

Coastal & Marine Birds

Bob Allen and Mark Anderson

Introduction

This assessment examines trends in populations of those seabirds, shorebirds, and waterbirds that interact regularly with the marine environment. For the purposes of this assessment, the terms “seabird,” “shorebird,” and “waterbird” are defined as:

Seabirds are colonial species that feed in salt waters, and often migrate spectacular distances from breeding grounds to wintering areas. Some, such as the Audubon’s Shearwater, come onto land only to breed, otherwise spending their lives at sea. In some cases, these birds may connect geographically disparate marine environments. Arctic Terns, for instance, breed along the coast of New England and Canada, but also use marine environments along the coast of Africa and on the continent of Antarctica. Within this region, a number of coastal and marine bird species are listed as state and federally threatened or endangered. World-wide, a higher percentage of seabird species are at risk of extinction than any other bird group.

Shorebirds, such as the piping plover, Semipalmated Sandpiper, and Greater Yellowlegs, spend their lives on sandy beaches, mudflats, and river and lake shores, and generally only interact with the edge of the marine environment.

Waterbirds, such as gulls, and colonial wading birds, such as herons, generally interact with the marine environment in the coastal zone. For instance, most gull species are found foraging within a few miles of land. Others, such as herons and egrets, feed in the marine/coastal zone in marshes and along brackish creeks.

Technical Team Members

Bob Allen, The Nature Conservancy, New Jersey

Doug Forsell, U.S. Fish and Wildlife Service

Scott Johnston, U.S. Fish and Wildlife Service

David Lee, Ph.D., North Carolina State Museum of Natural Sciences (retired)

Dan Morse, The Nature Conservancy, Eastern Division

Kathy Parsons, Ph.D., Manomet Center for Conservation Sciences, MA

Joe Smith, Ph.D., The Nature Conservancy, New Jersey



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Selection of Target Species

Over 80 species of seabirds utilize this region to some extent (Nisbet et al. 2008). The conservation needs of these species were assessed in several ways. First, high priority stopover sites and wintering concentrations for many species identified by (need source of map) were noted as outstanding features along Northwest Atlantic coastline and added to the characterization of coastal shoreline units (see the Coastal chapter of this document). Second, key breeding areas for beach and salt marsh breeding birds identified through a separate analysis of the North Atlantic Coast, Chesapeake Bay and Northern Appalachian ecoregions (Anderson et al. 2006a and b; Samson et al. 2003) were reproduced here to reemphasize their importance to the region. Third, a small subset of seabirds, for which the North Atlantic Coast ecoregion plays an important role, were identified and targeted for conservation action. The criteria used to identify these target species were as follows:

- 1) Species that primarily breed on offshore islands or primarily forage in marine waters during at least one part of year;
- 2) Species ranked as High or Highest Concern in North American Waterbird Conservation Plan rankings, High or Highest Concern by the Mid-Atlantic/New England Marine regional rankings in the Waterbird Conservation Plan, listed as a Seaduck Joint Venture declining species, or listed as an Atlantic Coast Joint Venture high priority pelagic/marine species;
- 3) Species for which the population trend is declining or unknown, or the population size is small.

The team assessed which species have available consistent datasets that cover the entire region or the portion of the region in which the species is found. The single largest eliminator of species was lack of standardized data across the region. More species can be added as additional information becomes available.

This process resulted in the selection of six marine targets:

- Arctic Tern (*Sterna paradisaea*)
- Audubon's Shearwater (*Puffinus lherminieri*)
- Barrow's Goldeneye (*Bucephala islandica*)
- Harlequin Duck (*Histrionicus histrionicus*)
- Razorbill (*Alca torda*)
- Roseate Tern (*Sterna dougallii*)

Three coastal species were added from coastal assessments, as discussed above:

- Least Tern (*Sternula antillarum*)
- Piping Plover (*Charadrius melodus*)
- Red Knot (*Calidris canutus rufa*)

Population Status and the Importance of Northwest Atlantic region

The Northwest Atlantic region is extremely important to populations of Roseate Tern, Arctic Tern, Least Tern, Harlequin Duck, Audubon's Shearwater, Barrow's Goldeneye, Red Knot, and Piping Plover. In all cases, significant percentages of the total species population breed, migrate through, winter, or have foraging concentrations in this region. In the case of the Red Knot, almost the entire population of the *rufa* race relies upon a small number of stopover locations within the Northwest Atlantic region. Fifty to 75% of the Caribbean population of Audubon's Shearwater forages in one area off the coast of North Carolina during the late summer. Eighty percent of the Atlantic population of breeding Piping Plovers can be found in the Northwest Atlantic region.

The conservation status of these species is mixed. Most species are considered of "least concern" at the global scale by the International Union for the Conservation of Nature (IUCN). However, in many cases, the significant populations or subspecies of these species that are found in the Northwest Atlantic region are threatened. Roseate Tern, Least Tern, Harlequin Duck, Red Knot, and Piping Plover are listed as threatened or endangered by the United States Fish and Wildlife Service (USFWS) or the Canadian Wildlife Service (CWS). All species except the Audubon's Shearwater are listed as threat-

ened or endangered by one or more states or provinces. Piping Plover have a NatureServe rank of G3 (vulnerable). Roseate Tern, Least Tern, Harlequin Duck, Audubon's Shearwater, and Red Knot are considered G4 (apparently secure). Arctic Tern, Razorbill, and Barrow's Goldeneye are ranked G5 (secure).

Ecosystem Interactions and Ecological Dependencies

The habitat needs of seabirds, shorebirds, and waterbirds are diverse - birds can be found in most coastal and marine environments. Sandy beaches and islands and tidal flats and bays along the Northwest Atlantic coast are particularly important habitats for many species of birds for breeding, migration, and wintering. Shallow waters (for example, sand shoals) are often very productive as foraging areas for many species of birds. Shallow waters along rocky coasts are often important foraging or wintering habitat for many species of birds that primarily breed in the northern reaches of this region and beyond. Complicating this array of habitat needs is the temporal variability in those needs: species often have different requirements during the breeding, migration, and wintering seasons. Seabirds and shorebirds depend on the resources of this region in a variety of ways, including for:

Breeding areas: Places where coastal features such as salt marshes, rocky coastline, gravelly or sandy beaches, and offshore islands, provide critical habitat for nesting. Breeding species include various Terns, Gulls, Piping Plover, and the American Oystercatcher.

Wintering areas: Surf breaks along rocky shores, sand shoals, and offshore islands where migratory sea ducks concentrate in the winter to feed on invertebrates such as mussels or shrimp. In this region, over a million individual sea ducks congregate in sites that are traditionally returned to year after year. Wintering species include Surf Scoter, Black Scoter, Long-tailed Duck, Harlequin Duck, Red-throated Loon, and Common Loon.

Summer foraging areas: Temporal resource pockets where marine birds congregate to feed on fish, squid, plankton, and other abundant food resources. Some species, such as the Audubon's Shearwater, concentrate a large percentage of their population in the same foraging areas from year to year.

Stopover and staging sites: Stopover sites are areas where migrating species stop to feed and refuel. Because many seabirds and shorebirds breed in the far north and winter in the southern hemisphere, productive stopover sites are important to maintaining the species. Intertidal areas, mudflats, and sandy beaches laden with horseshoe crab eggs are particularly important to many shorebird species. "Long-jump" migrators, those which fly long distances between staging sites, are particularly at risk from degraded sites. For example, the red knot gathers in large numbers at a few sites, the loss of which may seriously affect their ability to migrate successfully. Critical sites include the Delaware Bay shoreline, where eggs from spawning horseshoe crabs attract the second highest number of shorebirds of any location in North America, and the Bay of Fundy's tidal mudflats, which serve as important staging areas during fall migration.

Aspects of the life history of many marine birds are not well known, but radio tracking has revealed that individual species may use a network of breeding, staging, and wintering areas (Silverman et al. 2008). Critical migratory areas for many species overlap, forming important and well-known areas for conservation (Figure 12-1). These important shoreline areas are noted in the coastal chapter as outstanding features along the Northwest Atlantic coastline and associated with coastal shoreline units.

The seabird and shorebird targets share common predator types, though the species of predators may differ. Mammals, including raccoons, foxes, and skunks, commonly prey upon the eggs and nestlings of breeding birds. In many cases, the populations of these mammalian meso-predators (medium-sized predators) are tied to

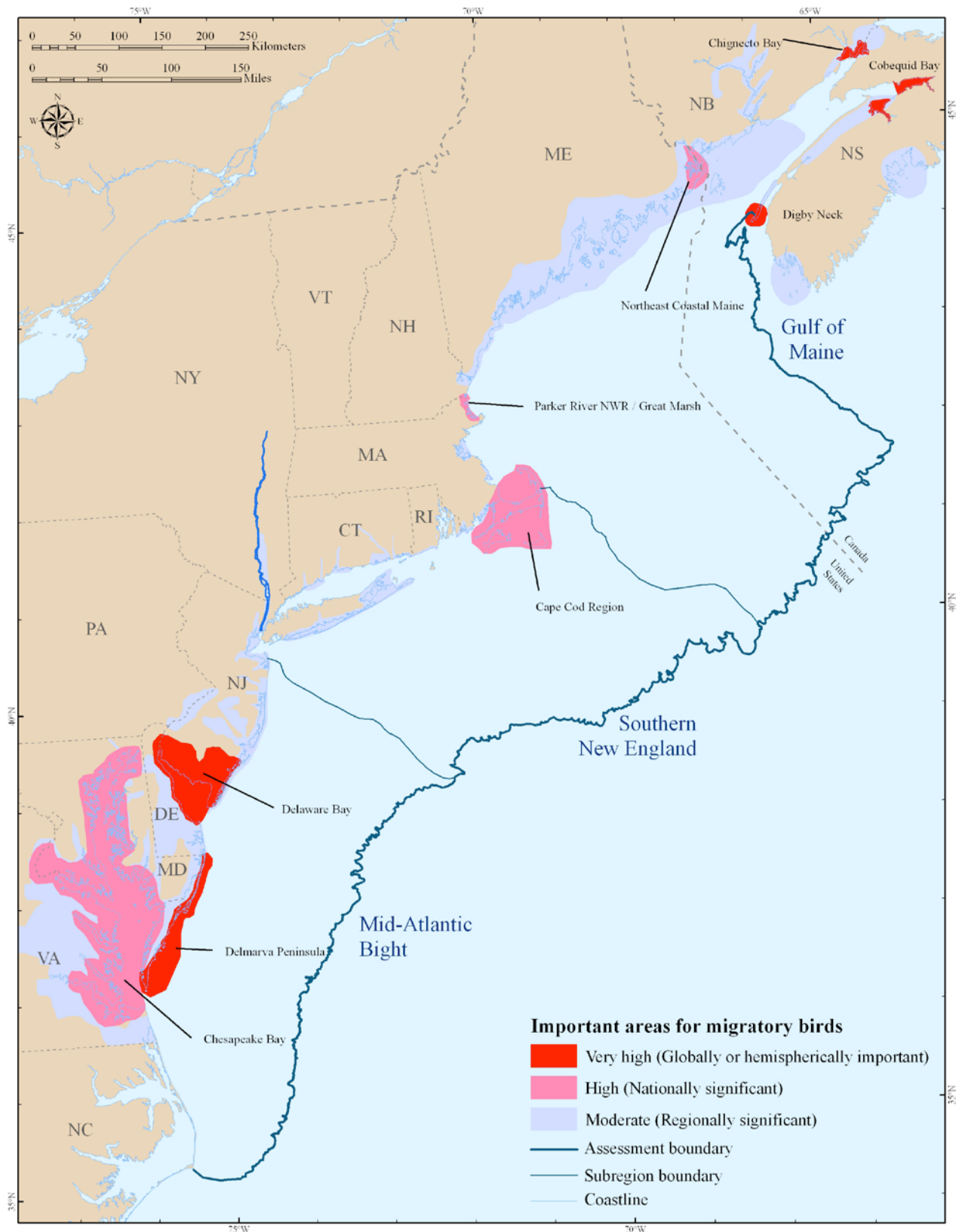


Figure 12-1. Coastal migratory stopover sites in the Northwest Atlantic region (very high = four bird groups or a hemispherically important shorebird site, high = three bird groups or an internationally important shorebird site, medium = 2 bird groups or a regional important shorebird site).

the human landscape and very much affected by human behaviors in the area (e.g. landfills, fast food restaurants, land use). Birds of prey, such as owls and hawks, will prey upon nestlings and adults. In some cases, gulls can be a significant source of predation on the eggs and nestlings of colonial breeding birds. The seabird and shorebird targets primarily feed on small forage fish or marine invertebrates. For example, Roseate Terns prefer small schooling fish such as sand eels (*Ammodytes americanus*). Audubon's Shearwaters feed on small fish and squid in deep open marine waters. Within Northwest Atlantic region, Red Knots feed on horseshoe crab eggs, mussels, and mussel spat.

The implications of the loss of seabirds, shorebirds, or waterbirds to marine ecosystems in the region are poorly understood. Although seabirds and shorebirds may compete with a number of fish and mammal species for forage fish resources, this relationship is not very well understood. The clearest case of competition with seabirds and shorebirds comes from gulls. Gulls compete with red knots for access to horseshoe crab eggs; recent research indicates that the presence of gulls actually excludes red knots from quality foraging areas (Karpanty et al. 2006). Gulls also compete with Roseate and Arctic Terns for limited breeding locations such as islands and beaches. Gull competition is known to have caused the abandonment of Tern colonies (Gochfield et al. 1998).

Northwest Atlantic Distribution and Important Areas

Data

Occurrence data for all target species were collated and mapped in order to determine important areas for these species. Data for the Roseate and Arctic Terns came from the state of Maine element occurrences, USFWS Gulf

of Maine Coastal Program, and the National Audubon Society's Maine Coast Seabird Sanctuaries program reports. Most of these data were from the past ten years. For the Harlequin Duck, spatial data includes element occurrences from TNC's North Atlantic Coast ecoregional plan and the states of Maine and Rhode Island. New Jersey records come from New Jersey Audubon



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reports and the Birds of New Jersey (Walsh et al. 1999). The Canadian Wildlife Service provided abundance and location data for Canada. Data for Barrow's Goldeneye winter distribution in Maine were provided by the Maine Department of Inland Fisheries and Wildlife. Spatial data used for the Audubon's Shearwater are based upon the Continental Shelf shape file for North Carolina's Continental Shelf Important Bird Area. Red Knot important sites were based upon Delaware and New Jersey natural resource agency shorebird surveys and the 2008 East Coast-wide surveys coordinated by the New Jersey Department of Environmental Protection. Least Tern and Piping Plover important sites were based upon state agency surveys and reports and, in some limited cases, state heritage element occurrences.

Table 12-1. Criteria used to determine critical areas for seabird and shorebird conservation targets.

	Habitat	Breeding	Wintering	Stopover or Concentration
Arctic Tern	Marine	A site with greater than 10 pairs that has been occupied within the past 15 years		
Least Tern	Coastal	A site with greater than 50 pairs		
Roseate Tern	Marine	A site with greater than 10 pairs that have been occupied within the past 15 years		
Piping Plover	Coastal	A site with more than four piping plover pairs during the most recent year for which we have data, or where there were greater than four pairs at any point during the past five years and the population continues to be more than three pairs		
Razorbill	Marine	A site with more than 20 pairs that have been occupied in five of the past ten years	One well-known wintering concentration area was	
Barrow's Goldeneye	Marine		A site where ten or more Barrow's goldeneye have been observed in some years (State of Maine and the Canadian Wildlife Service)	
Harlequin Duck	Marine		A site with greater than 25 birds occupying the area for more than one month per year	
Red Knot	Coastal			An important stopover area was defined as a beach where more than 500 individuals have been recorded in one day, has been used consistently over the past 10 years, and is relatively protected from human disturbance
Audubon's Shearwater	Marine			The area of concentration was based upon water depth information and expert opinion (David Lee)

Methods

As opposed to the data collection methods using in other chapters in this assessment, bird data is not available in ten-minute squares. In most cases, occurrences were mapped based on spatial records using the above data sources. In a few cases, only the name of an island was available, in which case the location of the island was re-searched, and then the occurrence was mapped. Due to the variation in data available by species, a separate metric was defined for each species (Table 12-1).

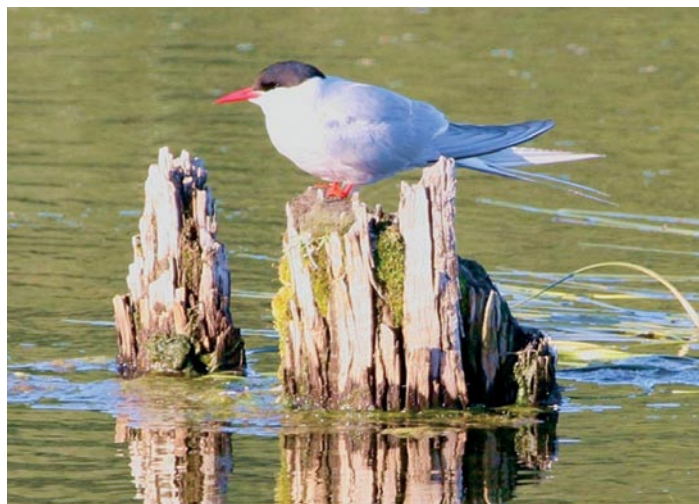
Maps, Analysis, and Areas of Importance

Arctic Tern

Within Northwest Atlantic, Arctic Terns nest along the coast of Maine. In 1999-2002, there were about 12,800 pairs along the Atlantic coast of Maine and Canada. Arctic Tern breeding numbers are known to have been higher in 1950s, but declined into the 1970s and have fluctuated since (Hatch 2002).

Important areas for Arctic Terns

Breeding: Islands along the coast of Maine (Figure 12-2)



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Audubon's Shearwater

During the late summer, Audubon's Shearwaters are concentrated along the edge of the Continental Shelf off the coast of North Carolina, with a less important concentration area extending northward to the Virginia border. The

total breeding population size of the Caribbean population (the same population found off North Carolina in the late summer) is estimated at 3800 pairs in 2008. Species experts believe the population to have likely decreased, but no long-term data exist (D. Lee, personal communication).

Important areas for Audubon's Shearwater

Foraging Concentration: The edge of the Continental Shelf off the coast of North Carolina (Figure 12-3)

Barrow's Goldeneye

Most wintering Barrow's Goldeneye are outside of the Northwest Atlantic region, but within the region they are found along the coasts of Maine, Nova Scotia, and New Brunswick. Their population trend is unknown.

Important areas for Barrow's Goldeneye

Wintering: Shallow marine waters along the coasts of Maine, Nova Scotia, and New Brunswick (Figure 12-4)

Harlequin Duck

Harlequin Ducks are found along the Atlantic coast as far south as New Jersey. However, the most significant wintering populations are along the coasts of Maine, Nova Scotia, and New Brunswick. Their population has been decreasing over the past 30 years, but has been stable or even slightly increasing for the past 15 years.

Important areas for Harlequin Ducks

Wintering: Rocky coasts and islands of Maine, Nova Scotia, and New Brunswick (Figure 12-5)

Razorbill

Seven percent of the Razorbill population is found within the Northwest Atlantic region. Their population is thought be stable.

Important areas for Razorbills

Wintering: Nearshore marine water along the coast of Maine, Nova Scotia, and New Brunswick (Figure 12-6)

Roseate Tern

While Roseate Terns nest from Long Island to Maine, 80% nest on two islands: Great Gull Island off of Long Island, NY, and Bird Island, MA. Roseate Tern populations have been decreasing over the past 100 years, but may have stabilized over past 10 years (Gochfield et al. 1998).

Important areas for Roseate Terns

Breeding: Great Gull Island off of Long Island, NY, and Bird Island, MA (Figure 12-7)

Least Tern

Least Terns breed from southern Maine to North Carolina. Their population has been decreasing over the past 30 years, but may have stabilized over the past 10 years.

Important areas for Least Terns

Breeding: Sandy beaches on Cape Cod, Long Island, Virginia barrier islands, and New Jersey barrier islands and mainland beaches (Figure 12-8)

Piping Plover

Piping Plovers are distributed from Maine to North Carolina, but the largest populations are, in order, Massachusetts, New York, Virginia, and New Jersey. Their population has been decreasing over the past 100 years, but has been increasing over the past 20 years since their federal listing as an endangered species (Elliot-Smith and Haig 2004).

Important areas for Piping Plovers

Breeding: Sandy beaches on Cape Cod, Long Island, Virginia barrier islands, and New Jersey barrier islands and mainland beaches (Figure 12-9)

Red Knot

Red knots migrate through the Northwest Atlantic region during the spring and fall. Their population has decreased by over 90% since 1990 and has been predicted to go extinct within 5-10 years.

Important areas for Red Knots

Spring stopover: The most important stopover location is the sandy beaches on both the New Jersey and Delaware sides of Delaware Bay. Barrier islands along the Virginia coast are also proving to be important stopovers for migrating red knots.

Fall stopover: Although in much smaller numbers than the spring stopover in the Delaware Bay, Red Knots utilize sandy beaches on Cape Cod and the southern Atlantic coast of New Jersey during the fall migration (Figure 12-10)

Human Interactions

For species that use coastal areas for feeding, nesting, and roosting within the Northwest Atlantic region, human activity that displaces birds is a key source of disturbance. Such coastal areas are both important habitat for birds and in high demand for human recreation. Disturbance of birds at breeding colonies, nest sites, roosting areas, and feeding areas, while not causing direct mortality, can impact survival and reproduction in these species (Peters and Otis 2007, Rodgers and Schwikert 2002, Sabine et al. 2008, Shepherd and Boates 1999). Human activity in these habitats can promote increases in predators such as raccoons, skunks, and gulls that directly prey upon eggs, young, and adults of these bird species (Erwin et al. 2001).



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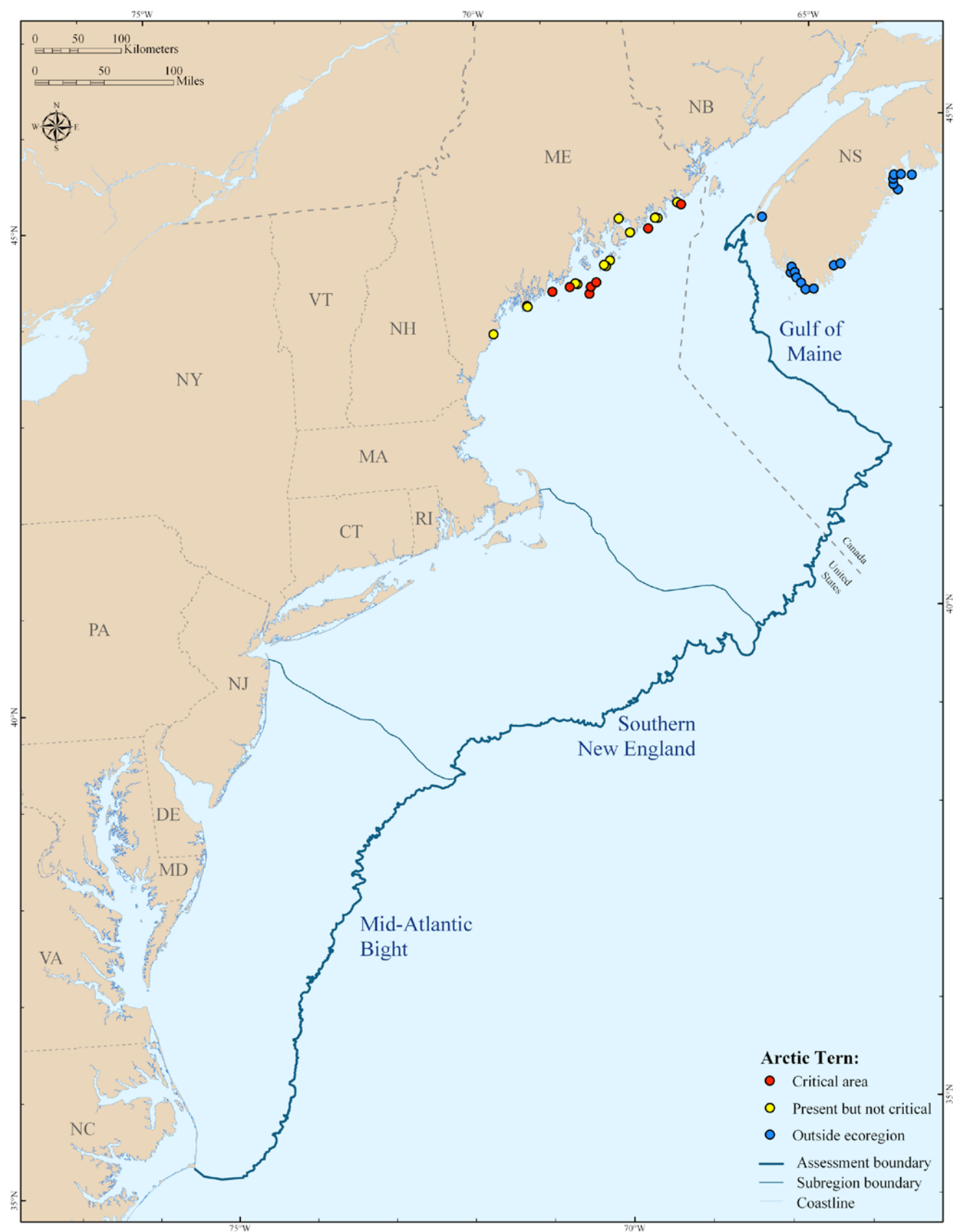


Figure 12-2. Critical areas for Arctic Terns.

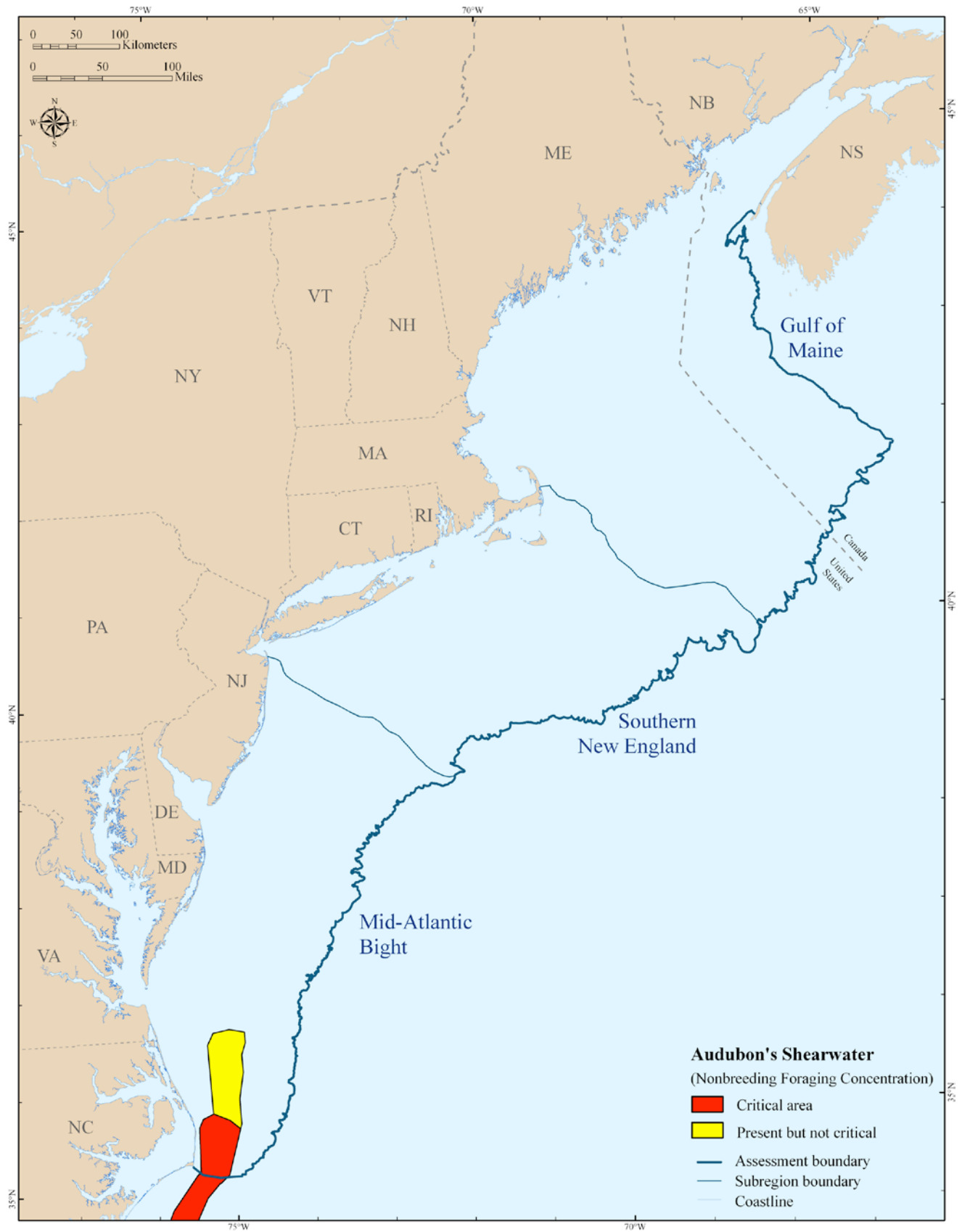


Figure 12-3. Foraging concentration (nonbreeding area) for Audubon's Shearwater.



Figure 12-4. Critical wintering areas for Barrow's Goldeneye.

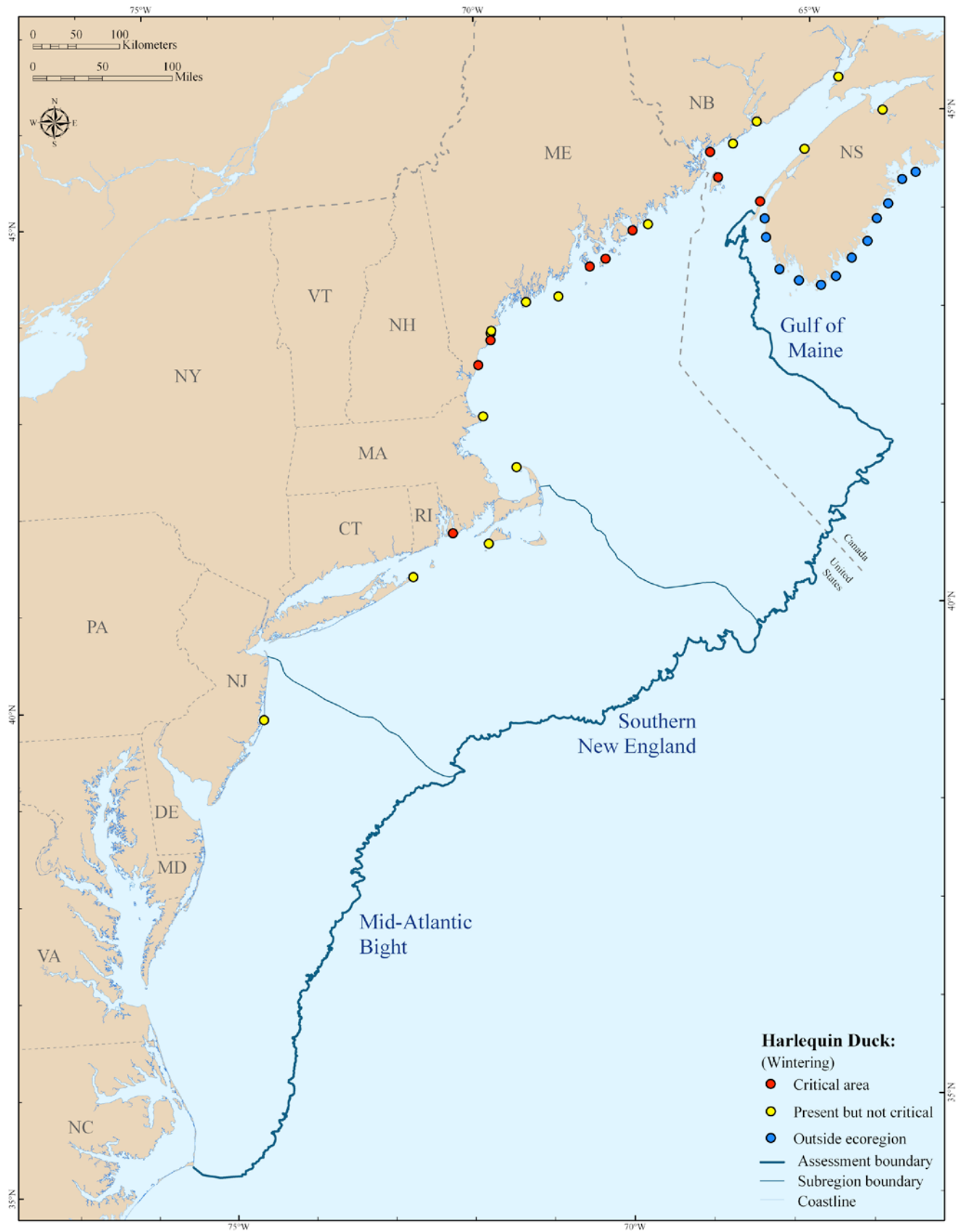


Figure 12-5. Critical wintering areas for Harlequin Duck.

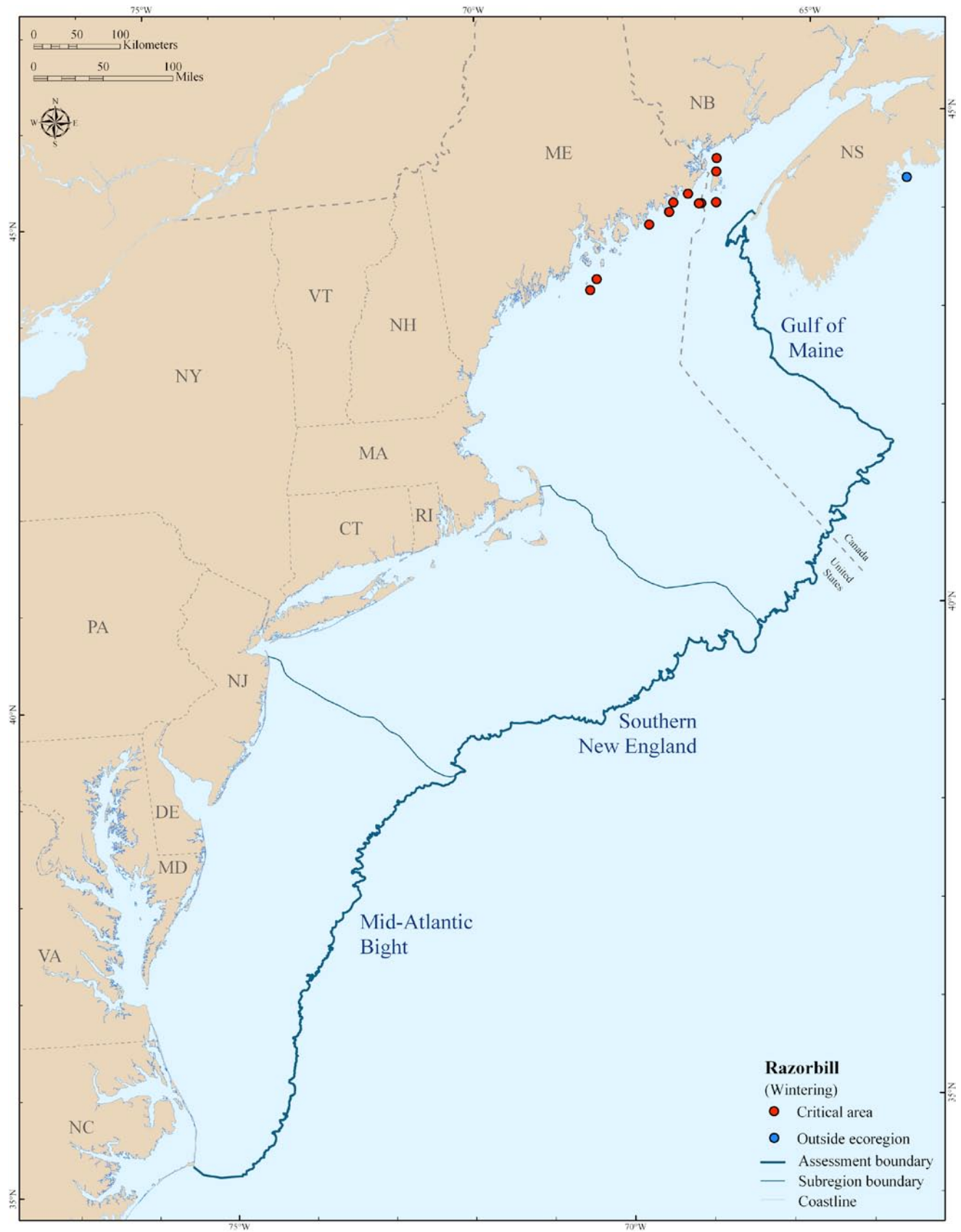


Figure 12-6. Critical wintering areas for Razorbill.

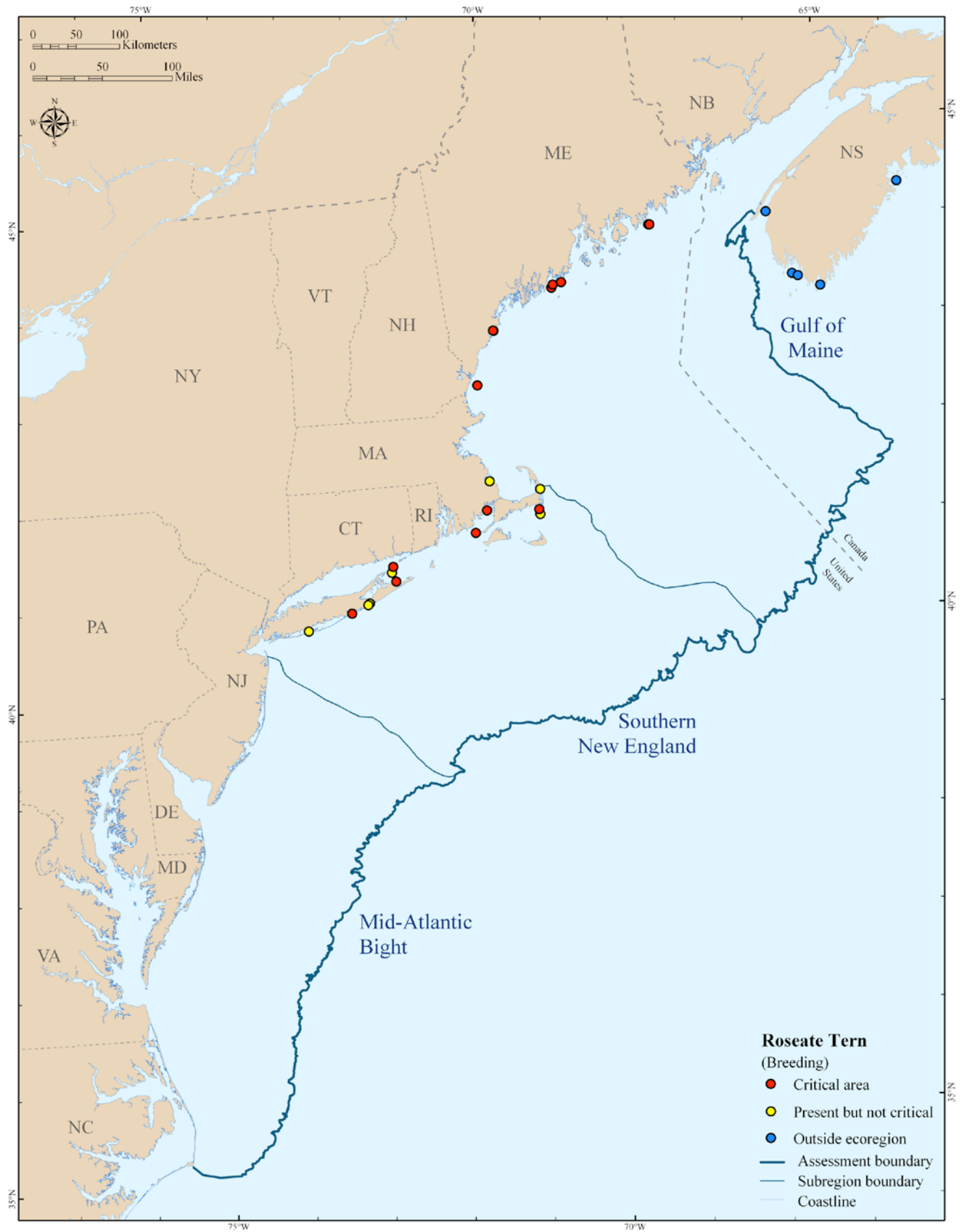


Figure 12-7. Critical breeding areas for Roseate Tern.

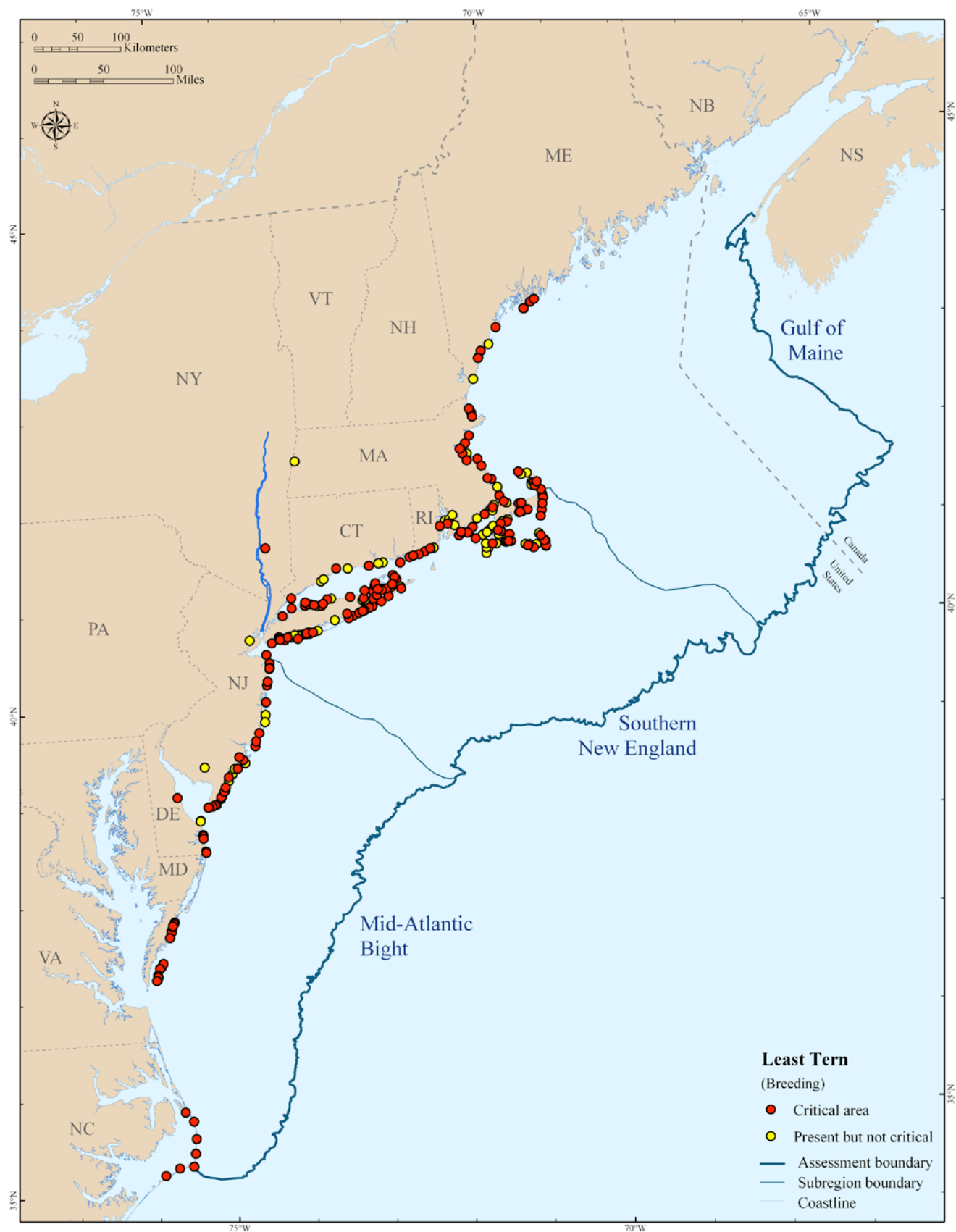


Figure 12-8. Critical breeding areas for Least Tern.

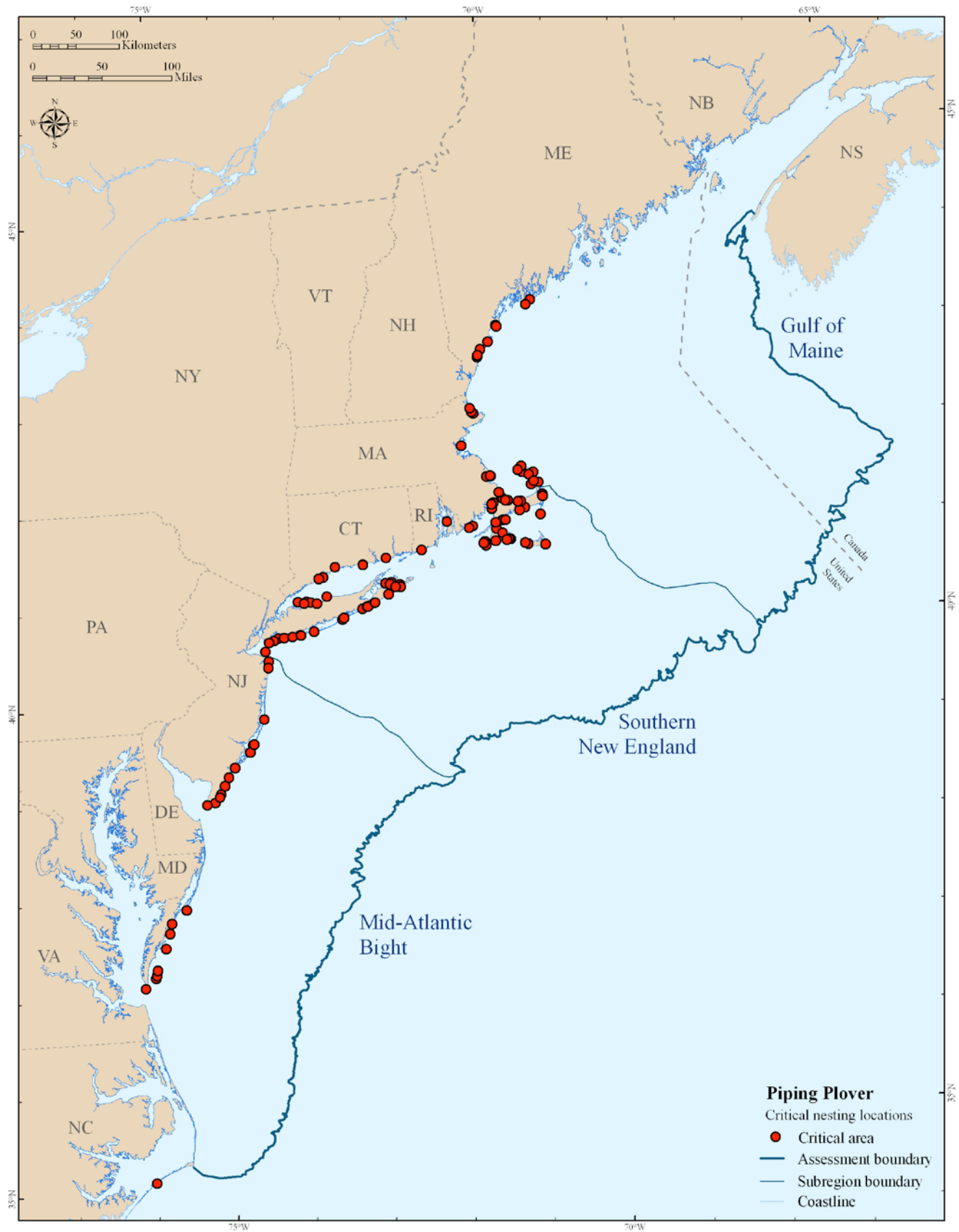


Figure 12-9. Critical nesting locations for Piping Plover.

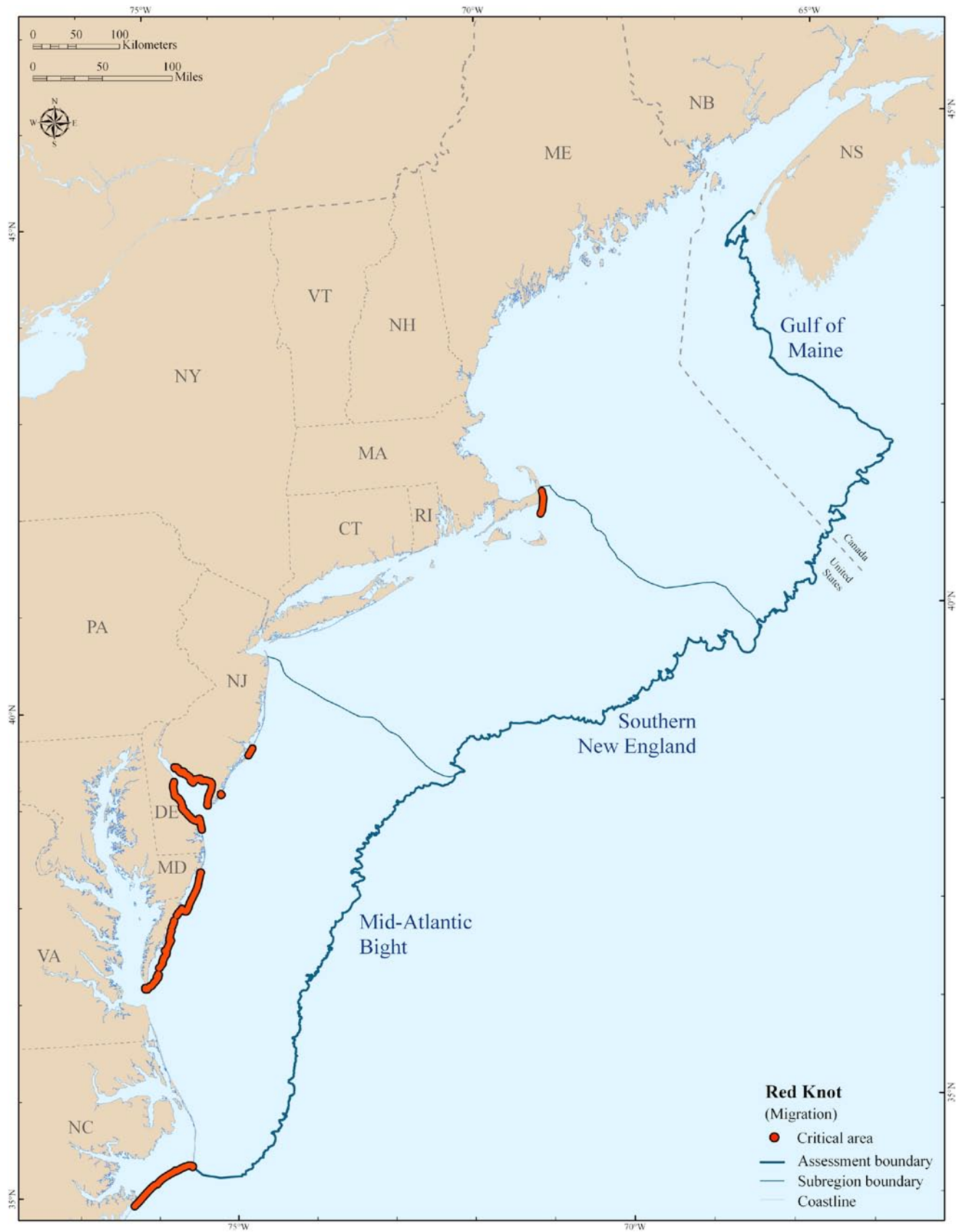


Figure 12-10. Critical migration stopover areas for Red Knot.

Most of the habitat used by these species is dynamic, shifting in distribution over space and time as currents and storms continually shape coastal areas. Activities such as dredging, jetty building, bulkheading, and beach replenishment all have the potential to alter the quality and extent of habitat available to these species by interrupting natural habitat dynamics. Human activities can also directly disturb habitat. For example, in stopover areas for Semipalmated Sandpiper in the Bay of Fundy, commercial bait harvesting can degrade feeding habitat and foraging efficiency of these birds (Shepherd and Boates 1999).

For species using offshore areas, such as Harlequin Duck and Razorbill, little is known about how human activities may indirectly affect their populations within the Northwest Atlantic region, although it had been documented that Razorbills experience mortality via fisheries bycatch (Murray et al. 1994, Piatt and Nettleship 1987). Because habitat requirements for benthic feeding species are also poorly known, the effect of human activities such as bottom dredging or sand extraction is unclear.

Management and Conservation

Regulatory Authorities

The primary regulatory agency for birds in the United States is the USFWS. In Canada, it is the CWS. In addition, state and province-based natural resource agencies have trustee responsibilities for birds.

Current Conservation Efforts

Current conservation activities for Roseate Terns, Least Terns, Arctic Terns, and Piping Plovers are coordinated by the USFWS and CWS with state and conservation non-profit partners. The conservation actions geared towards these species are primarily aimed at protection and management of nesting sites. Efforts for Roseate Terns (and, to a lesser extent, Arctic Terns) include vigorous nesting colony management, including predator and competitor removal. On some islands, gull control is important to Roseate Tern colony viability. For Least Terns and Piping Plovers, efforts to reduce the impact of domestic and wild predators and to reduce human disturbances to nesting and foraging areas, especially at beaches that are popular

recreation areas, are particularly important. Actions at many beaches across the region include the installation of symbolic fencing to discourage human beachgoers from



entering Plover and Tern nesting areas, installation of predator exclosures around Plover nests, and outreach to beachgoers to reduce direct human disturbance of foraging plovers.

Managing beach use at key stopover feeding areas is also a part of Red Knot conservation. Docents, symbolic fencing, and informational signage are used in the effort to educate the public and discourage beach use at critical feeding areas along the shores of Delaware Bay during the several weeks when red knots pass through the Northwest Atlantic region on migration routes. Another key management effort to ensure high-quality stopover feeding areas for this species is regional management of the horseshoe crab harvest. The states have different approaches to managing harvests, but overall harvest has been greatly reduced over the past ten years specifically to increase the amount of horseshoe crab spawning on Delaware Bay beaches. On these beaches, competition with gulls for

horseshoe crab eggs is suggested to be another limiting factor for red knots and, as a result, efforts are under way to develop a way to exclude gulls from key feeding areas as horseshoe crab stocks rebuild.

Thus far, there is little direct management of Audubon's Shearwater and Razorbill in American and Canadian waters. The state of Maine has undertaken efforts to inform hunters about areas frequented by Barrow's Goldeneye in order to avoid accidental hunting mortality caused by hunters mistaking Barrow's Goldeneye with Common Goldeneye (which can be hunted legally).

Species Accounts

Arctic Tern (*Sterna paradisaea*)

The Arctic Tern has a circumpolar Arctic breeding distribution (Hatch 2002). Within the Northwest Atlantic region, nesting occurs along the coast of Maine. Arctic terns that breed within this region migrate south over the Atlantic Ocean to wintering grounds in Antarctica, and then migrate back north in the spring along the same route.

Arctic Terns arrive in the Northwest Atlantic region in April and May (Hawksley 1953). Nesting occurs primarily on rocky, gravelly, or sandy substrate on small offshore or barrier islands in Maine. Most eggs are laid from mid-May

through mid-June, and begin hatching in the first half of June and continue through mid-July. After fledging, young birds feed near the colony for about ten days before dispersing and initiating migration. During the breeding season, the adults are generally found foraging within 20 km of their colonies.

Migration to non-breeding grounds in Antarctica is probably accomplished by tremendous flights broken up by stops at four to five feeding areas, though the true number and location of these feeding areas is unknown (Hatch 2002). It is likely that Arctic Terns do not feed in waters near the equator. These flights are primarily oceanic, but birds from the region may fly east to Europe and move southward along the coast of Africa towards Antarctica. After arrival in Antarctica in the northern hemisphere's mid- to late autumn, Arctic Terns forage around Antarctica, often completely circumnavigating the continent during the nonbreeding season. They then begin the northern migration back to the Arctic in March.

Roseate Tern (*Sterna dougallii*)

Roseate Terns primarily breed in the tropics in the Caribbean, western Atlantic, western Indian Ocean, and a variety of sites in the western Pacific (Gochfeld et al. 1998). However, the Terns also breed in a few temperate zones along the eastern coast of North America, the western coast of Europe, and the southern coast of Japan.

Roseate Terns arrive in the Northwest Atlantic region in April and early May (Shealer and Kress 1994). They nest on rocky or sandy substrate on small offshore or barrier islands, in this region primarily on two islands along the coasts of Long Island and Massachusetts, with a small number of nesting sites in Maine. Within the Northwest Atlantic region, all Roseate Terns nest within much larger Common Tern nesting colonies. Most eggs are laid from mid-May through mid-June, but can be laid as late as early July. Eggs begin hatching in the first half of June and continue through mid-July. After fledging, many Roseate Terns stage at Stratton Island and Saco Bay in southern



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Maine and Monomoy Island National Wildlife Refuge in Massachusetts for up to three weeks before initiating their southern migration.

Roseate Terns are thought to migrate south during July and August from the breeding areas along the northeastern United States and Canada to the Caribbean and then to Brazil (Kirkham 1988). The winter range is poorly understood, but they have been found in significant numbers near Bahia, Brazil. In spring, their northern migration is likely oceanic since they are rarely seen from land until they arrive in the northeastern United States.

Harlequin Duck (*Histrionicus histrionicus*)

Harlequin Ducks breed from Iceland west to eastern Siberia (Robertson and Goudie 1999). Within North America, there are two distinct breeding populations: an eastern population that breeds from Labrador south to Newfoundland and a western population that breeds from Wyoming north through Alaska and western Canada



(Robertson and Goudie 1999). There are no breeding harlequin ducks within the Northwest Atlantic region. However, most of the eastern North American breeding population (thought to be somewhat less than 1,500 individuals) winters in the region along the coasts of Nova Scotia and New Brunswick south to New Jersey (Vickery 1988, Mittelhauser 2002).

Harlequin Ducks build nests along fast-moving white-water rivers and streams in May and June. Most eggs hatch in late June and July. After breeding, from July through October, the ducks gather in larger groups before migration to the coast. No harlequin ducks have ever been observed migrating, so it is unknown whether they fly directly from breeding to wintering areas (the most likely scenario, as they have not been sighted migrating) or stop over at points in between. Harlequins winter along rocky coastlines in shallow marine waters. Birds can be observed on wintering grounds as early as September, but the largest numbers arrive in October and November.

Audubon's Shearwater (*Puffinus lherminieri*)

There are no breeding Audubon's Shearwaters within the Northwest Atlantic region. Within this region, the largest concentration of this species is found offshore of Cape Hatteras, North Carolina in the fall.

Audubon's Shearwaters initiate courtship in late November and begin egg-laying in January-May in the Bahamas (approximately 60% of the breeding population), Cayo del Agua, and the Lesser Antilles from the Virgin Islands to north of Tobago (Lee 2000). Breeding activity is nocturnal. Most of their nests are found in burrows, on cliffs, or under boulders on rocky open ground.

After breeding in spring to early summer in the Caribbean, most Audubon's Shearwaters follow the Gulf Stream north off the southeastern coast of the United States. Approximately 50-75% of the species' population can be found during the summer and early fall in a major foraging concentration area near Cape Hatteras, North Carolina (Lee and Socci 1989). Here they occur "along [the] inner edge of the Gulf Stream or over waters 50 to 500 fathoms deep" (Lee 1995). They can be found within the Gulf Stream as far north as Massachusetts in late summer.

Red Knot (*Calidris canutus rufa*)

The Red Knot is a western hemispheric subspecies of a globally distributed migratory shorebird (Harrington 2001). The five subspecies of red knot have varied distributions and migration strategies but only the *rufa* subspecies occurs within the Northwest Atlantic. This subspecies spends its breeding season in the Arctic tundra of North America and its non-breeding season in coastal areas at the southern tip of South America. Between these two areas, numerous stopover sites, including Delaware Bay and the barrier islands of Virginia, are important for refueling during migration.

Red Knots arrive on breeding grounds from late May to early June. While they breed on the tundra, knots spend most of migration and nonbreeding periods in marine intertidal areas where they primarily feed on small mollusks in sandy area, mudflats, and peat banks. In addition, in the Delaware Bay, they feed heavily on eggs deposited by horseshoe crab on sandy beaches during northward spring migration (Harrington 2001).

Southward migration from the Arctic begins by mid-July and knots are again seen within the Northwest Atlantic during this time. They begin arriving at stopover areas in South America in the Guianas and northern Brazil by mid-August and spend the rest of the boreal winter in southern Argentina and Tierra del Fuego (Harrington 2001). Return migration begins along the coast of South America from February through early April and birds arrive on the Delaware Bayshore from mid-April through early June.

Least Tern (*Sternula antillarum*)

The Least Tern has an extensive breeding range in coastal areas throughout the United States, Central America, the Caribbean, and northern South America as well as along large river systems in the United States (Thompson et al. 1997). Within this broad range, the Tern breeds colonially on sandy beaches free of vegetation. Little is known about movements of Least Terns during the non-breeding season, but Terns leave breeding areas of the United States, northern Mexico and the Caribbean and spend

the non-breeding season in Central and South America (Thompson et al. 1997).

The breeding season begins in April to May, depending on the location. Breeding pairs are monogamous and participate in courtship rituals. Nests consisting of simple scrapes in the sand house clutches of two to three eggs. Upon hatching, young need to be fed by adults until fledging (20 days) and up to several weeks beyond fledging, even after they have dispersed from the breeding colony.



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Migration timing and destinations are poorly known, although marked birds breeding in coastal Massachusetts migrated to northern South America for the non-breeding season (Thompson et al. 1997).

Piping Plover (*Charadrius melodus*)

The Piping Plover is a shorebird that breeds throughout the Northwest Atlantic area on beaches from North Carolina north to eastern Canada (Elliot-Smith and Haig 2004). There is also an inland population that breeds along rivers and in wetlands throughout the northern Great Plains of the U.S. and Canada. These separate breeding populations may receive subspecific designation in the future based on evidence that there is little mixing of individuals between the two populations. During the non-breeding season, individuals occur along the coasts of the southeastern United States and the Gulf Coasts of the United States and Mexico during the non-breeding season.

On breeding areas, arrival varies from mid-March at southern latitudes to early May at the northernmost parts of the range. Pairs are monogamous and courtship proceeds with males establishing territories and creating nest scrapes in the sand. Nest initiation begins after pair formation from early May to early June. The incubation period is approximately 30 days. Newly hatched young can forage independently but are attended by parents for an additional 30 days until they fledge. Post breeding behavior, migration timing, and important stopover sites of piping plover are poorly known but they depart their breeding grounds by mid-August. They begin arriving at non-breeding areas in August and arrivals can continue into November.

Razorbill (*Alca torda*)

This husky member of the Alcidae is a colonial breeder that forms colonies in the low Arctic on rocky coastlines and islands from eastern North America east to northwest Russia (Hipfner 2002). The greatest concentration of breeding Razorbills is in Iceland. A small fraction of the world's population breeds in North America in Maine, Nova Scotia, and Newfoundland. Important nonbreeding sites for North American populations are the Gulf of Maine, Bay of Fundy, and Georges Bank.

Razorbills, like many seabirds, are long-lived, maintain long-term breeding pair bonds, and are faithful to nest site locations. Age at first breeding is also late, at four to five years (Hipfner 2002). Egg laying ranges from late May to early June depending on the colony location, and laying timing within colonies tends to be synchronous. Females lay just one egg in nests that are primarily built in or near rock crevices on cliffs. Upon hatching, young remain at the nest site for approximately 20 days. Although not fully developed, they leave the nest site and move out to sea where they are still attended and fed by parents. Young are able to feed independently roughly one month after nest departure. Post breeding movements, juvenile dispersal and general non-breeding ecology are poorly known in this species (Hipfner 2002).

Barrow's Goldeneye (*Bucephala islandica*)

This cavity nesting duck has a known breeding distribution centered in two discrete areas: montane (subalpine highland) regions of western Canada and Alaska and a more recently discovered area of southeastern Quebec (Eadie et al. 2000). This latter population uses the Northwest Atlantic region during the non-breeding season. The nonbreeding range encompasses much of the northern coastlines of eastern and western North America as well as inland lake areas.



During the breeding season Barrow's Goldeneyes establish territories centered on lakes and ponds. Pairs are known to maintain bonds between years and are site faithful. Nesting extends from late April through early June depending on the location. Cavities in live or dead trees are used, and females remain faithful to nest cavities between years. The male generally only maintains the breeding territory up until incubation. It then leaves the territory and joins post-breeding congregations of other males. Upon hatching, ducklings are able to feed themselves and are led from the nest to a nearby body of water. Cohesion of the group gradually breaks down and young become able to fly at approximately five weeks of age. Post-breeding movements are poorly known, but birds appear to remain inland until freezing occurs which prompts movement to coastal areas. Non-breeding distribution is limited to specific benthic habitats associated with preferred food items, such as mussels (Eadie et al. 2000).

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