ecologically diverse. These are located typically in shallow intertidal and subtidal areas within bays, lagoons and river estuaries that are protected from sea currents. Eelgrass is generally accompanied by other plants including Widgeon Grass (*Ruppia maritima*), Sea Lettuce (*Ulva lactuca*) and red seaweeds. Eelgrass habitat acts as an important nursery for young fishes, crustaceans and molluscs (e.g., Sticklebacks, Pipefish, Killifish, Bay Scallop). Associated birds include Atlantic Brant (*Branta bernicla hrota*), Canada Goose (*Branta canadensis*) and Black Duck (*Anas rubripes*).

- 7) Inshore: Inshore (subtidal) habitat includes waters <30 m in depth, excluding intertidal areas, salt marsh estuaries and subtidal eelgrass habitat (treated separately). This habitat is accessible to both water column and benthic foraging bird species (loons, grebes, cormorants, bay ducks and sea ducks). Inshore habitat is characterized by waters of lesser salinity than deeper-water offshore habitat. However, within inshore habitat, exposed sites can differ from protected sites in the amount of current, exposure to ocean swell, wind, resulting wind wave action and in some cases ice cover. These factors influence mixing of fresh and salt water and resulting water temperatures in the water column and at the surface. Exposed versus protected sites can also differ in terms of substrate, with the former characterized more often by rock and cobble reef subtidal, benthic features than the latter. These differences are regarded as important determinants of the makeup of inshore plant, algal and faunal communities, with consequent impacts on prey distribution and availability for diving birds, especially ducks. In all cases, the benthos remains accessible to most diving birds, within this habitat type.

- 8) Offshore: Offshore “pelagic” habitat consists of waters ≥ 30 m in depth, including nearshore waters ≥ 30 m in depth, and offshore waters, and also including offshore banks and shoals <30 m in depth entirely surrounded by waters ≥ 30 m in depth. This habitat is largely used by species that forage on the surface or within the water column (shearwaters, auks, jaegers, phalaropes). The Pelagic Biome is dominated by animals that float free or drift, phytoplankton (i.e., seasonal variation, blooms and base of the food chain), zooplankton (e.g., copepod crustaceans), forage fish, and top predators including fish, marine mammals and birds.

Delineating important marine habitat areas

Influences on habitat selection are complex and often interrelated (predator distribution, prey distribution, behaviour, environmental conditions, breeding phenology, etc.). Areas used for foraging, nesting, roosting, chick rearing, staging, moult and migration can be expected to vary spatially and across years. For example, foraging areas can be expected to shift as prey distributions, or threats from predators, and/or disturbance change. Consequently, in some species, an important proportion of a population could be found anywhere within a large geographic region on any given day as a function of known and/or unknown factors. A relatively large area thereby could be interpreted as being “important.” Such variability in spatial distribution of species in response to dynamic ecological forces perhaps exemplifies inherent resilience potential of avifaunal components of some biological systems.

During the breeding season, the spatial distribution of breeding adults is constrained by the requirements of reproduction (site and mate guarding, incubation, chick rearing, etc.), and colonial marine bird species become highly concentrated at colony locations. Such sites tend to be persistent and/or enduring and are generally well known, especially in the case of larger congregations. As a consequence, occurrence of individual colonies, or assemblages thereof, tends to result in concentrations of individuals in adjacent or nearby marine habitats. The latter sites are used for foraging, bathing, preening, roosting and social interaction, and often are referred to as seaward extensions of colonies. To best represent habitat use by species associated with a given colony, extending beyond the terrestrial breeding site, a set area around the colony can be defined. Though foraging ranges can vary among locations, within breeding season, and in relation to prey distribution, researchers increasingly are using a statistic (mean, median, maximum, etc.) of a species' foraging range to define the general geographic extent of potentially important habitat surrounding colonies. Such buffers are expected to encompass areas where marine birds are most likely to occur, though the actual area used can be much smaller. The BirdLife International Seabird Wikispace presents up-to-date foraging range calculations for multiple species, from multiple locations and in different years (e.g., Black-legged Kittiwake). Buffers also can be defined in relation to species' individual sensitivities to disturbance. Consideration of such buffers can contribute to planning, with consequent management of disturbance and potentially harmful activities (e.g., fishing, tourism, development) in the vicinity of bird colonies.

The foraging range and related foraging buffer concept described above exemplifies how survey techniques and data-handling methods in particular can overemphasize specific locations (i.e., point locations of colonies). Point coordinates, though useful, often are used to represent the spatial location of a much broader geographic feature, habitat or ecological process. For example, spatial locations of colonies are often presented according to their centroid points even though some large colonies can extend for kilometres. Counts of shorebirds on a mud flat are often associated with point locations from which surveys took place rather than the multiple individual locations of the birds themselves, and represent only those birds visible from the surveyor's vantage point. Also, point coordinates are often used to identify the instantaneous location of individual, spatially dynamic bird flocks on the water or in flight and may not accurately represent true general patterns of occurrence.

Though identification and delineation of important habitat sites at large scales may otherwise seem relatively straightforward, the survey data needed to clearly define species' distributions, establish persistence of use, and explore the nature of relationships to environmental covariates, often do not exist, lack adequate spatial and/or temporal coverage, and/or lack resolution.

For these and other reasons, maps, lists and/or descriptions of important habitat sites presented attempt to show the most appropriate scale of patterns of occurrence

given the data available. Ideally, knowledge of habitat associations and habitat data can contribute to determining the scale at which sites should be delineated. The ecological scale at which the underlying processes contribute to the importance of a site should also be considered. In this report, unless specific surveys were conducted using specific spatial units (e.g., survey polygons), no explicitly defined boundaries are presented in maps of relative abundance and distribution. Though efforts to investigate the role of seasonal patterns of distribution and abundance, and trends over time, are warranted, this report only presents spatial distribution and abundance data independently of seasonal effects or interannual trends. The primary objective is to identify geographic locations where high concentrations of individuals of a given species or species guild have occurred or tend to have occurred over time.

Species Information

This document includes information on: 1) species known to frequent individual marine bioregions of Eastern Canada annually for at least part of their annual cycle; 2) the populations to which they belong; and 3) their use of marine habitats. Birds need not breed annually within an individual marine bioregion to be considered herein. However, species considered very rare, casual, accidental and vagrant were excluded for two reasons. First, factors leading to detection of rarely occurring species are often quite different (and less predictable) than those that determine detection of regularly occurring species. Second, data describing very rare species are often sparse, making inference regarding their spatial and/or temporal distribution unreliable. Species now extinct also were excluded, but those known to have occurred in at least part of the focal region in the past 200 years were considered. Where available, temporal and spatial use patterns were assessed against Birds of North America species accounts, published bird guides and annotated lists from within the region.

Datasets considered and related dataset-specific methodologies

The assessment and selection of candidate important sites began with the compilation of Environment Canada datasets having large spatial coverage (Eastern Canada, Atlantic Canada, Quebec, Gulf of Saint Lawrence, offshore waters, etc.). In situations where large spatial gaps in species or habitat data existed, large non-governmental dataset sources were used (e.g., Étude des populations d'oiseaux du Québec data). Though the potential contribution of additional datasets held by provincial governments and academic institutions is recognized, accommodating the challenges of merging data with limited or patchy geographic scope and differing methodologies, and summarizing results within maps, exceeded the scope of this report. Users of this report interested in specific sites and/or regions are encouraged to seek such data to improve resolution, and address gaps in knowledge and/or coverage. This process could include consideration of species-specific datasets, consultation of

published and unpublished reports, also communication with researchers, wildlife managers and habitat specialists as well as the broader birding community. Most of the datasets compiled and presented herein are actively updated with new and more complete information.

A table in the report also presents a summary of survey methodologies, temporal and spatial extents, as well as the names of dataset custodians (at time of publication) responsible for the data used in the preparation of this report. Other characteristics and considerations of datasets and methods of analysis adopted in this report are presented below. Though certain caveats, limitations and potential sources of bias are discussed herein, interaction with custodians of individual datasets should be sought prior to specific or in-depth analyses, as well as in the interpretation of results.

Unless indicated otherwise, map scaling (e.g., relative abundance, presented in each map legend) corresponds to data for the entire area of interest (all three marine bioregions). Scaling and mapping algorithms were applied in a consistent manner across suites of maps in the interest of presenting maps with a common look.

Discussion

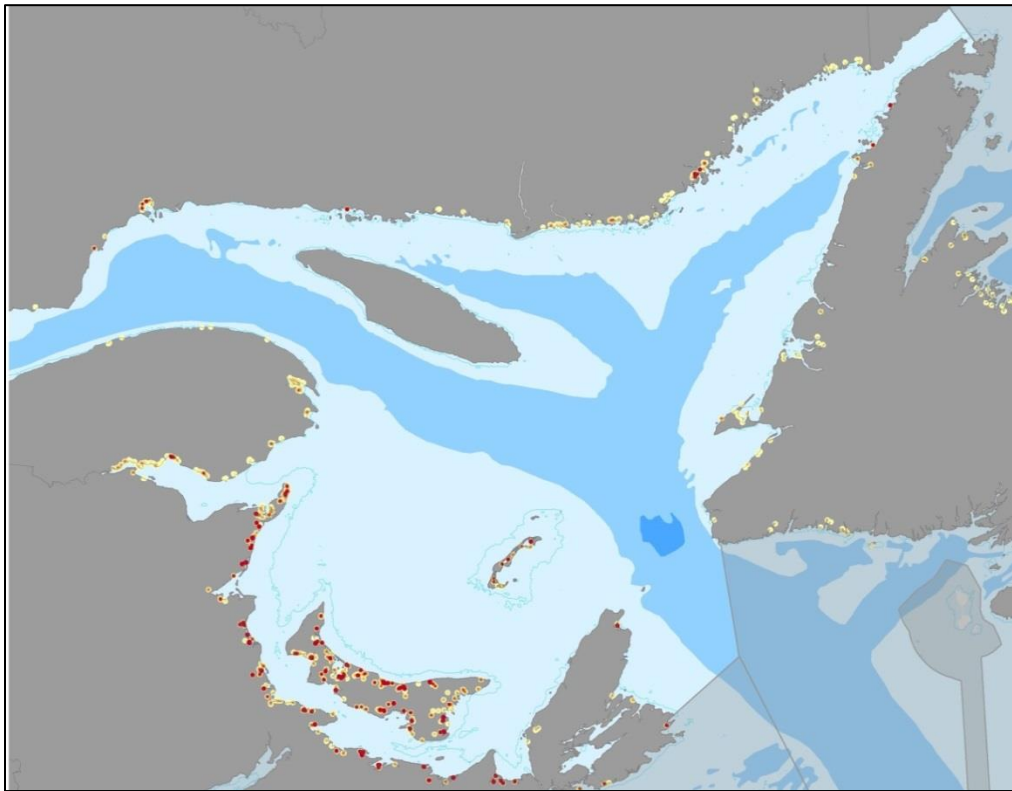
This report illustrates the extent and importance of marine habitats belonging to the provinces of Eastern Canada with coastline adjacent to the Atlantic Ocean. The combined land areas of Quebec (1 356 547 km²), New Brunswick (71 377 km²), Nova Scotia (52 939 km²), Prince Edward Island (5 686 km²), and Newfoundland and Labrador (370 511 km²) total approximately 1 857 060 km² (Statistics Canada 2011). In contrast, marine habitats described in this report total approximately 1 555 046 km², an area of comparable size. Though the marine realm is dominated by offshore habitat, occupied predominantly by pelagic bird species, the coastal and inshore habitats, which form a long narrow coastal band, are essential to an even broader and diverse suite of marine birds, and include the nesting habitats of many pelagic birds.

Our terrestrial landscapes traditionally have been the focus of habitat conservation initiatives, including identification of important areas, areas set aside for conservation, and protected areas. Recently, the 2010 Conference of the Parties to the Convention on Biological Diversity committed to a global target of “at least... 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services... conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures... integrated into the wider landscape and seascape” by 2020. As a result, processes have been initiated to develop suites of protected areas in a coherent and coordinated way, ecosystem-based and using best available science, overcoming jurisdictional barriers, to form a true “network” of sites that complement

one another such that the resulting total is greater than the sum of individual contributions. The design of such “networks” fundamentally relies on the availability and quality of foundational data derived from habitat and biological surveys.

The following information has been selected from the full report to highlight some of the more interesting large landscape-scale findings of the report; the full report contains many maps and a fuller discussion of the distribution of marine birds in Eastern Canada.

The report presents the first compilation of existing eelgrass distribution and abundance data for Eastern Canada. Though eelgrass habitat is recognized as important from an ecosystem perspective, the existing raw data available unfortunately lack the fine-scale information needed to assess extent, configuration and density, required for long-term monitoring. However, as Figure 2 indicates, eelgrass has a widespread distribution in Eastern Canada.



Relative density

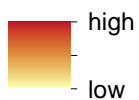
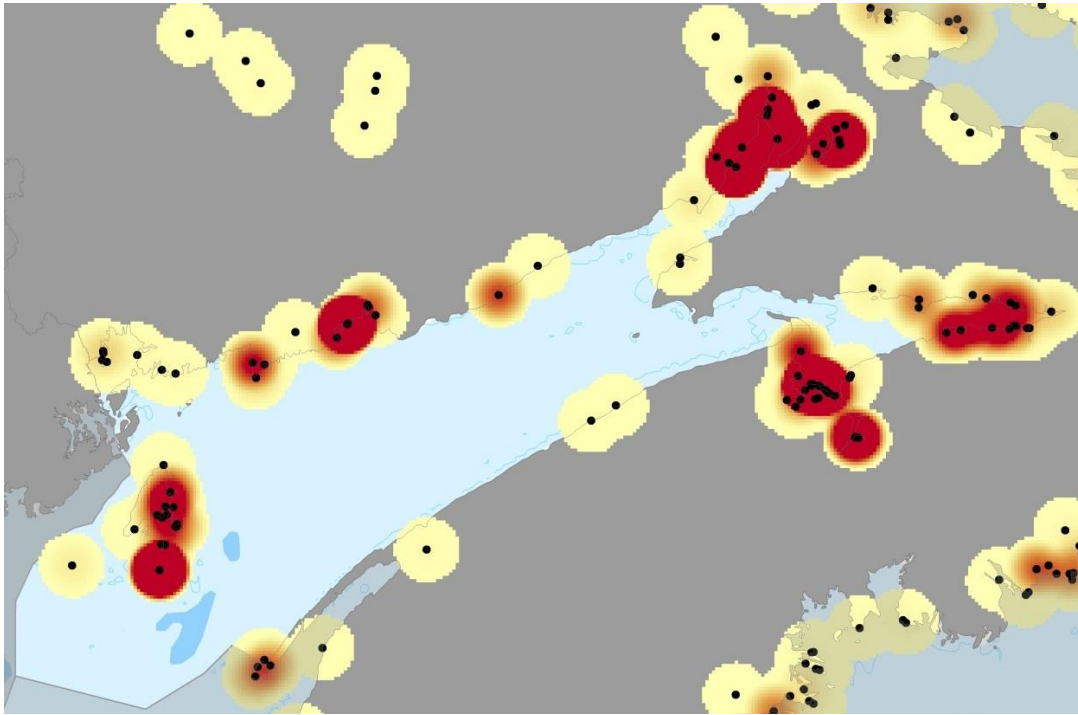


Figure 2 - Distribution of eelgrass in the Gulf of St. Lawrence Marine Bioregion

The following two maps (Figures 3 and 4) exemplify the co-occurrence of high shorebird concentrations (excluding Piping Plover, Red Knot and Purple Sandpiper) and coastal mud flat habitat. This is especially evident at Inner Bay of Fundy sites. This relationship holds especially for the more abundant species (e.g., Semipalmated Sandpiper).



- survey locations

Relative density

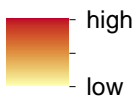
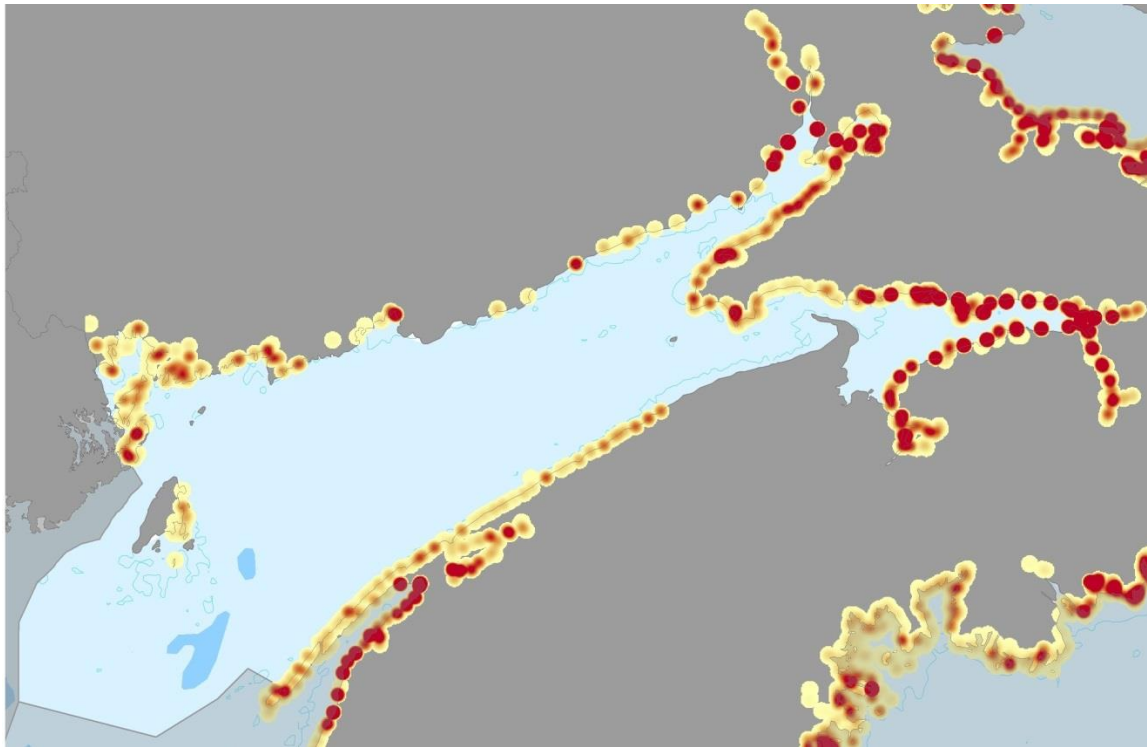


Figure 3 - Distribution of shorebirds in the Bay of Fundy

Here, black dots indicate survey locations (as not all shorebird habitat along the coast is surveyed), with yellow indicating low density and red indicating a high density of shorebirds.



Relative density

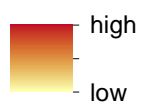
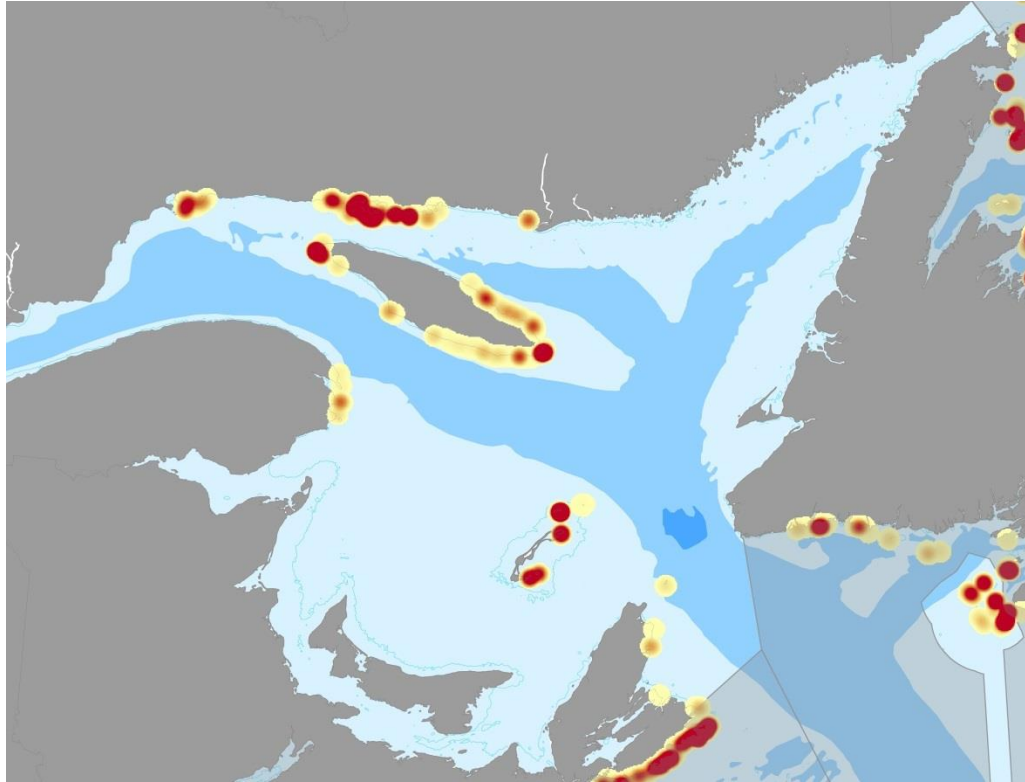


Figure 4 - Location of coastal mudflat habitat in the Bay of Fundy

Patterns show concentrations of sites with greater area of mud flats. Deeper red locations indicate extensive or clustered mud flat areas.

Rock shelf/rocky coastal habitat extent is poorly mapped outside of the Maritimes (not shown). Nonetheless, associations of this habitat type with species such as the Common Eider (mid-winter survey data shown below) emerge from the available data. In the Gulf, this is most apparent in ice-free areas including the coastline in the vicinity of the Mingan Archipelago.



Relative density

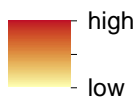


Figure 5 - Location of wintering Common Eider in the Gulf of St. Lawrence

Deeper red locations indicate where single large flocks or important clusters of smaller flocks were detected using aerial surveys. Survey data for Western Newfoundland and Labrador were unavailable.

This report constitutes the first time that two large Environment Canada offshore seabird at-sea program datasets have been assessed together, spanning six decades of at-sea survey data, to produce relative abundance distribution maps for marine birds. Though analyses are far from definitive, clear patterns of concentration emerge. Though the Northern Gannet, the area's only plunge-diving piscivore, is limited to six regularly used colony locations, congregations tend to be coastal and associated with the larger colonies. Exceptions include broad use of generally shallow waters of the Southern Gulf of St. Lawrence and movement corridors in the Belle-Isle Strait, Cabot Strait and eastern Avalon. Colony buffers shown are derived from apparent mean maximum foraging range of the species.

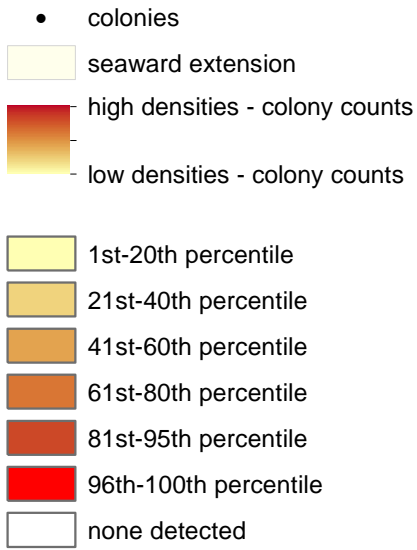
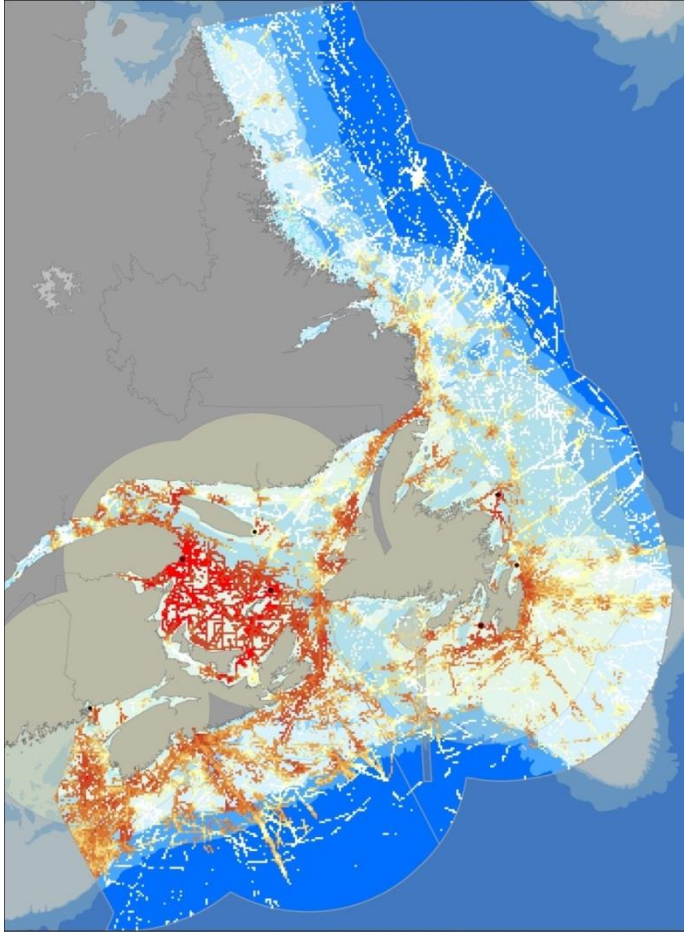


Figure 6 - Location of Northern Gannet in Eastern Canada

Locations of Northern Gannet nesting colonies are represented by black dots. Deeper red cells represent higher relative densities of Northern Gannet at sea. Transparent areas, where the bathymetry is shown, constitute survey gaps. Areas in white show where surveys occurred but the species was not detected (true zeroes).

The Ivory Gull, the only mapped pelagic marine bird species at risk, exhibits highest concentrations that appear limited to the northern Newfoundland and Labrador Shelves, mostly in the shelf break zone. In Canada, the species is known to breed only in the High Arctic.

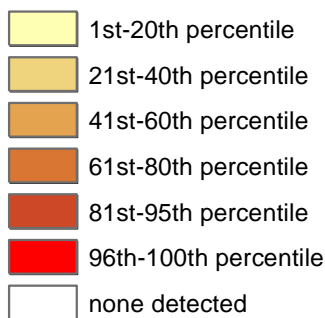
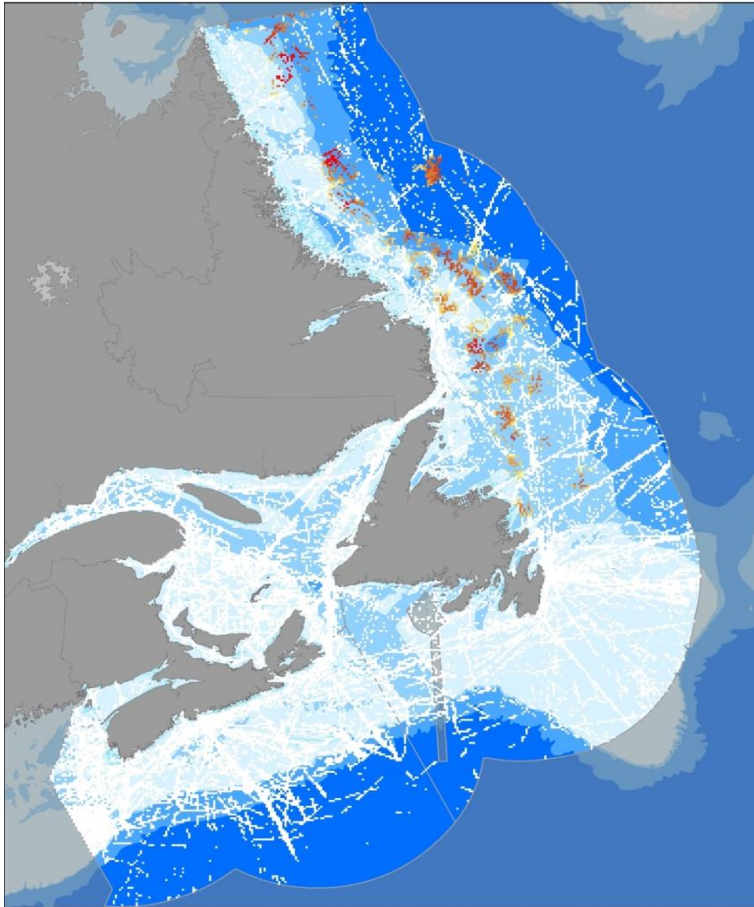


Figure 7 - Observations of Ivory Gull in Eastern Canada

Deeper red cells represent higher relative densities of Ivory Gull at sea. Transparent areas, where the bathymetry is shown, constitute survey gaps. Areas in white show where surveys occurred but the species was not detected (true zeroes).

Data and knowledge gaps

Efforts to monitor marine birds traditionally have focused on establishing range, population size and population trend information. The data described in this report reflect logistical constraints that limit occurrence, timing, spatial coverage and frequency, of certain survey initiatives. In many instances, surveys are opportunistic, rather than systematic, sometimes reliant on volunteers, making them more vulnerable to bias. Moreover, the foundational habitat data required to establish species-habitat associations and needed to ensure the design of representative networks of protected areas are outdated, incomplete, lacking or unavailable. Consequently, care should be exercised to interpret the available data. Opportunities to address uncertainty and gaps, through coordinated partnerships within and among government agencies, environmental non-governmental organizations and industry, should be explored whenever possible.

Gaps in what are considered “foundational data” exemplify the challenges that need to be overcome in order to undertake large-landscape level conservation assessment and planning. Efforts to address these gaps can be expected to benefit integrated management, coastal and offshore marine protected area planning, and broader marine spatial planning initiatives that use marine bird and habitat data. Given expected limitations on resources dedicated to addressing data and knowledge gaps, these efforts will need to be undertaken strategically, in coordination with partner federal agencies, provincial agencies, environmental non-governmental organizations, and in many cases, industry.

Examples of various survey gaps encountered during the preparation of this report include:

- 1) spatial and temporal gaps related to variation in survey effort within and among avifaunal surveys;
- 2) spatial gaps within and among available datasets describing the location and areal extent of certain habitat types, especially at broad landscape scales (most evident in salt marsh and eelgrass habitat types); and
- 3) gaps in relative availability of species distribution and abundance data for less abundant, more secretive species.

Conclusion

The maps presented in this report clearly illustrate the degree to which marine habitats of Eastern Canada are used by large numbers and a wide variety of migratory marine bird species. The presence of migratory birds in marine habitats indicates their inherent reliance on physical and biological resources available to them in the marine environment, with birds being integral components of marine ecosystems. Ultimately, it is hoped that the data presented and described herein will be the impetus for new efforts to better understand the relationships that link marine birds to physical and other biological components of marine ecosystems, leading to more informed ecosystem-based conservation planning. In order to bridge jurisdictional barriers, this will require well-supported, coordinated, collaborative protected area and integrated management efforts. Currently, such collaboration is exemplified within Federal Marine Protected Area Network planning initiatives being undertaken at the scale of individual marine bioregions.

Though important habitat areas for marine bird species and species guilds were identified using relative abundance maps of both landscape-scale habitat and population monitoring data, it is important to clearly state that these summary analyses should not be considered final or otherwise definitive. Analyses of raw data are fundamentally dependent on the questions being asked. As such, EC-CWS biologists and dataset custodians should be consulted during the development of analytical procedures designed to address questions surrounding spatial aspects of the raw data. Further data and additional information on various data sources continue to become available, enabling both finer-scale and more rigorous analyses of information useful to identify locations where important congregations of marine birds have occurred, may occur, and ultimately where they may be most vulnerable.

The data presented suggest the existence and relative importance of several important areas for marine birds. They constitute a broad summary of present knowledge, which can be accessed to serve and direct ongoing and future marine planning initiatives.